Endangered Species Act – Section 7 Consultation

Programmatic Biological Opinion for Aquatic Restoration Activities in the States of Oregon, Washington and portions of California, Idaho and Nevada (ARBO II)

[FWS *reference*: 01EOFW00-2013-F-0090].

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

for Paul Henson, Ph.D., State Supervisor

JUL 1 2013

Date

Federal Action Agencies: USDA Forest Service
USDI Bureau of Land Management
USDI Bureau of Indian Affairs

Affected Species and Determinations:

ESA-listed Species	**ESA Status**	**Is the action likely to adversely affect this species or its critical habitat?**		**Is the Action likely to jeopardize this species?**	**Is the action likely to destroy or adversely modify critical habitat for this species?**
		Spp.	**CH**		
Bull Trout *(Salvelinus confluentus)*	T	Yes	Yes	No	No
Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)	T	Yes	N/A	No	No
Borax Lake Chub (*Gila boraxobius)*	E	No	No	No	No
Lost River Sucker *(Deltistes luxatus)*	E	Yes	Yes	No	No
Modoc Sucker (*Catostomus microps*)	E	Yes	N/A	No	No
Shortnose Sucker *(Chasmistes brevirostris)*	E	Yes	Yes	No	No
Warner Sucker (*Catostomus warnerensis*)	T	Yes	Yes	No	No
Oregon Chub (*Oregonichthys crameri*)	E	Yes	Yes	No	No
Foskett Speckled Dace (*Rhinichthys osculus*)	T	Yes	N/A	No	No
Marbled Murrelet *(Brachyramphus marmoratus)*	T	Yes	No	No	No
Northern Spotted Owl *(Strix occidentalis caurina)*	T	Yes	No	No	No
Canada Lynx (*Lynx canadensis*)	T	No	No	No	No
Gray Wolf *(Canis lupus)*	E	No	N/A	No	No
Grizzly Bear *(Ursus arctos horribilis)*	T	No	N/A	No	No
Woodland Caribou *(Rangifer tarandus caribou)*	E	No	No	No	No
Howell's spectacular thelypody *(Thelypodium howellii ssp. spectabilis)*	E	No	N/A	No	No
MacFarlane's Four-O'clock (*Mirabilis macfarlanei*)	T	No	N/A	No	No
Spalding's Catchfly *(Silene spaldingii)*	T	No	N/A	No	No
Ute Ladies'- Tresses *(Spiranthes diluvialis)*	T	No	N/A	No	N/A
Water Howellia (*Howellia aquatilis*)	T	No	N/A	No	No
Wenatchee Mountains Checker-Mallow (*Sidalcea oregana* var. *calva*)	E	No	N/A	No	N/A
Rough Popcornflower (*Plagiobothrys hirtus*)	T	No	N/A	No	N/A
Macdonald's Rockcress *(Arabis mcdonaldiana Eastwood)*	E	No	N/A	No	N/A
Gentner's fritillary (*Fritillaria gentneri*)	E	No	N/A	No	
Nelson's checkermallow (*Sidalcea nelsoniana*)	T	No	N/A	No	N/A
Western lily (*Lilium occidentale*)	E	No	N/A	No	N/A
Willamette Valley Daisy (*Erigeron decumbens var. decumbens*)	E	No	No	No	N/A
Bradshaw's lomatium (*Lomatium bradshawii*)	E	No	N/A	No	N/A
Cook's Lomatium (*Lomatium cookii)*	E	No	No	No	N/A
Large-flowered Woolly Meadowfoam (*Limnanthes floccosa ssp. grandiflora*)	E	No	No	No	N/A
Applegate's Milk-vetch (*Astragalus applegatei)*	E	No	No	No	N/A
Malheur Wire-lettuce (*Stephanomeria malheurensis)*	E	No	No	No	No
Golden paintbrush (*Castilleja levisecta*)	E	No	N/A	No	N/A
Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*)	T	No	No	No	No
Fender's Blue Butterfly *(Icaricia icarioides fender)*	E	No	No	No	No

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LIST OF COMMON ACRONYMS

ARBO	aquatic restoration biological opinion
BA	aquatic restoration biological assessment II
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CM	conservation measure
CFR	Code of Federal Regulations
DBH	diameter at breast height
DPS	distinct population segment
ELJ	engineered logjams
EFH	Essential Fish Habitat
ESA	Endangered Species Act
EPA	U.S. Environmental Protection Agency
FR	Federal Register
HUC	Hydraulic Unit Code
HWM	high water mark
IRU	Interim Recovery Unit
LW	large wood
NMFS	National Marine Fisheries Service
NRF	nesting, roosting or foraging
ODFW	Oregon Department of Fish and Wildlife
PCE	primary constituent element
PDC	project design criteria
POEA	polyethoxylated tallow amine
RHCA	riparian habitat conservation areas
RPM	Reasonable and Prudent Measures
RRT	regional review team
T&C	Terms and Conditions
TRT	Technical Review Team
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into sections 2 and 3 below.

1.1 Background

This document transmits the U.S. Fish and Wildlife Service's (Service or USFWS) biological opinion (BO) based on our review of the biological assessment (BA) entitled Fish Habitat Restoration Activities Affecting ESA-listed Animal and Plant Species and their Designated Critical Habitat found in Oregon, Washington and parts of California, Idaho and Nevada, which was submitted by the U.S. Forest Service (USFS), Bureau of Land Management (BLM), and Bureau of Indian Affairs (BIA). This document was prepared in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.). The request for formal consultation, signed by all administrative units, was received by USFWS on January 29, 2013.

This BO is based on the following major sources of information: The January 23, 2013 BA; Forest Ecosystem Management: an Ecological, Economic, and Social Assessment (FEMAT) (Thomas and Raphael 1993); the Northwest Forest Plan (NWFP) (USDA and USDI 1994a); the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA and USDI 1994b) (FSEIS); Matrix of Pathways and Indicators (USFWS 1999); PACFISH (USDA and USDI 1995a); INFISH (USDA and USDI 1995b); Status and Trends in Demography of Northern Spotted Owls, 1985-2003 (Anthony et al. 2006, Forsman 2011); Scientific Evaluation of the Status of the Northern Spotted Owl (Courtney et al. 2004); Recovery Plan for the Northern Spotted Owl (USFWS 2011b); Memorandum to Regional Directors re- Solicitor's Review of the Arizona Cattle Growers Association Case. 9pp. (USFWS 2002a); Memorandum to Regional Directors re- Application of the "Destruction or Adverse Modification" Standard under Section 7(a)(2) of the Endangered Species Act (USFWS 2004a); Numerous Federal listings and critical habitat (CH) designations contained within the Federal Register (FR), scientific literature (as cited), our files; and communications between the various administrative units and Service staff.

1.2 Consultation History

In June, 2007, the USFWS issued the Aquatic Restoration Biological Opinion (ARBO) to the USFS, BLM, and BIA (collectively referred to as the Action Agencies hereafter) on the effects of funding or carrying out aquatic restoration activities in Oregon and Washington until the end of calendar year 2012 . The Coquille Indian Tribe, which is the only Tribal signatory to the Northwest Forest Plan, is represented by the BIA under the 2007 ARBO and proposed programmatic consultations.

On January 28, 2013, the Action Agencies submitted a BA (USDA-Forest Service et al. 2013) and determined that a similar programmatic action with additional categories of activities, as proposed, would be likely to adversely affect 11 species listed under the ESA and the critical habitat of four of those species (Table 1). The action agencies determined that the proposed action is not likely to adversely affect 24 species or their critical habitat (if designated). If the Action Agencies determined that species would not be affected by the proposed action (No Effect) those species are not considered in this BO. Due to workload priorities, the USFWS informed the Action Agencies that a final BO could not be rendered until June of 2013, and issued a letter extending ARBO through June 30, 2013, or the issuance of ARBO-II, whichever came first.

Table 1**.** Listing status, status of critical habitat designations and relevant Federal Register (FR) decision notices for ESA-listed species considered in this opinion. Listing status: 'T' means listed as threatened; 'E' means listed as endangered.

Species	**Listing Status**	**Critical Habitat**
Bull trout *(Salvelinus confluentus)*	T, 6/10/1998, 63 FR 31647	10/18/2010 , 75 FR 63898
Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)	T, 7/16/1975, 40 FR 29863	N/A
Borax Lake chub (*Gila boraxobius)*	E, 05/28/1980, 45 FR 35821	10/5/1982, 47 FR 43957
Lost River sucker *(Deltistes luxatus)*	E, 07/18/1988, 53 FR 27130	12/11/2012, 77 FR 73740
Modoc sucker (*Catostomus microps*)	E, 06/11/1985, 50 FR 24526	6/11/1985, 50 FR 24526
Shortnose sucker *(Chasmistes brevirostris)*	E, 7/18/1988, 53 FR 27130	12/11/2012, 77 FR 73740
Warner sucker (*Catostomus warnerensis*)	T, 09/27/1985, 50 FR 39117	9/27/1985, 50 FR 39117
Oregon Chub (*Oregonichthys crameri*)	T, 05/24/2010 75 FR 21179	3/10/2010, 75 FR 11010
Foskett speckled dace (*Rhinichthys osculus*)	T, 3/28/1985, 50 FR 12302,	N/A
Marbled murrelet *(Brachyramphus marmoratus)*	T, 10/01/1992, 57 FR 45328	10/5/2011, 76 FR 61599
Northern spotted owl *(Strix occidentalis caurina)*	T, 6/26/1990; 55 FR 26114	12/4/2012, 77 FR 71876
Canada lynx (*Lynx canadensis*)	T, 3/24/2000, 65 FR 16053	2/25/2009, 74 FR 8116
Gray wolf *(Canis lupus)*	E, 5/5/2011 66 FR51597	N/A
Grizzly bear *(Ursus arctos horribilis)*	T, 07/28/1975, 40 FR 31734	N/A
Woodland caribou *(Rangifer tarandus caribou)*	E, 02/29/1984, 49 FR 7390	11/28/2012, 77 FR 71042
Howell's spectacular thelypody *(Thelypodium howellii ssp. spectabilis)*	T, 05/26/1999, 64 FR 28393	N/A
MacFarlane's four-o'clock (*Mirabilis macfarlanei*)	T, 03/15/1996, 61 FR 10693	N/A
Spalding's catchfly *(Silene spaldingii)*	T, 10/10/2001 66 FR 51597	N/A
Ute ladies'- tresses *(Spiranthes diluvialis)*	T, 01/17/1992 57 FR 2048	N/A
Water howellia (*Howellia aquatilis*)	T, 07/14/1994 59 FR 35860	N/A
Wenatchee mountains checker-mallow (*Sidalcea oregana* var. *calva*)	E, 12/22/1999, 64 FR 71680	9/06/2001, 66 FR 46536
Rough popcornflower (*Plagiobothrys hirtus*)	E, 1/25/2000 65 FR 3866	N/A
Macdonald's rockcress *(Arabis mcdonaldiana Eastwood)*	E, 9/28/1978, 43 FR 44810.	N/A
Gentner's fritillary (*Fritillaria gentneri*)	E, 12/10/1999 64 FR 69195	N/A
Nelson's checkermallow (*Sidalcea nelsoniana*)	T, 2/12/1993 58 FR 8235	N/A
Western lily (*Lilium occidentale*)	E, 9/16/1994, 59 FR 42171	N/A
Willamette Valley daisy (*Erigeron decumbens var. decumbens*)	E, 01/25/2000, 65 FR 3875	10/31/2006, 71 FR 63862
Bradshaw's lomatium (*Lomatium bradshawii*)	E, 09/30/1988, 53 FR 38448	N/A
Cook's lomatium (*Lomatium cookii)*	E, 11/07/2002 67 FR 68004	7/21/2010, 75 FR 42490
Large-flowered woolly meadowfoam (*Limnanthes floccosa ssp. grandiflora*)	E, 11/07/2002 67 FR 68004	7/21/2010, 75 FR 42490

Species	Listing Status	Critical Habitat
Applegate's milk-vetch (*Astragalus applegatei)*	E, 07/28/1993 58 FR 40547	N/A
Malheur wire-lettuce (*Stephanomeria malheurensis)*	E, 11/10/1982 47 FR 50881	11/10/1982, 47 FR 50881
Golden paintbrush (*Castilleja levisecta*)	T, 06/11/1997 62 FR 31740	N/A
Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*)	T, 01/25/2000 65 FR 3875	10/31/2006, 71 FR 63862
Fender's blue butterfly *(Icaricia icarioides fender)*	E, 01/25/2000 65 FR 3875	10/31/2006, 71 FR 63862

For the period 2008-2012, the Action Agencies carried out 171 in-channel restoration projects (245 stream miles treated), 100 fish passage projects (202 stream miles of fish passage restored), 71 road treatment projects (320 road miles treated), and 22 vegetation projects (31,097 acres treated) (Table 3) under the ARBO consultation within the range of the species listed in Table 1.

Table 2. Total aquatic restoration biological opinion (ARBO all areas and species) actions per year, 2008 to 2011.

Year	In-channel Projects[1]		Fish Passage Projects[2]		Estuary Projects		Roads Treated		Vegetation Treated	
	# projects	miles treated	# projects	miles opened	# projects	acres treated	# projects	miles treated	# projects	acres treated
2008	52	104	31	62	0	0	13	28	26	1,525
2009	75	126	22	29	2	62	13	23	12	5,751
2010	102	121	59	107	0	0	32	277	25	680
2011	94	132	56	44	1	50	19	172	6	12,092
Totals	323	483	168	242	3	112	77	500	69	20,048

[1] In-channel Projects include large wood, boulder, and gravel placement; reconnection of side channels and alcoves, head-cut stabilization and associated fish passage, irrigation screen installation and replacement, reduction of recreation impacts, removal of legacy structures, and in-channel nutrient enhancement.
[2] Fish Passage Projects include culvert and bridge replacements or removals.

Table 3. ARBO accomplishments by IRU or basin for 2008 to 2012.[3]

IRU or Basin	In-channel Projects		Fish Passage Projects				Estuary Projects				Roads Treated		Vegetation Treated	
	# projects	miles treated	# projects	miles opened[3]	fish handled[4]	fish mortality	# projects	acres treated	fish handled	fish mortality	# projects	miles treated	# projects	acres treated
Columbia River	153	228	90	148	NA	6[4]	NA	NA	NA	NA	52	267	20	31,010
Coastal Puget Sound	9	12	3	2	0	0	0	0	0	0	18	52	1	10
Klamath River	9	5	5	47	1SnSucker 1MSucker	1bt	NA	NA	NA	NA	1	1	0	0
Warner Basin	0	0	2	5	0	0	NA	NA	NA	NA	0	0	1	77
Southeast Oregon Basins	0	0	0	0	0	0	NA	NA	NA	NA	0	0	0	0
Totals	171	245	100	202	NA	7	NA	NA	34	34	71	320	22	31,097

[3] Accomplishment numbers for IRU are close approximates
[4] Species of fish handled or killed was not reported.

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.

For purposes of this consultation, the proposed action is to fund or carry out 20 categories of restoration actions on USFS and BLM lands administered by offices in Oregon and Washington, which includes lands in Oregon, Washington, Idaho, Nevada and California, and the Coquille Indian Reservation in Oregon[5] and on private lands where they help achieve Forest Service or BLM aquatic restoration goals.[6] Non-Federal land projects must follow all elements of the proposed action described in this opinion for aquatic restoration. The Action Agencies will ensure that actions covered under this programmatic on non-federal land undergo the same process and compliance as projects occurring on Action Agency land. The Action Agencies shall retain discretion over the private land action to ameliorate any unexpected adverse effects during and after project implementation.

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)
2. Large Wood (LW), Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Vanes, Gravel Augmentation; Tree Removal for LW Projects)
3. Dam, Tide gate, and Legacy Structure Removal
4. Channel Reconstruction/Relocation
5. Off- and Side-Channel Habitat Restoration
6. Streambank Restoration
7. Set-back or Removal of Existing Berms, Dikes, and Levees
8. Reduction/Relocation of Recreation Impacts
9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering

[5] Also includes lands within 1 mile of Federal land when projects occur within the range of the spotted owl and marbled murrelet.

[6] The authority for restoring lands administered by the USFS, BLM and BIA derives from many laws enacted by Congress and Presidential executive orders (E.O.s) whose objectives include reestablishment and retention of ecological resilience on those lands to achieve sustainable management and provide a broad range of ecosystem services. Those statutes and E.Os include the Organic Administration Act, Weeks Law, Knutson-Vandenberg Act, Anderson-Mansfield Reforestation and Revegetation Joint Resolution Act, Granger-Thye Act, Surface Resources Act, Sikes Act, Multiple-Use Sustained-Yield Act, Wilderness Act, Wild and Scenic Rivers Act, National Environmental Policy Act, Endangered Species Act, Forest and Rangeland Renewable Resources Planning Act, National Forest Management Act, Clean Water Act, Clean Air Act, North American Wetland Conservation Act, Healthy Forests Restoration Act, Stewardship End Result Contracting Projects Guidance (i.e., Omnibus Appropriations Bill of 2003, section 323), Tribal Forest Protection Act, E.O. 11514 as amended by E.O. 11991 (Protection and enhancement of environmental quality); E.O. 11644 (Use of off-road vehicles on the public lands, amended by E.O. 11989 and E.O. 12608), E.O. 11988 Floodplain management), E.O. 11990 (Protection of wetlands); and E.O. 13112 (Invasive Species).

10. Piling and other Structure Removal
11. In-channel Nutrient Enhancement
12. Road and Trail Erosion Control and Decommissioning
13. Non-native Invasive Plant Control
14. Juniper Removal
15. Riparian Vegetation Treatment (controlled burning)
16. Riparian Vegetative Planting
17. Bull Trout Protection
18. Beaver Habitat Restoration
19. Sudden Oak Death (SOD) Treatments
20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration

1.3.1 Program Administration

1. **Integration of Project Design Criteria (PDC) and Conservation Measures and Terms and Conditions into Project Design and Contract Language –** The Action Agencies shall incorporate appropriate aquatic and terrestrial conservation measures along with PDC listed in the aquatic restoration BA along with any terms and conditions included in the subsequent ARBO II into contract language or all appropriate implementation plans.

2. **Restoration Review Team (RRT) –** The RRT will be comprised of highly skilled interagency (BLM, USFS, BIA, NMFS, USFWS) fisheries biologists, hydrologists, geomorphologists, soil scientists, or engineers to review and help select project designs. The RRT composition will be composed of a four member core group—one individual from each of the following agencies: USFS, BLM, NMFS, and USFWS. The designated USFS and BLM ARBO II contacts will serve as core group members. Additional technical experts from these agencies will be recruited depending on the project to be reviewed.

   The reviews will help ensure that projects 1) meet the obligations set forth in the BA and subsequent ARBO II; 2) are consistent with similar projects; 3) maximize ecological benefits of restoration and recovery projects; and 4) ensure consistent use and implementation throughout the geographic area covered by this opinion. Any RRT concerns must be described in detail, referencing underlying scientific (based on peer-reviewed science) or policy rationale, and include recommended changes to the proposed project to address the specific concerns. When requested (see Appendix B), RRT will provide an estimate of the time necessary to complete the review based on the complexity of the proposed action and work load considerations at the time of the request. Approval may be delayed if a substandard design is submitted for review during the post-design or action implementation stage and significant revision is necessary.[7] Project types that require RRT review include the following:

[7] USFWS completed the effects analysis for this opinion based on the actions as described in this section, with the application of all relevant general and activity-specific conservation measures and PDC, and on our review of the

a. Dam removal
b. Channel Reconstruction/Relocation projects
c. Precedent or policy setting actions, such as the application of new technology

The RRT will keep a record of the RRT clarifications, changes, and interpretations. The RRT does not replace any existing review process, nor shall it slow down project implementation unless significant technical, policy, or program concerns with a particular restoration approach are identified.

3. **Project Notification** – Streamlining Level 1 teams will review and discuss aquatic restoration projects planned for implementation during an upcoming work season through their team-specific processes. The Action Agencies shall provide a project Notification Form to ARBO.nwr@noaa.gov, arbo@fws.gov and Level 1 Aquatics Team members 30 days prior to implementation and will include the following information:

a. Action identifier – The same unique identification number is necessary for each project's Action Notification and Project Completion reports.
b. Project Name – Use the same project name from notification to completion (i.e., Jones Creek, Tillamook Co. OR, culvert replacement).
c. Location – 6th field HUC (hydraulic unit code), stream name, and latitude and longitude (decimal degrees)
d. Agency Contact – Agency and project lead name
e. Timing – Project start and end dates
f. Activity Category – As listed above in section 1.3. Project Description – Brief narrative of the project and objectives
g. Extent – Number of stream miles or acres to be treated
h. Species Affected – ESA-listed fish and or Wildlife species, Critical Habitat, and or EFH affected by project
i. Date of Submittal
j. For any action requiring a site assessment for contaminants, include a copy of the report explaining the likelihood that contaminants are present at the site.
k. For any action requiring NMFS fish passage and RRT reviews, attach a copy of the approval correspondence.
l. Verification – Check box that verifies that all appropriate General Aquatic Conservation Measures, Wildlife Conservation Measures, Project Design Criteria for Aquatic Restoration Activity Categories, and Project Design Criteria for Terrestrial Species and Habitats have been thoroughly reviewed and will be incorporated into project design, implementation, and monitoring.
m. SOD project notification requirements (see PDC 39h-i)[8]
n. The Level 1Team may require further documentation as they desire (photographs, more detailed specialist reports). Individual Level 1 Teams may opt to send email

best available scientific information, and our past experience with similar types of actions. We did not assume the RRT review process would result in a further reduction of the short-term adverse effects of any particular project.

[8] While the USFWS will analyze this category for probable effects to aquatic organisms, this category will not be analyzed for effects to spotted owls and murrelets. Any activities conducted within the range of these species will require separate consultation with USFWS.

notification once all pre-project notifications have been reviewed for consistency with the BO if desired, or simply memorialize the review of pre-project notifications through Level 1 Team meeting notes. Individual Level 1 Team requirements should be determined in cooperation with the team members.

4. **Minor Variance Process –** Because of the wide range of proposed activities and the natural variability within and between stream systems, some projects may be appropriate for minor variations from criteria specified herein. USFWS Division or Field Office Supervisors will authorize variances when there is a clear conservation benefit or there are no additional adverse effects (especially harm to listed species) beyond that covered by the ARBO II. Minor variances may be requested as part of the above notification process and must:

a. Cite ARBO II 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 why the variance will either provide a conservation benefit or, at a minimum, not cause additional adverse effects
f. Include as attachments any necessary approvals by state agencies

5. **Project Completion Report –** Level 1 teams will discuss and review aquatic restoration projects completed during a previous season. Each BLM, USFS, or BIA field office that completes a project will submit a project completion report to ARBO.nwr@noaa.gov , arbo@fws.gov and their USFWS and NMFS Level 1 Team counterparts. Reports are due 60 days after project completion. Reports will include the following information:

a. Action identifier (same number as in notification)
b. Action name (same name as in notification)
c. Location – 6th field HUC, stream name, latitude and longitude
d. Agency Contact – Agency and project lead name
e. Timing – Actual project start and end dates
f. Activity Category – As listed above in section 1.3
g. Project Description – Brief narrative of the completed project and objectives
h. Extent – Number of stream miles or acres treated
i. Species effected – Fish and or wildlife species, critical habitat, or EFH affected by the project
j. Fish Pursuit and Capture – If fish are pursued or captured during salvage operations, the project biologist will describe removal methods, stream conditions, and the number of fish handled, injured, or killed, and reasons for the fish mortality. This report will likely be limited to fish passage, dam removal, and channel restoration/relocation projects.
k. State-specific 401 Certification monitoring results. If protocol conditions were not met, describe effects and any remedial actions.
l. Post Project Assessment – Remedial actions taken, including any dates work ceased due to high flows
m. Date of Submittal
n. SOD project completion requirements (see PDC 39h-ii; Table 6)

6. **Annual Program Report –** The BLM Oregon State Office, USFS Region 6 Office, and BIA will provide an annual program report to NMFS and USFWS by February 15 of each year that describes BLM, USFS, and BIA projects implemented under ARBO II. The report will include the following information:
    a. An assessment of overall program activity
    b. A map showing the location and category of each action carried out under ARBO II
    c. A list of any actions which BLM, USFS, and BIA funded or carried out using the ARBO II and any actions for which BLM, USFS, and BIA was designated as the lead agency for ESA purposes
    d. Data or analyses that the BLM, USFS, and BIA deem necessary or helpful to assess habitat trends as a result of actions carried out under the ARBO II
    e. Totals for amount of take and extent of take indicators by IRU or affected basin
    f. Requests for variance and their disposition and a description of RRT activity
    g. SOD project annual report requirements (see PDC 39h-iii)

7. **Annual Coordination Meeting –** The BLM Oregon State Office, USFS Region 6 Office, and BIA will meet with NMFS and USFWS by April 30 each year to discuss the annual monitoring report and any actions that will improve conservation under the ARBO II or make the program more efficient or accountable.

8. **NMFS (and/or USFWS) Fish Passage Review and Approve** -- Projects that require NMFS fish passage review and approval will be coordinated through the NMFS Level 1 team member (see form in Appendix B). If similar projects fall outside of NMFS jurisdiction (inland fish) review and approval will be coordinated with NMFS through the USFWS Level 1 team member. For further protection of bull trout item j below will be required wherever applicable. Types of projects include the following:
    a. Dewatering construction sites by pumping at a rate that exceeds 3 cubic feet per second (cfs) will require fish screen review
    b. Fish passage culverts and bridges that do not meet width standards
    c. Headcut Stabilization and channel spanning non-porous rock structures that create discrete longitudinal drops > 6”
    d. Fish Ladders
    e. Engineered log jams (ELJs) that occupy >25% of the bankfull area
    f. Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement
    g. Dam removal
    h. Channel Reconstruction/Relocation projects
    i. Off and side channel reconstruction when the proposed side channel will contain >20% of the bankfull flow
    j. Passage that reconnects isolated populations of bull trout to new areas where they may face new exposure to populations of non-native (brook trout, etc.) must be approved by the USFWS Division or Field Office Supervisor.

9. **Aquatic Restoration Program Additions/Corrections –** The Action Agencies propose an amendment process for ARBO II to correct deficiencies and provide flexibility to include additional restoration actions or methods that are not identified in the present document, without reinitiating consultation on the entire program.[9] Existing political, social, technological, scientific, or capacity constraints that currently exclude certain types of restoration may change to such a degree as to allow the restoration under ARBO II at a future date. For example, a new restoration method or project type may have to proceed through several individual consultations before project design criteria are refined in a manner that ensures predictable effects and beneficial outcomes to ESA-listed fish. Once predictability is achieved, the Action Agencies or NMFS/USFWS may desire certain changes to ARBO II.

New restoration methods, project types, or other program changes can be proposed for inclusion into ARBO II at a local or provincial scale via a Level 1 Team. The Level 1 Team shall present a consistency document to the RRT (see PDC 2) who will then review the proposal and decide whether or not the project activity is consistent with the effects and beneficial outcomes described under in this opinion. Further, the RRT can propose new actions, accompanied by a consistency document, for inclusion into ARBO II. The consistency document shall include the following as consultation with USFWS:

- Project type, description
- Ecological process and disruption being addressed
- Benefits to ESA-listed species
- How the project is consistent with effects specified in ARBO II
- List conservation measures and PDC to be used that are not included in this opinion.

1.3.2 General Aquatic Conservation Measures

10. **Technical Skill and Planning Requirements**

a. Ensure that an experienced fisheries biologist or hydrologist is involved in the design of all projects covered by this BO. The experience should be commensurate with technical requirements of a project.
b. Planning and design includes field evaluations and site-specific surveys, which may include reference-reach evaluations that describe the appropriate geomorphic context in which to implement the project. Planning and design involves appropriate expertise from staff or experienced technicians (*e.g.*, fisheries biologist, hydrologist, geomorphologist, wildlife biologist, botanist, engineer, silviculturist, fire/fuels specialists.)
c. The project fisheries biologist/hydrologist will ensure that project design criteria are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the biologist or hydrologist must regularly coordinate with the project Contracting Officer Representative to ensure the project design criteria and conservation measures are being followed.

[9] The standard for reinitiation of formal consultation is established in 50 CFR 402.16, and NMFS shall request reinitiation when it believes that any condition described in that section applies.

11. **Climate Change –** Consider climate change information, such as predictive hydrographs for a given watershed or region, when designing projects covered by this opinion.

12. **In-water Work Period –** Follow the appropriate state (ODFW 2008; WDFW 2010) or most recent guidelines for timing of in-water work. If work occurs in occupied Oregon chub habitat, in-water work will not occur between June 1 and August 15. In those few instances when projects will be implemented in California, Idaho, or Nevada, follow appropriate state guidelines. The Action Agencies will request exceptions to in-water work windows through Level 1 NMFS or USFWS representatives as well as essential State agencies. NMFS branch chiefs and USFWS Division Managers or Field Office Supervisors will authorize variances to in-water work periods. For National Forests in the state of Washington, the USFS will work with Washington Department of Fish and Wildlife (WDFW) to determine in-water work periods, using the process contained in the 2012 Memorandum of Understanding between the WDFW and USDA-Forest Service, Pacific Northwest Region regarding hydraulic projects conducted by the USFS (WDFW and USDA-Forest Service 2012).

    While utilizing the appropriate State designated in-water work period will lessen the risk to bull trout, this alone may not be sufficient to adequately protect local bull trout populations. This is especially true if bull trout spawning is suspected in the project area because eggs, alevin, and fry are in the substrate or closely associated habitats nearly year round. The Action Agencies should work with their USFWS Level 1 Team member to insure the all reasonable design options are considered, and an appropriate in-water work window is being used.

13. **Fish Passage –** 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 naturally impassible at the time of construction. After construction, adult and juvenile passage that meets NMFS's fish passage criteria (NMFS 2011e) will be provided for the life of the structure. Note: Passage that reconnects isolated populations of bull trout or Oregon chub to new areas where they may face new exposure to populations of non-native (brook trout, etc.) must be approved by the USFWS Division or Field Office Supervisor (see Section 1.4). Passage for lamprey spp. should always be considered where practical. To the extent possible, incorporate lamprey BMPs found in Best Management Practices to Minimize Adverse Effects to Pacific Lamprey (*Entosphenus tridentatus*) (USFWS 2010e).

14. **Site Assessment for Contaminants –** In developed or previously developed sites, such as areas with past dredge mines, or sites with known or suspected contamination, a site assessment for contaminants will be conducted on projects that involve excavation of >20 cubic yards of material. The action agencies will complete a site assessment to identify the type, quantity, and extent of any potential contamination. 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. The assessment may include the following:

a. Review of readily available records, such as former site use, building plans, records of any prior contamination events
b. Site visit to observe the areas used for various industrial processes and the condition of the property
c. Interviews with knowledgeable people, such as site owners, operators, occupants, neighbors, local government officials, *etc.*
d. Report that includes an assessment of the likelihood that contaminants are present at the site.

15. Pollution and Erosion Control Measures – Implement the following pollution and erosion control measures:

a. Project Contact: Identify a project contact (name, phone number, an address) that will be responsible for implementing pollution and erosion control measures.
b. List and describe any hazardous material that would be used at the project site, including procedures for inventory, storage, handling, and monitoring; notification procedures; specific clean-up and disposal instructions for different products available on the site; proposed methods for disposal of spilled material; and employee training for spill containment.
c. Temporarily store any waste liquids generated at the staging areas under cover on an impervious surface, such as tarpaulins, until such time they can be properly transported to and treated at an approved facility for treatment of hazardous materials.
d. Procedures based on best management practices to confine, remove, and dispose of construction waste, including every type of debris, discharge water, concrete, cement, grout, washout facility, welding slag, petroleum product, or other hazardous materials generated, used, or stored on-site.
e. Procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities. Ensure that materials for emergency erosion and hazardous materials control are onsite (*e.g.*, silt fence, straw bales, oil-absorbing floating boom whenever surface water is present).
f. Best management practices to confine vegetation and soil disturbance to the minimum area, and minimum length of time, as necessary to complete the action, and otherwise prevent or minimize erosion associated with the action area.
g. No uncured concrete or form materials will be allowed to enter the active stream channel.
h. Steps to cease work under high flows, except for efforts to avoid or minimize resource damage.

16. Site Preparation

a. **Flagging Sensitive Areas –** Prior to construction, clearly mark critical riparian vegetation areas, wetlands, and other sensitive sites to minimize ground disturbance.
b. **Staging Area –** Establish staging areas for storage of vehicles, equipment, and fuels to minimize erosion into or contamination of streams and floodplains.

i. No Topographical Restrictions – place staging area 150 feet or more from any natural water body or wetland in areas where topography does not restrict such a distance.
ii. Topographical Restrictions –place staging area away from any natural water body or wetland to the greatest extent possible in areas with high topographical restriction, such as constricted valley types. .

c. **Temporary Erosion Controls –** Place sediment barriers prior to construction around sites where significant levels of erosion may enter the stream directly or through road ditches. Temporary erosion controls will be in place before any significant alteration of the action site and will be removed once the site has been stabilized following construction activities.
d. **Stockpile Materials –** Minimize clearing and grubbing activities when preparing staging, project, and or stockpile areas. Any LW, topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration. Materials used for implementation of aquatic restoration categories (*e.g.*, LW, boulders, fencing material) may be staged within the 100-year floodplain.
e. **Hazard Trees –** Where appropriate, include hazard tree removal (amount and type) in project design. Fell hazard trees when they pose a safety risk. If possible, fell hazard trees within riparian areas towards a stream. Keep felled trees on site when needed to meet coarse LW objectives.

17. Heavy Equipment Use

a. **Choice of Equipment –** Heavy equipment will be commensurate with the project and operated in a manner that minimizes adverse effects to the environment (*e.g.*, minimally-sized, low pressure tires, minimal hard turn paths for tracked vehicles, temporary mats or plates within wet areas or sensitive soils).
b. Fueling and Cleaning and Inspection for Petroleum Products and Invasive Weeds
  i. All equipment used for instream work will be cleaned for petroleum accumulations, dirt, plant material (to prevent the spread of noxious weeds), and leaks repaired prior to entering the project area. Such equipment includes large machinery, stationary power equipment (*e.g.*, generators, canes, *etc.*), and gas-powered equipment with tanks larger than five gallons.
  ii. Store and fuel equipment in staging areas after daily use.
  iii. Inspect daily for fluid leaks before leaving the vehicle staging area for operation.
  iv. Thoroughly clean equipment before operation below ordinary high water or within 50 feet of any natural water body or areas that drain directly to streams or wetlands and as often as necessary during operation to remain grease free.

c. **Temporary Access Roads –** Existing roadways will be used whenever possible. Minimize the number of temporary access roads and travel paths to lessen soil disturbance and compaction and impacts to vegetation. Temporary access roads will not be built on slopes where grade, soil, or other features suggest a likelihood of excessive erosion or failure. When necessary, temporary access roads will be obliterated or revegetated. Temporary roads in wet or flooded areas will be restored by the end of the applicable in-water work period. Construction of new permanent roads is not permitted.

d. **Stream Crossings –** Minimize number and length of stream crossings. Such crossings will be at right angles and avoid potential spawning areas to the greatest extent possible. Stream crossings shall not increase the risk of channel re-routing at low and high water conditions. After project completion, temporary stream crossings will be abandoned and the stream channel and banks restored.

e. **Work from Top of Bank –** To the extent feasible, heavy equipment will work from the top of the bank, unless work from another location (instream) would result in less habitat disturbance, less floodplain disturbance, less sediment in the stream channel, or less damage to the overall aquatic and riparian ecosystem.

f. **Timely Completion –** Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork (including drilling, excavation, dredging, filling and compacting) as quickly as possible. During excavation, stockpile native streambed materials above the bankfull elevation, where it cannot reenter the stream, for later use.

18. Site Restoration

a. **Initiate Rehabilitation –** Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, LW, trees, *etc.*) seeding, or planting with local native seed mixes or plants.

b. **Short-term Stabilization –** Measures may include the use of non-native sterile seed mix (when native seeds are not available), weed-free certified straw, jute matting, and other similar techniques. Short-term stabilization measures will be maintained until permanent erosion control measures are effective. Stabilization measures will be instigated within three days of construction completion.

c. **Revegetation –** Replant each area requiring revegetation prior to or at the beginning of the first growing season following construction. Achieve re-establishment of vegetation in disturbed areas to at least 70% of pre-project levels within three years. Use an appropriate mix of species that will achieve establishment and erosion control objectives, preferably forb, grass, shrub, or tree species native to the project area or region and appropriate to the site. Barriers will be installed as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

d. **Planting Manuals –** All riparian plantings shall follow USFS direction described in the Regional letter to Units, Use of Native and Non-native Plants on National Forests and Grasslands May 2006 (Final Draft), and or BLM Instruction Memorandum No. OR-2001-014, Policy on the Use of Native Species Plant Material.

e. **Decompact Soils –** Decompact soil by scarifying the soil surface of roads and paths, stream crossings, staging, and stockpile areas so that seeds and plantings can root.

19. **Monitoring –** Monitoring will be conducted by BLM, USFS, or BIA staff, as appropriate for that project, during and after a project to track effects and compliance with this opinion.

a. **Implementation**

i. Visually monitor during project implementation to ensure effects are not greater (amount, extent) than anticipated and to contact Level 1 representatives if problems arise.

ii. Fix any problems that arise during project implementation.

iii. Regular biologist/hydrologist coordination if biologist/hydrologist is not always on site to ensure contractor is following all stipulations.

b. **401 Certification –** To minimize short-term degradation to water quality during project implementation, follow current 401 Certification provisions of the Federal Clean Water Act for maintenance or water quality standards described by the following: Oregon Department of Environmental Quality (Oregon BLM, USFS, and BIA); Washington Department of Ecology (Washington BLM); and the Memorandum of Understanding between the Washington Department of Fish and Wildlife and USFS regarding Hydraulic Projects Conducted by USFS, Pacific Northwest Region (WDFW and USDA-Forest Service 2012); California, Idaho, or Nevada 401 Certification protocols (BLM and USFS).

c. **Post Project –** A post-project review shall be conducted after winter and spring high flows.

i. For each project, conduct a walk through/visual observation to determine if there are post-project affects that were not considered during consultation. For fish passage and revegetation projects, monitor in the following manner:

(a) Fish Passage Projects – Note any problems with channel scour or bedload deposition, substrate, discontinuous flow, vegetation establishment, or invasive plant infestation.

(b) Revegetation – For all plant treatment projects, including site restoration, monitor for and remove invasive plants until native plants become established.

ii. In cases where remedial action is required, such actions are permitted without additional consultation if they use relevant PDC and aquatic conservation measures and the effects of the action categories are not exceeded.

20. **Work Area Isolation, Surface Water Withdrawals, and Fish Capture and Release –** Isolate the construction area and remove fish from a project site for projects that include concentrated and major excavation at a single location within the stream channel. This condition will typically apply to the following aquatic restoration categories: Fish Passage Restoration; Dam, Tidegate, and Legacy Structure Removal; Channel Reconstruction/Relocation.

a. **Isolate Capture Area –** Install block nets at up and downstream locations outside of the construction zone to exclude fish from entering the project area. Leave nets secured to the stream channel bed and banks until construction activities within the stream channel are complete. If block nets or traps remain in place more than one day, monitor the nets and or traps at least on a daily basis to ensure they are secured to the banks and free of organic accumulation and to minimize fish predation in the trap. In bull trout spawning and rearing (SR) habitat the USFWS recommends that block nets be checked more frequently (every 1-4 hours depending on site-specific conditions). The frequency of block net and or trap monitoring should be determined by the Level 1 team on a site-specific basis.

b. **Capture and release –** Fish trapped within the isolated work area will be captured and released as prudent to minimize the risk of injury, then released at a safe release site, preferably upstream of the isolated reach in a pool or other area that provides cover and flow refuge. Collect fish in the best manner to minimize potential stranding and stress by seine or dip nets as the area is slowly dewatered, baited minnow traps placed overnight, or electrofishing (if other options are ineffective). Fish must be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided—large buckets (five-gallon minimum to prevent overcrowding) and minimal handling of fish. Place large fish in buckets separate from smaller prey-sized fish. Monitor water temperature in buckets and well-being of captured fish. If buckets are not being immediately transported, use aerators to maintain water quality. As rapidly as possible, but after fish have recovered, release fish. In cases where the stream is intermittent upstream, release fish in downstream areas and away from the influence of the construction. Capture and release will be supervised by a fishery biologist experienced with work area isolation and safe handling of all fish.

c. **1) Electrofishing –** Use electrofishing only where other means of fish capture may not be feasible or effective. If electrofishing will be used to capture fish for salvage, NMFS' electrofishing guidelines will be. followed (NMFS 2000)[10]

   i. Reasonable effort should be made to avoid handling fish in warm water temperatures, such as conducting fish evacuation first thing in the morning, when the water temperature would likely be coolest. No electrofishing should occur when water temperatures are above 18ºC (15º if bull trout are present) or are expected to rise above this temperature prior to concluding the fish capture.
   ii. If fish are observed spawning during the in-water work period, electrofishing shall not be conducted in the vicinity of spawning fish or active redds.
   iii. Only Direct Current (DC) or Pulsed Direct Current shall be used.
   iv. Conductivity <100, use voltage ranges from 900 to 1100. Conductivity from 100 to 300, use voltage ranges from 500 to 800. Conductivity greater than 300, use voltage to 400.
   v. Begin electrofishing with minimum pulse width and recommended voltage and then gradually increase to the point where fish are immobilized and captured. Turn off current once fish are immobilized.

[10] *Anadromous Salmonid Passage Facility Design* guidelines are available from the NMFS Northwest Region, Protected Resources Division in Portland, Oregon. (http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf).

vi. Do not allow fish to come into contact with anode. Do not electrofish an area for an extended period of time. Remove fish immediately from water and handle as described below. Dark bands on the fish indicate injury, suggesting a reduction in voltage and pulse width and longer recovery time.

vii. If mortality is occurring during salvage, immediately discontinue salvage operations (unless this would result in additional fish mortality), reevaluate the current procedures, and adjust or postpone procedures to reduce mortality.

2) Bull trout specific conditions

i. 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.

ii. 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 1 foot of water.

iii. Electrofishing will not be conducted within local populations that contain 100 or fewer adult bull trout.

iv. Electrofishing in SR habitat must be approved by the USFWS Field or Division Supervisor.

v. Bull trout must not be handled when water temperatures exceed 15º.

vi. Nets, hands, etc. must be free of insect repellant, sunscreen or any other substance that might harm fish.

vii. Ice packs will be used to keep capture water <15º

viii. If using MS 222, the formulation should be buffered.

d. **Dewater Construction Site –**When dewatering is necessary to protect species or critical habitat, divert flow around the construction site with a coffer dam (built with non-erosive materials), taking care to not dewater downstream channels during dewatering. Pass flow and fish downstream with a by-pass culvert or a water-proof lined diversion ditch. Diversion sandbags can be filled with material mined from the floodplain as long as such material is replaced at end of project. Small amounts of instream material can be moved to help seal and secure diversion structures. If ESA listed-fish may be present and pumps are required to dewater, the intake must have a fish screen(s) and be operated in accordance with NMFS fish screen criteria described below (in part e, iv) of this section. Dissipate flow energy at the bypass outflow to prevent damage to riparian vegetation or stream channel. If diversion allows for downstream fish passage, place diversion outlet in a location to promote safe reentry of fish into the stream channel, preferably into pool habitat with cover. Pump seepage water from the de-watered work area to a temporary storage and treatment site or into upland areas and allow water to filter through vegetation prior to reentering the stream channel.[11]

[11] To the extent possible, incorporate measures to protect lamprey. For instructions on how to dewater areas occupied by lamprey, see Best Management Practices to Minimize Adverse Effects to Pacific Lamprey, *Entosphenus tridentatus* (USFWS 2010e).

e. **Surface Water Withdrawals**

i. Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate. Where ESA-listed fish may be present, diversions may not exceed 10% of the available flow and fish screen(s) will be installed, operated, and maintained according to NMFS's fish screen criteria (NMFS 2011e).

ii. For the dewatering of a work site to remove or install culverts, bridge abutments *etc.* if ESA-listed fish may be present, a fish screen must be used on the pump intake to avoid juvenile fish entrainment that meets criteria specified by NMFS (2011e).

iii. When diverting water by pump or gravity at a rate that exceeds 3 cfs where ESA-listed fish may be present, the BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by the NMFS Portland Office for consistency with NMFS (2011e) criteria. If this situation exists in areas outside of NMFS jurisdiction the action agencies will have projects individually reviewed and approved by the appropriate USFWS Level 1 biologist.

iv. NMFS approved fish screens have the following specifications: (a) An automated cleaning device with a minimum effective surface area of 2.5 square feet per cfs, and a nominal maximum approach velocity of 0.4 feet per second (fps), or no automated cleaning device, a minimum effective surface area of 1 square foot per cfs, and a nominal maximum approach rate of 0.2 fps; and (b) a round or square screen mesh that is no larger than 2.38 mm (0.094") in the narrow dimension, or any other shape that is no larger than 1.75 mm (0.069") in the narrow dimension.

f. **Stream Re-watering –** Upon project completion, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden release of suspended sediment. Monitor downstream during re-watering to prevent stranding of aquatic organisms below the construction site.

1.3.3 Project Design Criteria for Aquatic Restoration Activity Categories

The 20 aquatic restoration activity categories will be designed and implemented to help restore watershed processes. These projects will improve channel dimensions and stability, sediment transport and deposition, and riparian, wetland, floodplain and hydrologic functions, as well as water quality. As such, these improvements will help address limiting factors—related to spawning, rearing, migration, and more—for ESA-listed and other native fish species. Aquatic habitat restoration and enhancement projects are conducted within stream channels, adjacent riparian/floodplain areas, wetlands, and uplands. Work may be accomplished using manual labor, hand tools (chainsaws, tree planting tools, augers, shovels, and more), all-terrain vehicles, flat-bed trucks, and heavy equipment (backhoes, excavators, bulldozers, front-end loaders, dump trucks, winch machinery, cable yarding, *etc.*). Helicopters will be used for many LW and salmon carcass placement projects.

21. Fish Passage Restoration includes the following: total removal of culverts or bridges, or replacing culverts or bridges with properly sized culverts and bridges, replacing a damaged culvert or bridge, and resetting an existing culvert that was improperly installed or damaged; stabilizing and providing passage over headcuts; removing, constructing (including relocations), 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 through road construction, stream degradation, creation of small dams and weirs, and irrigation diversions. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects. For projects that are proposed in non-anadromous areas passage review and approval from NMFS is still necessary. The USFWS may assist the Action Agencies with presenting their information, but NMFS will make the final decision on all design approval. This condition is true throughout this document wherever passage review and approval is required.

a. **Stream Simulation Culvert and Bridge Projects –** All road-stream crossing structures shall simulate stream channel conditions per *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008a), located at: http://stream.fs.fed.us/fishxing/aop_pdfs.html

i. **Culvert Criteria –** Within the considerations of stream simulation, the structure shall, at a minimum, accommodate a bankfull wide channel plus constructed banks to provide for passage of all life stages of native fish species (for more information, reference Chapter 6, page 35 of the USFS Stream Simulation Guide). The following crossing-width guidance applies to specific ranges of entrenchment ratios as defined by Rosgen (1996):

(a) Non-entrenched Streams: If a stream is not fully entrenched (entrenchment ratio of greater than 1.4), the minimum culvert width shall be at least 1.3 times the bankfull channel width. This is consistent with *Anadromous Salmonid Passage Facility Design* (section 7.4.2 “Stream Simulation Design”). (NMFS 2011e) However, if the appropriate structure width is determined to be less than 1.3 times the bankfull channel width, processes for variances are listed in “iv” and “v” below.

(b) Entrenched Streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the culvert width must be greater than bankfull channel width, allow sufficient vertical clearance to allow ease of construction and maintenance activities, and provide adequate room for the construction of natural channel banks. Consideration should be given to accommodate the flood-prone width. Flood-prone width is the width measured at twice the maximum bankfull depth (Rosgen 1996).

ii. **Bridge Design**

(a) Bridges with vertical abutments—including concrete box culverts, which are constructed as bridges—shall be designed according to NMFS (2011e) and USDA-Forest Service (2008a) stream crossing guidelines. NMFS (2011e), USDA-Forest Service (2008a) guidelines, and this opinion do not cover bridges that require pile driving in water.

(b) Structure material must be concrete or metal. Concrete must be sufficiently cured or dried[12] before coming into contact with stream flow. The use of treated wood for bridge construction or replacement is not allowed under this opinion.

(c) Riprap must not be placed within the bankfull width of the stream. Riprap may only be placed below bankfull height when necessary for protection of abutments and pilings. However, the amount and placement of riprap should not constrict the bankfull flow.

iii. **Crossing Design**

(a) Crossings shall be designed using an interdisciplinary design team consisting of an experienced Engineer, Fisheries Biologist, and Hydrologist/Geomorphologist.

(b) USFS crossing structures wider than 20 feet or with costs that exceed $100,000 shall be reviewed by the USDA-Forest Service, Region 6, Aquatic Organism Passage Design Assistance Team.

(c) At least one member of the design team shall be trained in a week-long Aquatic Organism Passage course based *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008a).

(d) Bankfull width shall be based on the upper end of the distribution of bankfull width measurements as measured in the reference reach to account for channel variability and dynamics.

iv. **NMFS Fish Passage Review and Approve –** If the structure width is determined to be less than the established width criteria as defined above, a variance must be requested from NMFS for consistency with criteria in NMFS (2011e) (this is true anywhere in the action area).

v. **Opportunity for Individual Consultation –** Action Agencies have a legal duty under the ESA to consult with NMFS and USFWS on a project-specific basis if they prefer to operate outside the conditions in this opinion. The standards provided in this document are conservative for the purpose of this programmatic and may or may not be applicable to projects that undergo individual Level 1 Consultation. The standards in this ARBO II are not new defaults to be used universally outside the programmatic arena.

b. **Headcut and Grade Stabilization –** Headcuts often occur in meadow areas, typically on Rosgen “C” and “E” channel types. Headcuts develop and migrate during bankfull and larger floods, when the sinuous path of Rosgen E type streams may become unstable in erosive, alluvial sediments, causing avulsions, meander cut-offs, bank failure, and development of an entrenched Rosgen G gully channel (Rosgen 1994).

i. **Stabilize Headcuts**

(a) In streams with current or historic fish presence, provide fish passage over stabilized headcut through constructed riffles for pool/riffle

[12] NMFS recommends 48 to 72 hours, depending on temperature.

streams or a series of log or rock structures for step/pool channels as described in part ii below.

(b) Armor headcut with sufficiently sized and amounts of material to prevent continued up-stream migration of the headcut. Materials can include both rock and organic materials which are native to the area. Material shall not contain gabion baskets, sheet pile, concrete, articulated concrete block, and cable anchors.

(c) Focus stabilization efforts in the plunge pool, the headcut, as well as a short distance of stream above the headcut.

(d) Minimize lateral migration of channel around headcut ("flanking") by placing rocks and organic material at a lower elevation in the center of the channel cross section to direct flows to the middle of channel.

(e) Short-term headcut stabilization (including emergency stabilization projects) may occur without associated fish passage measures. However, fish passage must be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period.

(f) In streams without current or historic fish presence, it is recommended to construct a series of downstream log or rock structures as described in part ii below to expedite channel aggradation.

ii. **Grade Stabilization to promote Fish Passage associated with Headcut Stabilization**

(a) **NMFS Fish Passage Review and Approve –** If a headcut stabilization structure spans the channel and creates one or more discrete longitudinal drops > 6", the BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by the NMFS for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011e).

(b) Provide fish passage over stabilized headcut through constructed riffles for pool/riffle streams or a series of log or rock structures for step/pool channels. If LW and boulder placement will be used for headcut stabilization, refer to <u>Large Wood, Boulder, and Gravel Placement</u> (PDC 22) below.

(c) Construct structures in a 'V' or 'U' shape, oriented with the apex upstream, and lower in the center to direct flows to the middle of channel.

(d) Key structures into the stream bed to minimize structure undermining due to scour, preferably at least 2.5x their exposure height. The structures should also be keyed into both banks—if feasible greater than 8 feet.

(e) 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 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 one-foot high step structure in a stream with a two-percent gradient will have a minimum spacing of 50-feet [1/0.02]).

(f) 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.

(g) 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.

c. **Fish Ladders**

i. **NMFS Fish Passage Review and Approve –** The BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by NMFS for consistency with criteria in *Anadromous Salmonid Passage Facility Design*. Refer to section "F" of this chapter.

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 graded mix of rock and sediment in an open channel that creates enough roughness and diversity to facilitate fish passage. NMFS's 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: the most recent version of *Anadromous Salmonid Passage Facility Design* (NMFS 2011e) for guidelines and design criteria. Through the NMFS Level 1 team member, collaborate with NMFS engineering prior to the conceptual design process of fishway projects to solicit NMFS preferred design type.

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.

iv. Design consideration should be given for Pacific Lamprey passage[13]. Fish ladders that are primarily designed for salmonids are usually impediments to lamprey passage as they do not have adequate surfaces for attachment, velocities are often too high and there are inadequate places for resting. Providing for rounded corners, resting areas or providing a natural stream channel (stream simulation) or wetted ramp for passage over the impediment have been effective in facilitating lamprey passage.

[13] 2010e (USFWS) Best Management Practices to Minimize Adverse Effects to Pacific Lamprey. http://www.fws.gov/pacific/Fisheries/sphabcon/lamprey/pdf/Best%20Management%20Practices%20for%20Pacific%20Lamprey%20April%202010%20Version.pdf

d. **Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement**[14]

i. **NMFS Fish Passage Review and Approve –** The BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by NMFS for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011e). This applies across the action area.

ii. Diversion structures—associated with points of diversion and future fish screens—must pass all life stages of threatened and endangered aquatic species that historically used the affected aquatic habitat.

iii. Water diversion intake and return points must 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 2011e) applies to federally listed salmonid 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 historic water use, whichever is less.

vi. Size of bypass structure should be big enough to pass steelhead kelt (a post-spawning fish) into 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:

(a) Material more than 60% silt or clay will be disposed in uplands, outside of the active floodplain.

(b) Material with more than 40% gravel will be deposited within the active floodplain, but not in wetlands.

(c) Material with more than 50% gravel and less than 30% fines (silt or clay) may be deposited below the ordinary high water mark (HWM).

[14] As part of this project category, the Action Agencies also proposed that "Multiple existing diversions may be consolidated into one diversion as long as there is new instream construction or structures and if the consolidated diversion is located at the most downstream existing barrier." However, NMFS excluded this action from further analysis due to the uncertain effect that it may have on streamflow necessary for survival and recovery of listed species.

22. **Large Wood, Boulder, and Gravel Placement** includes LW and boulder placement, ELJs, porous boulder structures and vanes, gravel placement, and tree removal for LW projects. 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 natural 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. Equipment such as helicopters, excavators, dump trucks, front-end loaders, full-suspension yarders, and similar equipment may be used to implement projects.

a. **Large Wood and Boulder Projects**

i. Place LW and boulders in areas where they would naturally occur and in a manner that closely mimic 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 bank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces.

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 root wads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with root wads should be a minimum of 1.5 x bankfull channel width, while logs without root wads should be a minimum of 2.0 x bankfull width.

vii. Structures may partially or completely span stream channels or be positioned along stream banks.

viii. Stabilizing or key pieces of LW must 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 increases stability

ix. Anchoring LW – Anchoring alternatives may be used in preferential order:[15]

(a) Use of adequate sized wood sufficient for stability

(b) Orient and place wood in such a way that movement is limited

[15] Anchoring LW with cables is not included in this opinion.

(c) Ballast (gravel or rock) to increase the mass of the structure to resist movement
(d) Use of large boulders as anchor points for the LW
(e) Pin LW with rebar to large rock to increase its weight. For streams that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (<12) an additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.

b. **Engineered Logjams (ELJs)** ELJs within this BO are defined as: "any large wood structure that includes an anchoring system, such as rebar pinning, ballast rock, or vertical posts. Passive soil earth pressure (burying wood into a streambank) is not considered an anchoring system." Further, only ELJs that occupy more than 25% of the bankfull cross-sectional area require NMFS fish passage review**.** These are structures designed to redirect flow and change scour and deposition patterns. To the extent practical, they are patterned after stable natural log jams and can be either unanchored or anchored in place using rebar, rock, or piles (driven into a dewatered area or the streambank, but not in water). Engineered log jams create a hydraulic shadow, a low-velocity zone downstream that allows sediment to settle out. Scour holes develop adjacent to the log jam. While providing valuable fish and wildlife habitat they also redirect flow and can provide stability to a streambank or downstream gravel bar.

i. **NMFS Fish Passage Review and Approve –** For ELJs that occupy >25% of the cross-sectional bankfull area, the BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by NMFS for consistency with criteria in *Anadromous Salmonid Passage Facility Design*(NMFS 2011e).

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 must be intact, solid (little decay). If possible, acquire LW with untrimmed root wads to provide functional refugia habitat for fish.

v. When available, trees with root wads attached should be a minimum length of 1.5 times the bankfull channel width, while logs without root wads should be a minimum of 2.0 times the bankfull width.

vi. The partial burial of LW and boulders may constitute the dominant means of placement, and key boulders (footings) or LW can be buried into the stream bank or channel

vii. Angle and Offset – The LW portions of engineered log jam structures should be oriented such that the force of water upon the LW increases stability. If a root wad 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 root wad pushes the bole into the streambank and bed. Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow.

viii. If LW anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, such as rebar pinning or bolted connections, may be used. Rock may be used for ballast but is limited to that needed to anchor the LW.

c. **Porous Boulder Structures and Vanes**

i. Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels 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.*), 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 channel-forming flow events (approximately a 1.5-year flow event).

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. Plunges shall be kept less than 6” in height.

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.

d. **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.

iii. Gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible use gravel of the same lithology as found in the watershed. Reference the *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organism*s at Road-Stream Crossings (USDA-Forest Service 2008a) 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 would cause stranding during future flood events. Crushed rock is not permitted.

v. After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.

vi. 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.

vii. Imported gravel must be free of invasive species and non-native seeds. If necessary, wash gravel prior to placement.

e. Tree Removal for LW Projects

i. Live conifers and other trees can be felled or pulled/pushed over in a Northwest Forest Plan (USDA and USDI 1994b) Riparian Reserve or PACFISH/INFISH (USDA-Forest Service 1995; USDA and USDI 1994a) riparian habitat conservation areas (RHCA), and upland areas (*e.g.*, late successional reserves or adaptive management areas for northern spotted owl and marbled murrelet critical habitat) for in-channel LW placement only when conifers and trees are fully stocked. Tree felling shall not create excessive stream bank erosion or increase the likelihood of channel avulsion during high flows.

ii. Danger trees and trees killed through fire, insects, disease, blow-down and other means can be felled and used for in-channel placement regardless of live-tree stocking levels.

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

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

v. Trees may be stock piled for future instream restoration projects.

vi. The project manager for an aquatic restoration action will coordinate with an action-agency wildlife biologist in tree-removal planning efforts.

vii. In Northern Spotted Owl and Marbled Murrelet habitat, meet the following requirements:

viii. The following Project Design Criteria applies to tree removal within the range of marbled murrelets and the spotted owl in Douglas-fir dominated stands less than 80 years old that are not functioning as foraging habitat[16] within a spotted owl home range and which do not contain murrelet nesting structure. It does not apply to tree selection in older stands or hardwood-dominated stands unless stated otherwise. The purpose of these

[16] This applies in spotted owl provincial home ranges where the levels of NRF are so low that spotted owls rely on dispersal habitat as their primary foraging habitat. Site-specific determinations should be made by the unit wildlife biologist.

criteria is to ensure that there would be no removal or undesirable modification of suitable habitat for marbled murrelet or spotted owl.

a. A wildlife biologist must be fully involved in all tree-removal planning efforts, and be involved in making decisions on whether individual trees are suitable for nesting or have other important listed bird habitat value.
b. Outside of one site potential tree height of streams (see Table 5 for riparian restrictions), trees can be removed to a level not less than a Relative Density (RD) of approximately 35 (stand scale), which is considered as fully occupying a site. This equates to approximately 60 trees per acre in the overstory and a tree spacing averaging 26 feet. Additionally 40% canopy cover would be maintained when in spotted owl or marbled murrelet CH, when within 300 feet of occupied or unsurveyed murrelet nesting structure, and when dispersal habitat is limited in the area
c. Trees to be removed can be live, hazard trees, or killed through fire, insects, disease, blow down and other means. Down trees and snags should only be removed if the stand will retain NWFP standards post removal.
d. Trees may be removed by cable, ground-based equipment, horses or helicopters, felled or pushed/pulled directly into a stream. Trees may be stock piled for future instream restoration projects.
e. Tree species removed should be relatively common in the stand (i.e., not “minor” tree species).
f. Snags and trees with broad, deep crowns (“wolf” trees), damaged tops or other abnormalities that may provide a valuable wildlife habitat component should be reserved.
g. No gaps (openings) greater than 0.5 acre will be created in spotted owl CH. No gaps greater than ¼ acre will be created in murrelet CH. No gaps shall be created in Riparian Reserves that contain ESA-listed fish habitat.

ix. The following Project Design Criteria applies to tree removal within the range of marbled murrelet and the spotted owl in Douglas-fir dominated stands greater than 80 years old (or stands under 80 years old that are functioning as primary foraging habitat) within a spotted owl home range, and/or do contain marbled murrelet nesting structure.

a. Individual trees or small groups of trees should come from the periphery of permanent openings (roads etc.) or from the periphery of non-permanent openings (e.g., plantations, along recent clear-cuts etc.). Groups of trees greater than 4 trees shall 1) not be within marbled murrelet suitable stands or stands buffering (300 ft.) MM suitable stands, 2) not be buffering (300 ft.) individual trees with marbled murrelet nesting structure. A minimum distance of one potential tree height feet should be maintained between individual or group removals.

b. Trees up to 36" dbh may be felled in any stands with agreement from a wildlife biologist that the trees are not providing marbled murrelet nesting structures or providing cover for nest sites. No known spotted owl nest trees or alternate nest trees are to be removed. Potential spotted owl nest trees may only be removed in limited instances when it is confirmed with the wildlife biologist that nest trees will not be limited in the stand post removal.

c. In order to minimize the creation of canopy gaps or edges, groups of adjacent trees selected should not create openings greater than ¼ acre within 0.5 miles of marbled murrelet occupied habitat or when within murrelet CH. Within spotted owl critical habitat, stands greater than 80 years old or within stands providing foraging habitat to spotted owl home ranges, gaps will be restricted to 0.5 acre openings or less. Gaps shall not be created in Riparian Reserves where ESA-listed fish occur.

23. Dam, Tidegate and Legacy Structure Removal includes removal of dams, tidegates, 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. 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 proposed. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. **Dam Removal**

i. **Design Review**

(a) **NMFS Fish Passage Review and Approve –** The BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by NMFS for consistency with criteria in NMFS (2011e).

(b) **Restoration Review Team (RRT) –** The BLM, USFS, and BIA will ensure that the action is individually reviewed by the RRT.

ii. Dams greater than 10-feet in height require a long-term monitoring and adaptive management plan that will be developed between the Services and the action agency.

iii. At a minimum, the following information will be necessary for review:

(a) 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.

(b) A minimum of three 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.

(c) Sediment characterization to determine the proportion of coarse sediment (>2mm) in the reservoir area.
(d) A survey of any downstream spawning areas that may be affected by sediment released by removal of the water control structure or dam. Reservoirs with 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; reservoirs 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.

iv. 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.

b. **Tide Gate Removal –** This action includes the removal of tide gates.

i. **NMFS Fish Passage Review and Approve –** For projects that constrain tidal exchange, the BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by the NMFS for consistency with criteria in NMFS (2011e).

ii. Follow Work Area Isolation, Surface Water Withdrawals, and Fish Capture and Release (PDC 20). If a culvert or bridge will be constructed at the location of a removed tide gate, then the structure should be large enough to allow for a full tidal exchange.

c. **Removal of Legacy Structures –** This action includes the removal of past projects**,** such as LW, boulder, rock gabions, and other in-channel and floodplain structures.

i. If the structure being removed contains material (i.e., LW, boulders, concrete, *etc.*) not typically found within the stream or floodplain at that site, remove material from the 100-year floodplain.

ii. If the structure being removed contains material (i.e., LW, boulders, *etc.*) that is typically found within the stream or floodplain at that site, the material can be reused to implement habitat improvements described under the LW, Boulder, and Gravel Placement 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 stream bank 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 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. If headcutting and channel incision are likely to occur due to structure removal, additional measures must 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 ARBO II restoration categories to decrease the width to depth ratio of the stream to a level commensurate with the geomorphic setting.

24. **Channel Reconstruction/Relocation** projects include reconstruction of existing stream channels through excavation and structure placement (LW and boulders) or relocation (rerouting of flow) into historic 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 resulting from watershed disturbances. This activity type will be implemented to improve aquatic and riparian habitat diversity and complexity, reconnect stream channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, provide long-term nutrient storage, provide substrate for macroinvertebrates, moderate flow disturbance, increase retention of organic material, and provide refuge for fish and other aquatic species. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. **General Project Design Criteria**

i. **Design Review**

(a) **NMFS Fish Passage Review and Approve –** The BLM, USFS, and BIA will ensure that the action is individually reviewed and approved by NMFS for consistency with NMFS (2011e).

(b) **Restoration Review Team (RRT) –** The BLM, USFS, and BIA will ensure that the action is individually reviewed by the RRT.

ii. Design Guidance

(a) Construct geomorphically appropriate stream channels and floodplains within a watershed and reach context.

(b) 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.

(c) To the greatest degree possible, remove non-native fill material from the channel and floodplain to an upland site.

(d) 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.
(e) 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.
(f) Material selection (LW, rock, gravel) shall also mimic natural stream system materials.
(g) 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* or other appropriate design guidance documents (USDA-Forest Service 2008a).

b. **Project Documentation –** Prior to the Design Review, the project contact will provide NMFS and the RRT with the following documentation:
   i. Background and Problem Statement
      (a) Site history
      (b) Environmental baseline
      (c) Problem Description
      (d) Cause of problem
   ii. Project Description
      (a) Goals/objectives
      (b) Project elements
      (c) Sequencing, implementation
      (d) Recovery trajectory –how does it develop and evolve?
   iii. Design Analysis
      (a) technical analyses
      (b) computations relating design to analysis
      (c) references
   iv. River Restoration Analysis Tool – The River Restoration Analysis Tool (restorationreview.com) was created to assist with design and monitoring of aquatic restoration projects. The following questions taken from the tool must be addressed in the project documentation:
      (a) Problem Identification
         (i) Is the problem identified?
         (ii) Are causes identified at appropriate scales?
      (b) Project Context
         (i) Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
         (ii) Does the project consider ecological, geomorphic, and socioeconomic context?
      (c) Goals & Objectives
         (i) Do goals and objectives address problem, causes, and context?
         (ii) Are objectives measurable?
      (d) Alternatives/Options Evaluation

(e) Were alternatives/options considered?
(f) Are uncertainties and risk associated with selected alternative acceptable?
(g) Project Design
   (i) Do project elements collectively support project objectives?
   (ii) Are design criteria defined for all project elements?
   (iii) Do project elements work with stream processes to create and maintain habitat?
   (iv) Is the technical basis of design sound for each project element?
(h) Implementation
   (i) Are plans and specifications sufficient in scope and detail to execute the project?
   (ii) Does plan address potential implementation impacts and risks?
(i) Monitoring & Management
   (i) Does monitoring plan address project compliance?
   (ii) 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 Services. The plan will include the following:
   i. Introduction
   ii. Existing Monitoring Protocols
   iii. Project Effectiveness Monitoring Plan
   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

25. **Off- and Side-Channel Habitat Restoration** projects will be implemented to reconnect historic 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. These project types will increase habitat diversity and complexity, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macroinvertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refuge for fish during high flows. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. **Review and Approve –** When a proposed side channel will contain >20% of the bankfull flow,[17] the BLM, USFS, and BIA will ensure that the action is reviewed by the RRT and reviewed and approved by NMFS for consistency with criteria in NMFS (2011e).

[17] Large side channels projects are essentially channel construction projects if they contain more than 20% of flow.

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 ($\leq$ 10% of volume) of naturally accumulated sediment within historical channels. There is no limit as to the amount of excavation of anthropogenic fill within historic 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.

26. **Streambank Restoration** will be implemented through bank shaping and installation of coir logs or other soil reinforcements as necessary to support riparian vegetation; planting or installing LW, trees, shrubs, and herbaceous cover as necessary to restore ecological function in riparian and floodplain habitats; or a combination of the above methods. Such actions are intended to restore banks that have been altered through road construction, improper grazing, invasive plants, and more. Benefits include increased amounts of riparian vegetation and associated shading, bank stability, and reduced sedimentation into stream channels and spawning gravels. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils.
b. Complete all soil reinforcement earthwork and excavation in the dry. When necessary, use soil layers or lifts that are strengthened with biodegradable fabrics and penetrable by plant roots.
c. Include LW to the extent it would naturally occur. If possible, LW should have untrimmed root wads to provide functional refugia habitat for fish. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream.
d. Rock will not be used for streambank restoration, except as ballast to stabilize LW.
e. 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, stream channels, *etc.*
f. Do not apply surface fertilizer within 50 feet of any stream channel.
g. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
h. Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

27. Set-back or Removal of Existing Berms, Dikes, and Levees will be conducted to reconnect historic fresh-water deltas to inundation, stream channels with floodplains, and historic estuaries to tidal influence as a means to increase habitat diversity and complexity, moderate flow disturbances, and provide refuge for fish during high flows. Other restored ecological functions include overland flow during flood events, dissipation of flood energy, increased water storage to augment low flows, sediment and debris deposition, growth of riparian vegetation, nutrient cycling, and development of side channels and alcoves. Such projects will take place where estuaries and floodplains have been disconnected from adjacent rivers through drain pipes and anthropogenic fill. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

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 capital projects 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, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion 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. Elevations of dike/levee setbacks shall not exceed the elevation of removed structures

vi. 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. Project implementation shall be conducted in a sequence that will not preclude repairing or restoring estuary functions once dikes/levees are breached and the project area is flooded.

ii. Culverts and tide gates will be removed using the design criteria and conservation measures, where appropriate, as described in Work Area Isolation, Surface Water Withdrawals, & Fish Capture and Release (PDC 20) and Fish Passage Restoration (PDC 21) above.

iii. 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.

iv. 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.

v. 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. When required, use PDC in the Channel Reconstruction/Relocation (PDC 24).

vi. 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.

28. **Reduction/Relocation of Recreation Impacts** is intended to close, better control, or relocate recreation infrastructure and use along streams 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. The primary purpose is to eliminate or reduce recreational impacts to restore riparian areas and vegetation, improve bank stability, and reduce sedimentation into adjacent streams. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

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 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 32) below.

29. **Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering Facilities** 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. Such projects promote a balanced approach to livestock use in riparian areas, reducing livestock impacts to riparian soils and vegetation, streambanks, channel substrates, and water quality. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. **Livestock Fencing**

i. Fence placement must allow for lateral movement of a stream and to allow establishment of riparian plant species. To the extent possible, fences will be placed outside the channel migration zone.

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.

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 must 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 ESA-listed species spawn or are suspected of spawning (*e.g.*, pool tailouts where spawning may occur), or within 300-feet upstream of such areas.

iv. Existing access roads and stream crossings will be used whenever possible, unless new construction would result in less habitat disturbance and the old trail or crossing is retired.

v. Access roads or trails will be provided with a vegetative 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 project design criteria listed for Stream Simulation Culvert and Bridge Projects under Fish Passage Restoration (PDC 21).

ix. Stream crossings and water gaps will be designed and constructed to a width of 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 or riparian pastures.

c. Off-channel livestock watering facilities

i. The development of a spring is not allowed if the spring is occupied by ESA-listed species.

ii. Water withdrawals must not dewater habitats or cause low stream flow conditions that could affect ESA-listed fish. Withdrawals may not exceed 10% of the available flow.

iii. Troughs or tanks fed from a stream or river must have an existing valid water right. Surface water intakes must be screened to meet the most recent version of NMFS fish screen criteria (NMFS 2011e), 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.

iv. 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.

v. 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.

vi. Minimize removal of vegetation around springs, wet areas.

vii. When necessary, construct a fence around the spring development to prevent livestock damage.

30. **Piling and other Structure Removal** 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. Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to riparian dependent species. Pilings and other structures occur in estuaries, lakes, and rivers and are typically used in association with boat docks and other facilities. Equipment such as boats, barges, excavators, dump trucks, front-end loaders, and similar equipment may be used to implement projects. The driving of steel or concrete piles within the wetted width of any stream channel, or wetted area of any lake is not covered under this BO.

a. **When removing an intact pile**
   a. Install a floating surface boom to capture floating surface debris.
   b. 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.
   c. Dislodge the piling with a vibratory hammer, whenever feasible. Never intentionally break a pile by twisting or bending.
   d. Slowly lift piles from the sediment and through the water column.
   e. 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.
   f. Fill the holes left by each piling with clean, native sediments located from the project area.
   g. 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 2 feet below the surface, every attempt short of excavation will be made to remove it entirely. If the pile cannot be removed without excavation, excavate sediments and saw the stump off at least 3 feet below the surface of the sediment.
   ii. If a pile breaks above contaminated sediment, saw the stump off at the sediment line; if a pile breaks within contaminated sediment, make no further effort to remove it and cover the hole with a cap of clean substrate appropriate for the site.
   iii. If dredging is likely in the area of piling removal, use a global positioning device (GPS) to note the location of all broken piles for future use in site debris characterization.

31. **In-channel Nutrient Enhancement** includes the placement of salmon carcasses, carcass analogs (processed fish cakes), or inorganic fertilizers in stream channels to help return stream nutrient levels back to historic 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, projects are permitted through ODEQ. Use carcasses from the treated watershed or those that are certified disease free by an Oregon Department of Fish and Wildlife (ODFW) pathologist.

b. In Washington, follow WDFW's *Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State*, *2004* or 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.

32. **Road and Trail Erosion Control and Decommissioning** includes 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; soil stabilization and tilling compacted surfaces to reestablish native vegetation. Roads closed under USFS and BLM/BIA-equivalent Travel and Access Management Plans will be subject to these PDC and may be addressed under this BO. Actions will target priority roads that contribute sediment to streams, block fish passage, or disrupt floodplain and riparian functions. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. **Road Decommissioning and Stormproofing**
   i. For road decommissioning and hydrologic closure 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 if space is available.
   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 21).

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.

ii. The relocation will not increase the drainage network and will be constructed to hydrologically disconnect it 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.

33. **Non-native Invasive Plant Control** includes manual, mechanical, biological, and chemical methods to remove invasive non-native plants within Riparian Reserves, Riparian Habitat Conservation Areas, or equivalent and adjacent uplands. In monoculture areas (*e.g.*, areas dominated by black berry or knotweed) heavy machinery can be used to help remove invasive plants. This activity is intended to improve the composition, structure, and abundance of native riparian plant communities important for bank stability, stream shading, LW, and other organic inputs into streams, all of which are important elements to fish habitat and water quality. Manual and hand-held equipment will be used to remove plants and disperse chemical treatments. Heavy equipment, such as bulldozers, can be used to remove invasive plants, primarily in areas with low slope values. (Invasive plant treatments included in this opinion are to serve BLM, USFS, and BIA administrative units until such units complete a local or provincial consultation for this activity type.)

a. **Project Extent –** Non-native invasive plant control projects will not exceed 10% of acres within a Riparian Reserve under the Northwest Forest Plan (USDA and USDI 1994b) or RHCA under PACFISH/INFISH (USDA-Forest Service 1995; USDA and USDI 1994a) within a 6th HUC/year.

b. **Manual Methods –** Manual treatments are those done with hand tools or hand held motorized equipment. These treatments typically involve a small group of people in a localized area. Vegetation disturbance varies from cutting or mowing to temporarily reduce the size and vigor of plants to removal of entire plants. Soil disturbance is minimized by managing group size and targeting individual plants.

c. **Mechanical Methods –** Mechanical treatments involve the use of motorized equipment and vary in intensity and impact from mowing to total vegetation removal and soil turnover (plowing and seed bed preparation). Mechanical treatments reduce the number of people treating vegetation. Impacts could be lessened by minimizing the use of heavy equipment in riparian areas, avoiding treatments that create bare soil in large or extensive areas, reseeding and mulching following treatments, and avoiding work when soils are wet and subject to compaction.

d. **Biological Methods –** Release of traditional host specific biological control agents (insects and pathogens) consists of one or two people depositing agents on target vegetation. This results in minimal impact to soils and vegetation from the actual release. Over time, successful biological control agents will reduce the size and vigor of host noxious weeds with minimal or no impact to other plant species.

e. **Chemical Methods –** Invasive plants, including state-listed noxious weeds, are particularly aggressive and difficult to control and may require the use of herbicides for successful control and restoration of riparian and upland areas. Herbicide treatments vary in impact to vegetation from complete removal to reduced vigor of specific plants. Minimal impacts to soil from compaction and erosion are expected.

  i. General Guidance

  (a) Use herbicides only in an integrated weed or vegetation management context where all treatments are considered and various methods are used individually or in concert to maximize the benefits while reducing undesirable effects.

  (b) Carefully consider herbicide impacts to fish, wildlife, non-target native plants, and other resources when making herbicide choices.

  (c) Treat only the minimum area necessary for effective control. Herbicides may be applied by selective, hand-held, backpack, or broadcast equipment in accordance with state and federal law and only by certified and licensed applicators to specifically target invasive plant species.

  (d) Herbicide application rates will follow label direction, unless site-specific analysis determines a lower maximum rate is needed to reduce non-target impacts.

  (e) An herbicide safety/spill response plan is required for all projects to reduce the likelihood of spills, misapplication, reduce potential for unsafe practices, and to take remedial actions in the event of spills. Spill plan contents will follow agency direction.

  (f) Pesticide applicator reports must be completed within 24 hours of application.

  ii. **Herbicide Active Ingredients –** Active ingredients are restricted to the following (some common trade names are shown in parentheses; use of trade names does not imply endorsement by the US government):[18]

  (a) aminopyralid (*e.g.*, *terrestrial*: Milestone VM)
  (b) chlorsulfuron (*e.g.*, *terrestrial*: Telar, Glean, Corsair)
  (c) clopyralid (*e.g.*, *terrestrial*: Transline)
  (d) dicamba (*e.g.*, *terrestrial*: Vanquish, Banvel)
  (e) diflufenzopyr + dicamba (*e.g.*, *terrestrial*: Overdrive)
  (f) glyphosate (*e.g.*, *aquatic*: Aquamaster, AquaPro, Rodeo, Accord)
  (g) imazapic (*e.g.*, *terrestrial*: Plateau)
  (h) imazapyr (*e.g.*, *aquatic*: Habitat; *terrestrial*: Arsenal, Chopper)

[18] 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 the Interior or USFWS of any product or service to the exclusion of others that may be suitable.

(i) metsulfuron methyl (*e.g.*, *terrestrial*: Escort)
(j) picloram (*e.g.*, *terrestrial*: Tordon, Outpost 22K)
(k) sethoxydim (*e.g.*, *terrestrial*: Poast, Vantage)
(l) sulfometuron methyl (*e.g.*, *terrestrial*: Oust, Oust XP)
(m) triclopyr (*e.g.*, *aquatic*: Garlon 3A, Tahoe 3A, Renovate 3, Element 3A; *terrestrial*: Garlon 4A, Tahoe 4E, Pathfinder II)
(n) 2,4-D (*e.g.*, *aquatic*: 2,4-D Amine, Clean Amine; *terrestrial*: Weedone, Hi-Dep)

iii. **Herbicide Adjuvants –** When recommended by the label, an approved aquatic surfactant would be used to improve uptake. When aquatic herbicides are required, the only surfactants and adjuvants permitted are those allowed for use on aquatic sites, as listed by the Washington State Department of Ecology: http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html. (Oregon Department of Agriculture also often recommends this list for aquatic site applications). The surfactants R-11, Polyethoxylated tallow amine (POEA), and herbicides that contain POEA (*e.g.*, Roundup) will not be used.

iv. **Herbicide Carriers –** Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil.

v. **Herbicide Mixing –** Herbicides will be mixed more than 150 feet from any natural waterbody to minimize the risk of an accidental discharge. Impervious material will be placed beneath mixing areas in such a manner as to contain any spills associated with mixing/refilling. Spray tanks shall be washed further than 300 feet away from surface water. All hauling and application equipment shall be free from leaks and operating as intended.

vi. **Herbicide Application Methods** – Liquid forms of herbicides will be applied as follows:
(a) Broadcast spraying using booms mounted on ground-based vehicles (this consultation does not include aerial applications).
(b) Spot spraying with hand held nozzles attached to back pack tanks or vehicles and hand-pumped sprayers to apply herbicide directly onto small patches or individual plants.
(c) Hand/selective through wicking and wiping, basal bark, frill ("hack and squirt"), stem injection, or cut-stump.
(d) Dyes or colorants, (*e.g.*, Hi-Light, Dynamark) will be used to assist in treatment assurance and minimize over-spraying within 100 feet of live water.

vii. **Minimization of Herbicide Drift and Leaching –** Herbicide drift and leaching will be minimized as follows:
(a) Do not spray when wind speeds exceed 10 miles per hour to reduce the likelihood of spray/dust drift. Winds of 2 mph or less are indicative of air inversions. The applicator must confirm the absence of an inversion before proceeding with the application whenever the wind speed is 2 mph or less.

(b) Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.
(c) Keep boom or spray as low as possible to reduce wind effects.
(d) Avoid or minimize drift by utilizing appropriate equipment and settings (*e.g.*, nozzle selection, adjusting pressure, drift reduction agents, *etc.*). Select proper application equipment (*e.g.*, spray equipment that produces 200-800 micron diameter droplets [Spray droplets of 100 microns or less are most prone to drift]).
(e) Follow herbicide label directions for maximum daytime temperature permitted (some types of herbicides volatilize in hot temperatures).
(f) Do not spray during periods of adverse weather conditions (snow or rain imminent, fog, *etc.*). Wind and other weather data will be monitored and reported for all pesticide applicator reports.
(g) Herbicides shall not be applied when the soil is saturated or when a precipitation event likely to produce direct runoff to fish-bearing waters from a treated site is forecasted by NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides can be applied as long as label is followed. Do not conduct any applications during periods of heavy rainfall.

viii. **Herbicide buffer distances –** The following no-application buffers—which are measured in feet and are based on herbicide formula, stream type, and application method—will be observed during herbicide applications (Table 4). Herbicide applications based on a combination of approved herbicides will use the most conservative buffer for any herbicide included. Buffer widths are measured as map distance perpendicular to the bankfull for streams, the upland boundary for wetlands, or the upper bank for roadside ditches.

Table 4. No-application buffer widths in feet for herbicide application, by stream types and application methods.

Herbicide	Perennial Streams and Wetlands, and Intermittent Streams and Roadside Ditches with flowing or standing water present			Dry Intermittent Streams, Dry Intermittent Wetlands, Dry Roadside Ditches		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
Aquatic Glyphosate	100	*waterline*	*waterline*	50	0	0
Aquatic Imazapyr	100	*waterline*	*waterline*	50	0	0
Aquatic Triclopyr-TEA	***Not Allowed***	15	*waterline*	***Not Allowed***	0	0
aquatic 2,4-D (amine)	100	*waterline*	*waterline*	50	0	0
Low Risk to Aquatic Organisms						
Aminopyralid	100	waterline	waterline	50	0	0
Dicamba	100	15	15	50	0	0
Dicamba+diflufenzopyr	100	15	15	50	0	0

Imazapic	100	15	*bankfull elevation*	50	0	0
Clopyralid	100	15	*bankfull elevation*	50	0	0
Metsulfuron-methyl	100	15	*bankfull elevation*	50	0	0
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	*bankfull elevation*	50	15	*bankfull elevation*
Sulfometuron-methyl	100	50	5	50	15	*bankfull elevation*
Chlorsulfuron	100	50	*bankfull elevation*	50	15	*bankfull elevation*
High Risk to Aquatic Organisms						
Triclopyr-BEE	***Not Allowed***	150	150	***Not Allowed***	150	150
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50
2,4-D (ester)	100	50	50	100	50	50

34. **Juniper Tree Removal** 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, aspen, alder, sedge, and rush. This action will help restore composition and structure of desired riparian species, thereby improving ground cover and water infiltration into soils. Equipment may include chainsaws, pruning shears, winch machinery, feller-bunchers, and slash-busters. The following measures will apply:

a. Remove juniper to natural stocking levels where BLM and USFS determines that 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 (Miller *et al.* 2005).
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 would be most appropriate before or after juniper treatment.
g. 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.

35. **Riparian Vegetation Treatment (controlled burning)** includes reintroduction of low- and moderate-severity fire into riparian areas to help restore plant species composition and structure that would occur under natural fire regimes in dry forest types east of the Cascade mountain crest and southwestern Oregon, such as oak woodlands. Conifer thinning may be required to adjust fuel loads for moderate-severity burns to regenerate deciduous trees and shrubs. Equipment would include drip torches and chainsaws, along with fire suppression vehicles and equipment.

a. Low and Moderate Severity Burns

i. Experienced fuels specialists, silviculturists, fisheries biologist, and hydrologists shall be involved in designing prescribed burn treatments.
ii. Prescriptions will focus on restoring the plant species composition and structure that would occur under natural fire regimes.
iii. Burn plans are required for each action and shall include, but not be limited to the following: a description of existing and desired future fire classifications, existing and target stand structure and species composition (including basis for target conditions); other ecological objectives, type, severity, area, and timing of proposed burn; and measures to prevent destruction of vegetation providing shade and other ecological functions important to fish habitat.
iv. Low-severity burns will be used except where the objective is to restore deciduous trees, as describe below under part "v.", with a goal of creating a mosaic pattern of burned and unburned landscape. Low severity burns are characterized by the following:

    Low soil heating or light ground char occurs where litter is scorched, charred, or consumed, but the duff is left largely intact. LW accumulation is partially consumed or charred. Mineral soil is not changed. Minimal numbers of trees, typically pole/saplings, will be killed.

v. Moderate-severity burns are permitted only where needed to invigorate decadent aspen stands, willows, and other native deciduous species and may be targeted in no more than 20% of the area within RHCAs or Riparian Reserves /6th field HUC/year. Such burns shall be contained within the observable historical boundaries of the aspen stand, willow site, other deciduous species, and associated meadows; additional area outside of the "historical boundaries" may be added to create controllable burn boundaries. Moderate severity burns are characterized by the following:

    Moderate soil heating or moderate ground char occurs where the litter on forest sites is consumed and the duff is deeply charred or consumed, but the underlying mineral soil surface is not visibly altered. Light colored ash is present. LW is mostly consumed, except for logs, which are deeply charred.

vi. Fire lines will be limited to five feet in width, constructed with erosion control structures, such as water bars, and restored to pre-project conditions before the winter following the controlled fire. To the extent possible, do not remove vegetation providing stream shade or other ecological functions that are important to streams.

vii. Ignition can occur anywhere within the Riparian Reserve and RHCAs area as long as project design criteria are met.

viii. Avoid water withdrawals from fish bearing streams whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating fish. Pump intakes shall have fish screens consistent with NMFS fish screening criteria (NMFS 2011e).

b. Non-commercial thinning associated with Moderate-severity burns

i. Non-commercial tree thinning and slash removal is allowed only as required to adjust fuel loads to implement a moderate-severity burn to promote growth of deciduous trees and shrubs, such as aspen, cottonwood, willow, other deciduous species, and associated meadows.

ii. Thinning is allowed only in dry forest types (i.e., east of the crest of the Cascade mountains and southwestern Oregon, and in localized lowland areas in western Oregon, (i.e., oak woodlands)).

iii. To protect legacy trees, thinning from below is allowed. If conifers are even-aged pole, sapling, or mid-seral with no legacy trees, thin existing trees to the degree necessary to promote a moderate-severity burn.

iv. No slash burning is allowed within 30’ of any stream. To the extent possible, avoid creating hydrophobic soils when burning slash. Slash piles should be far enough away from the stream channel so any sediment resulting from this action will be unlikely to reach any stream.

v. Apply PDC in National Fire Plan salmonid criteria (USDI-Bureau of Land Management 2005b) for limits on mortality to residual overstory vegetation.

vi. Only hand equipment—chain saws, axes, Pulaski’s, *etc.*—may be used for felling.

vii. Where livestock or wildlife grazing could be a threat to restoration of aspen, cottonwood, willow, alder, and other deciduous vegetation and an immediate moderate-severity burn would consume large amounts of felled trees, consider delaying the burn and leaving felled trees in place to create grazing barriers to help assure plant growth.

viii. If in an existing grazing allotment, projects in this category shall be accompanied by livestock grazing practices that promote the attainment of moderate-severity burn objectives.

36. **Riparian Vegetation Planting** includes the planting of native riparian species that would occur under natural disturbance regimes. Activities may include the following: planting conifers, deciduous trees and shrubs; placement of sedge and or rush mats; gathering and planting willow cuttings. The resulting benefits to the aquatic system can include desired levels of stream shade, bank stability, stream nutrients, LW inputs, increased grasses, forbs, and shrubs, and reduced soil erosion. Equipment may include excavators, backhoes, dump trucks, power augers, chainsaws, and manual tools.

a. Experienced silviculturists, botanists, ecologists, or associated technicians shall be involved in designing vegetation treatments.
b. Species to be planted will be of the same species that naturally occur in the project area. Acquire native seed or plant sources as close to the watershed as possible.
c. Tree and shrub species, willow cuttings, as well as sedge and rush mats to be used as transplant material shall come from outside the bankfull width, typically in terraces (abandoned flood plains), or where such plants are abundant.
d. Sedge and rush mats should be sized to prevent their movement during high flow events.
e. Concentrate plantings above the bankfull elevation.
f. Removal of native and non-native vegetation that will compete with plantings is permitted.
g. Exclosure fencing to prevent utilization of plantings by deer, elk, and livestock is permitted.

37. **Bull Trout Protection** 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.

a. 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.
b. 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 1 foot of water.
    v. Electrofishing will not be conducted within local populations that contain 100 or fewer adult bull trout.
    vi. Electorfishing in SR habitat must be approved by the USFWS Field or Division Supervisor.

vii. Bull trout must not be handled when water temperatures exceed 15º.
viii. Nets, hands, etc. must be free of insect repellant, sunscreen or any other substance that might harm fish.
ix. Ice packs will be used to keep capture water <15º
x. If using MS 222, the formulation should be buffered.

c. Other removal methods, such as dip netting, spearing, and other means can be used.

38. **Beaver (*Castor Canadensis*) Habitat Restoration** includes installation of in-channel structures to encourage beavers to build dams in incised channels and across potential floodplain surfaces. The dams are expected to entrain substrate, aggrade the bottom, and reconnect the stream to the floodplain.

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 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 (Pollock *et al.* 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, and alder) and building exclosures (such as temporary fences) to protect and enhance existing or planted riparian hardwoods until they are established (Malheur National Forest and the Keystone Project 2007).
ii. Maintain or develop grazing plans that will ensure the success of beaver habitat restoration objectives.
iii. As a means to restore desired vegetation (*e.g.*, aspen, willow, alder, and cottonwood) associated with quality beaver habitat, follow project design criteria in the *Riparian Vegetation Treatment (controlled burning) b. Non-commercial thinning associated with Moderate-severity burns* category.

39. **Sudden Oak Death Treatments (Aquatic Species Only)[19]–** Treatments, within 1 site potential tree height of streams, would be used to eradicate *Phytophthora ramorum*, an invasive pathogen of unknown origin, to maintain and protect riparian and adjacent upland vegetation. Oregon state regulations require eradication of the pathogen on sites considered to be of highest risk for advancing further spread of *P. ramorum* into previously un-infected areas. Eradication activities include: 1) Manual and mechanical treatment (cutting of infected host species to create a buffer area; common examples are tanoak, rhododendron, and evergreen huckleberry); 2) Herbicide (aquatic glyphosate or aquatic imazapyr) treatment of tanoak to prevent resprouting; 3) Fuel treatment (burning the cut vegetation), 4) Temporary site access (for heavy equipment or foot traffic), and 5) Site restoration/planting. The proposed action does not include commercial extraction or the cutting of non-host trees or plants.

a. **General –** Treatments will occur within 1 site potential tree height of streams. The zone of eradication includes all host plants (i.e., infected AND uninfected host plants, such as tanoaks, Pacific rhododendron, and evergreen huckleberry) in a buffer zone that extends out up to 300 feet from the infected plant(s). Also proposed for treatment would be understory conifer trees (sapling sized, generally less than or equal to 6 inches) but *only* if they are infected.
   i. Host plant species are determined based on host species affected at the site or information from recent research. Updated host lists are posted at http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/index.shtml
   ii. Multiple infestations within close proximity to each other would be buffered by up to 300 feet to create a single treatment site.
   iii. The proposed action does not include commercial extraction or the cutting of non-host trees or plants.

b. **Manual & Mechanical Treatment (Cutting and Piling) –** Manual or mechanical treatment (cutting) would occur on all sites. Host species as described above, would be cut or piled as stated below:
   i. General
      (a) Retain/protect non-host conifer LW and conifer and non-tanoak reserve trees.
      (b) Cut only host vegetation adjacent to an ESA-critical habitat unless fire behavior or fire effects warrant it. Maintain as much understory shade as practical.
      (c) Non-host brush or hardwood tree species may also be cut if resource specialists determine they pose the risk of fire spread.
      (d) Non-host conifers *less than* eight inches in diameter at breast height (DBH) would be cut only when needed to allow for safe burning of the site.
      (e) Non-host conifers *greater than* eight inches DBH, but less than or equal to 16 inches, would generally be reserved from cutting except when needed to facilitate falling of tanoak or to reduce ladder fuels.

[19] While the USFWS will analyze this category for probable effects to aquatic organisms, this category will not be analyzed for effects to spotted owls and murrelets. Any activities conducted within the range of these species will require separate consultation with USFWS.

(f) Host leaf litter and other fine plant material in the eradication zones would also be raked into the piles.
(g) Piles would be located a minimum of 15 feet from conifer logs, stumps, snags, or conifer trees greater than 16 inch diameter-at- DBH whenever possible.
(h) Every effort would be made to prevent piling within 25 feet of fish-bearing streams when topography allows. Piled material could be placed in the channel only when slopes are greater than 60%.

ii. Manual (chain saw) **–** Removal of the above-ground portion of the infected vegetation by cutting with chainsaws.
(a) Hand-piling of uninfected buffer zone cut vegetation less than or equal to eight inches DBH and all foliage would occur in the eradication zone.
(b) Transport no more than a one day supply of fuel for chainsaws into riparian areas.
(c) Fueling and refueling of chainsaws would not occur within 100 feet of surface waters to prevent direct delivery of contaminants into a water body.

iii. Mechanical Treatment (Excavator and Feller/Buncher) **–** Excavators and feller/bunchers would only be used in sites that are primarily tanoak and where site conditions are feasible.
(a) Minimize ground disturbance by operating equipment on cut slash and piling it upon egress.
(b) Only operate heavy mechanized equipment on slopes less than 35% and when soil moisture is not greater than 25%.
(c) Refuel equipment at least 150 feet from water bodies or use absorbent pads for immobile equipment (or as far as possible from the water body where local site conditions do not allow a 150 foot setback) to prevent direct delivery of contaminants into associated water bodies.
(d) See Temporary Site Access (Heavy Equipment and Trail Construction) below for additional heavy equipment project design criteria.

c. **Herbicide Treatment (Stem Injection, Cut-stump/Hack & Squirt, Wicking/Wiping, and Spot Spray)**

i. **Herbicides –** The only herbicides proposed for use are aquatic-labeled glyphosate and aquatic-labeled imazapyr in accordance with project design criteria for herbicides in PDC 33e, Non-native Invasive Plant Control (Chemical Methods).

ii. **Herbicide Application Methods –** Only stem injection, cut-stump/hack & squirt, wicking/wiping, and spot spraying with hand-held nozzles will be used for SOD treatments. Treat only the minimum area necessary for effective control.

iii. No broadcast spraying of herbicides.

iv. Only daily quantities of aquatic-labeled glyphosate or aquatic-labeled imazapyr will be transported to the project site.

v. Herbicides will be applied in accordance with state and federal law. An Oregon Licensed applicator with forestry, aquatic, or right-of-way categories would be utilized. All herbicide mixing would be done in the presence of an agency Project Inspector.

vi. Equipment cleaning and storage and disposal containers would follow all applicable state and Federal laws.

vii. The licensed herbicide applicator would prepare a written herbicide Spill Contingency Plan in advance of the actual aquatic-labeled glyphosate or imazapyr application, then submit it to the Authorized Officer prior to operations, and keep a copy with each crew. The plan would include reporting procedures, including reporting spills to the appropriate regulatory agency. The plan would also address transportation routes so that hazardous conditions are avoided to the extent possible. An agency approved Spill Containment Kit would be on-site during all stages of applications.

d. **Fuel Treatment (Broadcast or Pile Burning of Cut Vegetation)**

i. General

(a) An experienced fuels technician, silviculturists and fisheries biologist shall be involved in designing prescribed burn treatments.

(b) Prescriptions and burn plans will be prepared to implement safe and effective treatments.

(c) To minimize soil erosion, loss of soil productivity, and water quality degradation, an interdisciplinary team will review the infestation site prior to treatment and will evaluate the need for mitigation measures. Recommended rehabilitation work will be completed by the action agency prior to the fall run-off period.

(d) Consume infested material to reduce or eliminate the pathogen on the site.

(e) To the extent practical, retain all non-infected conifers, non-host hardwoods, and conifer large downed wood within and outside of fire line by wetting, directional falling, or limbing of live trees.

(f) Avoid creating hydrophobic soils.

(g) Any placement of portable pumps adjacent to streams for pre-treating of fuels or mop-up will have the required containment kit and absorbent pads for the pump and fuel can.

(h) Avoid water withdrawals from fish bearing streams whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating fish. Pump intakes shall have fish screens consistent with *Anadromous Salmonid Passage Facility Design* (NMFS 2011e).

ii. **Pile Burning –** Burning of hand piles would be the primary method of burning since there is a need to burn the infected sites in a short period of time and piles can be burned almost year round. Burning of hand piles normally occurs during November, December, and January, but could occur any time of the year.

(a) Piles would be located a minimum of 15 feet from conifer logs, stumps, snags, or Douglas-fir trees greater than 16 inch DBH whenever possible.

(b) Every effort would be made to prevent piling and burning within 25 feet of fish-bearing streams when topography allows. Slopes greater than 60% could have the potential for piled material in the channel.

iii. **Broadcast Burning –** Broadcast burning is highly dependent on variables including: location, slope, aspect, unit size and shape, neighboring ownership, defensible burning boundaries, road access, weather, fire danger levels, and length of drying period for vegetation to cure.

(a) Fire- lines would be dug or scraped where needed to prevent fire spread on the perimeter of treatment sites. Fire-line construction would clear an eight foot wide path of vegetation less than four inches in diameter and trees would be limbed eight feet from the ground. Up to three feet of the fire-line would be cleared to mineral soil. A three-foot section would be removed when needed from down logs where the log crosses the fire-trail. All snags and logs would remain on site. Fire-lines would be constructed with erosion control structures and restored to pre-project conditions before the winter following the controlled fire. To the greatest degree possible, vegetation providing stream shade or other ecological functions important to streams would not be removed.

(b) Broadcast burning would occur during the fall after the first heavy rains, in the winter, or in the spring prior to fire season. Most burning would likely occur in spring or under spring-like conditions. Spring-like conditions can generally be described by the following conditions 1) saturated soils; 2) fuel moistures of 32% or greater in larger fuels (1000 hour/9" diameter or greater fuels); 3) live fuel moistures of 250% or greater; 4) air temperatures less than 70°F; 5) relative humidity of 30% or greater; and 6) burning occurring within a dry period lasting typically no more than five days.

e. **Temporary Site Access (Heavy Equipment and Foot Traffic) –**Temporary heavy mechanized equipment access is proposed where one-time entry is needed for access to eradication sites. Temporary site access would only be used to move equipment off an existing road and "walk" the equipment to the site. Previously existing spur roads or skid roads and stable areas could be used for heavy equipment access. The need for temporary access would be highly variable, depending on availability and treatment being considered for the entry. Access trails could be constructed into sites without road access.

i. **General**

(i) No roads would be constructed or reconstructed for SOD treatments in riparian areas.

(j) Blading or rocking would not occur.

(k) No cutting of conifers greater than 16 inches DBH within the stream influence zone for access.

(l) See **Mechanical Treatment (Excavator and Feller/Buncher)** above for additional project design criteria.

ii. **Temporary Heavy Equipment Site Access**
   (a) Temporary heavy equipment access is defined as a minimal travelway for the purpose of site access that is used over the course of the eradication activities.
   (b) Temporary heavy equipment access locations and stabilization measures are typically determined by the Contract Officer Representative, who would request the advice of a watershed specialist in determining the most appropriate location and stabilization measures to be required.
   (c) All temporary travelways used to walk in heavy mechanized equipment will be designated by a soil scientist or hydrologist and approved as the course that will produce the least potential damage to water quality.
   (d) Site access off of existing roads for heavy equipment would be minimal and for the purpose of limited machine access only.
   (e) Stream channel crossing will be located as to minimize adverse effects to water quality, streambank stability, and riparian vegetation.
   (f) Minimize or avoid locating within stream influence zones (1 site potential tree height for fish bearing or perennial stream or critical habitat).
   (g) Do not locate on side slopes > 35 %.
   (h) Do not access areas determined to have high erosion potential.
   (i) Do not construct or use outside of dry conditions.
   (j) Restore as directed by physical scientist (*e.g.*, seed or plant access site, water bar, use erosion control techniques, prevent vehicle access after access).

iii. **Temporary Foot Traffic Access –** Temporary access trails within riparian areas could be constructed into sites without road access.
   (a) Access trail construction would entail minimal brushing necessary for safe access. Temporary trails may be up to four feet wide and all vegetation less than five inches would be cut by chainsaws or hand tools. Trees along the trail would be limbed up to eight feet on the side adjacent to the trail to allow for movement of equipment and personnel. No clearing of duff or organic layer would occur on the ground surface.
   (b) Up to twenty miles per year of temporary non-motorized access trails within riparian areas would be constructed. Repeat treatments to prevent re-sprouting of tanoak could require repeat access; temporary access trails would be rehabilitated after each season of use.

f. **Site Restoration --** Vegetation planting would occur as a means to help restore plant species composition and structure that would occur under natural disturbance regimes. Site restoration equipment may include manual tools, such as shovels and hoedads.
   i. Minimize ground disturbance by clearing only area necessary for effective planting.

i. Exposed soils that may deliver sediment to streams will be treated with grass seed (preferably native grass seed if available), slash, water bars or other appropriate methods that will minimize or eliminate sediment delivery.
ii. Planting will occur with Douglas-fir or other non-host species on sites when area is determined to be disease free.
iii. Species to be planted must be the same species that naturally occur in the project area.

g. **LIMITATIONS to SOD Treatments –** SOD eradication activities that *exceed* the below Limitations #1, #2 and #3 criteria in occupied coho salmon streams, designated critical habitat streams, and in unoccupied perennial streams that flow into SONCC coho salmon streams or SONCC coho critical habitat are not covered under this consultation.
i. **Limitation #1: Contiguous Stream Length**. The SOD eradication activities proposed for implementation within one site potential tree height shall not exceed the following shade removal criteria (Table 5).

Table 5. Limitation #1: Contiguous stream length and activity intensity criteria based on stream size.

Small perennial streams (defined as less than 27 feet ordinary-high-water elevation (OHW) width)
A maximum of **30% removal of canopy cover, which provides stream shade, may occur** over a contiguous maximum of **0.5 stream length mile***   ***OR***
A maximum of **50% removal of canopy cover, which provides stream shade, may occur over a** contiguous maximum of **0.25 stream length mile*.**
Medium-to-Large perennial streams (defined as equal to or greater than 27 feet ordinary-high-water elevation width)
A maximum of **50% removal of canopy cover, which provides stream shade, may occur over a** contiguous maximum of **0.5 stream length mile*.**
***Treatment Limitations to Contiguous Stream Length:** All contiguous treated riparian segments within one Site Potential Tree will be separated by a distance of **4,600 feet**, where no eradication activities have been or will be applied. This 4,600-foot separation of non-treatment will occur between sequential contiguous treatments.

ii. **Limitations #2 and #3.**
(a) Limitation #2. Must stay at or below 3 miles of treatment for any 5-year period. Treatments include activity within one Site-Potential-Tree-Height.
(b) Limitation #3. Must stay at or below 3% of the Total Federal Perennial Stream miles per Watershed.
(c) Tracking and Check Points. To stay within the limitations #2 and #3, the action agencies will implement the following parameters.

(i) **When eradication activities exceed 85% of either Limitation #2 *or* Limitation #3 for any 5-year period:** The action agencies will notify NMFS informing them of the approaching exceedance (via the ARBO II e-mail box). This notification will trigger a local Level 1 team meeting.

(A) The action agencies will present information on cumulative SOD activities including that listed under **Annual Requirements (see below, section h)**.

(B) The action agencies will present their best estimate of additional stream miles needing SOD eradication activities within the 5-year period, along with treatment information. The Level 1 team will develop a strategy and procedure for dealing with the exceedance when the action agency's best estimate of additional treatment reaches the 95% threshold.

(C) The primary goal will be to determine how to provide coverage for implementation of the additional needed SOD eradication activities without delay and without exceeding the amount and extent of effects authorized by the biological opinion.

h. **Reporting Requirements**

i. **Pre Project Notification.** Follow ARBO II Project Notification criteria (see PDC 3). For SOD treatment projects include the following items:

(a) Stream size (see Table 5)

(a) Acres treated within 1 Site Potential Tree Height of perennial streams

(b) Treatment on one or both sides of stream

(c) Proximity of treatment to edge of stream (bankfull width)

(d) Proximity of SONCC and OC coho salmon critical habitat and EFH to the treatment unit

ii. **Post Project Completion.** Follow ARBO II Project Completion Report criteria (see PDC 5). For SOD treatment projects within 1 SPTH of perennial streams, include the following items in Table 6.

Table 6. SOD Treatment Post-Notification Reporting

Units w/in 1 SPTH of Perennial Stream											
Unit number and stream size (small or medium -to- large)	**5th field HUC**	**Date Pre-reported**	**Acres Pre-reported**	**Date Cut and if applicable Piled**	**Date Burned**	**Acres treated**	**Linear distance of treatment along stream (feet or miles)**	**Treatment on one or both side of stream**	**Proximity of treatment to edge of stream (bankfull width) (feet)**	**Proximity of coho/CH/ EFH to the unit (feet or miles)**	**Percent removal of shade-providing -canopy cover**

iii. **Annual Monitoring.** Action agencies will also provide annual monitoring data to the Level 1 Team for post project activities covering the following four items. Note: Items (a) and (b) below could be reported by individual action agencies. Items (c) and (d) below will be reported jointly.

(a) **Site/Year Map:** Provide an annual map of all cumulative locations of SOD eradication activities. The map will depict treatment sites by year and 5th field watershed.

(b) **Monitoring:** Report treatment unit data, including information items required for project completion listed above (see h.ii).

(c) **Treatment Tracking – Limitation #1:** Report total annual miles of treatment as they apply to Table 6.

(d) **Treatment Tracking - Limitation #2:** Report the total annual miles of treatment (for all action agencies combined) per year. Also describe in relation to exceeding 3 miles of treatment for a 5 year period (i.e., combined cumulative treatments are x% of the 3 miles).

(e) **Treatment Tracking – Limitation #3:** Report the total annual miles of treatment by 5th field watershed (for all action agencies combined) per year. Also describe in relation to exceeding 3% of the total perennial stream miles in any given 5th field watershed for a 5 year period (i.e., combined cumulative treatments are x% of each watershed).

40. **Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration** include assessments and monitoring projects that could be or are associated with planning, implementation, and monitoring of aquatic restoration projects covered by this opinion. Such support projects may include surveys to document the following aquatic and riparian attributes: fish habitat, hydrology, channel geomorphology, water quality, fish spawning, fish presence, macro invertebrates, riparian vegetation, wildlife, and cultural resources (including excavating test pits <1 m^2 in size). This also includes effectiveness monitoring associated with projects implemented under

ARBO II, provided the effectiveness monitoring is limited to the same survey techniques described in this section.

a. Train personnel in survey methods to prevent or minimize disturbance of fish. Contract specifications should include these methods where appropriate.
b. Avoid impacts to fish redds. When possible, avoid sampling during spawning periods.
c. Coordinate with other local agencies to prevent redundant surveys.
d. 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.
e. Does not include research projects that have or should obtain a permit pursuant to section 10(a) of the ESA.

1.4 General Conservation Measures and Project Design Criteria for All Terrestrial and Fish Species

1. **The following CMs apply to all listed terrestrial species for all programmatic activities:**
   a. Aquatic restoration actions will not remove or downgrade suitable habitat (on either public or private land) for any listed terrestrial species.
   b. Effects of danger tree removal will be either discountable or insignificant to ESA-listed terrestrial species and their critical habitat.
   c. All restoration activities must have the unit's botanist and terrestrial wildlife biologist input/analysis of the project design and their site-specific species assessment to proceed. This includes a plant survey and nest analysis (or survey if deemed appropriate by the unit biologist, and suitable habitat is known to occur within the project prior to project implementation).
   d. There will be no disturbance allowed from blasting activities as they are not part of the proposed action.
   e. The unit wildlife biologist is responsible for ensuring that the correct effects determination is made for each project. The unit wildlife biologist may increase or decrease disturbance distances according to the best available scientific information and site-specific conditions. Refer to Tables 9-10. For instance, if a known spotted owl site is surveyed to protocol and the owls are determined to be non-nesting, the unit biologist may determine that no disturbance or disruption would occur and lift the associated restrictions on activities within disruption distances during the year of survey.

Table 7. Disturbance Distances and Time Periods When Disturbance (and Possibly Disruption) May Occur for Terrestrial Species.*

Species	Disturbance Distance (in miles)	Time Period Applicable
Northern spotted owl (nesting)	See Table 9	Mar 1 – September 30
Marbled murrelet (nesting)	See Table 10	Apr 1 – Sept 15***
Canada lynx (denning)	0.25	May 1 – Aug 31
Gray wolf (active dens/rendezvous sites)	1.0	Jan 1 – Dec 31
Grizzly bear (denning)	0.25	Oct 15 – May 15
Grizzly bear (early foraging habitat)	0.25	Mar 15 – July 15
Grizzly bear (late foraging habitat)	0.25 (actions >1 day)	July 16 – Nov 15
Woodland caribou	Recovery Area	Early winter
All Plants	0.25**	Jan 1 – Dec 31
*See PDCs below for additional details. **If project is within 0.25 mile of a listed plant, then measures must be taken to minimize threats to NE or NLAA the species to be covered by this programmatic consultation. ***General Conservation Measure MM1 requires daily timing restrictions. The first work restriction stops two hours after sunrise and the work restriction starts again 2 hours before sunset.		

2. **Mammals: For threatened or endangered mammals that may occur in project areas within the scope of this ARBO II, the following criteria will be applied where applicable:**
    a. Canada Lynx
        i. **CL1:** No active lynx dens are located within 270 yards (based on sight distance and attenuation of sound in forested environments) of a project.
        ii. **CL2**: The project will meet the standards and guidelines identified in the Lynx Conservation Assessment and Strategy (LCAS) and are within the LCAS thresholds (suitable, unsuitable, and denning habitat).
        iii. **CL3:** The project will not result in increased off-road vehicle access to lynx habitat during or following implementation.
    b. Gray Wolf
        i. **GW1**: Meets Recovery Plan direction for den and rendezvous sites (i.e., no projects/activities within 1 mile of den or rendezvous sites scheduled to occur between April 15 and June 30). If an active den, rendezvous site is within 1 mile, the project would fall outside the scope of this ARBA II, and a separate consultation would be required to address potential effects.
    c. Grizzly Bear
        i. **GB1**: Projects generating noise above ambient levels within ¼ mile (1 mile for blasting) of any known grizzly bear den site will not occur from November 1 through April 30.
        ii. **GB2**: Projects generating noise above ambient levels and located within ¼ mile (1.0 mile for blasting) of early season grizzly bear foraging areas (e.g., low elevation grass/forb habitat, deciduous forest, riparian forest, shrub

fields, montane meadows, avalanche chutes) will not occur from March 15 to July 15 if the activity will last for more than one day.

iii. **GB3**: Projects generating noise above ambient levels and located within ¼ mile (1.0 mile for blasting) of late season grizzly bear foraging areas (e.g., high elevation berry fields, shrub fields, fruit/nut sources, wet forest openings, alpine and sub alpine meadows, montane meadows [moist, cool, upland slopes dominated by coniferous trees]) will not occur from July 16 to November 15 if the activity will last for more than one day.

iv. **GB4**: Projects will not increase trail or road densities within grizzly bear core area. No road or trail construction or reconstruction will occur in recovery areas.

v. **GB5:** All attractants, including food and garbage, will be stored in a manner unavailable to wildlife at all times.

d. Woodland Caribou

i. **WC1**: Projects that are scheduled during early winter in the caribou recovery area (USDA et al. 2013) and generate noise above ambient levels will be evaluated by the local wildlife biologist to determine if there will be disturbance effects to caribou.

ii. **WC2:** Any vegetation management will not affect more than 1.0 acre of native forest per year.

iii. **WC3:** Projects will not result in increased off-road vehicle access to caribou habitat.

3. **Plants: For threatened or endangered plant species that may occur in project areas within the scope of this ARBO II, the following criteria will be applied:**

a. All Listed Plant Species

i. **PL1**: A unit botanist will have the following input in all project designs: (a) the botanist will determine whether there are known listed plants or suitable habitat for listed plants in the project area; (b) If a known site of a listed plant is within 0.25-mile of the project action area, or that suitable or potential habitat may be affected by project activities, then a botanist will conduct a site visit/vegetation survey to determine whether listed plants are within the project area. This visit and survey will be conducted at the appropriate time of year to identify the species and determine whether individual listed plants or potential habitat are present and may be adversely affected by project activities (see Table 8).

ii. **PL2:** If one or more listed plants are present and likely to be adversely affected by the project, then the project is not covered by this BO and consultation with the FWS under Section 7 of the ESA must be initiated. If a project will have no effect or is NLAA listed plants it is covered under this ARBA II. Project design criteria should address both the critical life cycle of listed plant species as well as the effective biotic and abiotic environmental factors sustaining rare plant taxa.

iii. **PL3:** Due to soil disturbance that may occur during aquatic restoration activities and use of heavy equipment that could carry seeds and plant parts into project areas, all appropriate prevention measures will be incorporated into contract or equipment rental agreements to avoid introduction of invasive plants and noxious weeds into project areas.

Table 8. Optimal Survey Times for Flowering Periods of Listed Plants in Oregon and Washington

Species	Optimal Survey Time Period*
Applegate's Milk-Vetch	June to early August
Bradshaw's Lomatium	April to mid-May
Cook's Lomatium	Mid-March through May (varies with spring moisture)
Gentner's Fritillary	April to May
Golden Paintbrush	April to September
Howell's Spectacular Thelypody	June through July
Kincaid's Lupine	May through June
Large-flowered Wooly Meadowfoam	Mid-March to May (varies with spring moisture)
MacFarlane's four o'clock	May through June
Malheur Wire-Lettuce	July through August
Marsh Sandwort	May to August
McDonald's Rock-cress	Mid-March through June
Nelson's Checkermallow	Late May to Mid-July
Rough Popcornflower	Mid-June through July
Showy Stickseed	May to July
Spalding's Catchfly	July through August
Ute Ladies'-Tresses	July to late August
Water Howellia	June through August
Wenatchee Mountains Checker-Mallow	June to Mid-August
Western Lily	June to July
Willamette Daisy	Mid-June to early July

*This is a guideline. The local botanist will survey when the time is appropriate.

4. Insects: To avoid adverse effects to Fenders blue butterfly the following will be applied:

a. Fenders Blue Butterfly

i. FBB1: No project included in this assessment will remove or disturb Kincaid's lupine, spur lupine *(Lupinus laxiflorus = L. arbustus)* or sickle-keeled lupine *(L. albicaulis*) within the range of the Fender's blue butterfly.

ii. FBB2: No project included in the assessment will remove habitat including the following nectar sources: wild onion (*Allium amplectans*); cat's ear mariposa lily (*Calachortus tolmiei*); common camas (*Camassia quamash*); Oregon sunshine (*Eriophyllum lanatum*); and rose checkermallow (*Sidalcea virgata)* within the range of the Fender's blue butterfly.

5. **Fish: To avoid adverse effects to Borax Lake chub, and to lesson adverse effects to bull trout and Oregon chub the following measures will be applied:**
    a. Borax Lake chub
        i. BLC1 No activities that could substantially alter water levels (including projects that might lower the water table), or change the natural outflows or inflows of the lake are covered by this BO.
    b. Bull Trout
        i. 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 USFWS Division or Field Manager.
        ii. The driving of steel or concrete piles within the wetted width of a stream or within the wetted area of a lake are not covered under this BO. If steel or concrete piles are to be driven adjacent to bull trout SR habitat, the action agencies will work with the USFWS Level 1 Team member to determine what (if any) site-specific PDCs or CMs are needed to reduce potential impacts to bull trout.
    c. Oregon chub
        i. Projects that would expose Oregon chub to non-native fish where such exposure does not currently exist must be approved by the USFWS Division or Field Manager.

6. **Birds:** ARBO II attempts to minimize or avoid adverse effects to listed birds by implementing aquatic restoration actions outside of critical nesting period windows and/or outside of disturbance or disruption distances from occupied habitat. However, some aquatic restoration activities must occur within a listed bird critical nesting period or within a disturbance or disruption distance. A limited number of aquatic restoration activities that adversely affect listed birds will therefore occur under this proposed action.
    a. Conditions common to all programmatic activities that will be applied to avoid disturbance or disruption of listed bird species include:
        i. The proposed activities included in this document are consistent with the Northwest Forest Plan (USDA and USDI 1994a) and FS Land and Resource Management Plans and BLM Resource Management Plans as amended by the Record of Decision for Amendments to the Survey and Manage, Protection Buffer, and Other Mitigation Measures Standards and Guidelines, USDA Forest Service and USDI BLM (USDA and USDI 2001, USDA and USDI 2008 as amended by the 2011 agreement).
        ii. The proposed activities do not include those that would result in loss of suitable habitat (on either public or private land) for the identified ESA-listed species.
        iii. The proposed activities must have wildlife biologist input/analysis to proceed.
        iv. As a general rule, a disruption site is defined as approximately 100 meters radius around the project site. However, the unit wildlife biologist has the

discretion to adjust disturbance and disruption distances, based on site-specific conditions.

b. **Northern spotted owl**

i. **NSO1**: To reduce adverse effects to spotted owl, projects will not generally occur during the critical breeding period, generally between March1 – July 15, but may vary by location (July 7 for the Oregon North Coast Planning Province) if there is an active known owl site, predicted owl site (as determined through an approved modeling process), RPO (Reference Point Owl) and/or occupied habitat within the disruption distance of the project area. Projects should (a) be delayed until after the critical breeding season (unless action involves Type I helicopters, which extend critical nesting window to September 30); (b) delayed until it is determined that young are not present.

ii. **NSO2**: The unit wildlife biologist may extend the restricted season based on site-specific information (such as a late or recycle nesting attempt).

iii. **NSO3**: Table 9 shows disruption distances applicable to the equipment types proposed in the ARBO II. These distances can be locally altered based on current information.

iv. **NSO4**: No activity within this BO will cause adverse effects to spotted owl critical habitat when analyzed against the appropriate local scale as determined by the unit wildlife biologist.

v. **NSO5**: For LW projects follow project design as outlined within section 22. e.

vi. **NSO6:** No hovering or lifting within 500 feet of the ground within occupied spotted owl habitat during the critical breeding season by ICS Type I or II helicopters would occur as part of any proposed action addressed by this assessment.

Table 9**.** 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 campgrounds, administrative facilities, and heavily-used roads	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA
Log hauling on heavily-used roads (FS 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]
Blasting	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile[4]	NA	≤ 100 yards (injury)[4]
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
Burning (prescribed fires, pile burning)	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile[10]	NA	NA

NLAA = "not likely to adversely affect." **LAA** = "likely to adversely affect" **≥ is greater than or equal to, ≤ is less than or equal to.**

Table 9 (Spotted Owl) Footnotes:

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)**

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. (1999, p. 67) which indicates that spotted owl flush responses to above-ambient equipment sound levels and associated activities are most likely to occur at a distance of 65 yards (60 m) or less.
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 50 ft 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 – 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 – 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 percent 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 2008e, p. 4).
11. The exact dates are variable by physiographic province, and differences by locality. Work with the USFWS to select the proper dates when planning or implementing projects.

c. **Marbled Murrelet**

i. **MM1:** Projects will not occur within the applicable disruption and disturbance distances for marbled murrelets within their critical nesting period (Table 10), unless a protocol survey determines marbled murrelets are not present. Otherwise the project would be LAA and either delayed until August 6 (with 2-hr timing restrictions) or until it is determined that young are not present or counted toward the limited number of LAA projects covered under this programmatic (with 2-hr timing restrictions).

ii. **MM2:** Projects within the applicable disruption and disturbance distances for marbled murrelets implemented between August 6 and September 15 would not begin until 2 hours after sunrise and would end 2 hours before sunset.

iii. **MM3:** No suitable, potential, or critical marbled murrelet habitat is to be removed or downgraded as part of this action.

iv. **MM4:** Garbage containing food and food trash generated by workers in project areas is secured or removed to minimize attraction of corvids, which have been identified as predators of murrelet eggs and young.

v. **MM5:** Table 10 shows marbled murrelet disruption distances that are applicable to the proposed actions under this BO. Distances and times can be locally revised based on current information.

vi. **MM6:** For LW projects follow project design as outlined within section 22. e.

Table 10**.** Disturbance, disruption (harass) and/or physical injury (harm) distance thresholds for **Marbled Murrelet** during the nesting season **(April 1 to September 15).** 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**	**ACTION LIKELY DETECTED BY BREEDING MURRELETS** disturbance distances	disruption distances	direct 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 (FS 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, etc.	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	NA
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	>0.25 mile	121 yards to 0.25 mile	≤ 120 yards[3]	≤ 5 yards(injury)[3]
Blasting	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile[3]	100 yards (injury)[4]
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[5]	100 yards[6] (injury/mortality)
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[7]	50 yards[6] (injury/mortality)
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[8]	50 yards[6] (injury/mortality)
Small fixed-wing aircraft (Cessna 185, etc.)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards	NA
Tree Climbing	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[9]	NA
Burning (prescribed fires, pile burning)	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile[10]	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 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012d, 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 50 ft for pile-driving, exposure to injurious sound levels would only occur at extremely close distances (e.g., ≤ 5 yards).
4. 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 – 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 – 146 dBA at a distance of 100 m (110 yards).
5. Based on an estimated 92 dBA sound-contour (approximately 265 yards) for the Chinook 47d (Newman et al. 1984, Table D.1).
6. Because murrelet chicks are present at the nest until they fledge, they are vulnerable to direct injury or mortality from flying debris caused by intense rotor wash directly under a hovering helicopter. 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.
7. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).
8. 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 recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012d, pp. 6-9).
10. Based on recommendations presented in *Smoke Effects to Northern Spotted Owls* (USFWS 2008d, p. 4).

1.5 Action Area

"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 ESA-listed salmon or steelhead, designated critical habitat, or designated EFH in Oregon and Washington. This includes all upland, riparian and aquatic areas affected by site preparation, construction, and site restoration design criteria at each action site.

Each individual project authorized under ARBO II will have a project-level action area that exists within the program action area. Because the size of these individual project-level action area will vary in size depending on the exact action being undertaken and the work categories being used, it is impossible to state what exact size the action area will be. The NMFS (2013) estimated on average that individual project-level action areas will include riparian areas, banks, and the stream channel in area extending no more than 150 feet upstream (the beneficial effects of the action can extend much further upstream if fish passage is restored) and 300 feet downstream from the action footprint. The USFWS will use the same estimation, where aquatic habitat conditions will be temporarily degraded until site restoration is complete, and sufficient time has passed for the system to rebound (although the USFWS acknowledges that some degree of adverse effects could extend much farther downstream). This estimate is based on an analysis of typical turbidity flux downstream allowable under State statutes of Oregon and

Washington from a nonpoint discharge in a stream with a low flow channel that is greater than 200 feet, although the actual turbidity flux at each project site is likely to be proportionately smaller for streams with a smaller low flow channel width (Rosetta 2005), or may be somewhat greater for project areas that are subject to tidal or coastal scour. The USFWS recognizes that many projects are capable of producing a turbidity flux of greater magnitude than this. In some cases projects such as culvert replacement may show effects 600 feet or more below the project. Larger projects that remove dams or that would realign a streamchannel could produce sediment and cobble embeddedness much farther than 300 below the project site, and could show effects ¼ mile or more below the actual site. Because of the wide variability of stream types, project types and site-specific conditions the USFWS has chosen to use 300 feet as an average distance, combined with turbidity monitoring criteria (see ITS section) that the USFWS believes will insure compliance with both EPA and State guidelines and therefore, allow for reasonable protection for ESA-listed fish.

All actions funded or carried out under this opinion will occur on Federal lands administered by the USFS, BLM, or the Coquille Indian tribe, or on eligible adjacent private lands, that are also within the present or historic range of ESA-listed species considered in this opinion and are administered by offices in the States of Oregon and Washington. USFS and BLM administrative units are primarily located in Oregon and Washington, but overlap into California (Rogue/Siskiyou National Forest), Nevada (Lakeview and Vale BLM District), and Idaho (Wallowa-Whitman National Forest) (Table 11).

Table 11**.** National Forests and BLM Districts, with state location, covered by this consultation.

Land Management Unit	**State**
National Forests	
Deschutes	OR
Fremont/Winema	OR
Malheur	OR
Mt. Hood	OR
Ochoco	OR
Rogue River/Siskiyou	OR/CA
Siuslaw	OR
Umpqua	OR
Wallowa/Whitman	OR/ID
Willamette	OR
Colville	WA
Gifford Pinchot	WA
Mt. Baker/Snoqualmie	WA
Okanogan/Wenatchee	WA
Olympic	WA
Columbia River Gorge Scenic Area	OR/WA
Umatilla	OR/WA
BLM Districts	
Burns	OR
Coos Bay	OR
Eugene	OR

Lakeview	OR/NV
Medford	OR
Prineville	OR
Roseburg	OR
Salem	OR
Vale	OR/NV
Spokane	WA

The precise number of actions that will occur each year and their exact location is unknown. It is likely that projects will be distributed across IRUs and affected basins in similar proportions as they were during the 2008-2012 period as described in Table 3.

2.0 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 USFWS, 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 specifying the impact of any incidental taking, and including reasonable and prudent measures to minimize such impacts.

2.1 Letter of Concurrence

The USFS, BLM and Coquille Tribe have requested concurrence that the activities described in the proposed action "may affect, but are not likely to adversely affect" a number of listed terrestrial species, one fish species and their critical habitats. In order to insure that no adverse effects will occur, PDCs as described under section 1.4 will be implemented:

Strict implementation of the PDCs (Section 1.4) will reduce the possibility of adverse effects to an extent that is discountable for both the species and their critical habitats. Therefore the USFWS concurs with the effects determinations that the activities associated with the proposed action "may affect, but are not likely to adversely affect" Canada lynx, grey wolves, grizzly bears, woodland caribou, Howell's spectacular thelypody, MacFarlane's four-O'clock, Spalding's catchfly, Ute ladies'- tresses, water howellia, Wenatchee Mountains checker-mallow, rough popcornflower, Macdonald's rockcress, Gentner's fritillary, Nelson's checkermallow, western lily, Willamette Valley daisy, Bradshaw's lomatium, Cook's lomatium, large-flowered woolly meadowfoam, Applegate's milk-vetch, Malheur wire-lettuce, golden paintbrush, Kincaid's lupine, and Fender's blue butterfly, Borax Lake chub or their critical habitats (if designated). These species are described in Appendix A of this document. This concludes consultation for these species and they will not be analyzed further.

2.2 Approach to the Analysis

2.2.1 Analytical Framework for the Jeopardy and Adverse Modification Determinations

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this Biological Opinion relies on four components: (1) the *Status of the Species*, which evaluates bull trout 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 BO 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 B O 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 B O relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the bull trout 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 BO 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. First ESA-listed fish will be discussed, followed by listed birds.

- *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 (also called “primary constituent elements” or PCEs) – which were identified when the critical habitat was designated.
- *Describe the environmental baseline in the action area.* The environmental baseline (section 2.3) 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 (section 2.4), we consider how the proposed action would affect the species’ reproduction, numbers, and distribution. We also evaluate the proposed action’s effects on critical habitat PCEs.
- *Describe any cumulative effects in the action area.* Cumulative effects (section 2.5), 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 (section 2.6), we add the effects of the action (section 2.4) to the environmental baseline (section 2.3) and the cumulative effects (section 2.5) 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 (section 2.2).

- *Reach jeopardy and adverse modification conclusions.* In this step (section2.7) we state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in section 2.7. These conclusions flow from the logic and rationale presented in sections 2.5 and 2.6 (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 in section 2.8. 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.

2.3 Rangewide Status of the Species and Critical Habitat

This BO examines the status of each species that would be adversely affected by the proposed action. The status is the level of risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The BO also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large is climate change.

2.3.1 Bull Trout

a. Species Description

i. *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.

ii. *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 41 inches (103 centimeters) in length, with weights as high as 32 pounds (14.5 kilograms) (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 2011c). Migratory bull trout are typically larger than resident bull trout (USFWS 1998a)

b. Current legal status, including listing history

The coterminous U.S. population of the bull trout was listed as threatened on November 1, 1999 (64 FR 58910). 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 and Brewin 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 (64 FR 58910). 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) (63 FR 31647; 64 FR 17110). 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 Act relative to this species (64 FR 58910):

c. Critical habitat Description

i. Current legal status of the critical habitat

The USFWS published a final critical habitat designation for the coterminous U.S. population of the bull trout on October 18, 2010 (70 FR 63898); 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)[20]. Rangewide, the USFWS designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat. Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing (SR), and 2) foraging, migration, and overwintering (FMO).

Table 12**.** 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 percent for miles of stream/shoreline and by approximately 71 percent 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 (6,758.8 ha) 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

[20] The Service'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.

were determined by the USFWS 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 USFWS; or 3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant 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.

ii. *<u>The primary constituent elements (PCEs)</u>*

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898:63943 [October 18, 2010]). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

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 Primary Constituent Elements (PCEs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

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, as described within 75 FR 63898 are essential for the conservation of bull trout. 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 36 °F to 59 °F (2 °C 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.

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 FMO 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 ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The USFWS 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 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 (75 FR 63898:63943; USFWS 2004d, Vol. 1. pp. 140-193, Vol. 2. pp. 69-114). The USFWS’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 1998b, pp. 4-39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (75 FR 63898:63943).

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of non-native species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

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

d. 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).

e. Life history

i. 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 6 to 12 inches total length, and migratory adults commonly reach 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.

ii. 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.

iii. *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.

iv. *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 (Mike Gilpin in litt. 1997; 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 59 °F), and spawning habitats are generally characterized by temperatures that drop below 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 35 °F to 39 °F whereas optimum water temperatures for rearing range from about 46 °F 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, 46 °F to 48 °F, within a temperature gradient of 4 °F 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 52 °F 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 46 °F 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 National Forest, 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).

f. Status

i. *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).

ii. *Current status and distribution of the listed species in rangewide (summary)*

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 2004c). The draft bull trout recovery plan (USFWS 2004c) 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 2004c).

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 2002c). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002c). The draft Klamath River bull trout recovery plan (USFWS 2002c) 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 2002c).

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 percent of the Columbia River Basin, and presently occur in 45 percent 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 percent 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 (63 FR 31647). 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. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game in litt. 1995). The USFWS 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 2005c).

The draft Columbia River bull trout recovery plan (USFWS 2002e) 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 2004c). 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 2004c) 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 2002d). 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 2002d). 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 2002d). The draft St. Mary-Belly bull trout recovery plan (USFWS 2002d) 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.

g. Threats, reasons for listing, current rangewide status

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 (63 FR 31647).

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).

h. 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. in press).

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 et al. 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. (in press) 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. in press).

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.

i. Conservation

i. <u>Needs</u>

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 2002b; 2004c; 2004d) 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 2002b; 2004c; 2004d). 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 2002b; 2004c; 2004d).

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 2002f, 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 National Forest 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.

j. Summary of Current Status and Actions

i. <u>Coastal-Puget Sound Interim Recovery Unit</u>

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 Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for HCP 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.

ii. *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 Act. 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.

iii. *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.

iv. *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 FMO habitat within the West Fork Jarbidge River and result in positive long-term effects to bull trout abundance, distribution, and trend.

v. *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 Act. 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.

k. 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) Establishing 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 are also being implemented 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 50 degrees Fahrenheit 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.

l. 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).

m. 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 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 36 to 59 °F are acceptable for bull trout this can vary to some degree by core area, or local population. The Willamette National Forest reports that they have never observed bull trout spawning in temperatures greater than 7.5°C (Ray Rivera, pers. comm).

2.3.2 Lost River Sucker and Shortnose Sucker

a. Species Description

i. *Taxonomy*

The Lost River sucker (*Deltistes luxatus*) was first described by Cope in 1879, as *Chasmistes luxatus*, based on specimens collected in Upper Klamath Lake. Shortly afterward, *Catostomus rex* was described from the Lost River and Tule Lake, in south-central Oregon and northern California, but has been regarded as a synonym of *D. luxatus*. Other authors have placed the Lost River sucker either in the genus *Deltistes* or *Catostomus*, but currently *Deltistes* is the generic epithet most widely used by fish taxonomists, and it is the name accepted by the American Fisheries Society (AFS) and the USFWS (Andreasen 1975; Markle et al. 2005; Miller and Smith 1981; Williams et al. 1985; USFWS 1988).

The shortnose sucker (*Chasmistes brevirostris*) was described by Cope in 1879 as *Chasmistes brevirostris*, based on specimens collected from Upper Klamath Lake. Fowler (1913) suggested that *C. brevirostris* should be transferred to the genus *Lipomyzon*, but this has not been adopted by later workers. Two additional nominal taxa, *C. stomias* and *C. copei*, were later described from Upper Klamath Lake and vicinity, but were synonymized with *C. brevirostris* by Miller and Smith (1981).

Molecular genetic evidence suggests that the genus *Chasmistes* is artificial and should be synonymized under *Catostomus* (Wagman and Markle 2000), but no formal revision has been published.

ii. Species Description

Upper Klamath River Basin suckers can be difficult to identify owing to considerable phenotypic variability, effects of hybridization, and to growth- and gender-related morphological changes. The three upper Klamath Basin sucker species (the two aforementioned and the Klamath largescale sucker - *Catostomus snyderi)* are best distinguished based on multiple characters, since no one character is diagnostic. Diagnostic characters include: lip morphology, vertebral number, gill raker number, and head shape (Andreasen 1975; Markle and Simon 1993; Markle et al. 2005). Markle et al. (2005) recently provided a diagnostic key for the three upper Klamath River basin sucker species which is summarized below in Table 13.

Table 13**.** Comparative morphology of Klamath largescale suckers, Lost River suckers, and shortnose suckers, based on Markle et al. (2005).

Species	Maximum Body Length (cm)	Body Shape	Snout Shape	Lip Shape	Number of Gill Rakers	Number of Vertebrae
Klamath Largescale Sucker	55	Deep	Short & rounded	Large & papillose, no gap	29-40	40-46
Lost River Sucker	100	Elongate	Long & angular	Small with a gap	23-37	44-48
Shortnose Suckers	64	Elongate	Short & rounded	Small with a gap	30-45	41-45

The greatest difficulty in identification of upper Klamath Basin suckers is separating the two listed species. However; Markle et al. (2005), state that they can be "readily distinguished" by lip morphology and gill raker counts. Other information can be helpful in separating these species as well and Markle et al. (2005) point to some differences in local distributions, for example Klamath largescale sucker is less common in Upper Klamath Lake than the shortnose sucker, but is the only sucker found in the upper Williamson River. Also, spawning run time and location is somewhat different in the Sprague River with Klamath largescale sucker running mid-March to early April and many spawning upstream of Chiloquin, whereas the shortnose suckers run mid-April to early May and mostly spawn below Chiloquin.

Field identification of individual suckers can be problematic due to the high degree of morphological variability expressed by each species and the "mixing" of phenotypes caused by hybridization. Therefore, accurate identification is frequently dependent on the experience of the observer, but is not accurate in every case, thus many specimens are reported as, "species uncertain." In an effort to ensure Klamath sucker identifications are as accurate and consistent as possible, Oregon State University (OSU), USGS, Klamath Tribes, Bureau of Reclamation, and USFWS biologists have participated in informal sucker identification workshops.

b. Legal Status

The Lost River sucker and shortnose sucker were listed as endangered on July 18, 1988 (Federal Register 53:27130-27134). Both species are also listed as endangered by the states of Oregon and California. A recovery plan for Lost River sucker and shortnose sucker was finalized on March 17, 1993 (USFWS 1993a). Five-year reviews for the Lost River sucker and shortnose sucker were completed on July 19, 2007 (Federal Register 73: 11945 and USFWS 2007 a, b). A considerable amount of scientific information has been collected since the 1993 recovery plan and an updated, revised recovery plan for the Lost River sucker and shortnose sucker was released in 2013 (USFWS 2013).

On September 9, 1991, the USFWS received a 60–day notice of intent to sue from the Oregon Natural Resources Council (ONRC) for failure to prepare a recovery plan and to designate critical habitat for the Lost River sucker and shortnose sucker. On December 1, 1994, we published proposed critical habitat for Lost River sucker and shortnose sucker (59 FR 61744); that proposal was never finalized. A settlement agreement was reached that stipulates the USFWS submit a final rule designating critical habitat for the Lost River sucker and the shortnose sucker to the Federal Register no later than November 30, 2012 (Wood et al. v. Thorson et al., No. 91–cv–6496– TC [D. Or.]).

c. Critical habitat description

i. <u>Current critical habitat status</u>

On December 11, 2012, USFWS published a final rule designating critical habitat for the Lost River sucker and shortnose sucker (77 FR 73740). The designation included two critical habitat units for each species. The Upper Klamath Lake Unit (Unit 1), situated in Klamath County, Oregon, includes Upper Klamath Lake and Agency Lakes, the Link River and upper Klamath River downstream to Keno Dam, as well as portions of the Williamson and Sprague Rivers, for a total of approximately 90,000 acres and 120 river miles (RM). Unit 1 is the same for both species with the following exception, for Lost River sucker, the unit extends up the Sprague River to the Beatty Gap east of Beatty (near RM 75), whereas for shortnose sucker the unit extends up the Sprague River only as far as Braymill near RM 8.

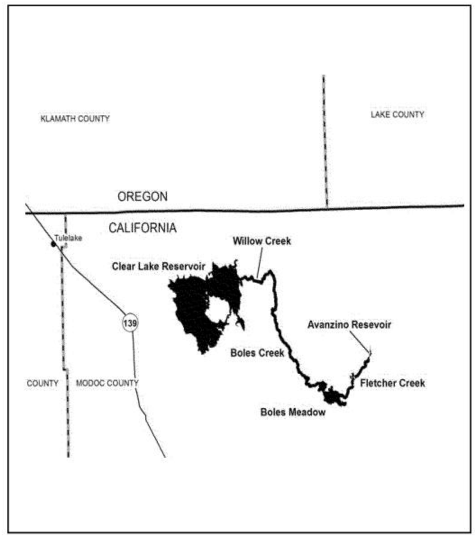
The Lost River Basin Unit (Unit 2) is situated in Klamath and Lake Counties, Oregon and Modoc County, California. It includes Clear Lake and its main tributary, Willow Creek, for both Lost River sucker and shortnose sucker, and Gerber Reservoir and its main tributaries for shortnose sucker only, for a total of approximately 33,000 acres and 88 RM. Additionally, there are differences in the amount of upstream critical habitat in Willow Creek for the two species. For the

Lost River sucker, critical habitat includes Willow Creek and its tributary, Boles Creek, upstream to Avanzino Reservoir in California. For shortnose sucker, critical habitat extends up Willow Creek to Boles Creek and upstream past Fletcher Creek, and includes Willow, Fourmile, and Wildhorse Creeks in California, and also includes Willow Creek to its East Fork in Oregon (Figure 1).

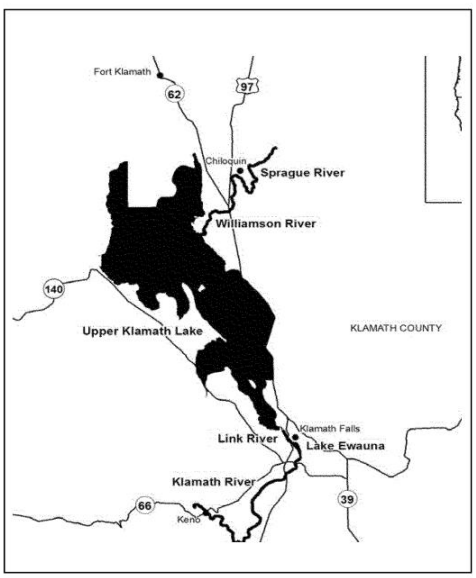
The following physical and biological features were considered essential to the conservation of the species and may require special management considerations or protection.

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

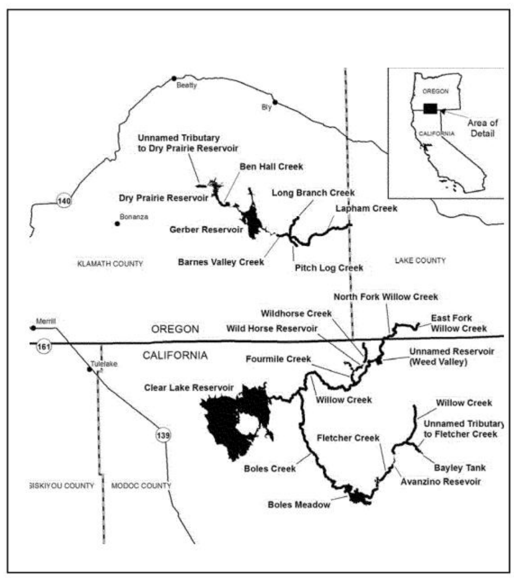
Lost River Sucker Critical Habitat Unit 1



Lost River Sucker Critical Habitat Unit 2



Shortnose Sucker Critical Habitat Unit 1



Shortnose Sucker Critical Habitat Unit 2

Figure 1 Designated critical habitat units for Lost River and shortnose suckers (figures taken from 77 FR 73740)

ii. *<u>Primary Constituent Elements</u>*

The PCEs are the specific elements of physical and biological features that are essential to the conservation of the species. Based on our current knowledge of the habitat characteristics required to sustain the species' life-history processes, the PCEs specific to self-sustaining Lost River sucker and shortnose sucker populations are:

- PCE 1- *Water.* Areas of sufficient quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refuge habitats with minimal physical, biological, or chemical impediments to connectivity. Water must have varied depths (up to 3.3 feet for larvae and 14.8 feet for adults); temperatures less than 28 ºC; pH less than 9.75; dissolved oxygen greater than 4.0 mg/L; low levels of microcystin; and un-ionized ammonia less than 0.5 mg/L.
- PCE 2 - *Spawning and Rearing Habitat.* Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4 feet with adequate velocity to allow spawning to occur. Areas identified in PCE1 containing emergent vegetation adjacent to open water that provides habitat for rearing.
- PCE 3- *Food.* Areas containing an abundant forage base, including an array of small aquatic invertebrates especially midges, cladocerans, and copepods Life History

iii. *Recovery Units*

The 2013 revised recovery plan identifies recovery units for both of these species, given the limited information on genetic and ecological distinction between sub-basins (USFWS 2013). The UKL Recovery Unit is subdivided into four management units: (1) UKL-river spawning individuals; (2) UKL-spring spawning individuals (Lost River sucker only); (3) the Keno Reservoir Unit including the area from Link River dam to Keno dam; and (4) the reservoirs along the Klamath River downstream of Keno Dam, known as the Klamath River Management Unit. The Lost River Recovery Unit is also subdivided into four management units – Clear Lake, Tule Lake, Gerber Reservoir (shortnose sucker only), and the Lost River proper. By specifying recovery units, USFWS indicates that recovery cannot occur without healthy populations occurring in each recovery unit; however, this does not mean that each management unit has equivalent conservation value or is even necessary for species recovery to be achieved.

In the 2013, recovery plan (USFWS 2013), the proposed criteria to assess whether the species have been recovered are focused on threat reduction, i.e., amelioration or elimination of threats, and on demographic evidence that sucker populations are healthy. The threats-based criteria include: (1) restoration and enhancement of habitats, including water quality; (2) reducing adverse effects from non-native species; and (3) reducing losses from entrainment. To meet the population-based criteria, the species must exhibit: (1) an increase in spawning population abundances over a sufficiently-long period to indicate they are resilient; and (2) adult populations must be comprised of diverse ages, as evidenced by a variety of sizes, indicative of recurrent recruitment.

d. Life History

i. *Reproduction*

Both suckers spawn from February through May over gravel substrates in streams and rivers (Buettner and Scoppettone 1990). The Lost River sucker also spawns over rock and gravel substrates associated with shallow, spring-influenced areas along the eastern shore of Upper Klamath Lake (Barry et al. 2007). Females broadcast their eggs where they fall into crevices between gravel or they are buried slightly.

Both sucker species grow rapidly in their first five to six years, reaching sexual maturity sometime between years four and six for shortnose sucker and four and nine for Lost River sucker (Perkins et al. 2000b). Lost River sucker and shortnose sucker have been aged to 55 and 33 years, respectively. Females produce a large number of eggs, 44,000 to 200,000 per year for Lost River sucker and 18,000 to 70,000 per year for shortnose sucker when they spawn (Buettner and Scoppettone 1990). Larger, older females produce substantially more eggs and, therefore, can contribute relatively more to recruitment than a recently matured female. However, only a small percentage of the eggs survive to become larvae. Because adult are potentially long-lived and fecund these life history traits should make the species less sensitive to larval and juvenile mortality, but under current conditions adult survival is low and there is inadequate recruitment, as will be discussed later. Lost River sucker and shortnose sucker do not normally die after spawning and can spawn many times during their lifetime.

ii. *Population Structure*

The Lost River sucker population in the Upper Klamath Lake appears to consist of two distinct stocks: 1) Several thousand Lost River sucker and a few shortnose sucker that spawn along shoreline springs; and 2) tens of thousands Lost River sucker fish that spawn in the Williamson and Sprague Rivers (Perkins et al. 2000b). Mark-recapture data show that the two stocks maintain a high degree of fidelity to spawning areas and therefore seldom interbreed (Hayes et al. 2002, Barry et al. 2007). Shortnose sucker spawning is primarily confined to the Williamson River system, so there is only one substantial population or stock in Upper Klamath Lake.

e. Ecology Habitat Characteristics

The Lost River sucker and shortnose sucker have complex life histories that include stream/river, lake, marsh, and shoreline spring habitats and both species utilize a number of different aquatic habitats through their lives. Adults primarily occupy open water habitats with depths of 3 feet to 15 feet, but appear to prefer depths from 5 feet to 10 feet (Peck 2000, Reiser et al. 2001, Banish et al. 2009). Lost River sucker and shortnose sucker are generally limited to lake habitats when not spawning, although river-resident fish have been documented, especially in the Lost River system (Buettner and Scoppettone 1991).

Soon after hatching, when larvae reach about 0.2 to 0.6 inches total length (TL) and are mostly transparent with a small yolk sac, they move out of the gravel and into the water column (Buettner and Scoppettone 1990). Larval suckers spend relatively little time in rivers/streams before drifting downstream to the lakes by mid-July (Cooperman and Markle 2003, 2004; Ellsworth et al. 2010); however, some instream rearing has been observed in the Sprague River and elsewhere. Larval habitat is generally in shallow water along the shoreline in both vegetated and unvegetated habitats (Buettner and Scoppettone 1990; Cooperman and Markle 2004; Crandall et al. 2008). Juvenile suckers also occupy a wide variety of near and off-shores habitat in Upper Klamath Lake including emergent wetlands and non-vegetated areas with sand, mud, gravel, and cobble substrates (Buettner and Scoppettone 1990; Simon and Markle 2001, 2004; Simon et al. 1996, 1998; Hendrixson et al. 2007a, 2007b; Burdick et al. 2008) and move offshore into the lake as they grow and move southward. Water quality, especially dissolved oxygen concentrations are likely to affect distributions (Burdick et al. 2009; Burdick and VanderKooi 2010).

f. Status

i. Historical status and distribution

Prior to settlement Lost River sucker and shortnose sucker occurred in UKL, Tule Lake, Lower Klamath Lake, and presumably Clear Lake, as well as their tributaries. However, at the time of listing, these species were known from UKL and its tributaries and outlet (Klamath Co., Oregon), including a "substantial population" of shortnose sucker in Copco Reservoir (Siskiyou Co., California), as well as collections of both species from Iron Gate Reservoir (Siskiyou Co., California) and J.C. Boyle Reservoir (Klamath Co., Oregon), and Lost River sucker from Sheepy Lake and Lower Klamath Lake (Siskiyou Co., California). Remnants and/or highly hybridized populations were also stated to occur in the Lost River system (Klamath Co., Oregon, and Modoc and Siskiyou Co., California) including both species in Clear Lake Reservoir (Modoc Co., California) and Lost River sucker in Tule Lake (Siskiyou Co., California; USFWS 1988, p. 27130).

Although not stated explicitly, the reference in the listing to "highly hybridized populations" in the Lost River Basin probably refers to shortnose suckers within Gerber Reservoir (Klamath Co., Oregon). Spawning likely occurred throughout the Upper Klamath Lake drainage in both rivers and springs along shoreline of the lake (Andreasen 1975, Stine 1982, NRC 2004). Spawning also occurred in significant numbers in the Lost River system (Bendire 1889, Howe 1969), some of which in the Big Springs area near Bonanza, Oregon.

These two fishes were once very abundant and were important seasonal foods of Native Americans and white settlers in the upper Klamath River basin prior to about 1900 (Cope 1879, Gilbert 1897, Howe 1969). Sucker spawning migrations occurred in the spring at a critical time when winter food stores had been exhausted. The Klamath and Modoc Indians dried suckers for later use. It was estimated that the aboriginal harvest at one site on the Lost River may have been 50 tons annually (Stern 1965). Settlers built a cannery on the Lost River and suckers were also processed into oil and salted for shipment. In 1900, the Klamath Republican newspaper reported that "mullet," as suckers were referred to, were so thick in the Lost River that a man with a pitch fork could throw out a wagon load in an hour. The first reference to sport fishing of "mullet" appears to be a 1909 reference to sportsmen snagging "mullet" in the Link River at Klamath Falls (Klamath Republican, Oct. 14, 1909).

In 1959, suckers were made a game species under Oregon State law and snagging suckers in the Williamson and Sprague River was popular with locals and out-of-town sportsmen (Bragg 2001, Markle and Cooperman 2002). In the 1960's ODFW estimated 100,000 pounds of suckers per year (ca. 12,500 fish) were harvested (Eugene Register-Guard, May 7, 1967). Oregon Department of Fish and Wildlife data indicated from 1966 through 1978, an approximate 50% decline in catches (from 3.5-5.6 suckers per angler before the 1969 bag limit, to 1.5-3.0 afterwards). More than 3,000 suckers were taken in the snag fishery in 1968 (Golden 1969). Numbers of harvested suckers from spawning runs in the Sprague and lower Williamson Rivers increased from 1.2 fish per hour in 1966 to 4.7 fish/hour in 1969 and then, from 1969 on, there was a steady decline to 0.8 fish/hour in 1974 (Andreasen 1975). Average weight of suckers caught in the fishery declined about 40% from 1966 to 1974 (from 7.5 to 4.9 pounds), and declines continued to the time of listing. By 1985, Bienz and Ziller (1987) estimated the harvest had dropped by about 95%, and based on this information, the game fishery was terminated in 1987, just prior to federal listing (USFWS 1988).

ii. *Current status and distribution*

For nearly a century, Lost River sucker and shortnose sucker have likely experienced declining population trends. As large swaths of habitat were converted to agriculture and barriers isolated populations from spawning grounds, these once super-abundant species began to decline in numbers. Later, from the 1960s to the early 1980s, recreational harvests in UKL progressively decreased (Markle and Cooperman 2002), and that led to the species listing in 1988. From 1995 to 1997, water-quality related die-offs killed thousands of adult suckers (Perkins et al. 2000a). Over the three years, >7,000 dead suckers were collected and many others likely escaped detection. More recently (between 2001 and 2010), the abundance of Lost River sucker males in the lakeshore-spawning subpopulation decreased by 50–60 percent and the abundance of females decreased by 29–44 percent (Hewitt et al. 2012; Figure 2). It is not clear if the river subpopulation has increased or decreased between 2002 and 2010, but it is likely that this population decreased by more than 40 percent for both sexes (Hewitt et al. 2012). Capture-recapture data suggest that the UKL shortnose sucker population has decreased in abundance by 64–82 percent for males and 62–76 percent for females between 2001 and 2010 (Hewitt et al. 2012) . Because shortnose sucker in UKL have declined substantially in abundance, they are at an increased risk of extinction.

As further evidence of reproductive problems, recent size distribution trends reveal that spawning populations within UKL are comprised mostly of similarly-aged, relatively old individuals. Since the late 1990s, populations of both species have exhibited an increasing trend in length of approximately 4 mm per year for shortnose sucker and 9-12 mm per year for Lost River sucker (Hewitt et al. 2012) , suggesting that recruitment of new adults is minimal to nonexistent. Most adult suckers currently in UKL are believed to be the result of spawning that occurred in the early-1990s (Janney et al. 2008) . These fish are now approximately 20 years of age and are well beyond the average life span of 12 years for shortnose sucker and are equal to that of 20 years for Lost River sucker. Because there is a lack of appreciable recruitment of new adults into sucker populations in UKL, they exist only because of their long-life expectancy. However, this trend is especially unstable and untenable for shortnose sucker, and without substantial recruitment in the next decade, the population will be so small that it is unlikely to persist.

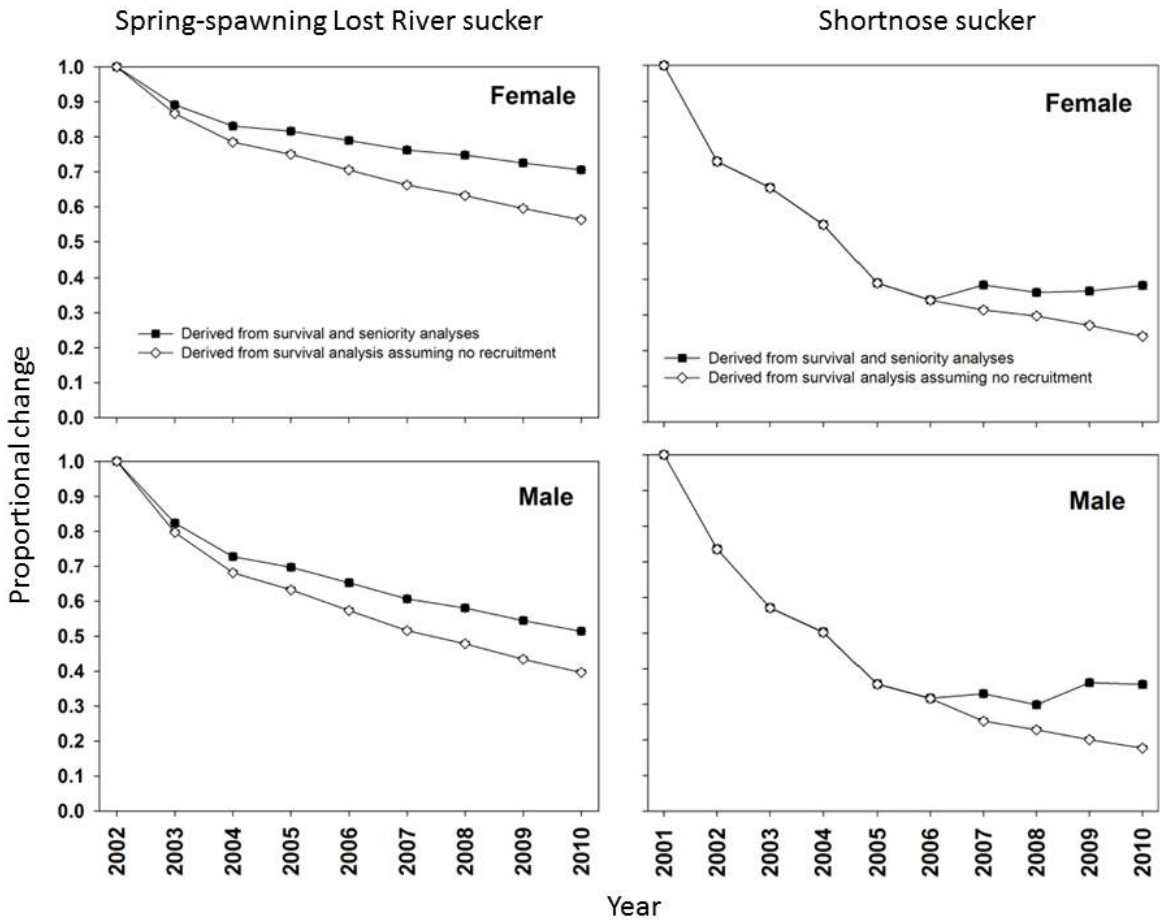


Figure 2 Spawning populations of suckers in Upper Klamath Lake have consistently declined since at least 2001, as estimated by two approaches using mark-recapture models in Program MARK (figures taken from Hewitt et al. 2012). For example, spawning, female Lost River sucker in 2010 were estimated to number between 60 and 80 percent of how many there were in 2002.

All other Lost River sucker and shortnose sucker populations lack sufficient monitoring to inform these types of long-term trend assessments, but given that UKL is likely the primary source of individuals for most populations, excepting those in the Clear Lake and Gerber Reservoirs, we expect these trends are reflected in the sink populations. Loss of the UKL populations would put both species at a high risk of extinction because the UKL populations represent approximately 40 to 80 percent of the total range-wide abundance for shortnose sucker and Lost River sucker, respectively (Table 14), and would reduce the number of self-sustaining populations for Lost River sucker from two to one for Lost River sucker and from three to two for shortnose sucker. If these losses occurred it would adversely affect both resiliency and redundancy, two factors that are critical for survival and recovery (USFWS 2011d).

g. Population Dynamics

i. Adult Population Sizes

Because of the wide-ranging behavior, expansive habitat, and rarity of these species, obtaining accurate population estimates is impracticable if not impossible. However, long-term monitoring using capture-recapture methods provide accurate information on changes in abundance as well as insights into the sizes of populations (Hewitt et al. 2012). For example, in 2011, UKL monitoring detected or captured approximately 25,000 tagged Lost River sucker (Hewitt et al. 2012). Approximately 30 percent of these individuals were spawning at the springs along the eastern shoreline of the lake. Estimates of what proportion of the total UKL populations is tagged are unknown, but these numbers suggest that Lost River sucker likely number between 50,000 and 100,000 (Hewitt et al. 2012). Numbers of adult shortnose sucker in UKL is likely to be less than 25,000, given that only approximately 5,000 individual shortnose sucker were detected or captured during the 2011 spawning season (Hewitt et al. 2012).

In Clear Lake, shortnose sucker are more abundant than Lost River sucker. Approximately; 2,500 tagged shortnose sucker were detected during the spawning run up Willow Creek in 2011(B. Hayes, USGS, pers. comm. 2011); slightly less than 500 tagged Lost River sucker were detected during the same period. Reliable estimates of what proportion of the total population has been tagged are unavailable, but these data suggest that shortnose sucker adults number less than 25,000 and Lost River sucker less than 10,000.

Data on other populations (i.e., Keno Reservoir, Klamath River Reservoirs, Tule Lake, Gerber Reservoir, and the Lost River) are limited, but the monitoring efforts completed for these populations indicate low numbers, with perhaps < 5,000 total Lost River sucker and shortnose sucker in Tule Lake (Hodge and Buettner 2009), Keno Reservoir (Kyger and Wilkens 2010) and in the Klamath River reservoirs below Keno (Desjardins and Markle 2000) . Gerber Reservoir may be an exception to this because spawning surveys in 2006 detected approximately 1,700 shortnose sucker of the nearly 2,400 that had been tagged the previous year (Barry et al. 2007). In Table 14 below, the approximate size of shortnose sucker and Lost River sucker populations are shown. Based on limited data, we estimate that the approximate total range-wide adult abundance of Lost River sucker is 65,000 to 115,000 and is less than 60,000 for shortnose sucker.

Table 14. Estimated adult sucker population sizes in the UKL (based on Hewitt et al. 2012), Clear Lake, and Gerber Reservoir, which are self-sustaining

populations, and the other areas (e.g., Keno Reservoir, Tule Lake, Lost River, and four Klamath River reservoirs downstream of Keno), which are considered sink populations.

Location	Lost River sucker	shortnose sucker
UKL	50,000-100,000	<25,000
Clear Lake	<10,000	<25,000
Gerber Reservoir	None	<5,000
Other Areas	<5,000	<5,000

ii. *Population Diversity*

Vital rates (e.g., survival and recruitment) of shortnose sucker and Lost River sucker adults in UKL have varied little over the past decade. Annual adult survival rates of shortnose sucker appear to vary more than Lost River sucker in this lake, but this rate for both species in UKL appears to be relatively stable (Hewitt et al. 2012), excluding years of large fish die-offs as in 1995, 1996, and 1997. Modeling of Lost River sucker and shortnose sucker adult populations since 2001, suggests a low rate of recruitment (Hewitt et al. 2012). This lack of recruitment has resulted in adult populations for both species that are homogenous in size and age, which if continued will cause instability and if not reversed will lead to extinction. It is currently generally accepted that the last substantial recruitment for both Lost River sucker and shortnose sucker in UKL occurred in the late nineties, from fish that were spawned in the early nineties (e.g. 1991). Although it is difficult to verify this using standard fish-ageing techniques (given the long life of these species annuli are often difficult to differentiate), age distributions of spawning adults appear to corroborate this view. Between 2000 and 2011, the length distribution of both species steadily shifted upwards, with few smaller (and presumably younger) individuals (Hewitt et al. 2012).

Monitoring of juvenile and sub-adult suckers in UKL by Oregon State University and the USGS has not produced evidence that a cohort of young suckers that could recruit into the adult population is present. Thus, it likely will be at least 4-7 years before substantial recruitment occurs. Although we don't know specifically how this current uniform age distribution compares to historical conditions, healthy adult populations of long-lived species should possess multiple reproducing year-classes.

In Clear Lake, shortnose sucker vital rates appear to be fairly consistent, given the persistent "normal-shaped" distribution of size classes of captured individuals since 2004 (D. Hewitt and E. Janney, USGS, pers. comm. 2011); although, this assessment is based on the assumption that size is generally related to age. During the same period, annual size-distributions of captures indicated a group of sub-adult Lost River sucker was progressing towards sexual maturation, but this cohort inexplicably disappeared from samples taken in 2008.

h) Demography

i. *Adult Demography and Population Trends in Upper Klamath Lake*

The size of Upper Klamath Lake and the scarcity of Lost River and shortnose suckers make it difficult to accurately estimate their abundance in the lake. Lost River sucker and shortnose sucker demography (demography is the study of population parameters) has been monitored since the mid-1990s using mark-recapture methods and passive integrated transponder tags. It is also difficult to determine the age of Lost River and shortnose suckers. The length of fish is often used to estimate age of individuals, and the distribution of fish in various age classes is often estimated by assessing the number of fish of various lengths.

Lost River and shortnose sucker populations transformed from ones dominated by old fish with little size diversity and consistently poor recruitment in the late 1980s and early to mid-1990s, to populations dominated by smaller young adult fish and very few remaining large individuals by the late 1990s (Janney et al. 2008). This marked shift in size structure to smaller individuals suggests that substantial recruitment in these populations occurred sometime during the mid-1990s from fish born in the early 1990s. In recent years, populations of both species exhibited a slight increasing trend in length (i.e., 1 to 1.5 cm increase in median fork length per year) while the number of age classes in the population decrease (Janney and Shively 2007; Janney et al. 2008). Decreasing relative abundance of younger fish suggests that populations are comprised mostly of similarly-aged, older individuals, and that recent substantial recruitment is lacking.

One way ecologists determine if a population is increasing or decreasing is by evaluating survival, mortality, and recruitment, and calculating a variable called lambda (λ) over time. When λ is greater than 1, the population is increasing, and when it is less than 1 the population is decreasing. Several sources of information can be used to derive λ, such as regular counts of individuals, recruitment rates, and survival rates. This information can be determined from regular sampling, but it must be quantified several times before accurate assessments of trends in abundance can be made. When λ is known from a number of samplings conducted over a long period of time, the relative change in the size of a population can be determined, which is a variable known as Δt.

When the USGS Lost River sucker and shortnose sucker capture-recapture program began in 1995, few fish were captured and tagged and mean estimates of survival and λ had little precision or statistical rigor, and Δt could not be accurately calculated. As the number of tagged fish increased each year, precision of these estimates improved and in 2001 (for shortnose sucker Williamson-Sprague River spawning fish) and 2002 (for shoreline- spawning Lost River sucker) information became adequately precise to accurately calculate λ, relatively accurate estimates of Δt became possible.

Results from passive integrated transponder tag studies in Upper Klamath Lake from 2002 to 2007 show that annual survival probabilities of shoreline springs spawning Lost River sucker ranged from 0.80 to 0.95, with a mean of 0.90, and Δt over the period was 0.56 for males and 0.75 for females. These Δts show that the abundance of male and female, shoreline-spring-spawning Lost River sucker in 2007 was 56 % and 75%, respectively, of their 2002 abundance. Estimates for river-spawning shortnose sucker show that annual survival probabilities were lower for this subpopulation. From 2001 to 2007 annual survival probabilities of river-spawning shortnose sucker were more variable than for Lost River sucker and ranged from 0.68 to 0.94, with a mean of 0.82. Over this period, Δts of male and female, river-spawning shortnose sucker were 0.42 and 0.49, respectively. Similar data are not currently available for Upper Klamath Lake Lost River sucker river-spawning fish or for Clear Lake Lost River sucker and shortnose sucker populations. This information will be forthcoming in the future when the number of tagged fish is sufficiently large to provide relatively precise, statistically rigorous estimates.

ii. *Demography of Lost River sucker and shortnose sucker Populations in Clear Lake*

Historically, large Lost River sucker and shortnose sucker spawning migrations occurred from Tule Lake up the Lost River to near Olene and Big Springs near Bonanza (Howe 1969, USFWS 2002a). Clear Lake currently supports the only substantial populations of shortnose sucker and Lost River sucker in the Lost River subbasin. Less is known about shortnose suckers and Lost River suckers in Clear Lake than those in Upper Klamath Lake because monitoring studies have been sporadic over the past 35 years, and studies similar those conducted by Janney et al. (2008) in Upper Klamath Lake were not initiated in Clear Lake until 2006 (Barry et al. 2009). Data collected by Koch et al. (1973) and Andreasen (1975) suggested both populations were in decline; however, monitoring from 1989-2000 indicated that populations were relatively large and had diverse age structures (Buettner and Scoppettone 1991; USBR 1994; Scoppettone et al. 1995; USFWS 2002a). In Upper Klamath Lake, 15 age classes were documented in the shortnose sucker population during 1989 and nine during 1993. Similar data are not available for Lost River sucker in Clear Lake, because they appear to be less abundant than shortnose sucker.

Summarizing historical and recently collected data, Barry et al. (2009) observed that populations of both species in Clear Lake have undergone major demographic changes during the past 15 years. Populations in the mid-1990s showed little evidence of recruitment and consisted mostly of large and presumably older suckers. The abundance of large suckers decreased in the late 1990s and early 2000s, and current populations are mostly ones recruited into the adult population in the late 1990s (Barry et al. 2009). Length-frequencies from 2005 – 2009 studies found little evidence of shortnose sucker recruitment and that recruitment into the Lost River sucker population had been relatively consistent over the period. Variability in age class structure, longevity, and abundance Lost River suckers and shortnose suckers in Clear Lake is poorly understood in comparison with populations in Upper Klamath Lake. Several more years of sampling and analysis are needed before data are sufficient to discern current status of these populations and their demographic health.

i) Threats

The reasons for listing as well as threats to the continued survival of Lost River sucker and shortnose sucker are well reviewed in a number of reports and peer reviewed articles (USFWS 1988; Markle and Cooperman 2002; NRC 2004; ISRP 2005; USFWS 2007a, b, 2008f, 2011d; Rasmussen 2011). The major threats are discussed below.

i. *Effects of Habitat Loss and Alteration*

Loss and alteration of habitats (including spawning and rearing habitats) were major factors leading to the listing of both species (USFWS 1988) and continue to be significant threats to recovery. As noted above, both species utilize the spectrum of aquatic habitats during some stage of the life cycle, including river or stream habitats, open-water lake habitats, and the wetlands areas along banks and shores. However, negative impacts and alterations to each of these different habitats have occurred, and continue to threaten the recovery of these species. Suitable habitat has drastically declined due to conversion of wetlands to agricultural use and construction of irrigation and hydroelectric facilities, both of which drained lakes and wetlands, created barriers preventing access to spawning habitat, and caused mortality by entraining fish.

ii. *Effects of Non-Native Fishes*

Non-native fishes were identified as a potential threat at the time of listing through predation or as sources of exotic diseases/parasites, although no direct evidence was cited. Since then, controlled experiments have demonstrated that adult fathead minnows prey on sucker larvae (Markle and Dunsmoor 2007). In Upper Klamath Lake negative relationships between fathead minnow population size and larval sucker survival rates (i.e., higher fathead minnow populations are associated with lower sucker survival rates) have been observed (Markle and Dunsmoor 2007). Likewise, as indirect evidence, higher larval survival rates were also associated with greater water depth and shoreline vegetative cover, habitat which help larvae avoid predation (Markle and Dunsmoor 2007). These data suggest that predation by highly-abundant fathead minnows may be an important threat to larval sucker survival, and that loss of emergent wetland habitat may exacerbate this. Other non-native fishes may also pose a threat to Lost River sucker and shortnose sucker; however, little quantitative information exists to indicate their influence on sucker abundance and distribution.

iii. *Effects of Adverse Water Quality*

Most water bodies currently occupied by Lost River and shortnose suckers do not meet water quality standards for nutrients, dissolved oxygen, temperature, and pH set by the States of Oregon and California (Boyd et al. 2002, Kirk et al. 2010). Lost River and shortnose suckers are relatively tolerant of degraded water quality conditions in comparison to species like trout and salmon. Suckers tolerate higher pH, temperature, and un-ionized ammonia concentrations, and lower dissolved oxygen concentrations than many other fishes (Saiki et al. 1999; Meyer and Hansen 2002; NRC 2004). Nevertheless, both species are regularly adversely affected by poor summer water quality in Upper Klamath Lake, Keno Reservoir, Lost River subbasin, and the hydropower reservoirs downstream in the Klamath River (NRC 2004). Adverse water-quality conditions, which have primarily occurred in summer, have caused multiple incidents of mass adult mortality (Perkins et al. 2000a). The primary cause of water-quality-related mortality appears to be caused by hypoxia (i.e., low levels of dissolved oxygen), but high concentrations of un-ionized ammonia resulting from elevated total ammonia concentrations and high pH, could also be a contributing factor (Perkins et al. 2000a). Additionally, in the fish die-offs that occurred in Upper Klamath Lake in the 1990s, disease outbreaks contributed to mortality and continued to affect suckers after the adverse water conditions had abated (Perkins et al. 2000a, NRC 2004).

Adverse water quality conditions in Upper Klamath Lake are attributed to high nutrient loading, especially phosphorus, and the presence of blue-green algae, *Aphanizomenon flos-aquae* (AFA). This alga (actually categorized as a bacterium known as “cyanobacterium”) now dominates the algal community from June to November, and because of the high concentrations of nutrients, especially phosphorus, available, is able to reach seasonally high biomass levels that can lead to highly degraded water quality (Boyd et al. 2002, NRC 2004, Wood et al. 2006, Morace 2007). These conditions affect Lost River and shortnose suckers because rapid algal decay depletes dissolved oxygen levels and can create toxic conditions for suckers, especially when water temperatures are high and wind speeds low (Perkins et al. 2000a; Boyd et al. 2002; NRC 2004; Wood et al. 2006, Morace 2007).

Water quality remains one of the most important, if not the most important, proximate factor threatening sucker existence; however, the uncertainty surrounding many of the potential ultimate factors (i.e., the complex interactions of factors causing poor water quality), including wetland reduction, natural nutrient loads, nonpoint sources, and water management, also make it one of the most difficult threats to address.

iv. <u>*Effects of Algal Toxins*</u>

Some cyanobacteria, such as *Microcystis aerginosa*, which is also present in Upper Klamath Lake, produce toxins that may directly result in mortality or may indirectly cause mortality through a combination of disease and stress produced by hypoxia (low dissolved oxygen), high pH, and high ammonia concentrations. Recent studies by USGS provide preliminary support for a hypothesis that juvenile suckers in Upper Klamath Lake are at risk from biotoxins produced by *M. aerginosa* (USGS 2010, http://pubs.usgs.gov/fs/2009/3111/). The toxin, microcystin, attacks liver cells. Up to 50% of juveniles sampled showed evidence of liver damage, some severe enough that death would likely result. Microcystin levels in the water samples in 2008 were up to 17x higher than is considered safe for drinking water. Microcystin is an algal toxin that affects the liver and can lead to death. In a 2007 survey in Upper Klamath

Lake, 49% of a sample of juvenile suckers collected at 11 shoreline sites exhibited indications of microcystin exposure (Vanderkooi et al. 2010). However, these data are preliminary and further investigations are required to determine the extent of microcystin exposure and of the effects. Additionally, the means by which the toxin is introduced into the body remains unknown, but there is some evidence that suggesting that the toxin is indirectly ingested when suckers consume midge larvae, which feed on the algae.

v. *Effects of Pathogens and Parasites*

Degraded water quality conditions may weaken fish and increase their susceptibility to disease and parasites (Holt 1997; Perkins et al. 2000a). Parasites and pathogens were not identified as important threats at the time of listing; however, new information indicates that pathogens and parasites likely contribute to low rates of sucker survival, especially during adverse water quality events (USFWS 2007a, b). A number of pathogens have been identified from moribund (dying) suckers, but Columnaris disease or “gill rot” seems to be the primary organism involved (Foott 1997; Holt 1997). It is caused by the bacterium *Flavobacterium columnare,* which can damage gills and produce body lesions, which leads to respiratory problems and an imbalance of internal salt concentrations, which provides an entry route for lethal systemic pathogens.

Anchor worm, an external, copepod parasite affects suckers and other fish in Upper Klamath Lake and its incidence on age-0 suckers appears to be increasing (ISRP 2005). From 1994-1996, the percent of age-0 suckers parasitized by anchor worms ranged from 0% to 7%, but by 1997-2000 it had increased to between 9% and 40%. Anchor worms now infect about half of age-0 shortnose suckers. Parasites like anchor worm may not directly cause death to suckers, but they can provide a route for pathogens to enter fish, since they create a wound, or can make fish more susceptible to predation (Robinson et al. 1998). The degree to which parasites threaten sucker survival and reduce productivity is unknown.

vi. *Effects of Entrainment Losses*

Movement of fish into irrigation systems through unscreened diversions was identified as a threat to the suckers at the time of listing (USFWS 1988). At that time thousands of suckers, including some adults, were entrained into the A-Canal, the largest diversion in the upper basin located near the Link River Dam. Although some of these fish were salvaged, many likely died (NRC 2004). The impact of entrainment into the irrigation system of the Klamath Project was reduced by construction of screening facilities over the A-Canal; although larvae are still at risk. Fish screened from entering the A-Canal are returned via pipeline to the Link River above the dam (Marine and Gorman 2005). Further investigations are needed to determine the overall effects and stress on transferred fish and if fish expelled through the pipeline remain in Upper Klamath Lake or are subsequently entrained by flows through the Link River Dam (USFWS 2007a, b).

Substantial entrainment occurs at the river gates of the Link River Dam. Currently these gates have no structures to prevent drawing fish downstream. During the late summer of 2006, over 3,500 age-0 juvenile suckers were collected in the Link River just below the dam with intermittent sampling of a small fraction of the channel (Tyler 2007). The Committee on Endangered and Threatened Fishes in the Klamath River Basin of the National Research Council recommended screening to prevent downstream losses at Link River Dam (NRC 2004). Efforts to assess the impacts of this operation found significantly lower numbers of suckers were entrained during surface spill versus bottom spill experiments (Marine and Lappe 2009). Gutermuth et al. (2000) also documented tens of thousands of young suckers entrained at the PacifiCorp hydropower canals and turbines associated with the Link River Dam. Nonetheless, further research is required to better quantify the threats these structures pose to recovery.

Most suckers that pass through the gates at Link River Dam, or that survive passage through the hydroelectric facilities, are believed to be lost from the breeding population in Upper Klamath Lake. Most likely, these fish either die in poor summer water quality conditions in Keno Reservoir, or pass further downstream into reservoirs along the Klamath River, from which upstream passage is blocked. A fish ladder was constructed at Link River Dam in 2004 through which adult suckers have been documented moving upstream through Link River. As of 2008, only seven individuals had been documented as passing through the ladder (Korson et al. 2008). In 2010, at least 20 individuals were documented in the ladder during (Kyger and Wilkens 2010); additional untagged suckers likely also passed upstream through the ladder undetected.

In addition to major diversion point in the Keno Reservoir, the Lost River Diversion Channel, several hundred small, typically unscreened diversions in tributary streams and rivers and the lakes proper may also affect Lost River sucker and shortnose sucker. The influence of these diversions on sucker abundance and recovery is unknown.

vii. *Effects of Climate Change*

Climate variability, such as fluctuations between wet and dry periods, is part of natural processes; however, climatic models and other information suggests that much of the recent trends is driven by anthropogenic pollutants, primarily CO_2 (Barnett et al. 2008). Since the 1950s, western North America generally has exhibited trends toward less snowfall, earlier snowmelt, and earlier peak spring runoff, much of which cannot be attributed to natural fluctuations (Hamlet et al. 2005, Stewart et al. 2005, Knowles et al. 2006). Furthermore, models indicate that these trends are likely to continue (Barnett et al. 2008). Perhaps the greatest foreseeable concern related to climate change is more intense summer heat waves that have the potential to create especially severe water-quality conditions in Upper Klamath Lake.

It is difficult to predict how such climatic changes will affect these species (Matthews and Marsh-Matthews 2003). Certainly these species have evolved under variable climates with relatively dry periods (Dicken and Dicken 1985, Negrini 2002); however, given the current lack of recruitment, lack of population connectivity even in wet years when it should be higher, degraded habitat including poor water quality, the overall low number of individuals, and other threats, we consider populations of these species to be highly vulnerable to negative impacts from climate change, either from distinct droughts or from extended periods of declining trends. If current trends continue into the future, important changes, which may threaten the continued existence of these species, e.g., further reductions in water quality, water-quality refuge availability, food-web alterations, and spawning run timing, are likely to occur (Dahm et al. 2003, Magoulick and Kobza 2003). Further reductions in water quality and reduced inflows as a result of climate change, if they occur, could be a serious threat to the survival and recovery of the Lost River and shortnose suckers, especially for populations in Upper Klamath Lake.

j) Conservation

viii. *Needs*

Conservation of Lost River sucker and shortnose sucker depends on preserving or establishing sufficient viable (i.e., self-sustaining) populations in as much of their historic range as possible. Viable populations possess diversity and sufficient numbers that enable them to withstand detrimental events or rebound from them. Genetic and demographic (e.g. age composition of the spawning population) diversity is two components of diversity important to these species. To achieve such diversity and numbers it is important to have interconnected populations and adequate spawning, rearing, feeding, and over-wintering habitat to support successful completion of the life cycle regularly.

These needs are applicable to both species overall and to discrete populations of the species, but each group may be affected by different factors and/or break points within the life cycle. For example, populations in UKL apparently suffer from a lack of recruitment to the adult population mostly due to unnaturally high mortality rates during the juvenile stage, most likely during the first year. The Lost River sucker population in Clear Lake Reservoir also apparently suffers from negligible recruitment, but the source and timing of the mortality may be very different. Several populations, including Tule Lake; Keno Reservoir; the Klamath River reservoirs; and the Lost River, are unable to produce larvae because individuals lack access to suitable spawning habitat. These populations are presumed to persist only by the immigration of individuals from productive populations higher in the system. In addition, populations of shortnose sucker in Gerber Reservoir, and to a lesser extent Clear Lake Reservoir, are evidently intercrossed with the KLS, but it is still unclear to what degree or how this impacts the diversity of the species.

k) Current Actions

The USFWS has worked with other agencies and stakeholders to recover the endangered suckers since 1994. Important cooperators include the U.S. Bureau of Reclamation (USBR), National Resources Conservation Service (NRCS), The Nature Conservancy, Oregon Department of Environmental Quality (ODEQ), National Fish and Wildlife Conservation Fund, Klamath Water Users, and Modoc Irrigation District. Approximately 300 on-the-ground restoration projects, including 90 wetland, 130 riparian, 45 in-stream, 25 upland, and 15 fish passage projects have been funded and implemented in the Upper Klamath River Basin that directly or indirectly benefit Lost River and shortnose suckers since 2009. Many of the projects included elements of more than one category of restoration project type. These projects have had significant cost share from multiple sources, including Federal programs such as Partners for Fish and Wildlife, Hatfield, Jobs in the Woods, and Oregon Resources Conservation Act programs, as well as state and private grants, and contributions from landowners.

Major sucker recovery oriented projects completed include: screening of the main irrigation diversion on the Klamath Project (A-Canal) in 2002 and the outlet to Clear Lake Dam in 2003, and screening of Modoc Irrigation District's diversion on the Williamson River (2007), and the Geary Canal diversion in Howard Bay on Upper Klamath Lake in 2009; construction of a new fish ladder at Link River Dam (2004); restoration of Williamson River Delta approximately 6,000 acres between 2000 and 2008, restoration of the lower 3 miles of the Wood River in 1999; and removal of Chiloquin Dam in 2008, a major impediment to upstream migration of listed suckers. Removal of Chiloquin Dam provides improved upstream passage to spawning areas.

It is too early to assess the efficacy of these projects to support recovery, and some project modification may be required for the full benefit of each program to be realized. This is particularly true with the project screening the A-Canal. Under present design, fish screened from entering the A-Canal are delivered via pipeline to Upper Klamath Lake at a point that is upstream of the Link River Dam. Investigations are needed to determine if these suckers remain in Upper Klamath Lake or pass downstream into Lake Ewauna and possibly are lost to the spawning population because of poor water quality conditions in the lake during the summer and apparently are having difficulties moving upstream past the dam.

The NRCS completed a large number of projects under the 2002 Farm Bill to improve water quality and water conservation. This has resulted in restoration of over 2,200 acres of wetland habitat and conservation of over 6,700 acre-feet of on-farm water. Conservation systems on over 70,000 ac have been planned, and practices have been applied to over 30,000 acres to manage soil, water, air, plants, and animals on private lands.

The Sprague River, the primary spawning habitat for suckers in Upper Klamath Lake and the largest tributary to the Williamson River, is listed as water quality impaired for nutrients, temperature, sediment, and DO under the section 303(d) of the Clean Water Act. In 2002, ODEQ completed a Total Maximum Daily Load (TMDL) process for the Sprague River and Upper Klamath Lake (Boyd et al. 2002). Water quality management plans were developed which provide targets and guidance on improvements water quality in the Sprague River and Upper Klamath Lake. Many wetland and riparian restoration projects are now designed to address TMDL issues.

In 2004, Oregon State University Agricultural Extension Service and the Klamath Watershed Council (now called the Klamath Watershed Partnership) began a series of monthly meetings with rural landowners in the Sprague River Valley to discuss watershed restoration goals. With the help of the USFWS, NRCS and the Klamath Soil & Water Conservation District, this effort has effectively connected landowners with appropriate state and federal resource conservation programs. As a result, more than 70% of the private lands within the Sprague River Valley are partnering with local, state and federal agencies on land conservation and natural resource actions. The efforts of the Klamath Watershed Partnership have brought additional fiscal partners (e.g., Oregon Department of Agriculture, Klamath County, and Oregon Watershed Enhancement Board) into the conservation partnership. These partnership-forming actions will continue and build on themselves and enable more restoration to be done in the future.

The tributaries in the Wood River Valley supply a large portion of the inflow to Upper Klamath Lake. This valley also supports about half of the livestock in the Upper Basin and is responsible for approximately 30% of the external phosphorus loading to the lake. Because of this, it was identified by ODEQ as a priority water quality impaired area. The Klamath Basin Rangeland Trust (KBRT) has been active in the Wood River Valley encouraging landowners to adopt sustainable land and water management practices. Since 2002, the number of landowners who partner with KBRT on conservation and restoration activities has increased to include approximately 50% of the agricultural lands in the watershed.

Klamath River Basin stakeholders signed the Klamath Basin Restoration Agreement in February 2010. The agreement is intended to result in effective and durable solutions which will restore native fishes throughout the Klamath Basin including listed suckers; establish reliable water and power supplies which sustain agricultural uses, communities, and National Wildlife Refuges; and contribute to the public welfare and the sustainability of all Klamath Basin communities. With authorization and appropriation of funds from federal and state governments and implementation of the Agreement substantial progress should be made toward the recovery of Lost River and shortnose suckers.

2.3.3 Modoc sucker

In the status section, information on the species' status, life history, population dynamics, distribution, and other factors essential for survival are described. Relevant biological and ecological information presented in the status section is essential to formulation of the BO.

The environmental baseline presents an analysis of the effects of past and present human and natural factors that have led or that will continue to affect the status of Modoc sucker within the action area, including habitat/ecosystem conditions. In simplest terms, it is the status of the species within the action area given the response to past, present, and future factors. Although it focuses on the impacts past and present actions have had on the listed species, it includes an analysis of any future impacts from Federal actions that have undergone section 7 consultation and any contemporaneous State and private actions.

a. Status of the Species in the Action Area

This section reviews the current condition of Modoc sucker in the action area and the factors responsible for that condition. Many of the factors impacting sucker status represent Project effects and will be discussed in greater detail in the *Effects of the Action* section below.

i. *Legal Status*

The Modoc sucker was listed as endangered June 11, 1985 (50 FR 24526), under the Endangered Species Act of 1973, as amended. The Modoc sucker also was listed as endangered by the state of California in 1980 and is categorized as a "sensitive-critical" species in Oregon. Critical habitat was designated for the Modoc sucker in 1985 at the time of listing (50 FR 24526). In 1984 when Modoc sucker was first proposed for listing, several agencies, including USFWS, California Department of Fish and Game, and the USFS, were working towards on "Action Plan for the Recovery of the Modoc sucker" [hereafter, Action Plan]. The April 27, 1983, revision of the Action Plan was formally signed by all agencies in 1984 that then progressed through subsequent revisions from 1984 to 1992, none of which were signed. The signed 1984 Action Plan (USFWS 1984) obviated the need for a formal recovery plan developed by USFWS (USFWS 1985a). The 1984 Action Plan and the 1989 revisions were once more formalized in place of a formal Recovery Plan for the Modoc sucker in a memorandum (dated February 28, 1992) from the Region 1 Director to USFWS's Director. The purpose of the 1984 Action Plan was to provide direction and assign responsibilities for the recovery of the Modoc sucker. In addition, the Action Plan provided recovery tasks and reclassification (downlisting/delisting) criteria (Reid 2008a).

ii. *Taxonomy*

The Modoc sucker was first described by Rutter in 1908 based on specimens collected from Chamberlain and Rush creeks, Modoc County, California (Reid 2008a). The taxonomy of the Modoc sucker has not changed since its original description.

iii. *Species Description*

The Modoc sucker is a relatively small member of the sucker family (Catostomidae), generally maturing around 8-10 centimeters (cm; 3-4 inches), and usually reaching only 18 cm (7 inches) in length. Rutter differentiated the Modoc sucker from the sympatric Sacramento sucker, *C. occidentalis*, and the nearby Klamath largescale sucker, *C. snyderi*, by its small eye, small conical head, small scales and a nearly closed frontoparietal fontanelle (Rutter 1908). Martin (1967, 1972) further characterized the morphometric and meristic characters and elucidated osteological differences in the jawbones of the two species. Subsequent authors and researchers have differentiated the two species primarily by lateral line scale and dorsal fin ray counts, or locality.

The similarity in non-breeding coloration and external morphology between Modoc and Sacramento suckers have made it difficult to field-identify specimens visually without the excessive handling necessary for meristic counts. Differentiation of the two species has been further confused by dependence on relatively few Modoc sucker specimens for the analysis of meristic characters. Recent analysis of an extensive data set of several hundred Modoc and Sacramento suckers, suggests that there is natural overlap in the meristic counts for the two species, and that the actual range for the Modoc sucker is 73-91 lateral line scales and 9-12 dorsal rays (Kettratad 2001).

Non-breeding coloration is similar in both sexes and is similar to Pit River Sacramento suckers of similar size (Moyle 2002). The back varies from greenish brown through bluish to deep grey and olive. The sides are lighter with generalized mottling, and usually with 3-4 darker blotches along the sides, which are also evident in immature Sacramento Suckers. The belly is white to cream or yellowish but unmarked and the caudal and paired fins are light yellow-orange.

Breeding coloration is particularly marked in males, which develop a strong reddish-orange lateral stripe and intensified orange coloration on the caudal fin and paired fins (Moyle 2002). Some spawning males develop strong counter-shading, with a dark back and light belly (Reid 2008a). The lower limit of the dark dorsal coloration is about one width of the orange lateral band below the lateral line and about at (or slightly below) the level of the bottom of the eye, such that the orange lateral band is bounded by dark coloration above and below. This line of demarcation is also evident in males exhibiting a more blotchy coloration pattern intermediate to that of non-spawning individuals. Spawning males also develop extensive tuberculation on various parts of the body and fins, which varies between individuals and perhaps state of readiness to spawn. Females occasionally exhibit a weak, dull orange lateral stripe and reduced tuberculation on the fins.

iv. Life History and Ecology of Modoc Sucker

Modoc suckers are primarily found in relatively small (second- to fourth-order), perennial streams and occupy an intermediate zone between the high-gradient and higher elevation, coldwater trout zone and the low-gradient and low elevation, warm-water fish zone. Most streams inhabited by Modoc sucker are characterized by moderate gradient (15-50 feet drop per mile), low summer flow (1-4 cubic feet per second), and relatively cool (59-72° F) summer temperatures (Moyle and Daniels 1982).

In the Pit River system, Modoc sucker occupy stream reaches above the Sacramento sucker/pikeminnow/hardhead zone of the main-stem Pit River and the lower reaches of its primary tributaries (Moyle and Marciochi 1975; Moyle and Daniels 1982). The known elevation range of Modoc sucker is from about 4,200 to 5,000 feet in the upper Pit River drainage (Ash and Turner Creeks) and from about 4,700 to 5,800 feet in the Goose Lake subbasin (Reid 2008a). However, most known populations are constrained by the effective upstream limit of permanent stream habitat. Only Rush and Thomas creeks extend substantially above the elevations occupied by Modoc sucker.

The pool habitat occupied by Modoc sucker generally includes fine sediments to small cobble bottoms, substantial detritus, and abundant in-water cover. Cover can be provided by overhanging banks, larger rocks, woody debris, and aquatic rooted vegetation or filamentous algae. Larvae occupy shallow vegetated margins and juveniles tend to remain free-swimming in the shallows of large pools, particularly near vegetated areas, while larger juveniles and adults remain mostly on, or close to, the bottom (Martin 1967, 1972; Moyle and Marciochi 1975).

Modoc sucker often segregate themselves along the length of a stream by size with larger individuals being more common in lower reaches of streams. This may indicate a temperature-growth relationship or that larger Modoc sucker move downstream into larger, deeper, warmer pool habitats as they outgrow the relatively limited habitat in upper stream reaches. Spawning often occurs in the lower end of the pools over gravel-dominated substrates containing gravels, sand, silt and detritus (Reid 2008a).

Because spawning and rearing habitats are relatively non-specific and common, suitable habitat is not considered limiting except during severe droughts. There are approximately 40 miles of suitable habitat within their range and most of that is occupied.

Modoc sucker appear to be opportunistic feeders, similar to other catostomids, feeding primarily on algae, small benthic invertebrates, and detritus (Moyle 2002). Moyle and Marciochi (1975) reported the digestive tracts contained detritus (47 percent by volume), diatoms (19 percent), filamentous algae (10 percent), chironomid larvae (18 percent), crustaceans (mostly amphipods and cladocerans; 4 percent), and aquatic insect larvae (mostly tricopteran larvae, 2 percent). Based on gut content, it appears that Modoc sucker feed in low-energy pool environments, containing detritus and chironomids (Reid 2008a).

No complete study of activity patterns has been done for Modoc sucker; however, they do appear to exhibit diurnal and seasonal differences. They are most active, and visible to creek-side observers, later in the morning and through the afternoon. At this time they are frequently seen foraging on the substrate (including rocks) and along submerged plant stems (Reid 2008a). While they spend much of their time apparently resting on the bottom, they are quick to respond to disturbance and swim away. They frequently change positions and locations within a pool even during undisturbed observations. In contrast, extensive night snorkeling observations indicate Modoc sucker are resting and relatively lethargic after dusk (Reid 2008a).

v. *Distribution*

The current distribution of the Modoc sucker includes populations in ten streams in three sub-drainages (Figure 1in Reid 2008a). At the time of listing in 1985, the distribution of the Modoc sucker was considered to be restricted to the Turner and Ash Creek sub-drainages of the Pit River (i.e., Turner, Hulbert, and Washington creeks [all tributaries to Turner Creek], and Johnson Creek [a tributary of Rush Creek]). The original listing also recognized four additional creeks (Ash, Dutch Flat, Rush, and Willow creeks) as having been occupied historically. However, these populations were presumed lost due to hybridization with Sacramento suckers (*Catostomus occidentalis*). Although there was no genetic corroboration of hybridization available at that time (Ford 1977; Mills 1980; USFWS 1985a), hybridization was suspected because of overlapping occurrences.

New information is available which documents the occurrence of three additional populations not considered in the original listing (i.e., Coffee Mill and Garden Gulch creeks in the Turner sub-drainage and Thomas Creek in the Goose sub-basin). New genetic information also is available on the four populations considered lost to hybridization in 1985.

Examination of the Oregon State University fish collection revealed several lots of Modoc suckers collected in Thomas Creek that were misidentified as Sacramento suckers. Modoc sucker specimens were found in collections from five sites on Thomas Creek taken in 1954, 1974, 1993 (two collections), and 1997 (Reid 2008a). Thomas Creek in the Goose Lake sub-basin of Oregon is a disjunct, upstream sub-basin of the Pit River; all of the other populations are in the Pit River sub-basin in California (Reid 2007a).

Surveys conducted in 2001 and 2007 confirmed Modoc suckers were present throughout 15 miles of upper Thomas Creek (Figure 1 in Reid 2008a). Modoc Suckers were abundant in pools that remained at the end of a summer of drought, when intervening channel reaches were dry. A waterfall on lower Thomas Creek may impede upstream passage of suckers, and although Modoc Suckers have been documented in the past below the falls, their downstream distribution on privately owned reaches is unknown (Reid 2007a). Habitat on private land is more likely to be suitable for Sacramento suckers than Modoc suckers because it is at a lower elevation and has less gradient.

As discussed in the Status of the Species section, the discovery of suckers in Thomas Creek represents an expansion of the range of the species from the 1985 listing rule. Thomas Creek was not considered to contain Modoc suckers in the original listing, because at that time the Modoc sucker was considered to be confined to California.

The majority of the upper Thomas Creek watershed and the stream reaches containing Modoc suckers are managed by Fremont-Winema National Forests (USFS). Prior to the recognition that there were Modoc suckers in Thomas Creek, the USFS in 1986 established the Thomas Creek Riparian Recovery Project with the objective to halt erosion, stabilize stream banks, and reduce water temperatures for the benefit of native fishes. As part of this project, there have been numerous riparian restoration and channel improvement projects to promote deeper pool development and water retention, as well as improved grazing management.

There are two privately-owned meadow reaches of Thomas Creek, above the lower USFS boundary that are characterized by low gradient and large open pools. Both are managed for grazing by the USFS permittee. The lower parcel, which is unfenced and grazed with neighboring USFS allotments, contains substantial populations of Modoc sucker (Reid 2007a). The upper parcel is fenced and has not been surveyed; although, Modoc suckers are abundant in pools at its boundaries and therefore the suckers are likely occur on the un-surveyed stream reach. At this time, USFWS has no indication that current land management practices on public and private lands on Thomas Creek are incompatible with the conservation of the species, and therefore upward habitat trends are expected to continue.

b. Threats to the Species

The 1985 listing rule identified threats to the Modoc sucker which include habitat modification, range reduction, presence of movement barriers, predation and hybridization. Range reduction was discussed early in this section under the sub-section entitled “Distribution”.

The Service recently drafted a 5-year status review for the Modoc sucker (USFWS 2009a), which states the following:

“Most threats to the Modoc sucker that were considered in the 1985 listing rule (e.g., habitat modification, range reduction, and hybridization) have undergone substantial improvements or been ameliorated by new information and improved technology such that they no longer threaten the continued existence of the species. Habitat conditions on both public and private lands have shown substantial improvement, with continuing upward trends and a reasonable expectation that similar land management practices will continue. The distribution of known populations has remained stable or expanded slightly over the last 20 years, through a number of regional droughts. In addition, the range of the Modoc sucker has been expanded with the discovery of additional populations and documentation of genetic integrity in populations originally considered lost through hybridization. A greater understanding of the genetic relationships and natural gene flow between the Modoc and Sacramento suckers has reduced concerns over hybridization between the two naturally sympatric species.

The principal remaining threat to the Modoc sucker is predation by non-native fishes, in particular brown trout in the Ash Creek sub-drainage and largemouth bass in the Turner sub-drainage. While the Modoc sucker has survived for decades in the presence of non-native fish, if left unchecked introduced fish predators have the potential to threaten the Modoc sucker with local extinction in at least one of three sub-drainages. Additional work is needed to understand the effects of non-native fish to the survivability of Modoc suckers and to develop a long-term management plan to address these effects."

Each of the threats identified in the 1985 listing rule are discussed in more detail below, as well as a discussion on climate change and drought.

i. *Habitat Modification*

The 1985 listing rule stated that land management activities had: 1) dramatically degraded Modoc sucker habitat, 2) removed natural passage barriers allowing hybridization with Sacramento suckers and providing exposure to predaceous fishes, and 3) decreased the distribution of the Modoc sucker to only four streams (USFWS 1985a).

Since listing, the majority of Modoc sucker streams on public land have been fenced to exclude or actively manage cattle grazing (Reid 2008a). In 2001, California Department of Fish and Game, in cooperation with the Modoc National Forest and USFWS, carried out extensive habitat surveys of all known occupied stream reaches on public land and all private lands in the Turner Creek drainage and lower Johnson Creek to determine Proper Functioning Condition (Reid 2008a). Proper Functioning Condition is a method of assessing the physical functioning of riparian and wetland areas. The team found that all streams reaches of designated critical habitat on public lands were in "proper functioning condition" (i.e., Turner, Coffee Mill, Hulbert, Washington, Johnson Creeks) and that Dutch Flat and Garden Gulch, two occupied streams not originally listed as critical habitat, were "functional-at risk" with "upward trends," which is a positive condition just below proper functioning condition. On private lands surveyed in critical habitat, most habitat was assessed to be "functional-at risk;" however, all habitat also showed upward trends.

Extensive landowner outreach and improved land stewardship in Modoc and Lassen Counties in California have also resulted in improved protection of riparian corridors on private lands. Cattle are currently excluded from critical habitat on private land on Rush Creek and Johnson Creek below Higgins Flat (Modoc National Forest), allowing continued upward trends in habitat condition (Reid 2008a).

ii. *Movement Barriers*

In the 1985 listing rule, USFWS assumed that natural passage barriers in streams occupied by Modoc suckers had been eliminated by human activities, allowing hybridization between the Modoc and Sacramento suckers, as well as providing access to Modoc sucker streams by non-native predatory fishes. However, recent review of all streams where Modoc suckers occur indicates no evidence for historical natural barriers that would have physically separated the two species in the past, particularly during higher springtime flows when Sacramento suckers make their upstream spawning migrations (Reid 2008a). In addition, there is no evidence showing the historical range of the Modoc sucker, or its distribution within that range, has been substantially reduced in the recent past. To the contrary, continued field surveys have resulted in recent expansions of our understanding of the species' range and distribution. Furthermore, the distribution of Modoc suckers within the stream populations recognized in 1985 has either remained stable over the past 22 years, or slightly expanded, and the ten populations appear to occupy all available and suitable habitat.

iii. *Predation*

The listing rule identifies the presence of introduced and highly piscivorous brown trout (*Salmo trutta*) as threat because it reduced sucker numbers through predation (USFWS 1985a). Although non-native predatory fish are a problem in parts of the range in California (Reid 2008a), no non-native fishes have been found (Reid 2007a; Heck et al. 2008) in Thomas Creek. Predation on Modoc suckers by brown trout is of particular concern in the Ash Creek sub-drainage and largemouth bass in the Turner sub-drainage, but those threats have been substantially reduced by predator control mechanisms and through construction of fish screens at source reservoirs (Reid 2007b). The only native predatory fish in Thomas Creek is the native redband trout (*Oncorhynchus mykiss* ssp.). Stream-resident redband trout, which are not substantially larger than the Modoc sucker, is a primarily insectivorous species that occasionally feeds on small fishes (Moyle 2002). Because stream-resident redband trout are small and primarily feed on insects, they do not pose a threat to the Modoc sucker.

iv. *Hybridization*

The 1985 listing rule identified hybridization with the Sacramento sucker, also native to the Pit River drainage, as a principal threat to the Modoc sucker. Hybridization can be cause for concern in a species with restricted distribution, particularly when a closely related non-native species is introduced into its range, and can lead to loss of genetic integrity or even extinction (Rhymer and Simberloff 1996). In 1985, USFWS assumed that hybridization between Modoc and Sacramento suckers had been prevented in the past by natural physical barriers, which had been recently eliminated by human activities, allowing contact between the two species. Modoc sucker populations from streams in which both species were present were considered hybrid populations and were excluded when evaluating the Modoc sucker's distribution in 1985. The assumption that extensive hybridization was occurring was based solely on the opportunity presented by co-occurrence and the identification of a few specimens exhibiting what were thought to be intermediate morphological characters. At that time, genetic information to assess this assumption was unavailable.

Modoc and Sacramento suckers are naturally sympatric (occurring in the same streams) in the Pit drainage. There is no indication that Sacramento suckers are recent invaders to the Pit River or its tributaries. Both morphological and preliminary genetic data suggests that the upper Pit River population of Sacramento suckers is distinct from other Sacramento River drainage populations (Ward and Fritsche 1987; Dowling 2005). There is also no available information suggesting Modoc and Sacramento suckers were geographically isolated from each other in the recent past by barriers within the Pit River Drainage. Separation of the two species appears to be primarily ecological, with Modoc suckers occupying smaller, headwater streams typically associated with trout and speckled dace, and Sacramento suckers primarily occupying the larger, warmer downstream reaches of tributaries and main-stem rivers with continuous flow (Moyle and Marciochi 1975; Moyle and Daniels 1982; Reid 2008a). Further reproductive isolation is probably reinforced by different spawning times in the two species and their size differences at maturity (Reid 2008a).

The morphological evidence for hybridization in 1985 listing was based on a limited understanding of morphological variation in the Modoc and Sacramento suckers, derived from the small number of specimens available at that time. Subsequent evaluation of variability in the two species, based on a larger number of specimens, shows that the overlapping character states (primarily lateral line and dorsal ray counts), interpreted by earlier authors as evidence of hybridization, are actually part of the natural meristic (involving counts of body parts such as fins and scales) range for the two species and are not associated with genetic evidence of introgression (Kettratad 2001; Reid 2008a). Furthermore, the actual number of specimens identified as apparent hybrids by earlier authors was very small and in great part came from streams without established Modoc sucker populations.

In 1999, USFWS initiated a program to examine the genetics of suckers in the Pit River drainage and determine the extent and role of hybridization between the Modoc and Sacramento suckers using both nuclear and mitochondrial genes (Palmerston et al. 2001; Wagman and Markle 2000; Dowling 2005; Topinka 2006). The two species are genetically similar, suggesting that they are relatively recently differentiated and/or have a history of introgression throughout their range that has obscured their differences (Wagman and Markle 2000; Dowling 2005; Topinka 2006). Although the available evidence cannot differentiate between the two hypotheses, the genetic similarity in all three sub-drainages, including those populations shown to be free of introgression based on species-specific genetic markers (Topinka 2006), suggests that introgression has occurred on a broad temporal and geographic scale and is not a localized or recent phenomenon. Consequently the evidence indicates that introgression is natural and is not caused or measurably affected by human activities.

There is no evidence that the observed hybridization has been affected by human modification of habitat, and genetic exchange between the two species under such conditions may be a natural phenomenon and a part of their evolutionary legacy. Despite any hybridization that has occurred in the past, the Modoc sucker maintains its morphological and ecological distinctiveness, even in populations showing low levels of introgression, and is clearly distinguishable from the Sacramento sucker using morphological characteristics (Kettratad 2001). Therefore, given the observed low-levels of observed introgression in nine known streams dominated by Modoc suckers, the absence of evidence for extensive ongoing hybridization in the form of first generation hybrids, the fact that Modoc and Sacramento suckers are naturally sympatric, and the continued ecological and morphological integrity of Modoc sucker populations, hybridization is not considered a threat to Modoc sucker populations.

v. *Drought and Climate Change*

The 1985 listing rule did not identify drought or climate change as threats to the continued existence of the Modoc sucker (USFWS 1985a). However, the northwestern corner of the Great Basin is naturally subject to extended droughts, during which even the larger water-bodies such as Goose Lake have dried up (Laird 1971). Regional droughts have occurred every 10 to 20 years in the last century (Reid 2008a). The "dustbowl" drought of the 1920's to 1930's appears to have been the most extreme regional drought in at least the last 270 years and probably the last 700 years (Keen 1937; Knapp et al. 2004).

There is no record of how frequently Modoc sucker streams went dry except for occasional pools. However, reaches of these streams likely did stop flowing in the past because some reaches dry up (or flow goes through the gravel instead of over the surface) nearly every summer under current climatic conditions (Reid 2008b). Collections of Modoc sucker from Rush Creek and Thomas Creek near the end of the dust bowl drought (Hubbs and Miller 1934; Merriman and Soutter 1933), and the continued persistence of Modoc sucker throughout its known range through substantial local drought years since 1985 without active management, demonstrate the resiliency of the population given availability of suitable refuge habitat. Based on this, drought does not pose a substantial threat to the species.

Human-induced climate change could exacerbate low-flow conditions in Modoc sucker habitat during future droughts. A warming trend in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, reduce summer stream flows, and increase summer temperatures (IPCC 2007; PPIC 2008). Lower flows as a result of smaller snowpack could reduce sucker habitat, which might adversely affect Modoc sucker reproduction and survival. Warmer water temperatures could lead to physiological stress and could also benefit non-native fishes that prey on or compete with Modoc suckers. Increases in the numbers and size of forest fires could also result from climate change (Westerling et al. 2006) and could adversely affect watershed function resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. While it appears reasonable to assume that the Modoc sucker will be adversely affected by climate change, we lack sufficient information to accurately determine what degree of threat climate change poses and when the changes will occur.

c. Demography and Population Trends

Several researchers have attempted to quantify the population size of Modoc sucker from their range in California and used these estimates to assess population trends. However, no population estimates have ever been conducted within Thomas Creek, Oregon. Nevertheless, surveys by Reid in 2001 and 2007 found the species to be common and widespread in Thomas Creek (Reid 2007a).

d. Status of Critical Habitat within the Action Area

Critical habitat in California was designated for the Modoc sucker in 1985 at the time of listing (50 FR 24526). However, because the species was not known from Oregon at the time of listing it was not been proposed or designated within Oregon.

2.3.4 Warner sucker

a. Species Description

i. *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. Preliminary genetic results by Harris (P. Harris, Oregon State University, pers. comm., 1996) places the Warner sucker as a sister species to the Wall Canyon sucker of Nevada (species yet to be described). Morphologically, all these species are similar and probably the result of speciation due to geographic isolation (USFWS 1998b pp. 4-5).

ii. *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 456 millimeters (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 millimeter (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.

iii. *Current legal status, including listing history (or reference to)*

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

b. Critical habitat Description

i. *Current legal status of the critical habitat*

Critical habitat has been designated. Warner sucker critical habitat includes the following areas: Twelvemile Creek from the confluence of Twelvemile and Twentymile Creeks upstream for about six stream kilometers (four stream miles); Twentymile Creek starting about 14 kilometers (nine miles) upstream of the junction of Twelvemile and Twentymile Creeks and extending downstream for about 14 kilometers (nine miles); Spillway Canal north of Hart Lake and continuing about three kilometers (two miles) downstream; Snyder Creek, from the confluence of Snyder and Honey Creeks upstream for about five kilometers (three miles); Honey Creek from the confluence of Hart Lake upstream for about 25 kilometers (16 miles). Warner sucker critical habitat includes 16 meters (50 feet) on either side of these waterways.

c. Life history

i. *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 14-20 degrees Celsius (57-68 degrees Fahrenheit) 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+ centimeters (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 percent and 89 percent, respectively, although accurate larval Warner sucker counts were hampered by dense macrophyte cover (Tait and Mulkey 1993b).

ii. *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 percent 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 percent 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 percent confidence intervals of 439-563) (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 percent 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.

d. 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 (8-12 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 millimeters (10.5 inches) SL in 1996 (Chris Allen, The Nature Conservancy, Fishery Biologist, Portland, Oregon, pers. comm., 1996), 244 millimeters (9.6 inches) SL in 1995 (Allen et al. 1995a) and 198 millimeters (7.8 inches) SL in 1994 (Allen et al. 1995b). Stream caught fish averaged 138 millimeters (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 millimeters (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 millimeters (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 millimeters (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 meters [166.6 feet] or longer pools. These pools tended to have undercut banks, large beds of aquatic macrophytes (usually greater than 70 percent of substrate covered), root wads or boulders, a surface to bottom temperature differential of at least two degrees Celsius (at low flows), a maximum depth greater than 1.5 meters (5 feet), and overhanging vegetation (often Salix spp.). About 45 percent 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 kilometer (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 meters (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.

e. Status

i. Historical status and distribution (summary)

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 kilometers (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.

ii. *Current status and distribution of the listed species in rangewide (summary)*
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 USFWS'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 millimeters (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 10-17.5 centimeter (4-7 inch) 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 1998b). 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 1998b). 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.

f. Threats; including reasons for listing, current rangewide threats

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.

With few exceptions, designated Warner sucker critical habitat is excluded from grazing and other land use authorizations analyzed in the Lakeview Resource Area Resource Management Plan. The one exception is on the Deppy Creek/ Honey Creek confluence where a water gap allows stock access. The other exception is in the 0207 allotment on Twentymile Creek. This area is not occupied by Warner sucker and is an intermittent, rock-armored channel. Both these areas are covered by the ten-year programmatic opinion on grazing issued by USFWS in 1997.

g. Conservation

i. Needs (summary)

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.

ii. Current Actions (summary)

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 meter (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).

h. Federal land management

The Federal agencies responsible for management of the habitat in the Warner Basin have consulted on activities that might impact the Warner sucker. On May 21, 1995, the BLM, USFS, NMFS and USFWS signed the Streamlining/Consultation Guidelines to improve communication and efficiency between agencies. In the Warner Basin, the outcome of streamlining has been regular meetings between the Federal agencies conducting and reviewing land management actions that may affect Warner sucker. These meetings have greatly improved the communication among agencies and have afforded all involved a much better understanding of issues throughout the entire watershed. As a result of close coordination, the USFS and BLM have modified many land management practices, thus reducing negative impacts, and in many cases bringing about habitat improvements to Warner sucker and Warner Valley redband trout.

Since the listing of Warner sucker as threatened in 1985, the Lakeview Resource Area has completed numerous consultations on BLM actions affecting Warner sucker. The following lists the subject and year the consultation was completed: Habitat Management Plan for the Warner Sucker 1985; Fort Bidwell-Adel County road realignment 1987; Warner Wetlands Habitat Management Plan 1990; relocation of Twentymile stream gauge 1993; Lakeview BLM grazing program 1994; reinitiation of consultation on grazing program 1995; Noxious Weed Control Program 1996; reinitiation of consultation on grazing program 1996; informal consultation on guided fishing activities 1997; reinitiation of consultation on grazing program and consultation on a number of small non-grazing projects 1997; reinitiation of consultation on grazing program 1999; informal consultation on Long Canyon Prescribed Fire 1999; grazing permit renewal concurrence 1999; reinitiation of consultation on grazing program 2000; and reinitiation of consultation on grazing program 2001.

In 1994, Lakeview Resource Area determined that ongoing site-specific livestock grazing actions were likely to adversely affect Warner sucker in the Warner Valley Watersheds and has, to date, consulted under recurring biological opinions with USFWS. Present grazing prescriptions and monitoring protocols are in accordance with biological opinions issued by the USFWS, and results of grazing monitoring appear annually in reports to the Service. Consultation for Lakeview Resource Area's grazing activities has been reinitiated due to changes in the action, changes due to new information, and for failure to comply with terms and conditions of the biological opinions.

2.3.4 Foskett Speckled Dace

a. Species Description

i. *Taxonomy*

The Foskett speckled dace is considered to be an undescribed subspecies of *Rhinichthys osculus* (Girard) 1857. *R. osculus* (speckled dace) have a large geographic range throughout major drainages in the western United States, and populations show high degrees of endemism and exhibit large differences in morphological traits (Pfrender et al. 2003). Pfrender et al. (2003) stated that our understanding of the relationships among populations in this complex is limited, and there is no clear consensus regarding the number of distinct evolutionary lineages within *R. osculus*. Foskett speckled dace can be distinguished from other speckled dace by external characteristics, such as: a much reduced lateral line with about 15 scales with pores; about 5 lateral line scales; a large eye; the dorsal fin is positioned well behind the pelvic fin but before the beginning of the anal fin; and barbells are present on most individuals (USFWS 1998b). However, Bond (1974) did not provide a formal description or a scientific name for this subspecies, nor was his work peer reviewed. No changes to the taxonomic classification of Foskett speckled dace has occurred since the time it was listed in 1985. Recent genetic investigations by Ardren et al. (2009, no pagination), provides new information regarding the evolutionary relationship of Foskett speckled dace to other Warner Basin and Goose Lake Basin speckled dace.

ii. *Species Description*

The Foskett speckled dace (*R. osculus* ssp.) is represented by a single population that inhabits Foskett Spring on the west side of Coleman Lake in Lake County, Oregon (USFWS 1998b). Size ranges up to 4" (10 cm). Foskett speckled dace is described as elongate, rounded with a flat belly. Color of its back is dusky to dark olive; sides are grayish green, with dark lateral stripe, often obscured by dark speckles or blotches; and the fins are plain. Breeding males are reddish on lips and fin bases. The snout is moderately pointed; the eyes and mouth are small, and ventral barbels are present. Foskett speckled dace have 8 dorsal fin rays; 7 anal fin rays and the caudal fin is moderately forked. The lateral line is complete with 60–90 scales (REF).

iii. *Current legal status, including listing history*

The Foskett speckled dace is endemic to one spring on the western margin of Coleman Lake, Lake County, Oregon and was listed as threatened March 28, 1985 (USFWS 1985c). Special rules concerning "take" for this subspecies can be found in 50 CFR 17.44(j). The “Recovery Plan for the Threatened and Rare Native Fishes of the Warner Basin and Alkali Subbasin”, which includes Foskett speckled dace, was finalized April 27, 1998 (USFWS 1998b).

b. Critical habitat Description

i. *Current legal status of the critical habitat*

No critical habitat has been designated or proposed for the Foskett speckled dace.

c. Life history

i. *Reproduction*

Breeding behavior has not been observed. Presumably Foskett speckled dace have habits similar to other dace and require rock or gravel substrate for egg deposition (Sigler and Sigler 1987, p.208). Foskett speckled dace are believed to spawn between late May and early July and apparently reproduce in their second year of age.

The 2009 abundance estimate conducted by ODFW, included dace ranging from 18-76 mm TL. A length-frequency analysis suggests the presence of multiple age-classes, with two apparent peaks, one approximately 25 mm the other approximately 45 mm. The presence of fish < 25mm in all three sampling years suggests that successful reproduction occurs annually. Presence of young-of-the- year fish (<25 mm) provides evidence of recent recruitment (Scheerer and Jacobs 2009, p. 5).

ii. *Population structure*

The population of Foskett speckled dace was monitored in 2009 and appears to be healthy and near carrying capacity. Bond (USFWS 1985c) estimated the population of Foskett speckled dace in Foskett Spring to be approximately 1,500 individuals. In 1997, ODFW obtained mark-recapture population estimates at both Foskett and Dace springs (Dambacher et al. 1997). The Foskett Spring estimate was 27,787 fish (95% CI: 14,057-41,516). The majority of the fish (97%) were found in the downstream open water pool located outside the cattle exclosure. In 2005, 2007, and 2009, ODFW obtained population estimates of 3,147 (95% CI: 2,535-3,905); 2,879 (95% CI: 2,319-3,573); and 2,830 (95% CI: 2,202-3,633) dace, respectively (Scheerer and Jacobs 2009, pp. 3-4).

Although the three estimates were statistically valid, there is a great discrepancy between the sizes of the population present in 1997 compared to the number that was estimated in 2005; the distribution of the fish was also substantially different. Scheerer and Jacobs (2007a) postulated that the lower population abundance in 2005 and 2007 compared to 1997 was probably due to the reduction of open water habitat in the cattail marsh. Additional population estimates will be needed before a population trend can be established. General observations made during the population surveys of 2005 and 2007 included the presence of multiple age-classes, and evidence of recent recruitment as indicated by presence of young-of-the-year.

A genetic analysis was conducted by Ardren et al. (2009), and compared Foskett speckled dace to other populations of dace in the Warner basin as well as the adjacent Goose Lake Basin. The results indicate that Foskett dace and other populations of dace in the in the Warner basin are approximately equally diverged from one another evolutionarily, suggesting similar times of divergence since the late Pleistocene. It appears further studies are needed to determine if rapid evolution of novel traits have occurred in dace inhabiting the unique ecological setting of Foskett Spring during the past 10,000 years (Ardren et al. 2009, no pagination)

iii. *<u>Ecology / Habitat Characteristics</u>*

The Foskett speckled dace became isolated in Foskett Spring at the end of the Pluvial Period about 9-10,000 yrs. ago. Its main natural habitat is the small, shallow pool at the spring source. Foskett Spring is a cool-water spring with temperatures recorded at a constant temperature of approximately 18 degrees Celsius (Scheerer and Jacobs 2009). The source pool has a loose sandy bottom and is choked with macrophytes. The spring brook (outflow channel) eventually turns into a marsh and dries up before reaching the bed of Coleman Lake. Foskett speckled dace occur naturally in the main spring pool, outflow channel, and tiny outflow rivulets that are at times only a few inches wide and deep. The fish find cover under overhanging bank edges, grass, exposed grass roots, and filamentous algae. Foskett Spring is fenced to exclude cattle and dace were the only fish species found to be present. The fish appeared to be in good condition with no obvious external parasites.

The wet areas at the spring, along the course of the rivulets, and at the edge of the playa supports growth of grasses and some aquatic vegetation, including bull rush and cattails. The main population is in the spring-hole, which is about 6 feet in diameter and mostly 6 to 12 inches deep. Water in the spring is clear, the water flow slow but significant. The bottom is primarily mud. No information is available on growth rates, age of reproduction, or behavioral patterns.

Foskett speckled dace appear to be non-territorial and is known to form small aggregations. The individuals are found in restricted habitats including the small spring pool, narrow rivulets, and small depressions, including cow tracks, so that home range and total range might coincide. Extensive migration is not known, but larval and early juvenile dace have been observed only in the marsh at the edge of the lake bed, so there is either a migration of adults downstream to spawn, or a migration of the hatched larvae from the spring hole or rivulets to the marsh (a distance of about 6-12 feet).

Baseline water quality and vegetation monitoring at Foskett and Dace springs were initiated by BLM in 1987. The following data collected on 28 September 1988 from Foskett Spring and Dace Spring, respectively, exemplify the two habitat similarities: air temperature 19 and 17 C, water temperature 17 and 16 C, dissolved oxygen 5.3 and 5.9 mg/I, conductivity 350 and 250 mohs/cm, pH 8.1 and 8.2, alkalinity 114 and 99 mg/l CaC03, hardness 40.0 and 24.7 mg/l, and turbidity 1.4 and 1. 8 NTU.

The waters of Foskett Spring are high in mineral content and the temperature of the spring is fairly constant (Scheerer and Jacobs 2009, p. 5). Either decreases or increases in water temperature could affect Foskett speckled dace. The spring temperatures measured in Foskett Spring from 14 August 2007 through 16 August 2009, were a constant 18.2oC, similar to temperatures recorded previously (Scheerer and Jacobs 2009, p. 5).

In 2005, 2007, and 2009, the ODFW considered the Foskett speckled dace habitat to be in good condition, but limited in extent (Scheerer and Jacobs 2005, 2007a, and 2009). They noted that encroachment by aquatic macrophytes may be limiting population abundance and that the decline in abundance of Foskett speckled dace since 1997 is probably due to the reduction in open water habitat. Dambacher et al. (1997) noted that past habitat enhancement efforts to increase open water habitat have been unsuccessful due to sediment infilling and growth of macrophytes. Little information is available on water quality or flows. Deeper water with moderate vegetative cover would presumably be better habitat, judging from conditions under which other populations of speckled dace live.

d. Status

i. Historical status and distribution (summary)

Foskett speckled dace were probably distributed throughout prehistoric Coleman Lake of the Warner Basin during times that it held substantial amounts of water. The timing of the isolation between the Warner Lakes Subbasin and the Coleman Subbasin is uncertain although it might be as recent as 10,000 years ago (Bills 1977). Foskett speckled dace were probably distributed throughout prehistoric (approximately 12,000 years ago) Coleman Lake during times that it held substantial amounts of water. As the lake dried, the salt content of the lake water increased. Suitable habitat would have been reduced from a large lake to any spring systems that provided enough suitable habitat for survival. Springs that remain within the vicinity of Coleman Lake include Foskett Spring and Dace Spring. Both springs are extremely small and shallow with limited habitat for fish. Foskett Spring has the only known native population of Foskett speckled dace. The Recovery Plan describes Foskett Spring as originating in a pool about 5 meters across. The outflow channel is approximately 5 centimeters deep and it gradually transitions to marshland, drying up before reaching the dry bed of Coleman Lake (USFWS 1998b).

Dace Spring is approximately 0.8 kilometer (0.5 mile) south of Foskett Spring. This spring may have originally been occupied by Foskett speckled dace but there were none found in the 1970's. In November 1979, 50 Foskett speckled dace were transplanted into the then fishless Dace Spring from Foskett Spring (Williams *et al.* 1990). In August 1980, 50 more Foskett speckled dace were introduced into Dace Spring. Dace Spring is smaller than Foskett Spring and the spring outflow terminates in a cattle watering trough where fewer than 20 Foskett speckled dace were seen in 1996 (Dambacher 1997). Foskett speckled dace appeared to have persisted in the trough for several additional years, but none were detected during surveys in 2005

ii. *Current status and distribution of the listed species in rangewide (summary)*

In 1987 the BLM acquired Foskett Spring and the surrounding 65 ha, of which approximately 28 ha were fenced to exclude cattle. The dace population at Foskett Spring has since expanded to the spring pool its outflow, and downstream marsh (Williams et al.1990 p 244). Current management of the Foskett and Dace spring systems excludes livestock use.

The known range of the Foskett speckled dace is limited to Foskett Spring in the Coleman Subbasin, in southeast Oregon. At the time of listing, Foskett speckled dace was restricted to Foskett Spring and a transplanted population at nearby Dace Spring. Surveys of Foskett Spring conducted in 2005 and 2007 document Foskett speckled dace in the spring pool, outflow stream, and the tule and cattail marshes of Foskett Spring. The ODFW estimated approximately 722 m^2 of wetted habitat in the spring pool, spring brook, tule marsh, cattail marsh, and sedge marsh (Scheerer and Jacobs 2005). In 2005 and 2007, approximately half of the population of Foskett speckled dace was located in the 33 m^2 spring pool.

iii. *Threats; including reasons for listing, current rangewide threats*

Threats identified at the time of listing Foskett speckled dace included actual or potential modification of habitat; restricted distribution; and pumping of ground water with concomitant lowering of the water table. Mechanical modification of the aquatic ecosystem had occurred in the past evidenced by the remnant rock dam. The spring also had been used for livestock watering resulting in negative affects to Foskett speckled dace. The State of Oregon has listed the Foskett speckled dace as threatened under the Oregon Endangered Species Act, which prohibits taking the fish without an Oregon scientific collecting permit, but does not protect the habitat (USFWS 1985c, p. 12304).

The outflow of the spring at one time apparently formed a small rivulet, which prior to listing was used heavily for cattle grazing and is now occupied by Foskett speckled dace. At the time of listing, trampling of the habitat by cattle was perceived as the main reason for diminution of the habitat. The wetland on the edge of normally dry Coleman Lake may have formerly afforded some habitat, but is now either occupied by cattails and other vegetation. Therefore, a new threat would be encroachment of vegetation (cattails and rushes) into the open water habitat occupied by Foskett speckled dace. No other fish occur in Coleman Valley (Williams et al.1990, p. 244).

e. Conservation

i. *Needs (summary)*

The Recovery Plan for the Threatened and Rare Native Fishes of the Warner Basin and Alkali Subbasin states that this species will probably not be delisted in the near future because of its extremely isolated range and potential for degradation of its habitat from localized events. The primary recovery objective for this species is the long-term persistence through preservation of its native ecosystem. The plan further states that the conservation and long-term sustainability of this species will be met when: 1) long-term protection to its habitat, including spring source aquifers, springpools and outflow channels, and surrounding lands is assured; 2) long-term habitat management guidelines are developed and implemented to ensure the continued persistence of important habitat features and guidelines include monitoring of current habitat and investigation for and evaluation of new spring habitats; and 3) research into life-history, genetics, population trends, habitat use and preference, and other important parameters is conducted to assist in further developing or refining criteria 1) and 2), above. Actions needed to meet these criteria include protecting and rehabilitating fish populations and habitats, conserving genetic diversity of fish populations, ensuring adequate water supplies are available for recovery, monitoring population and habitat conditions, and evaluating long-term effects of climatic trends on recovery (USFWS 1998b).

Maintenance of acceptable water quality, spawning and rearing areas, and open water habitat is required for conservation of Foskett speckled dace. Speckled dace in general occupy a wide variety of habitats, and the species is tolerant of environmental variation of its particular habitat (Sigler and Sigler 1987, p. 208). Because Foskett speckled dace is a narrow endemic occupying habitats of a small spring and outflow in a desert environment, efforts need to be made to continue to protect and preserve the unique habitats which Foskett speckled dace inhabit.

ii. *Current Actions (summary)*

In 2009, the USFWS and BLM implemented a project to create two spring-fed ponds for the purpose of establishing the refuge population and to re-introduce Foskett speckled dace into habitat formally established in 1980 to serve as habitat at Dace spring. In September 2010, 49 Foskett speckled dace were transferred from Foskett Spring to the two Dace Spring ponds. The objectives of the translocation of Foskett speckled dace to Dace Spring are to provide more open water habitat and to provide a refugial population in addition to the Foskett Spring.

f. Status of the Species in the Action Area

i. *Current status and distribution of the listed species in the state of Oregon including population size, variability, and trend*

Current status and distribution of Foskett speckled dace in the action area is as described in the sections above.

ii. Current critical habitat designation within the action area

No critical habitat has been designated for Foskett speckled dace in the action area.

2.3.5 Oregon chub

a. Species Description

i. Taxonomy

The Oregon chub was first described in scientific literature in 1908 (Snyder 1908), however it was not identified as a unique species until 1991 (Markle et al. 1991). The genus O*regonichthys* is endemic to the Umpqua and Willamette Rivers of western Oregon. In the past, the common name "Oregon chub" has been used to refer to all *Oregonichthys* from both of these drainages. However, the Umpqua River form of *Oregonichdiys (0. kalawatseti)* was formally described by Markle et al. (1991), and is taxonomically distinct from *Oregonichthys* in the Willamette River which retains the earlier name of *0. crameri.* Use of the term "Oregon "chub" therefore refers only to *0. crameri.*

ii. Species Description

The Oregon chub is a small minnow (Family: Cyprinidae) with an olive-colored back grading to silver on the sides and white on the belly. Scales are relatively large with fewer than forty occurring along the lateral line and scales near the back are outlined with dark pigment (Markle et al. 1991). While young of the year range in length from 7 to 32 millimeters (mm) (0.3 to 1.3 inches), adults can be up to 90 mm (3.5 inches) in length (Pearsons 1989). The species is distinguished from its closest relative, the Umpqua chub (*Oregonichthys kalawatseti*), by Oregon chub's longer caudal peduncle (the narrow part of a fish's body to which the tail is attached), mostly scaled breast, and more terminal mouth position (Markle et al. 1991).

b. Current legal status

The USFWS listed the Oregon chub as an endangered species in 1993, (USFWS 1993b) and a final recovery plan for the Oregon chub was published in 1998, (USFWS 1998c). The Oregon chub recovery plan established the following criteria for delisting (i.e., removing the species from the List of Endangered and Threatened Wildlife):

Establish and manage 20 populations of at least 500 adults each; (2) All of these populations must exhibit a stable or increasing trend for 7 years; (3) At least four populations must be located in each of the three subbasins (Mainstem Willamette River, Middle Fork, and Santiam River); and (4) Management of these populations must be guaranteed in perpetuity.

In 2008, the USFWS completed a 5-year review of the Oregon chub, concluding that downlisting criteria had been met and the species should be downlisted to threatened status (USFWS 2008b). The final rule designating critical habitat (USFWS 2010a, b) and the final rule to downlist Oregon chub were published in 2010 (USFWS 2010c).

c. Critical Habitat Description

i. Current legal status of critical habitat

Critical habitat was designated for Oregon chub in 2010 (USFWS 2010b, c). In the final rule, the USFWS determined that 25 units totaling approximately 132 acres in Benton, Lane, Linn and Marion Counties met the proposed definition of critical habitat. Land ownership of the proposed critical habitat is as follows: 32.9 acres private, 30.11 acres state, 66.3 acres Federal and 2.8 acres other public lands.

ii. The Primary Constituent Elements

The PCEs of Oregon chub critical habitat are the habitat components that provide the following:

1. Off-channel water bodies such as beaver ponds, oxbows, side-channels, stable backwater sloughs, low-gradient tributaries, and flooded marshes, including at least 500 continuous square meters (m^2) (0.12 acres) of aquatic surface area at depths between approximately 0.5 and 2.0 meters (m) (1.6 and 6.6 feet)
2. Aquatic vegetation covering a minimum of 250 m^2 (0.06 acres) (or between approximately 25 and 100 percent) of the total surface area of the habitat. This vegetation is primarily submergent for purposes of spawning, but also includes emergent and floating vegetation, and algae, which are important for cover throughout the year. Areas with sufficient vegetation are likely to also have the following characteristics.
    a. Gradient less than 2.5 percent;
    b. No or very low water velocity in late spring and summer;
    c. Silty, organic substrate; and
    d. Abundant minute organisms such as rotifers, copepods, cladocerans, and chironomid larvae.
3. Late spring and summer subsurface water temperatures between 15 and 25 °C (59 and 78 °F), with natural diurnal and seasonal variation.
4. No or negligible levels of non-native aquatic predatory or competitive species. Negligible is defined for the purpose of this rule as a minimal level of non-native species that will still allow the Oregon chub to continue to survive and recover.

d. Life History

i. Reproduction

Oregon chub reach maturity at about 2 years of age (Scheerer and McDonald 2003, p. 78) and in wild populations can live up to 9 years. Most individuals over 5 years old are females (Scheerer and McDonald 2003, p. 68). Oregon chub spawn from May through August; individuals are not known to spawn more than once a year. Spawning activity has only been observed at water temperatures exceeding 16 °C (61 °F). Males over 35 mm (1.4 inches) have been observed exhibiting spawning behavior (Pearsons 1989, p. 4). Egg masses have been found to contain 147-671 eggs (Pearsons 1989, p.17).

ii. Population Structure

Conservation efforts have successfully increased the abundance and distribution of Oregon chub in the short-term, but according to annual monitoring reports (Scheerer et al. 2006 and 2007b) there is still concern about the long-term conservation and recovery of the species. The reports indicate the genetic exchange among Oregon chub populations is believed to be minimal. In 2007, nineteen out of 34 Oregon chub populations (56 percent) were isolated and had a low probability of annual floodplain connectivity, and 16 of the 34 populations (47 percent) had less than 500 fish (Scheerer 2007c). Research suggests there may be risks associated with isolating populations that previously interacted with a larger network of interacting populations (Meffe and Vrijenhoek 1988; Burkey 1989).

Isolating populations that would normally experience gene exchange can result in a general decline in local genetic diversity and a corresponding increase in divergence among populations within a drainage system (Meffe and Vrijenhoek 1988). 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). Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events (Hard 1995; Healy & Prince 1995; Rieman & Allendorf 2001; Rieman & McIntyre 1993; Spruell et al. 1999). Migration and occasional spawning between populations increases genetic variability and strengthens population variability (Rieman and McIntyre 1993).

Effective population sizes of 500 to 5000 have been recommended for the retention of evolutionary potential (Franklin & Frankham 1998; Lynch & Lande 1998). According to the 2007 annual monitoring report 16 out of 34 populations (47 percent) had less than 500 fish (Scheerer et al. 2007b), and therefore do not have sufficiently large effective population sizes to retain optimal evolutionary potential. Increased homozygosity of deleterious recessive alleles is thought to be the main mechanism by which inbreeding depression decreases the fitness of individuals within local populations (Allendorf & Ryman 2002). Hedrick and Kalinowski

(2000) provide a review of studies demonstrating inbreeding depression in wild populations with very small effective population sizes.

The USFWS' Abernathy Fish Technology Center conducted a genetic analysis on Oregon chub that will be used to guide future restoration efforts. The report suggests that four genetically distinct groups of Oregon chub exist and these groups corresponded to the subbasins of the Willamette River. The report supports the current approach for chub reintroductions using a donor population for a given reintroduction from within the same subbasin as the reintroduction site. The report authors examined genetic diversity within and among 20 natural and four introduced populations at 10 microsatellite loci and observed moderate levels of diversity with the exception of one population that displayed signs of a genetic bottleneck (Shetzline Pond) (Ardren et al. 2008).

e. Ecology / Habitat Characteristics

Oregon chub are found in slack water off-channel habitats such as beaver ponds, oxbows, side channels, backwater sloughs, low gradient tributaries, and flooded marshes. These habitats usually have little or no water flow, are dominated by silty and organic substrate, and contain considerable aquatic vegetation providing cover for hiding and spawning (Pearsons 1989, p. 27; Markle et al. 1991, p. 289; Scheerer and McDonald 2000, p. 1). The average depth of habitat utilized by Oregon chub is less than 1.8 m (6 ft), and summer water temperatures typically exceed 16 °C (61 °F).

Adult chub seek dense vegetation for cover and frequently travel in the mid-water column in beaver channels or along the margins of aquatic plant beds. Larval chub congregate in shallow near-shore areas in the upper layers of the water column, whereas juveniles venture farther from shore into deeper areas of the water column (Pearsons 1989, p. 16). In the winter months, Oregon chub can be found buried in the detritus or concealed in aquatic vegetation (Pearsons 1989, p. 16). Fish of similar size school and feed together. In the early spring, Oregon chub are most active in the warmer, shallow areas of the ponds.

Oregon chub are obligatory sight feeders (Davis and Miller 1967, p. 32). They feed throughout the day and stop feeding after dusk (Pearsons 1989, p. 23). Chub feed mostly on water column fauna. The diet of Oregon chub adults collected in a May sample consisted primarily of minute crustaceans including copepods, cladocerans, and chironomid larvae (Markle et al. 1991, p. 288). The diet of juvenile chub also consists of minute organisms such as rotifers and cladocerans (Pearsons 1989, p. 2).

Of the known Oregon chub populations, the sites with the highest diversity of native fish, amphibian, and reptile species have the largest populations of Oregon chub (Scheerer and McDonald 2000, p. 24). Beavers appear to be especially important in creating and maintaining habitats that support these diverse native species assemblages (Scheerer and Apke 1998, p. 45).

f. Status

i. Historical status and Distribution

Historically, Oregon chub were found throughout the Willamette River drainage from Oregon City to Oakridge. Records note collections from the Clackamas River, Molalla River, Mill Creek, Luckiamute River, North Santiam River, South Santiam River, Calapooia River, Long Tom River, Muddy Creek, McKenzie River, Coast Fork Willamette River, Middle Fork Willamette River drainages, and the mainstem Willamette River. Oregon chub were distributed throughout the Willamette River Valley (Snyder 1908) in off-channel habitats such as beaver ponds, oxbows, stable backwater sloughs, and flooded marshes. These habitats usually have little or no water flow, have silty and organic substrate, and have an abundance of aquatic vegetation and cover for hiding and spawning. In the last 100 years, these habitats have largely disappeared because of changes in seasonal flows resulting from the construction of dams throughout the basin, channelization of the Willamette River and its tributaries, and agricultural practices. This loss of habitat combined with the introduction of non-native species to the Willamette Valley resulted in a sharp decline in Oregon chub abundance.

At the time of listing in 1993, there were only eight known populations of Oregon chub. These locations represented a small fraction (estimated as two percent based on stream miles) of the species' formerly extensive distribution within the Willamette River drainage. Since the time of listing, several Oregon chub populations have been extirpated, a number of new populations have been discovered, and there have been a number of successful introductions (Bangs et al. 2012).

ii. Current Status and distribution

The Oregon chub is endemic to the Willamette River drainage of western Oregon. Historical records show Oregon chub were found as far downstream as Oregon City and as far upstream as Oakridge. At the time of listing in 1993, there were only eight known populations of Oregon chub. These locations represented a small fraction (estimated as two percent based on stream miles) of the species' formerly extensive distribution within the Willamette River drainage.

Since the time of listing, several Oregon chub populations have been extirpated, a number of new populations have been discovered, and there have been a number of successful introductions (Bangs et al. 2012). In 2012, the ODFW confirmed the continued existence of Oregon chub at 61 locations in the North and South Santiam River, McKenzie River, Middle Fork and Coast Fork Willamette River, and several tributaries to the mainstem Willamette River downstream of the Coast Fork/Middle Fork Willamette River confluence (Bangs et al. 2012). These included 42 naturally occurring and 19 introduced populations. Twelve new populations of Oregon chub were also discovered in connected sloughs in the Middle Fork Willamette and Mainstem Willamette drainages (Bangs et al. 2012). Thirty-six of these Oregon chub populations have an estimated abundance of over 500 fish; and 20 of these populations have also exhibited a stable or increasing trend over the last seven years (Bangs et al. 2012). The current status of Oregon chub populations meets the goals of the recovery plan for delisting. The distribution of these sites is shown in Table 15.

Table 15**.** Distribution of Oregon chub populations meeting recovery criteria (Bangs et al. 2012).

Subbasin	# of populations	# of large populations (over 500)	# of large populations with stable/increasing trend	Total chub in subbasin	Size range of populations
Santiam	17	11	5	29,070	10 to 5,730
Mainstem Willamette*	25	9	6	146,509	4 to 82,800
Middle Fork Willamette	33	15	9	44,999	1 to 13,460
Coast Fork Willamette	4	1	0	962	2 to 700
*includes McKenzie River subbasin					

Although certain populations of Oregon chub have remained relatively stable from year to year, substantial fluctuations in population abundance are normal. For instance, the largest known population at Ankeny National Wildlife Refuge had an estimated abundance of 21,790 chub in 2010 and increased to 96,810 chub in 2011.

g. Threats

Historically, the mainstem of the Willamette River was a braided channel with many side channels, meanders, oxbows, and overflow ponds that provided habitat for the chub. Periodic flooding of the river created new habitat and transported the chub into new areas to create new populations. The construction of flood control projects and dams, however, changed the Willamette River significantly and prevented the formation of chub habitat and the natural dispersal of the species. Other factors responsible for the decline of the chub include habitat alteration; the proliferation of nonnative fishes; desiccation of habitats; sedimentation resulting from timber harvesting in the watershed; and possibly the demographic risks that result from a fragmented distribution of small, isolated populations.

Elevated levels of nutrients and pesticides have been found in some Oregon chub habitats (Materna and Buck 2007, p. 67). The source of the contamination is likely agricultural runoff from adjacent farm fields (Materna and Buck 2007, p. 68). Water quality investigations at sites in the Middle Fork and mainstem Willamette subbasins have found some adverse effects to Oregon chub habitats caused by changes in nutrient levels. Elevated nutrient levels at some Oregon chub locations, particularly increased nitrogen and phosphorus, may result in anoxic (absence of oxygen) conditions unsuitable for chub, or increased plant and algal growth that severely reduce habitat availability because of succession.

Many populations of chub are currently isolated from other chub populations due to the reduced frequency and magnitude of flood events and the presence of migration barriers such as impassible culverts and permanent, high beaver dams. Managing Oregon chub in isolation may have genetic consequences (DeHaan et al. 2010, p. 20). 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). A genetic analysis completed in 2010 shows that while gene flow is limited among Oregon chub populations, most of the populations in isolated ponds are currently genetically viable and have remained so over several years (1997 to 2005)(DeHaan et al. 2010). However, the data were collected over only a 3 to 4-generation time period and it may be too soon to see evidence of negative genetic effects. Additionally, genetic data from historic populations (pre-Willamette project) is not available to compare with these results.

h. Climate Change

Climate change presents substantial uncertainty regarding the future environmental conditions in the Willamette Basin and is expected to place an added stress on the species and its habitats. The Intergovernmental Panel on Climate Change (IPCC) has concluded that recent warming is already strongly affecting aquatic biological systems; this is evident in increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers (IPCC 2007, p. 8). Projections for climate change in North America include decreased snowpack, more winter flooding, and reduced summer flows (IPCC 2007, p. 14). Projections for climate change in the Willamette Valley in the next century include higher air temperatures that will lead to lower soil moisture and increased evaporation from streams and lakes (Climate Leadership Initiative (CLI) and the National Center for Conservation Science and Policy 2009, p. 9). While there is high uncertainty in the total precipitation projections for the region, effective precipitation (precipitation that contributes to runoff) may be reduced significantly even if there is no decline in total precipitation (CLI and the National Center for Conservation Science and Policy 2009, p. 9).

Although climate change is almost certain to affect aquatic habitats in the Willamette Basin (CLI 2009, p. 1), there is great uncertainty about the specific effects of climate change on the Oregon chub. The USFWS has developed a strategic plan to address the threat of climate change to vulnerable species and ecosystems; goals of this plan include maintaining ecosystem integrity by protecting and restoring key ecological processes such as nutrient cycling, natural disturbance cycles, and predator-prey relationships (USFWS 2009b; p. 21). The Oregon chub recovery program will strive to achieve these goals by working to establish conditions that allow populations of Oregon chub to be resilient to changing environmental conditions and to persist as viable populations into the future. Our recovery program for the species focuses on maintaining large populations distributed across the species' entire historical range in a variety of ecological settings (e.g., across a range of elevations). This approach is consistent with the general principles of conservation biology. In their review of minimum population viability literature, Traill et al. (2009, p. 3) found that maintenance of large populations across a range of ecological settings increases the likelihood of species persistence under the pressures of environmental variation and facilitates the retention of important adaptive traits through the maintenance of genetic diversity. Maintaining multiple populations across a range of ecological settings, as described in the recovery plan, will also increase the likelihood that at least some of these populations persist under the stresses of a changing climate.

i. Conservation

i. Needs

The recovery strategy has focused on improving Oregon chub habitats in isolation due to the loss and fragmentation of suitable habitats and the threats posed by non-native fishes. Increasing the abundance and distribution of Oregon chub in isolation has proven to be effective at halting the decline of Oregon chub populations and in meeting the recovery criteria for downlisting. However, managing Oregon chub in isolation does not allow genetic transfer between populations and may have future genetic consequences. Floodplain connectivity at many sites near mainstem rivers is not well understood. Recent hydrological data were collected by ODFW at sites that are influenced by the operation of dams in the Willamette Basin to determine the point of connectivity at each site and the duration of floodplain connection. They found that several sites connect to the river more frequently or for longer periods than previously known. Although, it is not known whether Oregon chub are moving between these habitats during high water events, the study shows that the mechanism for dispersal does exist. Genetic studies are needed to determine whether the populations in these periodically connected sites are operating as a metapopulation.

Additionally, some populations are persisting even in the presence of non-natives, although these populations are less abundant than populations without non-natives present. Understanding what habitat characteristics allow Oregon chub to coexist with non-natives in these connected habitats will be useful in determining whether chub can be reintroduced in connected habitats.

ii. Current Actions

The Oregon Chub Working Group was formed in 1991 and has been proactive in conserving and restoring habitat for the Oregon chub and raising public awareness of the species since before the Federal listing in 1993 (USFWS 2008b, p. 11).

In 1992, an interagency Conservation Agreement for the Oregon Chub in the Willamette Valley, Oregon was completed and signed by the USFWS, the U.S. USFS, the BLM, the ODFW, and Oregon Parks and Recreation Department (USFWS 1998c). The purpose of the coordinated plan was to facilitate Oregon chub protection and recovery and to serve as a guide for all agencies to follow as they conduct their missions.

In February 1997, a Memorandum of Understanding was signed by the USFWS and the City of Salem to protect and enhance the population of Oregon chub located in the drinking water treatment facility at Geren Island in the North Santiam River until a formal Habitat Conservation Plan is developed.

In 1996, a no-spray agreement with the Oregon Department of Transportation was formalized to protect Oregon chub sites located in the Middle Fork Willamette River drainage adjacent to Highway 58 in Lane County. The agreement prohibits spraying of herbicides in the vicinity of Oregon chub sites and limits vegetation control to mechanical methods if necessary.

The USFWS has completed three individual safe harbor agreements (SHA) for Oregon chub. To streamline the process for landowners to enter into a SHA in the future, a programmatic SHA was prepared by the USFWS and ODFW in 2009 (USFWS 2009b). Under a SHA, property owners who undertake management activities that attract listed species onto their property or that increase the numbers or distribution of listed species already present on their property will not incur future property-use restrictions. SHAs provide assurances to the property owner that allow alterations or modifications to enrolled property, even if such action results in the incidental take of the covered listed species or, in the future, returns the species back to an originally agreed-upon baseline condition.

In 2008, the USFWS signed a biological opinion on the continued operation and maintenance of the Willamette River Basin Project and effects to Oregon chub, bull trout, and bull trout critical habitat (USFWS 2008c). To address specific terms and conditions outlined in the opinion, ODFW initiated a study in 2009 to determine the current status of chub populations, fish assemblages, and habitat conditions in habitats potentially affected by the operation of Willamette River Basin Project dams. They are assessing relationships between pond bathymetry, pond elevations, pond temperatures, river flow levels, site connectivity, and fish assemblages. Data from this study will be used to provide the USACE with flow management recommendations that will contribute to Oregon chub recovery and minimize incidental take of chub.

The improvement in status of Oregon chub is due largely to the implementation of actions identified in the Oregon chub recovery plan. This includes habitat restoration, the discovery of many new populations as a result of ODFW’s surveys of the basin, and the establishment of additional populations via successful reintroductions within the species’ historical range. Introduced populations have been established in suitable habitats with low connectivity to other aquatic habitats to reduce the risk of invasion by non-native fishes.

j. Status of the Species in the Action Area

i. *Current status and distribution of the listed species in the action area including population size, variability, and trend*

The Oregon chub is endemic to the Willamette River Valley of western Oregon; therefore, the status of the species throughout its range, as discussed above, constitutes the status of the species in the Action Area.

ii. *Current critical habitat designation within the action area*

The Oregon chub is endemic to the Willamette River Valley of western Oregon; therefore, the status of the critical habitat, as discussed above, constitutes the status of the species in the action area.

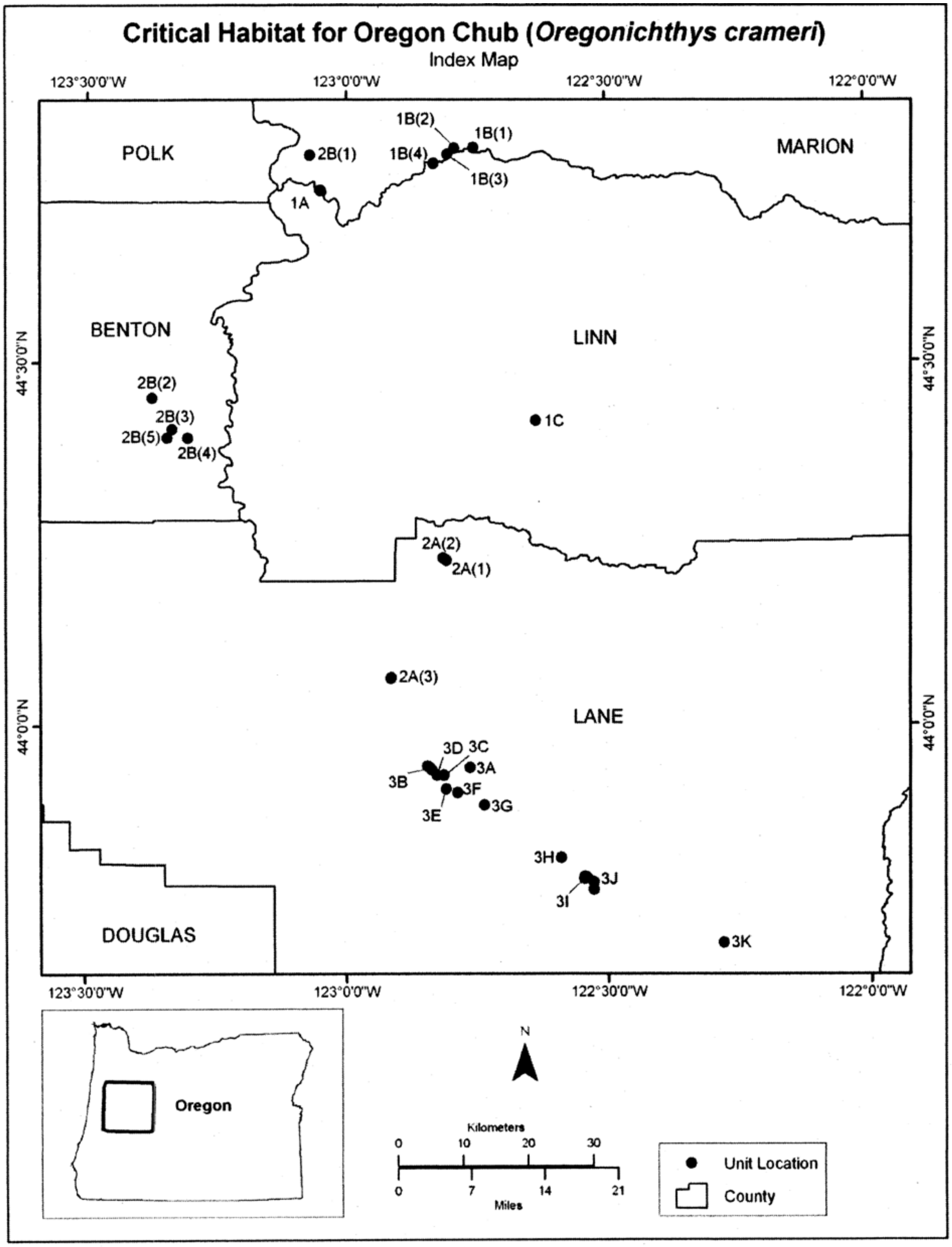


Figure 3. Locations of Oregon chub critical habitat.

k. Threats specific to action area and discussion of threats relative to water quality

The analysis of threats in the final rule to list the Oregon chub as an endangered species and the recovery plan for the species discussed numerous potential threats to water quality in Oregon chub habitats. Many Oregon chub populations occur near rail, highway, and power transmission corridors; near agricultural fields; and within public park and campground facilities; prompting concern that these populations could be threatened by chemical spills and runoff (USFWS 1998c, p. 14). In the 18 years since listing, a few of these concerns have been realized, and are discussed in the paragraphs below.

Water quality investigations at sites in the Middle Fork and Mainstem Willamette subbasins have found some adverse effects to Oregon chub habitats. Nutrient enrichment may have caused the crash of the Oregon chub population at Oakridge Slough on the Middle Fork. The slough is downstream from the Oakridge Sewage Treatment Plant and has a thick layer of decaying organic matter, which may limit the amount of useable habitat available to the chub (Buck 2003, p. 2). In the late 1990s, the Oregon chub population in Oakridge Slough peaked at nearly 500 individuals; since then, the population has apparently declined to zero (Scheerer et al. 2007b, p. 2). Increased nitrogen and phosphorus concentrations have been detected in the slough; while the nutrient concentrations are not believed to be directly harmful to Oregon chub, the elevated nutrient levels may have resulted in eutrophication of the pond, with associated anoxic conditions unsuitable for chub, or increased plant and algal growth that severely reduced habitat availability (Buck 2003, p. 12).

Studies at William L. Finley National Wildlife Refuge have found evidence of elevated levels of nutrients and pesticides in Oregon chub habitats (Materna and Buck 2007, p. 67). Water samples were collected in 1998 from Gray Creek Swamp, which is home to a large population of Oregon chub. Analyses detected three herbicides, although all were below criteria levels recommended for protection of aquatic life; however, one form of nitrogen (total Kjeldahl N) exceeded Environmental Protection Agency (EPA) criteria levels recommended for protection of aquatic life in the Willamette Valley (Materna and Buck 2007, p. 67). The source of the contamination is likely agricultural runoff from farm fields adjacent to the Refuge (Materna and Buck 2007, p. 68).

2.3.6 Lahontan cutthroat trout

a. Species Description

i. *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.

ii. *Species Description*

The Lahontan cutthroat trout is represented by several populations residing in streams in Harney and Malheur Counties, Oregon (USFWS 1995a). 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.

iii. *Current legal status, including listing history*

The Lahontan cutthroat trout was first listed, as endangered under the Endangered Species Protection Act of 1969 (USFWS 1970) and as endangered on October 13, 1970 (35 FR 16047), but was downlisted to “threatened” on July 16, 1975 (40 FR 29863). 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).

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 1995a).

The Service completed a 90-day finding on a petition to delist LCT (USFWS 2008d, pp. 52257-52260). Our conclusion was that the petition did not present substantial information that recovery of LCT throughout the range had been met.

The Service completed the Lahontan cutthroat trout 5-year Review (USFWS 2009c). 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 1995a), and the 5-year Review (USFWS 2009c).

b. Critical habitat Description

No critical habitat has been designated or proposed for Lahontan cutthroat trout.

c. Life history

i. 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).

ii. Population structure

Surveys conducted by ODFW indicated that Lahontan cutthroat trout populations were reduced from 1985 to 1989 by 62 percent on Willow Creek, 69 percent on Whitehorse Creek, 93 percent on Little Whitehorse Creek, and 42 percent 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.

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) 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).

d. 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) and large daily fluctuations (up to 20 ºC). 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).

e. Status

i. Historical status and distribution (summary)

The Lahontan cutthroat trout is native to Willow and Whitehorse creeks in Harney and Malheur Counties, and several out of basin transfers to streams on the east side of the Steens Mountain and Pueblo Mountain in Harney County, Oregon.

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 1970's and 1980's.

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).

ii. *Current status and distribution of the listed species in rangewide (summary)*

Lahontan cutthroat trout are currently listed as threatened (USFWS 1975 p 1). The final recovery plan was completed in 1995 (USFWS 1995a).

f. Threats; including reasons for listing, current rangewide threats

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.

g. Conservation

i. Needs (summary)

The Lahontan cutthroat trout recovery plan (USFWS 1995a) 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; 2) specific to fluvial populations, relatively stable summer temperature averaging 13 ± 4 °C; and 3) specific to lacustrine habitat, a mid-epilimnion pH of 6.5 to 8.5 and DO content ≥8 mg/L in the epilimnion.

The Lahontan Cutthroat Trout Recovery Plan (USFWS 1995a) identified a need for development of ecosystem plans for LCT 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 LCT specific to the Truckee and Walker River Basins and utilize adaptive management to refine the long-term recovery strategy. The Service also recently published the LCT 5-year Review (USFWS 2009c). 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 LCT, life history traits, population dynamics, habitat requirements, threats, and historical and current distribution can be found in the Recovery Plan (USFWS 1995a), Action Plans (USFWS 2003c, 2003d), and the 5-year Review (USFWS 2009c). A brief summary of our findings in the 5-year Review is presented below.

The impacts to LCT 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 LCT. Adding stressors predicted by climate change may exacerbate the current threats to LCT populations throughout its range, many of which already have multiple stressors affecting their persistence.

In the 5-year Review, the USFWS concluded that the LCT still meets the definition of threatened throughout its range. The status of LCT in the Western and Northwest Lahontan Basins are the most tenuous due to having a few isolated small populations, the presence of non-native species in most fluvial and lacustrine habitats, complexity of threats for the lacustrine form of LCT, and poor water quality in Walker Lake. While the Eastern Lahontan Basin has the largest intact habitat for LCT, populations also suffer from non-native species and small isolated populations.

ii. *Current Actions (summary)*

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. The BLM has developed a Draft Water Quality Restoration Plan (WQRP), currently being revised in coordination with ODEQ, to address the streams identified in the TMDL and WQMP that will further describe the existing and potential riparian conditions.

h. Status of the Species in the Action Area

i. *Current status and distribution of the listed species in the state of Oregon including population size, variability, and trend*

The range of Lahontan cutthroat trout is primarily in streams of the Lahontan and Coyote Lake Basins in southeastern Oregon and occurs 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 of stream habitat available (approximately 25,000 in the Whitehorse Creek drainage and about 15,000 cutthroat occupied the Willow Creek drainage).

2.3.7 Northern Spotted Owl

a. 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 U.S. USFWS recovery priority number for the spotted owl is 12C (USFWS 2011b, 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 USFWS 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 2004b, p. 55) and to 12C in the 2011 Revised Recovery Plan for the spotted owl (USFWS 2011g, p.22).

b. Life History

i. 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).

ii. 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 centimeters (18 inches to 19 inches) long and the sexes are dimorphic, with males averaging about 13 percent smaller than females. The mean mass of 971 males taken during 1,108 captures was 580.4 grams (1.28 pounds) (out of a range 430.0 to 690.0 grams) (0.95 pound to 1.52 pounds), and the mean mass of 874 females taken during 1,016 captures was 664.5 grams (1.46 pounds) (out of a range 490.0 to 885.0 grams) (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman, pers. comm. cited in USFWS 2008g, 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).

iii. 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).

iv. *<u>Behavior</u>*

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).

v. *<u>Habitat Relationships</u>*

1. *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).

2. *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).

3. *Habitat Selection*. Spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging. Features that support nesting and roosting typically include a moderate to high canopy closure (60 to 90 percent); a multi-layered, multi-species canopy with large overstory trees (with diameter at breast height [dbh] of greater than 30 inches); a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990, p. 19). 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 31 in (80 cm) dbh (North et al. 1999, p. 524), volume of woody debris (Irwin et al. 2000, pp. 179-180), and young forests with some structural characteristics of old forests (Carey et al. 1992, pp. 245-247; Irwin et al. 2000, pp. 178-179). Spotted owls select old forests for foraging in greater proportion than their availability at the landscape scale (Carey et al. 1992, pp. 236-237; Carey and Peeler 1995, p. 235; Forsman et al. 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 percent of nest sites were in old-growth forests, 57 percent were in the understory reinitiation phase of stand development, and 17 percent were in the stem exclusion phase (Buchanan et al. 1995, p. 304). In the western Cascades of Oregon, 50 percent of spotted owl nests were in late-seral/old-growth stands (greater than 80 years old), and none were found in stands of less than 40 years old (Irwin et al. 2000, p. 41).

In the Western Washington Cascades, spotted owls roosted in mature forests dominated by trees greater than 50 centimeters (19.7 inches) dbh with greater than 60 percent canopy closure more often than expected for roosting during the non-breeding season. Spotted owls also used young forest (trees of 20 to 50 centimeters (7.9 inches to 19.7 inches) dbh with greater than 60 percent canopy closure) less often than expected based on this habitat's availability (Herter et al. 2002, p. 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 meters) (2,395 feet). Survival decreased dramatically when the amount of non-habitat (non-forest areas, sapling stands, etc.) exceeded approximately 50 percent of the home range (Dugger et al. 2005, pp. 873-874). The authors concluded that they found no support for either a positive or negative direct effect of intermediate-aged forest—that is, all forest stages between sapling and mature, with total canopy cover greater than 40 percent—on either the survival or reproduction of spotted owls. It is unknown how these results were affected by the low habitat fitness potential in their study area, which Dugger et al. (2005, p. 876) stated was generally much lower than those in Franklin et al. (2000) and Olson et al. (2004), and the low reproductive rate and survival in their study area, which they reported were generally lower than those studied by Anthony et al. (2006). Olson et al. (2004, pp. 1050-1051) found that reproductive rates fluctuated biennially and were positively related to the amount of edge between late-seral and mid-seral forests and other habitat classes in the central Oregon Coast Range. Olson et al. (2004, pp. 1049-1050) concluded that their results indicate that while mid-seral and late-seral forests are important to spotted owls, a mixture of these forest types with younger forest and non-forest may be best for spotted owl survival and reproduction in their study area.

vi. *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).

vii. *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 percent 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).

viii. *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 percent of the biomass consumed. However, it is unclear if the causative factor behind this correlation was prey abundance or a synergistic response to weather (Rosenberg et al. 2003, p. 1723). Ward (1990, p. 55) also noted that mice were more abundant in areas selected for foraging by owls. Nonetheless, spotted owls deliver larger prey to the nest and eat smaller food items to reduce foraging energy costs; therefore, the importance of smaller prey items, like *Peromyscus*, in the spotted owl diet should not be underestimated (Forsman et al. 2001, p. 148; 2004, pp. 218-219).

ix. 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.

c. Threats

i. 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 3). 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.

ii. *New Threats*

The Service conducted a 5-year review of the spotted owl in 2004 (USFWS 2004b), for which the USFWS 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)

1. *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 percent) 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 kilometer (0.5 miles) of the territory center but was "only marginally lower" ($p = 0.06$) if barred owls were located more than 0.8 kilometer (0.5 miles) from the spotted owl territory center (Kelly et al. 2003, p. 51). Pearson and Livezey (2003, p. 271) found that there were significantly more barred owl site-centers in unoccupied spotted owl circles than occupied spotted owl circles (centered on historical spotted owl site-centers) with radii of 0.8 kilometer (0.5 miles) ($p = 0.001$), 1.6 kilometer (1 mile) ($p = 0.049$), and 2.9 kilometer (1.8 miles) ($p =$

0.005) in Gifford Pinchot National Forest. In Olympic National Park, Gremel (2005, p. 11) found a significant decline (*p* = 0.01) in spotted owl pair occupancy at sites where barred owls had been detected, while pair occupancy remained stable at spotted owl sites without barred owls. Olson et al. (2005, p. 928) found that the annual probability that a spotted owl territory would be occupied by a pair of spotted owls after barred owls were detected at the site declined by 5 percent in the HJ Andrews study area, 12 percent in the Coast Range study area, and 15 percent in the Tyee study area.

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 2008g 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. 739-740; Olson et al. 2005, pp. 930-931). 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).

2. *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 National Forest in Washington's eastern Cascades, affecting six spotted owl activity centers (Gaines et al. 1997, p. 125). Spotted owl habitat within a 2.9-kilometer (1.8-mile) radius of the activity centers was reduced by 8 to 45 percent (mean = 31 percent) as a result of the direct effects of the fire and by 10 to 85 percent (mean = 55 percent) 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 percent 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).

3. *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 percent 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).

4. *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 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).

5. *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 percent (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.

6. *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 percent 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.

7. *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.

d. 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:

i. *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.

ii. *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.

iii. *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 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.

iv. *Federal Contribution to Recovery*

1. *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 percent 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 2004b, 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.

2. *Spotted owl Recovery Plan*. In May, 2008, the USFWS published the 2008 Final Recovery Plan for the spotted owl (USFWS 2008g). 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 2008g, 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 2008g, 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 2008g, 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 2008g, 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 2008g, 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 2008g, 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 2008g, 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 2008g, p. 15). The recovery plan estimates that recovery of the spotted owl could be achieved in approximately 30 years (USFWS 2008g2008h, p. VIII).

v. 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 U.S. USFWS'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 2008g, 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 percent) 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

1. *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).

2. *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 2008g, p. 56).

3. *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 U.S. USFWS took over that review function in 2000. Several large industrial owners operate under spotted owl management plans that have been reviewed by the U.S. USFWS 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 2008g, p. 56)

e. 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 USDC NMFS 1998, pp. 4-19).

vi. <u>*Range-wide Habitat and Population Trends*</u>

1. *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.

2. *NWFP Lands Analysis 1994 – 2001*. In 2001, the USFWS 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 USFWS 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).

3. *Range-wide Analysis from 1994 to February 4, 2013*. This section updates the information considered in USFWS (2001), relying particularly on information in documents the USFWS produced pursuant to section 7 of the Act 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 USFWS 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 August 17, 2010, the USFWS had consulted on the proposed removal and had natural events resulting in the loss of approximately 916,863 acres (Table 17) or 12.39 percent of 7.4 million acres (Table 17) of spotted owl suitable habitat on Federal lands. Of the total NWFP Federal acres consulted on for removal, approximately 195,303 acres (Table 16) or 2.64 percent 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).

April 13, 2004 marked the start of the second decade of the NWFP. Decade specific baselines and summaries of effects by State, physiographic province and land use function from proposed management activities and natural events are not provided here, but can be calculated using the USFWS's Consultation Effects Tracking system.

An improved baseline for spotted owl habitat was created based on data collected in 2006 (Table 17). This new baseline has improvement in identifying stands and shows ingrowth since 1994. Table 16 tracks habitat loss from Federal lands due to management activities and natural events against the 2006 baseline.

4. *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 percent 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 percent of the owl habitat in the study area distributed across all ownerships (Pierce et al. 2005, p. 91). Approximately 77 percent of the harvested habitat occurred on private lands and about 15 percent 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 percent suitable habitat in the circle across all landscapes.

Values in the study ranged from an average of 7 percent in southwest Washington to an average of 31 percent in the east Cascades, suggesting that many owl territories in Washington are significantly below the 40 percent suitable habitat threshold used by the State as a viability indicator for spotted owl territories (Pierce et al. 2005, 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 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 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.

5. *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 1990, p. 26118), approximately 90 percent of the roughly 2,000 known spotted owl breeding pairs were located on Federally managed lands, 1.4 percent on State lands, and 6.2 percent 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 1990, p. 26115). The range of the spotted owl is partitioned into 12 physiographic provinces (Figure 3) 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 percent) in Washington, 2,893 sites (53 percent) in Oregon, and 1,687 sites (31 percent) in California (USFWS 1995b, 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 2008g, 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 (1995b, 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 18), 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 percent confidence interval [CI] = 0.960 to 0.983), which indicated an average population decline of 2.9 percent per year from 1985 to 2006. This is a lower rate of decline than the 3.7 percent 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 percent 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 percent CI = 0.958 to 0.985), which indicated an estimated decline of 2.8 percent 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 percent CI = 0.938 to 1.000), yielding an estimated average decline of 3.1 percent 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 percent 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 percent whereas the Tyee, Klamath, Southern Cascades, and Hoopa study areas showed declines of 5 to 15 percent.

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 percent 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 2008g, p. 48). Prior to initiating the captive-breeding program, the population of spotted owls in Canada was declining by as much as 10.4 percent per year (Chutter et al. 2004, p. *v*). The amount of previous interaction between spotted owls in Canada and the United States is unknown.

Table 16. Range-wide Aggregate of Changes to NRF[1] Habitat Acres From Activities Subject to Section 7 Consultations and Other Causes from 1994 to February 4, 2013.

Land Ownership	**Consulted On Habitat Changes[2]**		**Other Habitat Changes[3]**	
	Removed/ Downgraded	**Maintained/ Improved**	**Removed/ Downgraded**	**Maintained/ Improved**
NWFP (FS,BLM,NPS)	195,303	538,048	246,111	39,720
Bureau of Indian Affairs / Tribes	108,210	28,372	2,398	0
Habitat Conservation Plans/Safe Harbor Agreements	295,889	14,430	N/A	N/A
Other Federal, State, County, Private Lands	68,673	27,514	279	0
Total Changes	**668,075**	**608,364**	**248,788**	**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 17. 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 4, 2013.

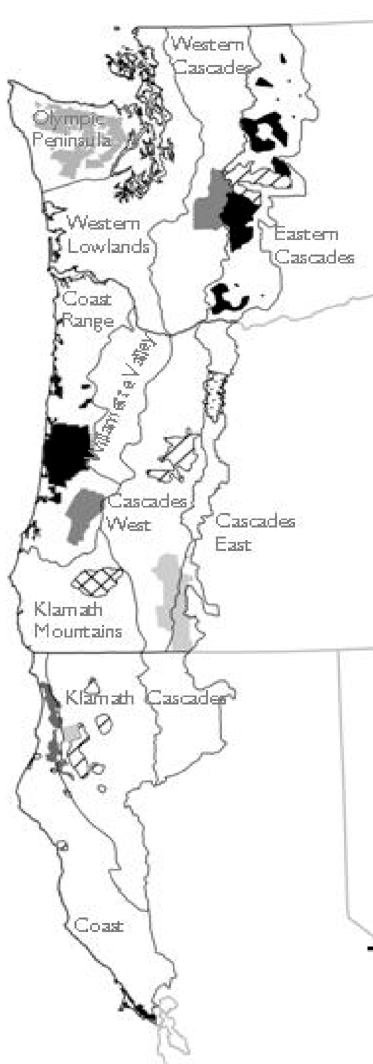
					Habitat Removed/Downgraded[4]								
		Evaluation Baseline (2006/2007)[3]			Land Management Effects			Habitat Loss from Natural Events					
State	Physiographic Province[2]	NRF[1] Acres in Reserves	NRF[1] Acres in Non-Reserves	Total Nesting Roosting Acres	Reserves[5]	Non-Reserves	Total	Reserves	Non-Reserves	Total	Total NRF removed/ downgraded	% Provincial Baseline Affected	% Range-wide Effects
WA	Eastern Cascades	462,400	181,100	643,500	2,435	2,238	4,673	1,559	132	1,691	6,364	0.99	6.7
	Olympic Peninsula	729,000	33,400	762,400	6	0	6	0	0	0	6	0	0.01
	Western Cascades	1,031,600	246,600	1,278,200	529	831	1,360	3	0	3	1,363	0.11	1.43
	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	1,296	4,794	6,090	7,639	1,981	9,620	15,710	4.17	16.53
	Cascades West	1,275,200	939,600	2,214,800	1,126	21,894	23,020	0	0	0	23,020	1.04	24.22
	Coast Range	494,400	113,400	607,800	183	698	881	0	0	0	881	0.14	0.93
	Klamath Mountains	549,400	334,900	884,300	2,616	4,092	6,708	0	0	0	6,708	0.76	7.06
	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	0.35
	Coast	132,900	10,100	143,000	274	1	275	0	175	175	450	0.31	0.47
	Klamath	910,900	501,200	1,412,100	75	646	721	19,072	20,409	39,481	40,202	2.85	42.3
Total		**5,961,000**	**2,594,200**	**8,555,200**	**8,550**	**35,195**	**43,745**	**28,598**	**22,697**	**51,295**	**95,040**	**1.11**	**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.
2. Defined in the Revised Recovery Plan for the spotted owl (USFWS 2011b) as Recovery Units as depicted on page A-3.

					Habitat Removed/Downgraded[4]								
		Evaluation Baseline (2006/2007)[3]			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

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						
■ (black)	Wenatchee (WEN)	Mixed	1,200	Declining	Declining	0.917	Declining
■ (dark gray)	Rainer (RAI)	Mixed	217	Stable	Declining	0.896	Declining
■ (light gray)	Olympic (OLY)	Federal	985	Stable	Declining	0.956	Declining
▨ (hatched)	Cle Elum (CLE)	Mixed	724	Declining[1]	Declining?[2]	0.938	Declining
	Oregon						
■ (black)	Oregon Coast Range (COA)	Mixed	1,025	Declining?[1]	Stable	0.968	Declining
■ (dark gray)	Tyee (TYE)	Mixed	1,032	Increasing	Stable	1.005	Stationary
■ (light gray)	South Oregon Cascades (CAS)	Federal	881	Declining	Stable	0.974	Stationary
▨ (hatched)	H.J. Andrews (HJA)	Federal	1,095	Stable?[3]	Stable	0.978	Declining
⊠ (crosshatched)	Klamath (KLA)	Mixed	1,147	Stable	Stable	0.997	Stationary
▩ (dotted)	Warm Springs (WSR)	Tribal	381	Stable	Stable	0.908	Declining
	California						
■ (black)	Marin (MAR)	Federal	96	Stable	Stable	NA	NA
■ (dark gray)	Simpson (SIM)	Private	1,344	Declining[1]	Stable	0.970	Declining
■ (light gray)	Hoopa (HUP)	Tribal	279	Increasing	Stable	0.980	Stationary
▨ (hatched)	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 4. Physiographic provinces, spotted owl demographic study areas, and demographic trends (Anthony et al. 2006).

Table 18. 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.

f. Status of Spotted Owl Critical Habitat

i. *Legal Status*

On December 4, 2012, the final rule for CH for spotted owls was published (USFWS 2012a), and became effective on January 3rd, 2013. The revised CH currently includes approximately 9,577,969 acres in 11 units and 60 subunits in California, Oregon, and Washington.

ii. *Conservation Role of Critical Habitat*

The expectation of CH 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).

g. Primary Constituent Elements

The PCEs are described in the CH 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, or dispersing (USFWS 2012a, p. 71904). The PCEs are the specific characteristics that make habitat areas suitable for nesting, roosting, foraging, 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 CH that impacts any of these PCEs may adversely affect spotted owl CH.

h. Special considerations for PCEs in the action area (USFWS 2012a, p. 71909-71910)

i. *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.

In general, to advance long-term spotted owl recovery and ecosystem restoration in moist forests in the face of climate change and past management practices, special management considerations or protections may be required that follow these principles as recommended in the 2011 Revised Recovery Plan (USFWS 2011b, p. III–18):

(1) Conserve older stands that have occupied or high-value spotted owl habitat as described in RA 10 (includes all territories, occupied or not), and RA 32 (older, high quality, and more structurally complex stands that support spotted owl recovery). On Federal lands, this recommendation applies to all land-use allocations.

(2) Management emphasis needs to be placed on meeting spotted owl recovery goals and long-term ecosystem restoration and conservation. When there is a conflict between these goals, actions that would disturb or remove the essential PBFs of spotted owl CH need to be minimized and reconciled with long-term ecosystem restoration goals.

(3) Continue to manage for large, continuous blocks of late-successional forest.

(4) In areas that are not currently late-seral forest or high-value habitat and where more traditional forest management might be conducted (e.g. Matrix), should be considered applying ecological forestry prescriptions.

These special management considerations or protections apply to Units 1, 2, 4, 5 and 6 of revised CH.

i. Analysis

The consultation process evaluates how a proposed action is likely to affect the capability of the CH 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 CH 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 CH subunit within which it occurs.
- The specific purpose for which the affected subunit was identified and designated as CH.
- 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 CH.

iii. Unit

- The extent of the proposed action, both its temporal and spatial scale, relative to the CH unit within which it occurs.
- The cumulative effects of all completed activities in the CH 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 CH network.

j. Summary of past adverse effects to revised Critical Habitat

Adverse effects from conferences and consultations, as of January 2, 2013, are summarized in Table 19.

Table 19. 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		
		Total Designated Critical Habitat Acres[3]	Nesting/Roosting/ Foraging Acres[4]	Reserves	Non-Reserves	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
	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%**

			Habitat Removed/Downgraded						
	Evaluation Baseline		**Land Use Allocations[5]**						
Physiographic Province[2]	**Total Designated Critical Habitat Acres[3]**	**Nesting/Roosting/ Foraging Acres[4]**	**Reserves**	**Non-Reserves**	**Total**	**Habitat Loss to Natural Events**	**Total**	**% Provincial Baseline Affected**	**% Range-wide Effects**

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 2011b) 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.

k. Framework for Analyzing Adverse Effects to Spotted Owl Critical Habitat

A “may affect, likely to adversely affect” determination for spotted owl critical habitat that triggers the need for completing an adverse modification analysis under formal consultation is warranted in cases where a proposed Federal action will: (1) reduce the quantity or quality of existing spotted owl nesting, roosting, foraging, or dispersal habitat to an extent that it would be likely to adversely affect the breeding, feeding, or sheltering behavior of an individual spotted owl; (2) result in the removal or degradation of a known spotted owl nest tree when that removal reduces the likelihood of owls nesting; or (3) prevent or appreciably slow the development of spotted owl habitat that currently do not contain all of the essential features, but have the capability to do so in the future; taking into special considerations for PCEs within the action area. Adverse effects to an individual tree within spotted owl CH will not trigger the need to complete an adverse modification analysis under formal consultation if those effects are not measurable at the stand scale.

2.3.8 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.

a. Legal Status

The murrelet was listed as a threatened species on September 28, 1992, in Washington, Oregon, and northern California (57 FR 45328 [October 1, 1992]). Since the species' listing, the FWS has completed two 5-yr status reviews of the species: September 1, 2004 (USFWS 2004e) and June 12, 2009 (USFWS 2009d). 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 FWS 1996 Distinct Population Segment (DPS) policy (USFWS and USDC NMFS 1996, USFWS 2004e). 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 2009d, pages 3-12). The legal status of the murrelet remains unchanged from the original designation.

b. Life history

i. 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),[21] 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[22] 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

[21] 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.

[22] Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

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 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. 2007a, 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 - 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.

ii. *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.

iii. *Recovery Zones*

The Recovery Plan identified six Conservation Zones (Figure 4) 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 FWS policy (USFWS 1997, p. 115).

iv. *Recovery Zones in Oregon*

1. *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 percent annual population decline for this zone. Miller et al. (2012, page 775) estimated a 1.5 percent population decline for this zone, with a 95 percent confidence limit of 5.4 percent decline to 2.6 percent increase in the population.

2. *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 percent annual population decline for this zone. Miller et al. (2012, page 775) estimated a 0.9 percent population decline for this zone, with a 95 percent confidence limit of 3.8 percent decline to 2.0 percent increase in the population.

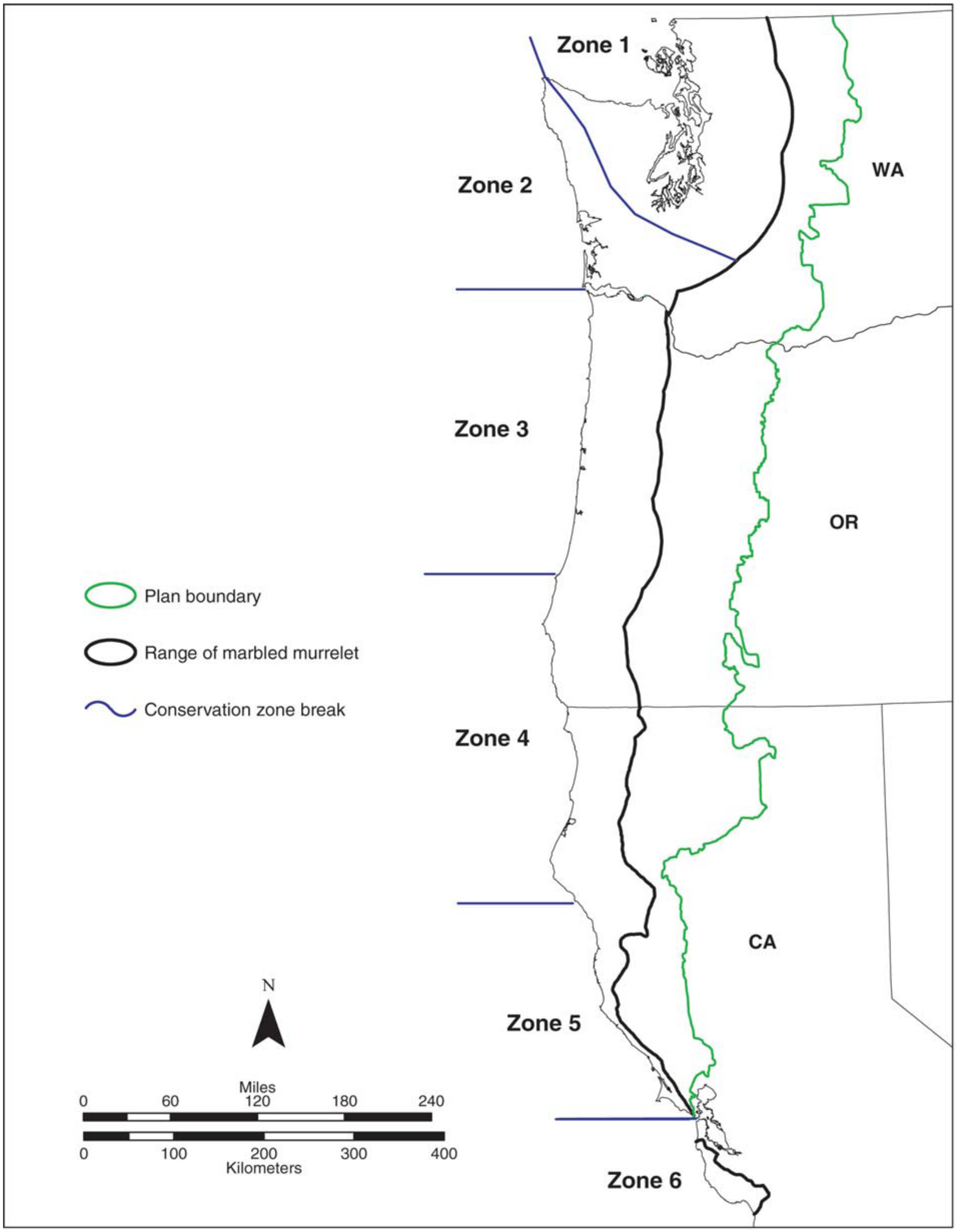


Figure 5. The six geographic areas identified as Conservation Zones in the recovery plan for the murrelet (USFWS 1997). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff et al. (2006, p. 6).

v. 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).

vi. Aquatic Habitat Use

Murrelets are usually found within 5 miles (8 km) from shore, and in water less than 60 meters deep (Ainley et al. 1995; Burger 1995; Strachan et al. 1995; Nelson 1997; Day and Nigro 2000; Raphael et al. 2007b). 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 328 feet (100 m) of shorelines, particularly where bull kelp was present.

Within the area of use, murrelets usually concentrate feedings in shallow, near-shore water less than 98 feet (30 m) deep (Huff et al. 2006), but are thought to be able to dive up to depths of 157 feet (47 m) (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; 57 FR 45328). In general, small schooling fish and large pelagic crustaceans are the main prey items. Pacific sand lance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), immature Pacific herring (*Clupea harengus*), capelin (*Mallotus villosus*), Pacific sardine (*Sardinops sagax*), juvenile rockfishes (*Sebastas* spp.), and surf smelt (Osmeridae) are the most common fish species taken. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey. Murrelets are able to shift their diet throughout the year and over years in response to prey availability (Becker et al. 2007). 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).

vii. *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 58-71 percent of adult mass (Nelson 1997). Fledging has seldom been documented, but it typically appears to occur at dusk (Nelson 1997).

viii. *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 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 percent of measured nest limbs were ≥15 cm diameter, with limb diameter ranges from 7-74 cm 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.

ix. *Nest Stand Characteristics*

Nest stands are typically composed of low elevation conifer species. In California, nest sites have been located in stands containing old-growth redwood and Douglas-fir, while nests in Oregon and Washington have been located in stands dominated by Douglas-fir, western hemlock and Sitka spruce. Murrelets appear to select forest stands greater than 123.6 acres (50 ha) (Burger 2002), 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 1992c, 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 31, 2013 that impact nest stands are summarized in Table 20.

Table 20. 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 January 31, 2013.

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	-43	0	-12	0
Outside CZ Area in WA	0	0	0	0
Oregon Coast Range	-702	-150	-137	0
Siskiyou Coast Range	-1,765	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	**-2,581**	**-150**	**-287**	

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 Primary Constituent Elements 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.

x. 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 37 miles [60 km]) 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 1,089 feet (332 m).

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).

c. Population Status

i. 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 21).

ii. *Current status and distribution of the listed species in rangewide (summary)*
Based primarily on the results from the NWFP Effectiveness Monitoring (EM) Program, the 2010 murrelet population for the listed range (Table 21) is estimated at 16,691 birds (95 percent confidence interval [CI]: 13,075 – 20,307;Table 21). Based on the 2010 estimates, Conservation Zones 3 and 4 support approximately 65 percent 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 21. Estimates of murrelet density and population size (95 percent confidence interval (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 (Peery and Henry 2010). Conservation Zone 5 estimates are from 2008, because the zone was not surveyed in 2009 or 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.

iii. *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 FWS 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.

iv. *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 percent (95 percent CI: -4.8 to -2.7 percent). This rate of annual decline suggests a total population decline of about 29 percent 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 percent per year (95 percent 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 percent (standard error = 1.31 percent) 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 percent of the murrelet population since 2001.

In Conservation Zone 6, the 2008 population estimate for Conservation Zone 6 suggested a decline of about 55 percent from the 2007 estimate and a 75 percent 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.

v. *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 22) 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 percent mean annual rates of population decline per decade the first 20 years of model simulations in murrelet Conservation Zones 1 through 5 (McShane et al. 2004, p. 3-52). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of 2.1 to 6.2 percent decline per decade (McShane et al. 2004, p. 3-52). These reported rates of decline are similar to the estimates of 4 to 7 percent per year decline reported in the Recovery Plan (USFWS 1997, p. 5).

Table 22. 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[23] of 16 percent and mean population size of 45 individuals in 100 years in the listed range of the species (McShane et al. 2004, pp. 3-58).

d. Threats; including reasons for listing, current rangewide threats

When the murrelet was listed under the Endangered Species Act (57 FR 45333-45336 [October 1, 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" ;

[23] Extinction was defined by McShane et al. (2004, p. 3-58) as any murrelet conservation zone containing less than 30 birds.

- 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.

There have been changes in the levels of these threats since the 1992 listing (USFWS 2004e, pp. 11-12; USFWS 2009d, 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 2004e, pp. 11-12). The levels for the other threats identified in 1992 listing (57 FR 45333-45336 [October 1, 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 FWS's 2004, 5-year, range-wide status review for the murrelet (USFWS 2004e, pp. 11-12).

However, new threats were identified in the FWS's 2009, 5-year review for the murrelet (USFWS 2009d, 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 2009d, 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 (57 FR 45328 [October 1, 1992]); the Recovery Plan, Ecology and Conservation of the Murrelet (Ralph et al. 1995); the final rule designating murrelet critical habitat (61 FR 26256 [May 24, 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 2004e; USFWS 2009d), and the final rule revising critical habitat for the murrelet (76 FR 61599 [October 5, 2011]).

e. Conservation

i. <u>Needs</u>

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[24] 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

[24] Fitness is measure of the relative capability of individuals within a species to reproduce and pass its' genotype to the next generation.

- 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 FWS estimates recovery of the murrelet will require at least 50 years (USFWS 1997).

ii. *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 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.

f. Status of Murrelet Critical Habitat

Critical habitat consists of geographic areas essential to the conservation of a listed species. Under the Act, conservation means to use and the use of all methods and procedures which are necessary to bring an endangered species or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary.

Critical habitat is provided protection under section 7 of the Act by ensuring that activities funded, authorized, or carried out by Federal agencies do not adversely modify such habitat to the point that it no longer remains functional (or retains its current ability for primary constituent elements to be functionally established) to serve the intended conservation role for the species.

On May 24, 1996, the USFWS 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 (76 FR 61599). 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 2011e, page 61599).

g. Primary Constituent Elements

The PCEs are physical and biological features the USFWS 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 kilometers (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 primary constituent elements are intended to support terrestrial habitat for successful reproduction, roosting and other normal behaviors.

h. 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).

i. Current Condition

The majority (77 percent) 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 – January 31, 2013 (Table 23), indicates 261 acres of PCE 1 and 462 acres of PCE 2 were planned for removal in CH, of which 137 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 23. Aggregate Results of All Critical Habitat (Acres) Affected by Section 7 Consultation for the Murrelet; Baseline and Summary of Effects By Conservation Zone and Habitat Type From October 1, 2003, to January 31, 2013.

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
Oregon Coast Range	1,024,122	-5	0	-208	0	0	0
Siskiyou Coast Range	1,055,788	-240	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**	**-261**	**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 Primary Constituent Elements 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 .5 mile of a potential nest tree.

j. Analytical Framework for analyzing impacts to critical habitat

A "may affect, likely to adversely affect" determination for critical habitat that triggers the need for completing an adverse modification analysis under formal consultation is warranted in cases where a proposed Federal action will cause: (1) Removal or degradation of individual trees with potential nesting platforms, or removal or degrade the nest platforms themselves, as this results in a significant decrease in the value of the trees for future nesting use. Moss may be an important component of nesting platforms in some areas; (2) Removal or degradation of trees adjacent to trees with potential nesting platforms that provide habitat elements essential to the suitability of the potential nest tree or platform, such as trees providing cover from weather or predators; (3) Removal or degradation of forested areas with a canopy height of at least one half the site-potential tree height and regardless of contiguity, within 0.5 mile of individual trees containing potential nest platforms. This includes removal or degradation of trees currently unsuitable for nesting that contribute to the structure/integrity of the potential nest area (i.e., trees that contribute to the canopy of the forested area). These trees provide the canopy and stand conditions important for murrelet nesting (USFWS 1996, page 26271).

A “may affect, not likely to adversely affect” determination for murrelet critical habitat is warranted in cases where a proposed Federal action will include, but are not limited to: (1) certain recreational use and personal-use commodity production (e.g., mushroom picking, Christmas tree cutting, rock collecting, recreational fishing along inland rivers) and certain commercial commodity production (e.g., mushroom picking, brush picking); (2) Actions that affect forest stands not within 0.5 miles of individual trees with potential nesting platforms; (3) Activities that do not affect the primary constituent elements. However, even though an action may not adversely affect critical habitat, it may still affect murrelets (e.g. through disturbance) and may, therefore, still be subject to consultation under section 7 of the Act. Activities conducted according to the standards and guidelines for Late Successional Reserves, as described in the ROD for the Northwest Forest Plan would be unlikely to result in the destruction or adverse modification of murrelet critical habitat. Activities in these areas would be limited to manipulation of young forest stands that are not currently murrelet nesting habitat. These forest management activities would be conducted in a manner that would not be likely to slow the development of these areas into future nesting habitat, and should speed the development of some characteristics of older forest (USFWS 1996, pages 26271-26272).

2.4 Environmental Baseline

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).

The environmental baseline for both listed bird species considered in this BO is adequately described within the Status of the Species section of this BO (see 2.3.8 and 2.3.9). Because the major effects analyzed in this BO will affect ESA-listed fish species more general discussion of the environmental baseline for fish species follows in this section.

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 fish 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, USFWS 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 fund or carry out stream restoration and fish passage improvements for the benefit of listed aquatic species; (2) each individual action area will be occupied by one or more listed species; (3) the biological requirements of individual fish in those areas are not being fully met because aquatic 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 fish in that area.

The condition of aquatic habitats on Federal lands and adjacent lands where Wyden Amendment projects occur (collectively referred to as Federal land hereafter) 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 on Federal lands 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 Action Agencies' proposed restoration actions that are the subject of this programmatic opinion are typically carried out in areas degraded by one or more human activity or natural events.

As described above 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 Columbia River Basin has a diverse assemblage of native and introduced fish species, some of which prey on ESA-listed fish. The primary resident fish predators of salmonids in the action are considered in this BO are northern pikeminnow (native), smallmouth bass (introduced), and walleye (introduced). Other predatory resident fish include channel catfish (introduced), Pacific lamprey (native), yellow perch (introduced), largemouth bass (introduced), and bull trout (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. 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, double-crested cormorants, glaucous-winged/western gull hybrids, California gulls, and ring-billed gulls 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).[25] In response to the ESA listing of the

[25] Environmental Assessment for the Implementation of Interim Strategies for Managing Anadromous Fish-

northern spotted (USDA and USDI 1994a) owl and the declining aquatic habitat condition on Federal lands, the Action Agencies developed these plans, each of which 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. Prior to adoption of these plans, the Action Agencies lacked a consistent aquatic conservation strategy and protection of stream and riparian function were not always a priority. Although the Action Agencies have been challenged to fully implement these strategies, the plans themselves represent a major step forward in protection of ESA-listed fish habitat.

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 (RHCA) has switched the focus of management in these areas to achievement of riparian management objectives rather than extractive resource management. The Action Agencies have implemented a restoration program that is focused on aquatic habitat limiting factors and restoring ecosystem function.

The environmental baseline also includes the anticipated impacts of all Federal projects in the action area that have already undergone consultation, as well as aquatic restoration projects that were completed under the 2007 ARBO and other programmatic agreements, such as a 2003 programmatic opinion with the USFS for culvert installation. USFWS 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 being met on Federal lands in some portions of the action area and not being 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 fish 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 programmatic consultation. 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 slight beneficial effect on the abundance and productivity of affected ESA-listed fish populations. After going through consultation, many ongoing actions, such as water management, have less impact on ESA-listed fish. 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.

producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH).

2.5 Effects of the Action on the Species and Designated Critical Habitats

"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.

The actions covered by this BO have predictable effects. The USFWS has conducted individual and programmatic consultations on restoration activities similar to those in the proposed action throughout the action area over the past 15 years, and the information gained from monitoring and feedback has been applied by the USFWS, NMFS, USFS and BLM to refine design criteria 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 fish, and their habitat. 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 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. 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 programmatic consultation all have predictable effects regardless of where on Federal lands in the action area they are carried out. Most of the adverse effects 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, manual and mechanical plant control, juniper removal, livestock crossings, channel and off-channel 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 to 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 (see Section 1.4). Those actions will include upland plant control, chemical plant control, upland juniper removal, construction and maintenance of livestock water facilities, SOD treatment, beaver habitat restoration, road treatment, 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 (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 a regional team of experts that includes NMFS, USFWS, and the Action Agencies. Monitoring and reporting data will be entered into our Public Consultation Tracking System (PCTS) consultation initiation and reporting system.

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 2013).

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 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 2013).

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 2013).

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 2013).

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 2013).

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 used by Action Agencies, along with cooperation with NMFS, USFWS and 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 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 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.

<u>Activity Category Specific Effects</u>

1. Fish Passage Restoration. The Action Agency's aquatic restoration program fish passage 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 PDCs 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 FMO habitat, however they will not fully protect bull trout, and will provide little protection in SR habitat.

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 polycyclic aromatic hydrocarbons (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 2011e). 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 on the issuance of special use permits or easements granted for diversions on, or crossing, Federal lands. 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, USFWS cannot predict exactly how many fish would be saved by installing screens on Federal lands 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, USFWS 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 which benefits 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 on Federal lands within 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. 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.

Replace/Relocate Existing Irrigation Diversions. 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 BO 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 2011e). This will prevent juvenile fish from being entrained into the irrigation system. Actions involving effects to ESA-listed fish, or their habitat caused by lack of stream flow are not covered by this consultation.

2. Large Wood, Boulder, and Gravel Placement; Porous Boulder Step Structures and Vanes; Engineered Logjams (ELJs); Tree Removal for LW Projects. Installation of wood and boulder instream structures is likely to require entry of personnel into the riparian area and channel which 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. LW, 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 on Federal lands 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. LW, 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). The Action Agencies propose this activity category to 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. 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 (McHenry *et al.* 2007).

Live conifers and other trees can be felled or pulled/pushed over in the RRs, RHCAs, and upland areas for in-channel LW placement only when conifers and trees are fully stocked. This action would result in increased LW. If the riparian zone is fully stocked the action would not likely result in increased sedimentation or an increase in stream temperature.

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 design criteria 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. 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, 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 BO. Equipment such as excavators, bull dozers, dump trucks, front-end loaders and similar equipment may be used to implement such projects. A NMFS engineer must review design plans for the removal of a dams greater than 10 feet in height. A long-term monitoring and adaptive management plan will be developed between the NMFS and the action agency.

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. Thus, it is likely that in some cases the best outcome of these a restoration actions will be a minimization of 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.

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) found the following preliminary findings:

- Juvenile Chinook salmon are present in lower numbers upstream of automatic tide gated sloughs than where found in un-gated sloughs
- These fish tended to spend less time behind the tide gate
- Tagged fish were shown to move less frequently across the gate and, in the case of larger fish released above the gate, to move only once downstream and out of the slough
- Indications are 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
- Tide gates alter the salinity, temperature, dissolved oxygen, total suspended solids, *etc.* of the habitat upstream

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).

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.

4. 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 of 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 of the Action Agency’s prospective project 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 which involve significant channel reconfiguration over a considerable stream length or require extensive alteration of land management practices are likely to have more constraints, be more costly, and have 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 USFWS 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, USFWS 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. We did not assume the RRT review would maximize the beneficial effects of any particular project.

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 also likely 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. Bull trout are extremely sensitive to suspended sediment, perhaps as much as 20 times more sensitive than Chinook salmon (G. Willmore pers. comm. 1994). However, the Action Agency’s 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-natives 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 programmatic 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 activity 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.

5. ***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 will be reviewed as a channel reconstruction/relocation project by the RRT (see PDC 25). 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).

6. 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 salmonids 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. Pacific salmonids are particularly vulnerable during the fall and winter, when adult salmonids are migrating and spawning, and the spring, when eggs and fry are still present in the substrate. Seasonal restrictions imposed by in-water work windows may afford some protection in bull trout FMO habitat, but cannot fully protect bull trout in SR habitat.

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 consultation by the Action Agencies. 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.

7. 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 activity 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 action 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.

8. 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 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 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.

9. 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 from occurring. Crossings will be located in areas where streambanks are naturally low, crossing widths are limited to 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 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.

10. 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.

11. 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.

12. 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; 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; 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 stream between substrate conditions and other stream 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.

13. Non-native Invasive Plant Control. The proposed action includes manual, mechanical, biological 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; NMFS 2012). 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 24).

Table 24**.** 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
Biological				X	X			
Herbicides		X	X	X	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, scotch 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, which could cause short-term stress to fish adults, juveniles and eggs. NMFS did not identify adverse effects to macroinvertebrates from herbicide applications that follow these proposed PDC. 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.

Biological controls work slowly, typically over several years, and are designed to work only on the target species. Thus, biological controls produce a smaller reduction of riparian and instream vegetation over a smaller area than manual and mechanical treatments and are unlikely to lead to bare ground and surface erosion that would release suspended sediment to streams. As treated invasive plants die, native plants are likely to become reestablished at each site, and they will restore soil and bank stability from root systems, and stream shade. Therefore, any adverse effects due to biological treatments, by themselves, are likely to be very mild. Biological controls typically work slowly over a period of years, and only on target species, and results in minimal impact to soils and vegetation from the actual release. Over time, successful biological control agents will reduce the size and vigor of host noxious weeds with minimal or no impact to other plant species.

Herbicide applications. USFWS identified three scenarios for the analysis of herbicide application effects: (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. For example, wild Chinook salmon rear near stream margins until they reach about 60 mm in length. 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 salmon and steelhead for a variety of reasons, including nocturnal resting, summer and winter thermal refuge, predator avoidance, and flow refuge (NMFS 2013).

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 80°F. When temperatures go above 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 four western states where listed Pacific salmonids are distributed (NMFS 2011d).

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 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 percent 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 percent of the time they had detections of 10 or more. 57 percent 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 percent of sites sampled during 1993–1994, 43 percent during 1995–1997, and 50 percent 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 (2000–2005), 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 four western states where listed Pacific salmonids are distributed (NMFS 2011d). 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. Herbicides included in the invasive plant programmatic activity were selected due to their low to moderate aquatic toxicity to ESA-listed fish. The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is minimized in this programmatic activity by reducing stream delivery potential by restricting application methods. Only aquatic labeled herbicides are to be applied within wet stream channels. Aquatic glyphosate and aquatic imazapyr can be applied up to the waterline using spot spray or hand selective application methods in both perennial and intermittent channels. Triclopyr TEA and 2,4-D amine can be applied up to the waterline, but only using hand selective techniques. 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 effects of the herbicide applications to various representative groups of species have been evaluated for each proposed herbicide. 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 HWM) 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 would 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 impact 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 2004d) imazapic (SERA 2004a), chlorsulfuron (SERA 2004b), dicamba (SERA 2004c), 2,4D (USDA-Forest Service 2006) aminopyralid (SERA 2007), imazapyr (SERA 2011d), glyphosate (SERA 2011b), and triclopyr (SERA 2011c). These assessments form the basis of the analysis in the Action Agencies' BA (USDA-Forest Service *et al.* 2013) and 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 ESA-listed fish. In the case of sulfometuron-methyl, threshold values for fathead minnow (surrogate) were lower than salmonid values, so threshold values for minnow were used to evaluate effects to ESA-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 would 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 were fully described by NMFS in other recent opinions with the U.S. Environmental Protection Agency (EPA) and USFS (NMFS 2010; NMFS 2011d; NMFS 2011f; NMFS 2012) and in SERA reports. For the 2007 ARBO the Action Agencies evaluated the risk of adverse effects to listed salmonids and their habitat in terms of hazard quotient (HQ) values (NMFS 2008c).

Hazard quotients (HQ) evaluations are summarized below for the herbicides used in the 2007 ARBO (chlorsulfuron, clopyralid, glyphosate, imazapyr, metsulfuron methyl, sethoxydim, and sulfometuron methyl). HQ 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 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 water contamination rate (WCR) values. All WCR values are from risk assessments conducted by SERA. Given that there are HQ values >1 adverse effects are likely to occur. Hazard quotient values were calculated for fish, aquatic invertebrates, algae, and aquatic macrophytes. 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 "no observable effect concentration," whichever was lower, found in available literature.

For aminopyralid, dicamba, diflufenzopyr + dicamba, imazapic, picloram, triclopyr, and 2,4D, which were added to list, we referred to the NMFS's opinions, SERA reports, various other literature sources, and the 2013 BA (USDA-Forest Service *et al.* 2013) to characterize risk to ESA-listed fish species.

<u>Aminopyralid</u>

Aminopyralid has is closely related chemically to clopyralid and picloram. It is considered to have slightly longer soil residual activity than clopyralid but considerably less soil activity than picloram. Many other characteristics of the herbicide are similar to clopyralid, including the soil mobility and toxicological properties. Aminopyralid was designated a reduced risk pesticide by U.S. Environmental Protection Agency (EPA) because of its toxicological and environmental profile (DiTomaso *et al.* 2006; SERA 2007). SERA (2007) summarized several acute exposure studies that reported no mortality to organisms exposed to aminopyralid in concentrations up to 100 mg/L. Aminopyralid has a low order of acute toxicity to aquatic animals. Therefore, aminopyralid fits into the "low risk to aquatic organisms" group.

<u>Chlorsulfuron</u>

No chlorsulfuron HQ exceedances occur for fish or aquatic invertebrates. HQ exceedences occur for algae at rainfall rates of 50 and 150 inches per year and for aquatic macrophytes at rainfall rates of 15, 50, and 150 inches per year.

The HQ values predicted for algae at 50 inches per year ranged from 0.002 to 2.8, and the HQ exceedance occurred at the maximum application rate on clay soils. The HQ values predicted for algae at 150 inches per year ranged from 0.02 – 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 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 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 50 inches per year ranged from 0.5 to 585, and ranged from 4.8 to 1,064 at 150 inches per year. The HQ exceedences at 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 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.

<u>Clopyralid</u>

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 salmonids or their habitat because HQ values are less than 1.

Dicamba

Dicamba is a growth regulator selective herbicide that controls many broadleaf plants, but generally will not harm grasses. Its soil activity is very short. Like 2,4-D, it also is available as both an amine and ester formulation. Drift from dicamba applications is common, especially from the ester formulation (DiTomaso *et al.* 2006). The Washington State Department of Agriculture has added dicamba to its list of Pesticides of Concern because it is being increasing detected in most of the streams sampled in Washington (Sargeant *et al.* 2013).

The risk characterization for aquatic animals is extremely limited by the available toxicity data. Another very substantial limitation in the risk characterization is that no information is available on the chronic toxicity of dicamba to aquatic animals and the available acute toxicity data do not permit reasonable estimates of toxicity values for chronic toxicity. Acute toxicity studies in fish indicate that dicamba is relatively non-toxic, although salmonids appear to be more sensitive than other freshwater fish to the acute toxicity of dicamba (SERA 2004c). However, the EPA concluded that dicamba compounds with currently registered uses will have "no effect" on listed ESA-listed fish and their critical habitat, and therefore consultation with the National Marine Fisheries Service is not necessary (U.S. EPA 2003). Therefore, dicamba likely fits into the “low” risk group.

diflufenzopyr + dicamba

Diflufenzopyr, typically used together with dicamba, is a selective systematic herbicide used for the control of annual broad-leaf weeds post-emergence, the suppression or control of many perennial broad-leaf weeds, and the suppression of annual grasses. Test results on coldwater and warmwater fish species suggest that diflufenzopyr has relatively low toxicity to fish species (USDI-BLM 2005a). U.S. EPA characterizes diflufenzopyr as slightly toxic to practically non-toxic for both freshwater and marine/estuarine organisms. For freshwater organisms, LC50 values ranged from 15 to >135 mg/L. The LC50 values for marine/estuarine organisms ranged from 18.9 to >138 mg/L (U.S. EPA 1999). The species tested in these studies was not provided and additional toxicity data were not identified. Microbes and sunlight break down diflufenzopyr in the environment. Diflufenzopyr’s potential to leach to groundwater is low; surface runoff potential is high, and potential for loss on eroded soil is low. Diflufenzopyr has moderate volatility and the potential for loss to the atmosphere is moderate. Diflufenzopyr does not bioaccumulate (build up) in aquatic animals and is not persistent in the environment.

Glyphosate

Glyphosate HQ exceedences occurred for fish and algae at a rainfall rate of 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 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 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 150 inches per year, on all soil types is likely to adversely affect listed salmonids. When glyphosate is applied adjacent to stream channels at rates approaching the maximum on sandy soils, in rainfall regimes approaching 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 >100 mg/L for both acute toxicity and reproductive effects. Aquatic macrophytes may be much more sensitive, with an acute EC50 of 6.1 :g/L in duck weed (*Lemna gibba*). Aquatic algae appear to be much less sensitive, with EC50 values of greater than 45 :g/L. No toxicity studies have been located on the effects of imazapic on amphibians or microorganisms (SERA 2004a).

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 150 inches per year.

The HQ values for algae at 150 inches per year ranged from 0 to 1.3. The HQ exceedance at 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 exceedance at 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 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 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. Consequently, adverse effects on algae and aquatic macrophyte production may cause a reduction in availability of forage for juvenile salmonids. Over time, juvenile salmonids that receive less food have lower body condition and smaller size at smoltification. 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 50 and 150 inches per year. The HQ values ranged from 0.009 to 1.0 at 50 inches, and from 0.02 to 1.9 at 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 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 salmonids 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. In the event of an accidental spill, substantial mortality would be likely in both sensitive species of fish and sensitive species of algae (SERA 2011a).

Sethoxydim

No HQ exceedences occurred for sethoxydim for aquatic invertebrates, algae, or aquatic macrophytes. The HQ exceedences for fish occurred at rainfall rates of 50 and 150 inches per year, and ranged from 0.3 to 1.0, and from 1.1 to 3.0, respectively. The HQ exceedance at 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). Project design criteria sharply reduce the risk of naptha solvent presence in percolation runoff reaching streams. When design criteria to reduce naptha solvent exposure are employed, application of sethoxydim adjacent to stream channels will not affect listed salmonids or their habitat.

Sulfometuron

No HQ exceedences occurred for sulfometuron for fish, aquatic invertebrates, or algae. The HQ exceedance for aquatic macrophytes occurred at a rainfall rate of 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 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 salmonids 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. Applications of triclopyr BEE in excess of about 1.5 to 3 lbs. acid equivalent/acre could be associated with acute effects in sensitive species of fish or invertebrates, in cases of substantial drift or off-site transport of triclopyr via runoff (SERA 2011c). 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. However, the developmental toxicity of other triclopyr-containing herbicides, especially formulations based on BEE (*e.g.,* Garlon 4), rewash were not determined. NMFS (2011d) determined that triclopyr BEE (esters) posed a medium risk to fish. However, given the uses, fate, and toxicity of triclopyr BEE, NMFS did not expect mortality to be a common occurrence.

2,4-D

Drift and runoff are the most likely pathways of deposition of 2,4-D into aquatic habitats (U.S. EPA 2009) and it is detected frequently in freshwater habitats within the four western states where listed Pacific salmonids are distributed. 2,4-D acid, salts, and esters are toxic to aquatic animals, with esters having greater toxicity than 2,4-D acid and salts. 2,4-D amine fits into the “moderate” risk group. Given their long residency period and use of freshwater, estuarine, and nearshore areas, juveniles and migrating adults have a high probability of exposure to herbicides that are applied near their habitats. The risk of adverse effects to fish and their habitats was evaluated in terms of hazard quotient values and “no observable effect concentration” levels. Over the range of 2,4-D acid/salt application rates used in USFS programs (0.5-4 lb. acid equivalent/acre), adverse effects on fish, amphibians, and aquatic invertebrates are likely only in the event of an accidental spill. With regard to 2,4-D esters, however, adverse effects on aquatic animals (fish, invertebrates, amphibians) are plausible in association with runoff (all application rates) and would be expected in direct application for weed control and in cases of relatively large accidental spills (USDA-Forest Service 2006). NMFS (2011d) determined that 2,4-D BEE posed a medium risk to fish. NMFS also determined that multiple populations of salmon could be exposed to direct water applications of 2,4-D within a single year, resulting in a decrease in population numbers significant enough to jeopardize the ESA-listed fish species. Based on risk from all use patterns, NMFS rated the likelihood of 2,4-D BEE affecting listed salmon as “medium” (NMFS 2011d). Here, 2,4-D amine is labeled for aquatic use and 2,4D ester is characterized as high risk to all ESA-listed fish due to the proposed no-spray buffers.

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, including salmonids. 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 salmonids. 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.*, smoltification, disease susceptibility, behavior, *etc.*) (NMFS 2013).

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.

*13. **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.

*14. **Riparian Vegetation Treatment (controlled burning).*** The Action Agencies propose to reduce fuel loads in riparian areas by conducting controlled burns. The BA (USDA-Forest Service *et al.* 2013) states that the long-term benefits of this activity include the restoration of desired levels of stream shade, bank stability, soil erosion and stream turbidity, stream nutrients, or LW inputs. Additional benefits include maintenance of late-seral (old-growth) trees which serve as sources of LW to streams. Controlled burning will be planned and implemented to result in low severity burns as defined in the National Fire Plan (2000).[26] An exception is allowed for burns designed to invigorate aspen (*Populus* sp.) and willow (*Salix* sp.) stands. In aspen, profuse sprouting occurs after moderate- to high-intensity fires; less sprouting occurs following light burns (Fitzgerald 2010). Therefore, a burn of moderate intensity as defined in the National Fire Plan (2000) is allowed. Moderate burns must be confined to the observable historic boundaries of the aspen or willow sites and must not encompass more than 20% of the riparian area being treated.

This activity is likely to cause some short-term adverse effects on salmonids 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, the Action Agencies carry out prescribed burns in the spring and fall when fuel moisture and relatively humidity are high. 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,

[26] In 2001, Congress approved funds for federal and state agencies and local communities to better plan and prepare for future wildfire seasons. The result of that planning and preparation is known as the "National Fire Plan," a long-term strategy for reducing the effects of catastrophic wildfires throughout the nation. The goals are to ensure sufficient firefighting resources for the future, to rehabilitate and restore fire-damaged ecosystems, to reduce fuels (combustible forest materials) in forests and rangelands at risk, especially near communities, and to work with local residents to reduce fire risk and to improve fire protection.

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).

Although there is considerable research available on the effects of wildfire on streams and riparian areas, there is less information available on the effects of controlled burn, and considerably less on controlled burns within riparian areas. In an Atlantic coastal pine forest, Richter (1982) concluded that prescribed fire had limited effects on nutrient cycling, soils, and hydrologic systems. In the western United States fires have a notably larger effect of wildfire on water quality (Gresswell 1999; Neary *et al.* 2005. (revised 2008); Spencer *et al.* 2003; Stednick 2010).

In the Payette National Forest in Idaho, the Joint Fire Science Program (2009) found that a prescribed fire conducted in the spring when fuels were moist had negligible effects on stream communities. However, they concluded that even the lowest severity wildfires produced changes in stream communities. Streamside buffers are often difficult to exclude from a prescribed burn, but the soil and vegetation are usually moist and do not burn. Prescribed fire effects in these forests on stream communities are negligible, at least when the riparian forest is not burned. They reached the following key findings:

- Habitat changes varied based on interactions of annual stream flow patterns and burn severity of the streamside forest.
- Changes in habitat were correlated with instabilities in macroinvertebrate communities.
- Macroinvertebrate communities in burned areas did not become similar to communities in unburned areas within 4 years after fire.
- Springtime prescribed fire effects on stream ecosystems were negligible and even lower than the effects observed after low severity wildfire.
- Riparian forest burn severity and extent were lower after prescribed fire than after wildfire, which may explain observed patterns.

In a study conducted in the Sierra Nevada Mountains of California, Bêche *et al.* (2005) concluded that low to moderate intensity prescribed fire that was actively ignited in the riparian area had minimal effects on a small stream and its riparian zone during the first year post-fire. The fire was most severe in those areas with large accumulations of conifer litter and debris and usually self-extinguished when it came into contact with moist soil and characteristic riparian vegetation. The prescribed fire resulted in a tenfold increase in bare ground and a significant decrease in understory vegetation, but did not result in a measurable decrease in riparian canopy cover. Mortality of trees in the riparian areas was low (4.4%). Fine sediment in pools did not increase as a result of the fire, but the authors note that relatively little precipitation occurred post-fire. Little to no response was observed in the macroinvertebrate community. In contrast, Chan (1998) observed a reduced diversity of stream macroinvertebrates due to increased fine sediments one year after a prescribed burn in Sequoia National Park.

Gresswell (1999) states that even in the event of extensive high severity wildfires, local extirpation of fishes is patchy and recolonization is rapid. He also warns however, that in situations where native populations of fish have declined, effects from severe wildfires can be longer-lasting. In contrast, Rinne (1996) found that a large wildfire and subsequent hydrologic events on the Tonto National Forest in Arizona effectively extirpated three populations of salmonids in headwater streams and drastically reduced macroinvertebrate densities. In this study, severe effects to streams and aquatic communities were not observed immediately after the fire, but rather after subsequent precipitation events washed exposed fine sediments into streams. The wildfire addressed by this study burned in an area with heavy fuel build-up due to years of fire suppression.

Changes in macroinvertebrate communities are generally associated with more intense burns (crown fires with at least 50% of a stream's catchment involved) (Minshall 2003). This is far above the expected fire severity that would result from implementation of this activity type. Minshall (2003) also concludes that in unfragmented habitats supporting functional ecosystems in the Rocky Mountain region, recovery from fire appears to be relatively rapid, and that fire can contribute to aquatic productivity and biodiversity. In Boise River basin streams (Idaho), Rosenberger *et al.* (2011) compared the effects of wildfire on the invertebrate prey base for rainbow trout a decade after fires in watersheds unburned, burned, and burned followed by a debris flow. The quantity of macroinvertebrate drift (biomass density) was more variable within than among disturbance categories. Average body weight and taxonomic richness of drift were significantly related to water temperature and influenced by disturbance history. During the autumn sampling period, the amount of terrestrial insects in rainbow trout diets varied with disturbance history and the amount of overhead canopy along the stream banks. Responses were better correlated with specific characteristics of the stream (water temperature, canopy cover) than with broad disturbance classes. Therefore, fuels reduction treatments implemented in heavily degraded watershed or treatments proceeded by high intensity rain would be expected to be negatively impacted and recovery would be more protracted.

Although dead salmonids have been discovered after the 1998 Yellowstone National Park wildfires, the reason for this mortality was unknown (Minshall and Brock 1991). It is reasonably certain that no mortality would occur and individual fish behavior will not be affected directly by the patchy low-intensity fires and no debris flows would likely occur. Indirect effects such as reduced forage for juvenile salmonids will be minor. Recolonization will restore macroinvertebrate abundance in one to two years after burning. Over this time, juvenile salmonids that receive less food have decreased body condition and smaller size at smoltification. The primary beneficial effect of reducing fuel loads in riparian areas is reduced chance of severe wildfire. The short-term adverse effects caused by this activity category are minor when compared to the potential adverse effects of severe wildfires.

14. 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 yearling and other juvenile salmonids 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.

15. Bull Trout Protection. This category 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.

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. The Action Agencies also propose to electrofish for brook trout or other non-native fish species. 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). Bull trout spawn in headwater areas of streams from late-August to November, generally further upstream than ESA-listed salmon and steelhead species. On the Clackamas River where bull trout were recently reintroduced, the potential impact of bull trout was considered to be very low or moderately low for spring Chinook salmon, coho salmon, and winter steelhead and mostly none to very low for fall Chinook salmon (Marcot *et al.* 2012). 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 PDCs within this document (see section 20 c.) are required.

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

16. 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 would 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.* 2012).

The loss of beaver from small streams networks lowers water tables, hampering recovery of willows. Beschta and Ripple (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 contributed by tall willows, 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 would occur are for the most part incised, lack adequate riparian vegetation, and contribute little to the conservation of the ESA-listed fish populations through demonstrated or potential productivity. Long-term, the establishment of beavers to these stream reaches would result in the aforementioned benefits to ESA-listed fish habitat.

To make habitat more suitable to beavers the Action Agencies would also plant riparian hardwoods, protect hardwoods with enclosures until they are established, and control grazing to the extent possible. Additionally, they propose to encourage growth of deciduous trees by thinning small conifers where they are taking over stands of aspens and other deciduous species. Thinning with hand equipment would occur only within the observable historical boundaries of a meadow, aspen stand, willow site, or other deciduous species that serve as sources of food and construction materials for beavers and would be limited to only 20% of the area within a Riparian Reserve or RHCA per 6^{th} field HUC unit per year. Fallen trees would be left on site to serve as stream and floodplain structure and to discourage grazing. Short-term adverse effects of riparian tree thinning include minor reductions in stream shade, input of allochthonous materials, and small woody materials. Since the proposed activity does not involve ground-disturbing actions, inputs of fine sediment will not occur.

17. Sudden Oak Death (SOD) Treatments. The Action Agencies propose an activity category that allows a rapid response to treat and eradicate SOD at infected sites as quickly as possible once infection is discovered. Eradication activities include the removal of infected and uninfected host plants in a buffer zone that extends out up to 300 feet from the infected plants. In Oregon, infestations have only occurred in tanoak, rhododendron, and evergreen huckleberry in Curry County, although a northward trend to the town of Myrtle Point is expected if the pathogen is not contained and eradicated. SOD treatment includes five project elements: (1) Herbicide treatment, (2) manual and mechanical treatment (i.e., cutting), (3) fuel treatment, (4) temporary site access, and (5) site restoration.

Although the USFWS currently has no aquatic or riparian-dependent listed species that are likely to occur within the area affected by these treatments, consideration of SOD treatments is included in the analysis presented herein to help facilitate timely completion of consultation if such aquatic or riparian-dependent species become listed in the future and reinitiation of formal consultation is triggered on the proposed action. Please note that the effects of proposed SOD treatments on the threatened spotted owl and the threatened marbled murrelet within the action area for this consultation are analyzed in a separate BO (USFWS 2012c).

Herbicide treatment. Aquatic-labeled glyphosate and aquatic-labeled imazapyr would be used in accordance with the PDC for herbicides described in the proposed ***Non-native Invasive Plant Control*** activity category above. Only stem injection, cut-stump/hack & squirt, wicking/wiping, and spot spraying with hand-held nozzles will be used for SOD treatments. Because the glyphosate formulations with proprietary ‘‘inert ingredients” are more toxic to fish than the active ingredient alone (Stehr *et al.* 2009), only aquatic glyphosate (Aquamaster and Rodeo) and aquatic imazapyr (Habitat), which are formulated for use in and around aquatic sites are proposed. Aquamaster and Rodeo differ from Roundup herbicide in that they have a higher concentration of the active ingredient, glyphosate, but contain no surfactant. POEA surfactant and herbicides that contain POEA (*e.g*., Roundup) are not proposed for inclusion in this programmatic opinion. The effects of using these herbicides should be similar to the effects described above for this activity category.

Glyphosate bonds very strongly to soil and is expected to be immobile (U.S. EPA 1993). Therefore, there is a negligible risk for glyphosate to enter groundwater or streams from percolation through soil adjacent to treated tanoak. Sheetwash and rain splash are relatively ineffective in transporting sediment in undisturbed forested basins in the Pacific Northwest. High soil permeability and thick humus layer confine such activity to areas of recent disturbance (Dietrich *et al.* 1982). In addition, glyphosate would not be applied in the rain or when the soil is saturated or when a precipitation event likely to produce direct runoff to ESA-listed fish bearing waters from the treated area is forecasted by NOAA/NWS (National Weather Service) or other similar forecasting service within 48 hours following application. Glyphosate transport to water with sediment in undisturbed areas would be unlikely.

Toxicity studies of imazapyr have failed to demonstrate any significant or substantial toxicity in test animals exposed to imazapyr via multiple routes of exposure (SERA 2011c). Imazapyr is effective at lower application rates and is less toxic than glyphosate. Imazapyr is soluble in water and can be strongly adsorbed by soils, but the adsorption coefficient varies for different types of soil. Degradation in water is photodegradation with a half- life of approximately 2 days. Exposure for fish can occur via direct contact to surface water that may contain the herbicide due to runoff after ground application. Bioaccumulation of imazapyr in aquatic organisms is low; therefore the potential of exposure through ingestion of exposed aquatic invertebrates or other food sources to fish is reduced. Toxicity to fish is considered practically non-toxic (insignificant) based on tests conducted using standardized EPA protocols. The 96-hour LC50 for the compound was recently established in rainbow trout fry exposed to the Arsenal formulation of the herbicide as 77,716 ppm, or 22,305 ppm as the active ingredient. Sub-lethal tests with Chinook salmon smolts exposed to Arsenal at concentrations up to 1600 ppm showed no significant differences from the control population for plasma sodium or gill ATPase (Washington State Department of Agriculture 2003). Based on the results of the results of these tests and the proposed PDC, the risk of using imazapyr and glyphosate for SOD treatments is low.

Manual and mechanical treatment. Removal of infected vegetation would involve the use of chainsaws and excavators and feller/bunchers used in sites that are primarily tanoak and where site conditions are feasible. Adverse effects to aquatic species are likely to occur because of equipment leaks and fuel spills. However, PDC have been included as part of the action to greatly reduce the risk of potential adverse effects associated with fuel and lubricant spills. Equipment staging and refueling areas will be at least 150 feet away from aquatic habitats. No more than a one day supply of fuel for chainsaws may be brought into riparian areas and fueling would not occur within 100 feet of surface waters to prevent direct delivery of contaminants into a water body.

Within one site potential tree height of streams, Action Agencies will only remove non-host conifers less than 8-inches when needed to allow for safe burning of the site. Non-host conifer trees 8- to 16-inches would be reserved, except when needed to facilitate felling of tanoak or to reduce ladder fuels. To the extent practical, the Action Agencies will retain all non-infected conifers, non-host hardwoods, and conifer large downed wood within and outside of fire line by wetting, directional falling, or limbing of live trees. Removal of vegetation mechanically will likely adversely affect stream habitat by removing shade trees, which could increase stream temperature. The Chetco River and the North Fork Chetco River are listed on the Oregon Department of Environmental Quality 303(d) list for elevated water temperatures (ODEQ 2012). However, the Action Agencies will not remove vegetation providing stream shade or other ecological functions important to streams to the greatest degree possible. The maximum amount of SOD treatment clearing is based on stream width and on the stream distance that treated areas must be separated by non-treated areas. To date only small portions of SOD treatments areas have been near streams. The proposed conservation measures described as Limitations #1, #2, and #3 (see Section 39. g) will manage the magnitude of the shade reduction and potential stream temperature increases due to SOD treatments.

Fuel Treatment. Adverse effects to aquatic species are likely to occur from broadcast burning, burning of slash piles, and water withdrawals. Broadcast burning will require the removal of vegetation down to bare soil, which could generate runoff and sedimentation to streams. However, fire lines would not be greater than 8 feet-wide with a strip only 3 feet-wide stripped to mineral soil. To mitigate for potential erosion, fire lines will be constructed with erosion control structures, snags and logs would remain on site, and the lines will be restored to pre-project conditions before the winter following the controlled fire. Broadcast burning would occur in spring and winter when soils are saturated; and only in the fall after the first heavy rains. Whenever possible, burn piles would be strategically located away from fish-bearing streams when topography allows. In conjunction with site restoration activities, removal of vegetation would also open the stand to sunlight, which would result in growth of new plants to minimize erosion.

Removal of vegetation through fuel treatment (as discussed for *Manual and mechanical treatment* above*)*, will also likely adversely affect stream habitat by removing shade trees, which could increase stream temperature. To minimize this adverse effect the Action Agencies have proposed to set limits on the maximum amount of SOD treatment clearing based on stream width and on the stream distance that treated areas must be separated by areas not treated.

For fire control safety, the Action Agencies may require water withdrawals that would have the potential to dewater the channel to the point of isolating fish and entrain juvenile fish on pump intakes. However, they will avoid water withdrawals from fish bearing streams whenever possible and take no more than 10% of the stream flow. Pump intakes will have fish screens consistent with NMFS fish screening criteria (NMFS 2011e).

Temporary Site Access and Site Restoration. The direct adverse effects of temporary site access 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. Site Restoration will be implemented to reverse these direct effects. However, the effects of temporary site access will be minimized by following PDC that would prohibit new roads and sets limits and conditions for heavy equipment access to minimize adverse effects. Additionally, PDC are in place to minimize impacts from temporary travel ways and access trails within riparian areas. Site restoration would include treating exposed soils that may deliver sediment to streams with grass seed (preferably native grass seed if available), slash, water bars or other appropriate methods to minimize or eliminate sediment delivery.

18. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration. The Action Agencies often conduct habitat or fish surveys as part of a restoration project. For instance, presence/absence fish surveys are often carried out prior to construction activities to determine if fish relocation will be necessary. NMFS has specified that 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. This activity category does not cover research activities requiring an ESA section 10(a)(1)(A) permit.

2.5.1 Effects to ESA-listed Salmonids

ESA-listed salmonids under consideration in this BO 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. PDC related to in-water work timing, sensitive area protection, fish passage, erosion and pollution control, choice of equipment, in-water use of equipment, and work area isolation have been proposed to avoid or reduce these adverse effects. Those measures will ensure that the Action Agency 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 SR habitat. 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. Therefore, cooperation between the USFWS and the action agencies, in cooperation with the State, will be needed to determine the best timing of projects 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 and reducing sedimentation, intergravel flow, 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 projects, resident adults, sub-adults and juvenile bull trout may be present at some portion of the restoration sites, particularly those located in SR habitat, and those located where bull trout exhibit the resident life form. At in- or-near-water construction projects (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 15ºC (59ºF), or if dissolved oxygen is below saturation. Debris buildup at traps can also 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 (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, 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 fish 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. If habitat abundance or quality is a limiting factor for ESA-listed fish in streams, the long-term effects of access to larger or 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 prey that reside there (NMFS 2013).

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, 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 2008 through 2011), 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 effects of a proposed action would have to occur to large proportions of juvenile fish in a single area or local population before those effects would be equivalent even to 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 small numbers of juvenile fish that are likely to be killed are spread out across dozens of local populations. The adverse effects of each proposed individual action will be too infrequent, short-term, and limited to kill more than a very small number of juvenile bull trout at a particular site or even across the range of a single local population, much less 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 after each action is completed, 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. This is also true for other very small populations of endangered species considered in this opinion, *i.e.*, Borax Lake chub, for which is habitat is restricted to the 10.2 acre Borax lake, in Harney County, in Oregon where the remote location and limited exposure to these activities make it unlikely that individuals handled from this species would even be killed by the proposed action, and no population decline would be anticipated.

The remaining population attributes are 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 in the long-term will improve spawning habitat attributes, they are unlikely to adversely affect spawning group distributions or within-population spatial structure. Actions that restore fish passage 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 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 BO 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 action area for two or more recovery actions overlap, *i.e.*, are placed within 100 to 300 feet of each other and are constructed at approximately the same time.

Under the 2007 ARBO, the Action Agencies did not complete any projects within the range of the Lahontan cutthroat trout, and averaged 54 restoration actions (in-channel and fish passage) per year within the range of the bull trout, with far fewer being completed in any single IRU. More in-channel and fish passage projects were completed in recent years, but those totals were influenced by economic stimulus legislation, which included hundreds of millions of dollars for “habitat restoration and mitigation activities." 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 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.

i. Capture and handling effects:

1. Bull trout:
   The USFWS estimates that 162 projects implemented on average per year would occur within the range of the bull trout. Of these, the USFWS estimates that around 60% will require fish capture and handling. While the majority of ESA-listed fish captured under these projects would be salmon and steelhead some portion of these fish are likely to be bull trout. We have no data as to the exact proportion of bull trout to other salmonids within the action area, nor do we fully understand the exact relationships between bull trout and other salmonids that serve as much of their primary prey. Cohen (1977) describes a species ratio of 3:4, where given a situation where three prey species are present, four species of predators would likely also be present in a natural food web. The actual number of individual natural predators would be dependent of the abundance of prey individuals. The introduction of numerous non-native predators to the system has confounded this natural dynamic. This makes determining a ratio of bull trout to other prey salmonids extremely difficult. The Action Agencies did not record handling numbers for bull trout under ARBO 2007, and the USFWS has been unable to find capture, handling or mortality data that would be relevant across the action area which suggesting what ratio of bull trout were captured in relation to the number of salmon or steelhead.

   In the absence of empirical data, and for programmatic assessments where there is uncertainty as to where projects will be implemented across the action area, the USFWS 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 it is believed that 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 SR habitat 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 SR habitat 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 FMO habitat during this time period to an extremely low ratio (<1%) because of its warmer temperatures and generally poorer water quality. During the five-year period 2008-2012 the Action Agencies reported seven bull trout mortalities. Because the ratio of bull trout to other salmonids varies considerably across their range, and to err on the side of caution the USFWS estimates that a ratio of bull trout to salmon and steelhead of 5% exists on average across the action area. Therefore based on an anticipated capture of 132 salmon and steelhead described previously the USFWS anticipates the average capture of 7 bull trout for projects where isolation and dewatering would be required.

Of the fish that the Action Agencies capture and release, less than 2% are likely to be injured or killed, including by delayed mortality, and the remainder is likely to survive with no long-term adverse effects (NMFS 2013). Of the bull trout to be captured and handled, 98% or more are expected to survive with no long-term effects. Thus, USFWS anticipates that up to 476 individual bull trout (when separated by IRU and rounded up) considered in the consultation will be captured, on average per year, and up to 10 individuals will be injured or killed, on average per year, (*i.e*., 60% of 113 projects x 7 bull trout = 476; and 2% [injured or killed] of 476 = 10 whole fish (rounded up) injured or killed as a result of fish capture necessary to isolate in-water construction areas. However, a mortality to five percent of the fish that are captured and released, with the remainder (95 percent) likely to survive with no long-term adverse effects has also been reported (McMichael *et al*. 1998; Cannon 2012). Therefore, to err on the side of caution the more expansive estimate of 5% average annual lethal take (i.e., 5% of 476 = 24 rounded up to the whole fish) will be used here to allow for variations in fish health, environmental conditions and work conditions. USFWS will, however, allocate these effects proportionally across IRUs, as it is more practical to predict where projects will occur in these defined areas.

When these handling effects are allocated between the three affected IRUs we discover the following possible effects likely to occur annually:

- Columbia River IRU: 88 projects x 7 bull trout = 616 bull trout captured. Thus, 616 bull trout captured x 5% injury/mortality rate = 31 bull trout injured or killed.

- Coastal Puget Sound IRU: 6 projects x 7 bull trout = 42 bull trout captured. Thus, 42 bull trout captured x 5% injury/mortality = 2 bull trout injured or killed.

- Klamath IRU: 4 projects x 7 bull trout = 28 bull trout captured. Thus, 28 bull trout captured x 5% injury/mortality = 2 bull trout injured or killed.

As discussed previously the value of adult salmonids to localized populations is far greater than that of juvenile fish. It takes large numbers of juveniles within any population to ultimately recruit one adult salmonid. 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[27] = number of adult equivalents "killed" each year
n = number of projects likely to occur in an IRU each year on average
p = 7, i.e., number of juveniles to be captured per project[28]
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:

- Columbia River IRU: 616 bull trout x 5% x 2% = 0.6 adult equivalents
- Coast Puget Sound IRU: 42 bull trout x 5% x 2% = 0.04 adult equivalents
- Klamath IRU: 28 bull trout x 5% x 2% = 0.03 adult equivalents

2. Lahontan cutthroat trout:
While there were no projects completed under the 2007 ARBO in Lahontan cutthroat trout habitat, the USFWS estimates that one project will be completed each year, on average, that could require the capture of fish. 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 need to be salvaged because of low flows during the time period when projects would be implemented. Therefore we will assume that no more than five Lahontan cutthroat trout will be captured in any one project. This would equate to a total of 25 fish captured over any five-year period. Mortality or injury is also expected to be low. Based on the 5% figure used above (5% x 25 fish = 1.25 fish) the USFWS estimates that no more than two (rounded up to the whole fish) Lahontan cutthroat trout would suffer injury or mortality in any five-year period.

[27] Equates to the number of immature fish needed in order to result in one surviving adult fish to display population effects (Smoker et al. 2004).

[28] 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. No sturgeon or eulachon have been captured as a result of ODOT Salvage operations.

The analysis above 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.

2.5.2 Effects to ESA-listed Suckers

Listed suckers (Warner, Modoc, shortnose, and Lost River suckers) are limited to a relatively few lake and stream systems. Generally suckers will spawn in areas along shallow streamabanks with large amounts of riparian vegetation, but may also spawn near lakeshore areas. Most of what was written in section 2.5 and much of that 2.5.1 is also applicable to suckers.

While there are certainly some differences between these sucker species, there is also much that they have in common. It can generally be said that 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 they 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 listed 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 sucker.

Suckers could also be exposed to temporary increases in sedimentation from juniper treatments, or prescribed burning proposed under ARBO II. 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. 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 PDCs and CMs included as part of ARBO II should greatly reduce risk to suckers. Local in-water work periods are established to reduce effects to fish. This would greatly 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; this reduces stress on the fish and avoids impacts to larval suckers. The Action Agencies should work closely with USFWS and 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.

Under ARBO 2007 shortnose and Lost River suckers were exposed to a total of nine instream and five fish passage projects (14 total projects) during the five-year period from 2008-2012. One shortnose sucker mortality was reported under the implementation of ARBO during this time. This rate of restoration equates to about three projects per year on average. The Warner and Modoc suckers were potentially exposed to only two fish passage projects during the same five-year period. Also, one vegetation management project was conducted under ARBO during that time in the Warner basin (77 acres). Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the population characteristics of any listed sucker population, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover.

i. Capture and handling effects

Projects that require dewatering and capture are expected. The USFWS estimates that about 20 suckers would be captured per project. Based on past projects done under ARBO it could be expected that somewhere around two projects 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 ARBO II the USFWS will anticipate that six projects per year will be conducted that could require capture and handling of Lost River and Shortnose suckers. Likewise, the USFWS expects the number of projects that could require the capture and handling of Modoc suckers to increase to six projects per year. Warner suckers were only minimally exposed to projects that required capture and handling under ARBO 2007, but for the same reasons discussed above the USFWS will anticipate the capture and handling of 20 Warner suckers twice each year on average.

As described in Section 2.5.1, the USFWS estimates that a maximum of 5% of those fish that are captured and handled will suffer injury or mortality. The vast majority of the fish captured will be juveniles. Thus the effect to population abundance will be very small.

2.5.3 Effects to ESA Listed Chub and Dace

This section discusses the likely effects to Oregon chub and the Foskett speckled dace. These two species are grouped because of their general similarities. While they have very specific differences, both species live in relatively small geographic areas; while Oregon chub uses ponds primarily and also some stream environments in the Willamette Valley, the Foskett speckled dace occurs in a single spring in the Warner Basin of Oregon. Both species could be affected by activities contained within ARBO II.

The Oregon chub is present on the Willamette National Forest. Oregon chub are found in slack water off-channel habitats such as beaver ponds, oxbows, side channels, backwater sloughs, low gradient tributaries, and flooded marshes. These habitats usually have little or no water flow, are dominated by silty and organic substrate, and contain considerable aquatic vegetation providing cover for hiding and spawning (Pearsons 1989, p. 27; Markle *et al.* 1991, p. 289; Scheerer and

McDonald 2000, p. 1). Many such environs are available on the Forest especially in the Middle Fork Willamette river drainage.

Oregon chub are obligatory sight feeders, thus suspended sediments produced from instream or construction projects could interfere with the visibility of prey and, therefore, their normal feeding behavior. Large amounts (25 to 100% cover) of aquatic vegetation is needed for hiding cover and spawning. Any construction activity that removes aquatic vegetation in Oregon chub habitat will have adverse effects on the species. However, because Oregon chub habitat has become so fragmented and disconnect, projects that reconnect habitat will have great long-term benefits to the species.

Within the range of the Oregon chub, only one project was implemented under the 2007 ARBO over the five-year period from 2008 through 2012. To err on the side of caution we will anticipate that as many as two projects would occur that will affect Oregon chub during each five-year period during the life of this BO. There was no handling of Oregon chub and no mortality reported under this project, but adverse effects from increased sediment, human presence and vegetation changes would have short-term adverse effects to Oregon chub.

The Foskett speckled dace is endemic to Foskett Springs in the Warner Basin of Oregon. High mineral content and constant temperature are extremely important to maintain their population. No projects that would substantially increase, or decrease water temperature should be undertaken where Foskett speckled dace occur. Projects implemented under ARBO II could cause adverse effects to Foskett Speckled dace by temporarily removing vegetation that helps maintain constant temperatures in their habitat. The adverse effects should be of short duration as native vegetation will return over time.

Under the first ARBO only two projects were conducted in the Warner Basin during the period from 2008 through 2012. So, taking this as an average one could expect about two projects over every five year period. Therefore the probability of adverse effects exists.

i. *Capture and handling effects*

1. Foskett Speckled Dace
   Foskett speckled dace could be exposed to an average of two projects per year that would require capture. The actual numbers of individuals varies widely between local populations. The USFWS is unable to predict how many individuals may be captured in any one project. Therefore the USFWS will simply estimate that no more than 5% of any local population will be captured during any project that requires de-watering, and that no more than 0.25% of any local population will be injured or killed. The Action Agencies must work directly with their local USFWS representative and the appropriate Level 1 Team to determine the proper number of Foskett speckled dace that may be handled or harmed on a site-specific basis to ensure compliance with this BO.

2. Oregon Chub
   Oregon chub were only exposed to one project under ARBO 2007 during the five-year period of 2008-2012. The USFWS will estimate that Oregon chub may be exposed to the effects of three projects during any five-year period

under this BO. The USFWS estimates that up to 50 Oregon chub may be captured during any project that requires de-watering within their habitat. That equates to the capture of 150 Oregon chub during any five-year period. Using an injury/mortality rate of 5% the USFWS estimates that that eight Oregon chub will be injured or killed in any five-year period.

Although adverse effects to individuals will occur, the adverse effects of any action funded or carried out under this opinion are not large enough to adversely affect the population characteristics of any listed populations of chub or dace, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover.

2.5.4 Scope of Effects to ESA-listed Fish

The specific anticipated amount and effects of capture have been discussed for individual species in the previous sections. The scope of effects from other actions under ARBO II 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.

i. *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 fish 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 fish 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 USFWS 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 ITS) up to 50 feet from the project area in streams that are 30 feet wide or less, up to 100 feet from the discharge point or nonpoint source of runoff for streams between 30 and 100 feet wide, up to 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, or up to 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.

ii. *Construction-related disturbance of streambank and channel areas:*
To measure those effects to ESA-listed fish as discussed previously (see Sections 2.5, 2.5.1, 2.5.2 and 2.5.3) the best available indicator for the extent of adverse effects 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 and harassment that each action is likely to cause through short-term degradation of water quality and physical habitat. Based on the number of in-channel project miles affected during the five year period from 2008-2012 under the 2007 ARBO ($\overline{X}$ = 245 miles/5 years = 49 miles per year). With the additional activity categories in this BO, USFWS assumes that the Action Agencies will affect up to 74 stream miles average per year under this opinion (49 miles x 2 = 98 miles). Therefore, the extent of adverse effects based on this group of actions at 98 linear stream miles, or 517,440 linear feet, of in-channel projects per year on average.

iii. *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 fish as discussed previously (see Sections 2.5, 2.5.1, 2.5.2 and 2.5.3), the extent of adverse effects is best identified by the total number of road miles and vegetation acres treated in each IRU or affected basin (Table 3) with a factor of increase (100%) in activity per year. Based on the 2008-2012 activity levels, the extent of adverse effects would be 128 miles per year on average (64 miles x 2), or 675,840 linear feet, and, 12,438 acres (6,219 acres x 2) of road and vegetation treatment per year on average, respectively. Because the Action Agencies have expressed interest in implementing even more projects than this amount, the USFWS will further increase the estimates of this activity. For the Coastal Puget Sound IRU an additional 150 miles of linear road and trail work is anticipated, on average each year. For the Klamath IRU an additional 10 miles of linear road and trail work is anticipated, each year on average, as will 200 additional acres of vegetation treatment. Therefore the extent of adverse effects of road treatment is 288 miles or 1,520,640 linear feet per year on average (128 miles + 150 miles + 10 miles), and the extent of adverse effects of vegetation treatment is 12,638 acres per year on average (12,438 acres + 200 acres).

iv. *Invasive and non-native plant control:*
Application of manual, mechanical, biological 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 USFWS 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 RHCA within a 6^{th-}field HUC watershed/year (see PDC 33.a).

2.5.5 Effects of the Action on Designated Critical Habitat for ESA-listed Fish

Completion of each action is likely to have the following effects to the PCEs or habitat features essential to the conservation of each species. These effects will vary somewhat in degree between individual actions because of differences in the scope of construction at each site, and in the current condition of PCEs, the factors responsible for those conditions, and the differences in PCEs between species. This assumption relies on all of the actions being based on the same set of underlying construction actions. In general, ephemeral effects are likely to last for hours or days, short-term effects are likely to last for weeks to months, and long-term effects are likely to last for months, years or decades. Actions with more significant construction component are likely to adversely affect larger areas, and to take a longer time to recover, than actions based in restoration of a single habitat element. However, they are also likely to have correspondingly greater conservation benefits over time.

Because the area affected for each individual project is small, because the intensity and severity of the effects described is relatively low, and because their frequency in a given watershed is very low, any adverse effects to PCE conditions and conservation value of critical habitat at the site level or reach level are likely to quickly return to, and improve beyond, baseline critical habitat conditions in existence before the action. Moreover, projects completed under the proposed program are also reasonably certain to lead to some degree of ecological recovery within each project area, including the establishment or restoration of environmental conditions associated with functional aquatic habitat and high conservation value. This is because each action is likely to partially or fully correct improper or inadequate engineering designs in ways that will help restore lost habitat, improve water quality, reduce upstream and downstream channel impacts, improve floodplain connectivity, and reduce the risk of structural failure. Improved fish passage through culverts and more functional floodplain connectivity, in particular, may have long-term beneficial effects.

As noted above, 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; Fox 1992; Simenstad and Thom 1996; Zedler 1996). Nonetheless, the careful, interagency process used by the Action Agencies to develop the proposed program ensures that it is reasonably certain to lead to some degree of ecological recovery within each project area, including the establishment or restoration of environmental conditions associated with functional habitat and high conservation value.

While the Matrix of Pathway Indicators (MPI) (USFWS 1999) was not specifically designed as an aid to determine probable effects to critical habitat it can easily be cross-walked to display these effects by PCE or Primary Biological Feature (PBF) where no PCEs have been designated. The following tables display the relationship between the PCE and the indicator pathways that relates to the effects to that PCE, by species. This will be followed by a brief discussion of projects are expected to effect the PCE based on effects to the indicators.

a. Bull trout critical habitat:

i. <u>*PCEs*</u>:

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 36 °F to 59 °F (2 °C 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.

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.

Table 25 Effects to the PCEs of bull trout critical habitat

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
1	**Pathway:** Channel Condition and Dynamics **Indicator:** floodplain connectivity	-S	-I	N	N	**LAA**
	Pathway: Flow/Hydrology **Indicator:** Change in peak/base flows	-S	-I	-S	N	
2	**Pathway:** Habitat Access **Indicator:** Physical barriers	B	N	N	N	**LAA**
	Pathway: Water Quality **Indicator:** Chemical contaminants/nutrients, temperature	-S	-I	-S	B	

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
	Pathway: Flow/Hydrology **Indicator:** change in peak/base flows	-S	N	-S	N	
3	**Pathways:** Water Quality, Habitat Elements, Channel Condition and Dynamics, Habitat Access **Indicators:** All associated with these pathways	-S	-I	-S	N	**LAA**
4	**Pathway:** Habitat Elements **Indicators:** large wood, pool frequency and quality, large pools, off channel habitat, refugia	N	B	S-	N	**LAA**
	Pathway: Channel conditions and Dynamics **Indicators:** wetted width/maximum depth ratio, stream bank condition, floodplain connectivity	N	B	N	N	
5	**Pathway:** Water Quality **Indicator:** temperature	N	N	-I	N	**NLAA**
6	**Pathway:** Water Quality **Indicator:** sediment	-S	-I	-S	N	**LAA**
	Pathway: Habitat Elements **Indicator:** substrate embeddedness	-S	-I	-S	N	
7	**Pathway:** Flow/Hydrology **Indicator:** change in peak/base flows	-S	N	-S	N	**LAA**
8	**Pathway:** Water Quality **Indicator:** chemical contamination/nutrients	-S	N	-S	B	**LAA**
9	**Pathway:** Subpopulation Characteristics **Indicator:** Life History Diversity and Isolation, Persistence and Genetic Integrity	B	N	N	N	**NLAA**
Key: -S = Negative effects significant magnitude, -I = Negative effects Insignificant						Overall Effects

<table>
<tr><th>PCE Number</th><th>MPI Pathways/Indicators</th><th>Construction Activities[1]</th><th>Instream Activities[2]</th><th>Vegetation Treatments[3]</th><th>Other Projects[4]</th><th>Effects Determination</th></tr>
<tr><td colspan="6">magnitude or duration, N = Neutral effect
-D=negative effect discountable probability, B = Beneficial effect</td><td>Determination</td></tr>
<tr><td colspan="6">NOTES:
[1]: Includes 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),
3. Dam, Tide gate, and Legacy Structure Removal
4. Channel Reconstruction/Relocation
5. Off- and Side-Channel Habitat Restoration
6. Streambank Restoration
7. Set-back or Removal of Existing Berms, Dikes, and Levees
8. Reduction/Relocation of Recreation Impacts
9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering facilities
10. Piling and other Structure Removal
12. Road and Trail Erosion Control and Decommissioning
[2]: Includes Categories:
2. Large Wood (LW), Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Vanes, Gravel Augmentation; Tree Removal for LW Projects)
17. Bull Trout Protection
[3]: Includes Categories:
13. Non-native Invasive Plant Control
14. Juniper Removal
15. Riparian Vegetation Treatment (controlled burning)
16. Riparian Vegetative Planting
18. Beaver Habitat Restoration
19. Sudden Oak Death (SOD) Treatments
[4]: Includes Categories:
11. In-channel Nutrient Enhancement
20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration</td><td>LAA</td></tr>
</table>

ii. *Summary of effects to bull trout critical habitat*

Construction projects have the greatest potential to affect 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 during construction 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. Some long term effects could occur possibly lasting years or decades where stream channels are realigned). While these PCEs will be adversely affected for some period of time by these projects, all of the projects described in this BO will eventually contribute to the improvement of fish habitat (see discussions in section 2.5). With long-term benefits resulting from passage enhancement. Thus they will result in benefits over time to these PCEs of critical habitat.

Instream projects will result in insignificant negative effects to PCEs 1, 2, 3 and 6. These are ephemeral effects of low intensity and short duration.

Vegetation management activities will have adverse effects on PCEs 1, 2, 3, 4, 6, 7 and 8. 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. These effects should diminish and eventually halt as native vegetation becomes reestablished. These projects will ultimately result in improved infiltration rates, reduced overland flows and sediment yields and a more natural hydrograph.

Projects described under the "other" category in Table 25 will have an overall neutral effect on critical habitat. While in some cases the placement of salmon carcasses will have a beneficial effect to some PCEs of bull trout critical habitat.

A more detailed description of how each project type will affect the individual PCEs of bull trout critical habitat follows:

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

Channel Condition and Dynamics (floodplain connectivity) will be greatly affected by construction projects. 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. In most cases these effects will be short-term (weeks to months), but could be long-term, lasting years. Ultimately these projects are designed to improve conditions (passage, channel dynamics, correct problematic 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, and in some cases long-term effects (stream realignment) lasting years could occur, these projects will adversely affect PCE 1.

Instream projects such as the placement of gravel, or LW may have slight negative effects to PCE 1by contributing to turbidity and donation of some amounts sediment to the system thus affecting water quality. Channels conditions will show some effects from many of these projects. These effects will be of low intensity, short duration (more likely hours than days), and are considered insignificant to PCE 1.

Vegetation management will have a neutral effect on this indicator. Also projects described as "other" in Table 25 will have a neutral effect on this indicator of bull trout critical habitat. This category lacks any causal mechanism to affect any of this PCE.

Flow/Hydrology (change in peak/base flows) will be affected by construction projects. 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 realignment could have adverse effects on flow for many years before beneficial effects to the system are recognized.

In general, construction projects described within this BO will adversely affect PCE 1.

Vegetation management projects will have short-term adverse effects on PCE 1 through this indicator. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well (see section 2.5). Any adverse effect to this PCE will be short-term and would be expected to lessen 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 or more) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

Projects described as “other” in Table 25 will have a neutral effect on this indicator of bull trout critical habitat. This category lacks any causal mechanism to affect any of this 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.

Habitat Access (barriers) may be disrupted during implementation of some construction projects. In many cases this disruption may only be ephemeral, but in other cases short-term adverse effects will occur to PCE 2. With long-term benefits resulting from passage enhancement. Thus they will result in benefits over time to PCE 2 of critical habitat eventually.

Instream projects such as the addition of LW, or the placement of gravel or boulders will have a neutral effect on this indicator. Also vegetation projects, and those projects described as “other” in Table 25 will have a neutral effect to this indicator as there is no causal mechanism for them to affect this indicator.

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 realigned). 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 PDCs (see 15. under Program Administration) contained within this BO. While PCE 2 will be adversely affected for some period of time by these projects, all of the projects described in this BO will eventually contribute to the improvement of fish habitat.

Instream projects will have a slightly negative effect on water quality (ephemeral effects). The addition of LW, or placement of gravel or boulders may contribute minor amounts of sediment to the system. These effects should be of short duration and low intensity and are considered insignificant to this indicator.

Vegetation treatments considered within this BO will adversely affect water quality in the short-term. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well (see section 2.5). Further, the removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased sediment delivery to the system. Most adverse effects to this PCE 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, or more) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

Most of the projects listed under the "other" category would have a neutral effect on this indicator as they lack a causal mechanism to affect the PCE 2 through this pathway. The lone exception would be the addition of salmon carcasses which would be entirely beneficial as it would add important nutrients to the system.

Flow/Hydrology ***(****change in peak/base flows)* will be affected by construction projects. 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 realignment could have adverse effects on flow for many years before beneficial effects to the system are recognized. In general, construction projects described within this BO will adversely affect PCE 2.

Vegetation management projects will have short-term adverse effects on PCE 2 through this indicator. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well (see section 2.5). Any adverse effect to this PCE will be short-term and would be expected to lessen 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 the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

Instream projects such as the addition of LW, or the placement of gravel or boulders will have a neutral effect on this indicator. Also vegetation projects, and those projects described as "other" in Table 25 will have a neutral effect to this indicator as there is no causal mechanism for them to affect this indicator.

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

Water Quality, Habitat Elements, Channel Condition and Dynamics, Habitat Access will be adversely affected by construction projects. These effects will limit the availability of prey species within critical habitat in the short-term. Increased sediment and reduced water quality will reduce the ability of critical habitat to provide foraging opportunities to bull trout through reduced visibility, and reduced presence of prey fish.

Instream projects may have a slightly negative effect on this indicator. These projects may increase, or disturb fine sediment at a small, localized scale. These effects are likely to be ephemeral, of short duration and of low intensity. Thus, these effects are considered insignificant to PCE 3 through these pathways.

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. Increased donations of sediment with increased turbidity may reduce both the availability of prey and the ability of bull trout to pursue such prey. 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.

Projects described as "other" in Table 25 will have a neutral effect on these indicators because they lack a causal mechanism to affect PCE 3.

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.

Habitat Elements **(***large wood, pool frequency and quality, large pools, off channel habitat, refugia)* will not be negatively affected by construction projects when applied to PCE 4. Instream projects such as additions of large wood, or placement of gravel or boulders would have entirely beneficial effects on these indicators. Vegetation management projects would generally have a neutral effect on these indicators as applied to PCE 4, however they may well have a short-term (months) adverse effect on refugia. Therefore they must be considered as an adverse effect on PCE 4 through this pathway. Projects described under the "other" category in Table 25 will have a neutral effect on these indicators.

Channel conditions and Dynamics (wetted width/maximum depth ratio, stream bank condition, floodplain connectivity) Construction projects will not have adverse effects to PCE 4 through this pathway. They will ultimately contribute to the ability of critical habitat to supply the elements of PCE 4.

Instream projects that provide additional LW, boulders and gravel will be entirely beneficial to this PCE as they will provide for an increased ability of critical habitat to provide the elements of PCE 4.

Vegetation projects and projects described under the "other" category will have a neutral effect on PCE 4 through this pathway.

5. Water temperatures ranging from 36 °F to 59 °F (2 °C 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.

Water quality (Temperature) will not be affected by construction projects, instream projects, or those projects described as "other" in Table 25. These activities lack a causal mechanism to affect water temperature. Vegetation projects will have a slightly negative effect on this indicator. The removal of vegetation could allow increased solar radiation which could affect temperatures to some degree. These effects will be extremely localized and of low intensity, and are considered insignificant to PCE 5.

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.

Water Quality (Sediment) will be adversely affected by 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 realigned).

Instream projects such as the placement of gravel, or LW may have slight negative effects to PCE 1by contributing to turbidity and donation of some amount of sediment to the system thus affecting water quality. Channel conditions will show some effects from many of these projects. These effects will be of low intensity, short duration (more likely hours than days), and are considered insignificant to PCE 6.

Vegetation treatments considered within this BO will adversely affect water quality in the short-term. The removal of vegetation can change overland flows and infiltration rates. Increased run-off from rainfall or snow melt will result in increased sediment delivery to the system. Most adverse effects to PCE 6 will be relatively short-term and would be expected to lessen and then terminate once native vegetation becomes reestablished on the project sites. However larger scale projects may increase sediment loads for long periods (up to five years). Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years depending on the exact project) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

Projects described under the "other" category in Table 25 will have a neutral effect on the sediment indicator as they lack any causal mechanism to affect it.

Habitat Elements (substrate embeddedness) will be adversely affected by instream or near-stream construction projects. The addition of sediment described above will result in some portion of substrate embeddedness. While it is expected that most of this would subside the year following the project when high flows would purge the system of most of the residual sediment on the substrate, these projects will still result in short-term adverse effects for most projects. Obviously in larger scale projects such as stream realignment these adverse conditions could persist longer, possibly up to years in time.

Instream projects such as the placement of gravel, or LW may have slight negative effects to PCE 6 by contributing to turbidity and donation of some amounts sediment to the system thus affecting water quality. These effects will be of low intensity, short duration (more likely hours than days), and are considered insignificant to this indicator.

Vegetation management projects will have an adverse effect on substrate embeddedness because they will result in increased sediment donations to the system short-term. If projects are located within bull trout SR habitat this could adversely affect the ability of critical habitat to provide high quality substrates needed for spawning. As mentioned above most of these effects would not last more than one season, but are considered an adverse effect on PCE 6.

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.

Flow/Hydrology (change in peak/base flows) will be adversely affected by construction projects. 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 realignment could have adverse effects on flow for many years before beneficial effects to the system are recognized. In general, construction projects described within this BO 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.

Vegetation management projects will have short-term adverse effects on PCE 7 through this indicator. 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 to the system. Any adverse effect to this PCE will be short-term and would be expected to lessen 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, and a more natural hydrograph over time.

Instream projects and projects described as “other” in Table 25 will have a neutral effect on this indicator of bull trout critical habitat. This category lacks any causal mechanism to affect this PCE through this pathway.

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

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 realigned). 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 PDCs (see 15. under Program Administration) contained within this BO. While PCE 2 will be adversely affected for some period of time by these projects, all of the projects described in this BO will eventually contribute to the improvement of fish habitat.

Instream projects will have a slightly negative effect on water quality. The addition of LW, or placement of gravel or boulders may contribute minor amounts of sediment to the system. These effects should be of short duration and low intensity and are considered insignificant to this indicator.

Vegetation treatments considered within this BO will adversely affect water quality in the short-term. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well (see section 2.5). Further, the removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased sediment delivery to the system. Any adverse effects to this PCE will be short-term and would be expected to lessen 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 the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

Most of the projects listed under the “other” category would have a neutral effect on this indicator as they lack a causal mechanism to affect the PCE 2 through this pathway. The lone exception would be the addition of salmon carcasses which would be entirely beneficial as it would add need nutrients to the system.

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.

Subpopulation Characteristics **(***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 (see Section 1.3.1 Program Administration, number 8-J, and Section 1.3.2 General Aquatic Conservation Measures, number 13) will improve genetic diversity.

Instream projects, vegetation treatment projects, and those projects described under the "other" category in Table 25 would have a neutral effect on the indicator as they have no causal mechanism to affect PCE 9.

iii. *Effects to bull trout CHUs, IRUs and critical habitat at the rangewide scale*

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, too far apart and too infrequent to adversely affect any one CHU. Because of this the effects of these projects cannot rise to a level to adversely affect any IRU, and thus cannot adversely modify critical habitat at the rangewide scale.

b. Lahontan Cutthroat Trout

No critical habitat has been designated for this species.

c. Modoc Sucker

No critical habitat has been designated within the action area.

d. Lost River Sucker and Shortnose Sucker Critical Habitat

i. *PCEs of Lost River and shortnose sucker critical habitat*

The designation of critical habitat includes five PCEs for these two species:

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

Table 26 below presents a crosswalk between these PCEs and the MPI to help display the effects of the proposed action on Lost River and Shortnose sucker critical habitat.

Table 26. Effect to PCEs of Lost River and shortnose sucker critical habitat.

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
1	**Pathway:** Habitat Access **Indicator:** Physical barriers	-I	N	N	N	**LAA**
	Pathway: Flow/Hydrology **Indicator:** Change in peak/base flows	-S	-I	-S	N	
2	**Pathway:** Habitat Elements **Indicator:** All associated with these pathways	-S	-I	-S	B	**LAA**
	Pathway: Water Quality **Indicator:** Chemical contaminants/nutrients, temperature	-S	-I	-S	B	
3	**Pathways:** Habitat Elements **Indicators:** Refugia	-S	-I	-S	N	**LAA**
4	**Pathway:** Habitat Elements, Integration of Species and Habitat Conditions **Indicators:** large pools, off channel habitat, refugia	-S	-I	-S	N	**LAA**
	Pathway: Channel conditions and Dynamics **Indicators:** wetted width/maximum depth ratio, stream bank condition, floodplain connectivity	-S	-I	N	N	
5	**Pathway:** Watershed conditions **Indicator:** disturbance history, disturbance regime	B	N	N	N	**NLAA**
Key: -S = Negative effects significant magnitude, -I = Negative effects Insignificant magnitude or duration, N = Neutral effect -D=negative effect discountable probability, B = Beneficial effect						Overall Effects Determination
NOTES: [1]: Includes 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),						**LAA**

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
3. Dam, Tide gate, and Legacy Structure Removal **4. Channel Reconstruction/Relocation** **5. Off- and Side-Channel Habitat Restoration** **6. Streambank Restoration** **7. Set-back or Removal of Existing Berms, Dikes, and Levees** **8. Reduction/Relocation of Recreation Impacts** **9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering facilities** **10. Piling and other Structure Removal** **12. Road and Trail Erosion Control and Decommissioning** **[2]: Includes Categories:** **2. Large Wood (LW), Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Vanes, Gravel Augmentation; Tree Removal for LW Projects)** **17. Bull Trout Protection** **[3]: Includes Categories:** **13. Non-native Invasive Plant Control** **14. Juniper Removal** **15. Riparian Vegetation Treatment (controlled burning)** **16. Riparian Vegetative Planting** **18. Beaver Habitat Restoration** **19. Sudden Oak Death (SOD) Treatments** **[4]: Includes Categories:** **11. In-channel Nutrient Enhancement** **20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration**						

ii. *Summary of the effects of the action by critical habitat PCEs:*

1. Space for individual and population growth and for normal behavior:

Habitat access (*Physical barriers)* is a prime need to support this PCE. While construction projects will ultimately aid in allowing suckers improved access to habitat over the long-term, these activities will likely have negative effects to this PCE in the short-term (days to weeks). Because these effects will be small in magnitude, of short duration, and localized in scale these negative effects are considered insignificant. Instream projects, vegetation projects, and projects described as "other" all have a neutral effect on this indicator as they have no causal mechanism of effect.

Flow/Hydrology (Change in peak/base flows) is an important pathway which allows habitat availability (space). Some of the construction activities (stream realignment) could cause changes in base or peak flows within the system. If such a project was designed or implemented within this critical habitat it would adversely affect this PCE. Instream projects such as gravel or boulder placement, LW or ELJ could cause short-term (days to weeks) changes in local flows. Changes at the local scale could have negative effects, but they would be of short duration and low intensity, and would be insignificant to PCE 1. Vegetation treatments could result in longer term changes in flow that would cause adverse effects to this PCE. These flow changes would last until native plants become established (herbicide treatment, juniper treatments) within the riparian zone and/or upland depending on the specific project. Over-time infiltration rates would improve and a more natural hydrograph would result. Projects from the “other” category (surveys and carcass treatments) would have a neutral effect as they have no causal mechanism to affect PCE 1.

2. Food, water, air, light, minerals, or other nutritional or physiological requirements;

Habitat elements would be affected by construction projects. In creased sediment will reduce the amount of sunlight available for the development of food. Minerals will be disturbed, and their distribution altered as these projects are implemented. Construction activities may alter streambank or lakeside vegetation which suckers need for refugia. Instream projects could have slight negative effects on the habitat elements needed by suckers. Small areas of streambank or lakeside vegetation could be disturbed, slight disruption of minerals could occur at a local scale, but these changes will be of low intensity and short duration and are considered as insignificant to PCE 2. Vegetation treatments will have significant short-term adverse effects to PCE 2. Removal of streamside vegetation will change the amount and intensity of light reaching the habitat in some areas. Refugia may also be reduced. While all projects considered within this BO are intended to produce long-term benefits, there will be short-term adverse effects. These adverse effects will only last until native vegetation becomes established and a more natural condition is achieved. Projects described in the “other” category will not adversely affect PCE 2, the addition of salmon carcasses would benefit the system and thereby benefit this PCE.

Water quality (Chemical contaminants/nutrients, temperature) would be adversely affected by construction projects at the local scale. The addition of sediment will reduce water quality. 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 PDCs (see 15. under Program Administration) contained within this BO. Instream projects could contribute to small, localized changes to water quality. Small amounts of sediment, and small localized changes to nutrients will occur, but these changes will be of low intensity and short duration (days to weeks) and are considered insignificant to PCE 2. Vegetation projects could affect temperature within localized areas. These projects will increase sediment delivery to the system over the short-term (months to a few years), and will provide benefit over the long-term (three to 20 years). The use of herbicide treatments expose critical habitat to possible contamination. While this contamination should be small (see 33e. under Program Administration) some delivery through drift will occur. Vegetation projects described within this BO will adversely affect PCE 2). Projects described in Table 26 under the “other category will not adversely affect water quality. The addition of salmon carcasses to the system will actually have a beneficial effect to this PCE.

3. Cover or shelter;

Habitat elements (refugia). Construction projects will adversely affect refugia through changes in the physical features of the system. Removal of streamside or lakeside vegetation may reduce the ability of critical habitat to provide cover or shelter in localized areas. This cover is vitally important for suckers during many life phases, including the travel of larval suckers to deep pools and lakes. Thus these activities will adversely affect PCE 3. Instream projects may have very small, localized negative effects on refugia. However, the scale of these changes will be small, of low intensity, and of short duration. Therefore, these changes are considered insignificant to PCE 3. Vegetation projects described within this BO may remove areas of streamside or lakeside vegetation. While these changes will be short-term (months to three years), and localized they are considered significant as the ability of the critical habitat to provide refugia will be impaired at a local scale until native vegetation becomes reestablished, and ultimately beneficial effects begin to occur. These vegetation projects will adversely affect PCE 3.

4. Sites for breeding, reproduction, or rearing (or development) of offspring;

Habitat Elements (Integration of Species and Habitat Conditions) will be adversely affected in the short-term by construction. Sediment loads will be increased immediately following these projects. Fine sediment will increase cobble embeddedness and reduce the quality of spawning habitat that critical habitat can supply during the short-term. The removal of streamside or lakeside shade, although localized will reduce the ability of critical habitat to provide hiding and rearing cover. While implementation during the in-water work period (especially if projects are done in October or November) will reduce these adverse effects these projects will still adversely affect PCE 4 during the short-term (months). Instream projects will have either a neutral effect or slightly negative effects on PCE 4. These effects will be of short duration and low intensity and are considered insignificant. The addition of gravel, boulders or LW will ultimately benefit instream habitat and thus allow critical habitat to better support reproduction and rearing. Vegetation projects would reduce streamside or lakeside vegetation over the short-term (months to three years). This will reduce the ability of critical habitat to provide cover needed for rearing and development of larval suckers. These adverse effects will lesson over time as native vegetation becomes established. Projects described in Table 26 under the “other” category will have a neutral effect on PCE 4 as they have no causal mechanism to affect this PCE.

Channel conditions and Dynamics (wetted width/maximum depth ratio, stream bank condition, floodplain connectivity) will be adversely affected by construction related projects during the short-term (weeks to months). Increased sediment donations, and removal of streamside or lakeside vegetation will affect streambank conditions. Over time these projects will supply better channel conditions and more natural dynamics, most likely starting the year following construction. However, these changes will have a significant adverse effect to PCE 4 for the first few months post-construction. Instream projects may have some small temporary negative effects to the channel conditions, slightly changing streambank conditions at a local scale, but these changes will be of low intensity and short duration, and are considered to be insignificant to PCE 4. Likewise, vegetation treatment may cause temporary changes to streambank conditions, but these changes will also be of low intensity and short duration, and should be insignificant to channel conditions and dynamics, which are important pathways for sucker reproduction and rearing. Projects listed under the "other" category in Table 26 will have a neutral effect on PCE 4 as they have no causal mechanism to affect this PCE.

5. Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

Watershed conditions (disturbance history, disturbance regime) often directly contribute to the disturbance regime and the associated disturbance history of a given area. Instream and near stream (or lake) construction projects are intended to restore more natural conditions to the aquatic system. Even large projects such as stream channel realignment done to return streams to historic natural channels should have no negative effects on these indicators. Construction projects will decrease the risk of disturbance caused by anthropogenic influences within the watershed. These projects would be completely beneficial to this pathway and its indicators. Instream projects such as the addition of LW, gravel and boulders, or that remove non-native fish such as brook trout would help to return the watershed to a more natural condition. While these projects will produce beneficial impacts over time, and would be slightly beneficial to returning the streams and lakes to a more natural condition, overall their effect would be neutral on the indicators or disturbance regime and disturbance history.

Vegetation projects would help to restore native plant communities, which in-turn would create more natural infiltration rates and reduce overland flows. The restoration of native plant communities would play a major role in returning watershed disturbance regimes to a more natural condition. Thus, the vegetation projects described within this BO would be entirely beneficial to these indicators. Those projects described under the category "other" in Table 26 are considered neutral to the indicators in question. This is because they possess no causal mechanism to affect PCE 5.

iii. *Effects to Lost River and shortnose sucker critical habitat at the rangewide scale*

While the proposed action will have adverse effects to Lost River and shortnose 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 too dispersed across the system and too infrequent to adversely affect any one recovery unit. Because of this the effects of these projects cannot rise to a level that adversely affects the critical habitat rangewide, and thus cannot adversely modify critical habitat at the rangewide scale.

e. Warner Sucker Critical Habitat

No PCEs have been described for Warner sucker critical habitat. However the designation describes the importance of maintaining the riparian zone for 50 feet on either side of the stream. Therefore, the USFWS considers the following as an interim PBF for Warner sucker critical habitat:

i. *Interim PBF*:

1. The bankfull width stream channel and a naturally diverse riparian zone extending at a minimum for 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.

Based on this interim PBF, the effects of the proposed action will be analyzed through the MPI as follows (Table 27).

Table 27. Effect to the interim PBF of Warner sucker critical habitat.

Interim PBF	**MPI Pathways/Indicators**	**Construction Activities[1]**	**Instream Activities[2]**	**Vegetation Treatments[3]**	**Other Projects[4]**	**Effects Determination**
1	**Pathway:** Watershed conditions **Indicator:** Riparian Conservation Areas	-S	B	-S	N	**LAA**
	Pathway: Channel Condition &Dynamics **Indicator:** Streambank Condition	-S	N	-S	N	
	Pathway: Water Quality **Indicator:** Chemical contaminants/nutrients, temperature	-S	N	-S	B	
Key: -S = Negative effects significant magnitude, -I = Negative effects Insignificant magnitude or duration, **N = Neutral effect** **-D=negative effect discountable probability, B = Beneficial effect**						Overall Effects Determination
NOTES: **[1]: Includes 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),** **3. Dam, Tide gate, and Legacy Structure Removal** **4. Channel Reconstruction/Relocation** **5. Off- and Side-Channel Habitat Restoration** **6. Streambank Restoration** **7. Set-back or Removal of Existing Berms, Dikes, and Levees** **8. Reduction/Relocation of Recreation Impacts** **9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering facilities** **10. Piling and other Structure Removal**						**LAA**

Interim PBF	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
12. Road and Trail Erosion Control and Decommissioning **[2]: Includes Categories:** **2. Large Wood (LW), Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Vanes, Gravel Augmentation; Tree Removal for LW Projects)** **17. Bull Trout Protection** **[3]: Includes Categories:** **13. Non-native Invasive Plant Control** **14. Juniper Removal** **15. Riparian Vegetation Treatment (controlled burning)** **16. Riparian Vegetative Planting** **18. Beaver Habitat Restoration** **19. Sudden Oak Death (SOD) Treatments (Not fully analyzed in this BO)** **[4]: Includes Categories:** **11. In-channel Nutrient Enhancement** **20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration**						

ii. <u>*Summary of the effects of the action to critical habitat interim PBF:*</u>

Watershed conditions (Riparian Habitat Conservation Areas (RHCA)): PACFISH/INFISH suggests that a potential natural community (PNC) comprised of greater than 50% native riparian vegetation is needed to achieve properly functioning condition for riparian habitat conservation areas. Construction projects may adversely affect riparian vegetation through removal at project sites. The effects of this removal will be short-term (weeks to months), but may adversely affect the ability of critical habitat to meet the desired PNC. Thus, these projects will adversely affect this interim PBF through this pathway over the short-term. All such projects are designed to improve aquatic habitat in the long-term, and hence will ultimately be beneficial to the interim PBF 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.

Vegetation management projects will adversely affect the RHCA in the short-term. Projects that remove non-native streamside vegetation may ultimately benefit the RHCA, but will cause a decrease 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.

Projects described under the “other” category in Table 27 would have a neutral effect on the interim PBF through this pathway as they lack any causal mechanism to affect this indicator.

Channel Condition & Dynamics (Streambank Condition): Construction projects will adversely affect streambank conditions in some areas. The removal of vegetation combined with the disturbance of soils will change streambank dynamics to some extent wherever these projects occur within Warner sucker critical habitat. These effects are expected to be short-term (weeks to months), but they will adversely affect the interim PBF under consideration.

Instream projects will have a neutral effect on this indicator. There is no causal mechanism for projects that place LW, boulders, or gravel to adversely affect the interim PBF through this pathway.

Vegetation projects described within this BO will have a short-term adverse effect on streambank condition. These effects will result from the removal of vegetation that holds soil in place, and prevents erosion, and helps to regulate sediment delivery to the system. Most of these effects would occur short-term (weeks to months), but some could last longer (> than one year). Ultimately, projects that improve the density of native plants will benefit streambank and overall riparian conditions over-time.

Projects described under the "other" category in Table 27 would have a neutral effect on the interim PBF through this pathway as they lack any causal mechanism to affect this indicator.

Water Quality (Chemical contaminants/nutrients, temperature):
Instream construction projects will adversely affect water quality by removing some riparian vegetation in site-specific areas. This 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. These effects should be short-term (lasting weeks to months). Over time any vegetation removed will return.

Instream projects will have a neutral effect to water quality. The addition of LW could add some nutrients to the system short-term, but the other activity types in this category would not affect the interim PBF through these indicators.

Vegetation management projects would adversely affect water quality short-term (weeks to months). The removal of streamside vegetation would reduce the ability of critical habitat to provide a riparian buffer to filter sediment and other pollutants. If the treatment involves the loss of small trees or shrubs stream shade could be reduced. This could cause increased exposure of stream surfaces to solar radiation which will result in increased temperatures.

From the projects listed in Table 27 under the "other" category the addition of salmon carcasses would be entirely beneficial to the interim PBF through this pathway, while surveys would have a neutral effect.

iii. Effects to Warner sucker critical habitat at the rangewide scale

The projects described within this BO will have some adverse effects to Warner sucker critical habitat at the site-specific, local scale. These effects will be dispersed rangewide across critical habitat. These effects are too small, and of too short duration to adversely affect critical habitat at the larger rangewide scale. During the five-year period from 2008 through 2012 only two construction projects and one vegetation project were conducted within the range of the Warner sucker under ARBO. 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. Therefore implementation of projects within ARBO II will not adversely modify critical habitat for the Warner sucker.

f. Oregon chub critical habitat

i. PCEs of Oregon chub critical habitat

The designation of critical habitat includes four PCEs for this species:

1. Off-channel water bodies such as beaver ponds, oxbows, side-channels, stable backwater sloughs, low-gradient tributaries, and flooded marshes, including at least 500 continuous square meters (m^2) (0.12 acres) of aquatic surface area at depths between approximately 0.5 and 2.0 meters (m) (1.6 and 6.6 feet)
2. Aquatic vegetation covering a minimum of 250 m^2 (0.06 acres) (or between approximately 25 and 100 percent) of the total surface area of the habitat. This vegetation is primarily submergent for purposes of spawning, but also includes emergent and floating vegetation, and algae, which are important for cover throughout the year. Areas with sufficient vegetation are likely to also have the following characteristics.
   a. Gradient less than 2.5 percent;
   b. No or very low water velocity in late spring and summer;
   c. Silty, organic substrate; and
   d. Abundant minute organisms such as rotifers, copepods, cladocerans, and chironomid larvae.
3. Late spring and summer subsurface water temperatures between 15 and 25 °C (59 and 78 F), with natural diurnal and seasonal variation.
4. No or negligible levels of non-native aquatic predatory or competitive species. Negligible is defined for the purpose of this rule as a minimal level of non-native species that will still allow the Oregon chub to continue to survive and recover.

Table 28. Effect to the PCEs of Oregon chub critical habitat.

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
1	**Pathway:** Habitat Elements **Indicator:** Off-channel Habitat	-S	N	N	N	**NLAA**
	Pathway: Channel Condition &Dynamics: **Indicator** Floodplain Connectivity	-I	N	N	N	

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
2	**Pathway:** Channel Condition &Dynamics **Indicator:** Streambank Conditions	-I	-D	-I	N	**LAA**
	Pathway: Water Quality **Indicator:** Chemical contaminants/nutrients, sediment	-S	-I	-S	B	
3	**Pathways:** Water Quality **Indicators:** Temperature	-I	-D	-I	N	**NLAA**
4	**Pathway:** Subpopulation Characteristics **Indicators:** survival, Subpopulation size	N	N	N	N	**NE**

Key: -S = Negative effects significant magnitude, -I = Negative effects Insignificant magnitude or duration, **N = Neutral effect** **-D=negative effect discountable probability, B = Beneficial effect**	Overall Effects Determination
NOTES: **[1]: Includes 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),** **3. Dam, Tide gate, and Legacy Structure Removal** **4. Channel Reconstruction/Relocation** **5. Off- and Side-Channel Habitat Restoration** **6. Streambank Restoration** **7. Set-back or Removal of Existing Berms, Dikes, and Levees** **8. Reduction/Relocation of Recreation Impacts** **9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering facilities** **10. Piling and other Structure Removal** **12. Road and Trail Erosion Control and Decommissioning** **[2]: Includes Categories:** **2. Large Wood (LW), Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Vanes, Gravel Augmentation; Tree Removal for LW Projects)** **17. Bull Trout Protection** **[3]: Includes Categories:** **13. Non-native Invasive Plant Control** **14. Juniper Removal** **15. Riparian Vegetation Treatment (controlled burning)** **16. Riparian Vegetative Planting** **18. Beaver Habitat Restoration** **19. Sudden Oak Death (SOD) Treatments**	**LAA**

PCE Number	MPI Pathways/Indicators	Construction Activities[1]	Instream Activities[2]	Vegetation Treatments[3]	Other Projects[4]	Effects Determination
[4]: Includes Categories: **11. In-channel Nutrient Enhancement** **20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration**						

ii. *Summary of the effects of the action to critical habitat PCEs:*

1. Off-channel water bodies such as beaver ponds, oxbows, side-channels, stable backwater sloughs, low-gradient tributaries, and flooded marshes, including at least 500 continuous square meters (m^2) (0.12 acres) of aquatic surface area at depths between approximately 0.5 and 2.0 meters (m) (1.6 and 6.6 feet)

Habitat Elements (Off-channel Habitat): Construction activities will generally have a neutral effect on PCE 1 of Oregon chub critical habitat through this pathway. While projects done under this category could benefit chub through improving off-channel habitat and connectivity between ponds, this would rarely be the case as most projects would occur outside of Oregon chub critical habitat, because this critical habitat is only present in a very small portion of the action area.

Instream projects, vegetation projects, and projects listed under the “other” category in Table 28 would all have a neutral effect as there is no causal mechanism for them to affect PCE 1 through this pathway.

Channel Condition & Dynamics (Floodplain Connectivity): Some minor effects could occur to connectivity from the disruption of flows during certain construction activities. These disruptions should be of low intensity and short duration and are considered insignificant to PCE 1. Any negative effects resulting from construction activities are not expected to significantly reduce water depths or aquatic surface area and will thus not have sufficient magnitude to adversely affect PCE 1 of Oregon chub critical habitat.

Instream projects, vegetation projects, and projects listed under the “other” category in Table 28 would all have a neutral effect as there is no causal mechanism for them to affect PCE 1 through this pathway.

2. Aquatic vegetation covering a minimum of 250 m^2 (0.06 acres) (or between approximately 25 and 100 percent) of the total surface area of the habitat. This vegetation is primarily submergent for purposes of spawning, but also includes emergent and floating vegetation, and algae, which are important for cover throughout the year. Areas with sufficient vegetation are likely to also have the following characteristics.
    a. Gradient less than 2.5 percent;
    b. No or very low water velocity in late spring and summer;
    c. Silty, organic substrate; and

d. Abundant minute organisms such as rotifers, copepods, cladocerans, and chironomid larvae.

Channel Condition & Dynamics (Streambank Conditions): It is possible that construction activities could alter streambanks within Oregon chub critical habitat in some isolated cases. This alteration would occur infrequently, only when a project is conducted in critical habitat, which is expected to be quite rare. The effects would be extremely localized and of short duration (ephemeral), and are considered to be insignificant to the indicators of this pathway. The effects of construction activities will not have sufficient magnitude to adversely affect PCE 2 through this pathway.

Water Quality (Chemical contaminants/nutrients, sediment): Construction activities in, or near Oregon chub critical habitat may increase sediment within the system. While these increases will likely be short term (lasting days to weeks) they will adversely affect elements of PCE 2. Increased sediment will result in a decrease in the ability of critical habitat to provide minute organisms (including micro invertebrates and associated algae). Therefore, construction activities will adversely affect PCE 2.

Instream projects may add a slight amount of sediment to the system, but these increases would likely be very small and ephemeral. These projects are unlikely to occur within Oregon chub critical habitat. There is a discountable probability that insignificant effects to water quality for Oregon chub critical habitat could occur. Projects under this category will not cause adverse effects through this pathway.

Vegetation projects could remove vegetation that helps to filter sediment and other pollutants from flows before they reach Oregon chub critical habitat. This too will result in a reduction in the ability of critical habitat to supply elements necessary to support PCE 2. Most of these effects would be short-term (lasting weeks to months) and would subside once native vegetation is reestablished on the project site. Long-term benefits (months to years) would ultimately result which would reduce sediment donations to more natural levels over time. Because PCE 2 would be adversely affected in the short-term projects under this category will adversely affect Oregon chub critical habitat.

Projects listed under the "other" category will have a neutral (surveys) or beneficial (salmon carcasses) effect to PCE 2 through this pathway. The addition of salmon carcasses to the stream system could increase nutrients to Oregon chub critical habitat. While it is unlikely that this activity would occur in Oregon chub critical habitat, it is likely to occur upstream of chub ponds that are fed by the stream system.

3. Late spring and summer subsurface water temperatures between 15 and 25 °C (59 and 78 F), with natural diurnal and seasonal variation.

Water Quality (Temperature): Construction activities could remove some shade in isolated areas. While this could affect water temperatures through increased solar radiation that effect would be slight and localized. Projects described under this category in Table 28 would not remove shade at a magnitude sufficient to cause adverse effects to this indicator. The slightly negative effect to temperature associated with construction activities is considered insignificant to PCE 3.

Instream projects could remove some trees providing streamside shade allowing increased exposure of stream surfaces to solar radiation. This, in turn can cause increased stream temperatures. Because these projects are usually somewhat linear, and do not decrease the shading ability within the primary shade zone they are usually considered insignificant to stream temperature. Most of the projects in this category that could cause a reduction in stream shade (LW placement) would occur in main channels far away from chub ponds. There is a discountable probability that instream projects would adversely affect PCE 3, and therefore they will not adversely affect Oregon chub critical habitat through this pathway.

Some vegetation treatments could occur adjacent to Oregon chub critical habitat. Removal of streamside or bankside vegetation could reduce shade slightly, but the effects would be of low intensity and short duration (weeks to months). Any shade reduction will slow and cease over time as native vegetation becomes established and a more natural condition is achieved. Thus vegetation treatments discussed in this BO are considered as contributing negative effects of insignificant magnitude to PCE 3.

Projects listed under the "other" category in Table 28 would have a neutral effect on this indicator as they possess no causal mechanism to affect PCE 3 through this pathway.

4. No or negligible levels of non-native aquatic predatory or competitive species. Negligible is defined for the purpose of this rule as a minimal level of non-native species that will still allow the Oregon chub to continue to survive and recover.

Subpopulation Characteristics (Survival, Subpopulation size: There are no causal mechanisms for any projects, in any category within this BO to affect these indicators. Therefore, all proposed activities have a neutral effect on PCE 4.

iii. *<u>Effects to Oregon chub critical habitat at the rangewide scale</u>*

The projects described within this BO will have adverse effects to Oregon chub critical habitat at the site-specific, local scale. These effects will be short term (lasting days to months). These effects are too small, and of too short duration to adversely affect critical habitat at the larger rangewide scale. During the five-year period from 2008 through 2012 only one construction was conducted within the range of the Oregon chub under ARBO. No other projects of any type were conducted under ARBO within the range of the Oregon chub. 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. Therefore implementation of projects within ARBO II will not adversely modify critical habitat for the Oregon chub.

g. **Summary of Effects to Critical Habitat for ESA-listed Fish**

ARBO II projects are likely to have some short-term impacts, but none of those impacts would be severe enough to impair the ability of critical habitat to support recovery. The frequency of disturbance will usually be limited to a single event or, at most, a few projects within the same watershed. It is also unlikely that several projects within the same watershed, or even within the same action area, would have a severe enough adverse effect on the function of PCEs or the conservation value of critical habitat in the action area, watershed, or designation area.

All of the activities are designed to have long-term beneficial effects to critical habitat. However, as noted above, the long-term effectiveness of habitat restoration actions, in general, have not been well documented. In part, this is because they often concentrate on instream habitat without addressing the processes that led to the loss of the habitat (Cederholm *et al.* 1997; Doyle and Shields 2012; Fox 1992; Roper *et al.* 1997; Simenstad and Thom 1996; Zedler 1996). Nevertheless, the proposed actions 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. Fish passage improvement actions, in particular, are likely to have long-term beneficial effects at the watershed or designation-wide scale (Roni *et al.* 2002).

i. *Synthesis of Effects*

The scope of each type of activity that could be authorized under the proposed restoration program is narrowly proscribed, and is further limited by PDC tailored to avoid direct and indirect adverse effects of those actions. Administrative PDC are in place to ensure that requirements related to the scope of actions allowed and the mandatory PDC operate to limit direct lethal effects on ESA - listed fish to a few deaths associated with isolation and dewatering of in-water work areas, an action necessary to avoid greater environmental harm. Most other direct adverse effects will likely be transitory and within the ability of both juveniles and adult fish to avoid by bypassing or temporarily leaving the proposed action area. Such behavioral avoidance will probably be the only significant biological response of ESA-listed fish to the proposed restoration program. This is because areas affected by the specific projects undertaken are likely to be widely distributed (the frequency of the disturbance will be limited to a single event or, at most, a few projects within the same watershed) and small compared with the total habitat area.

As noted above (Table 3), the number of restoration actions in a single IRU or basin using the prior version of this BO in a single year has varied greatly. During the period 2008-2012, the majority of the restoration projects (315, 87%) occurred in the Columbia River IRU. However, it is likely that few actions per year would have occurred in a single 5th field watershed over this large region. Projects were likely even more separated in the other areas. The intensity of the predicted effects within the action area, in terms of the total condition and value of PCEs after each action is completed, and the severity of the effects, given the recovery rate for those same PCEs, are such that the function of PCEs and the conservation value of critical habitat are likely to be only impaired for a short time due to restoration actions funded or carried out under this opinion. The PCE conditions in each action area are likely to quickly return to, or exceed, pre-action levels. Thus, it is unlikely that several actions within the same watershed, or even within the same action area, would have an important adverse effect on the function of PCEs or the conservation value of critical habitat at the action area, watershed, or designation scales. The intensity and severity of environmental effects for each project will be comprehensively minimized by targeted PDC. The recovery timeframe for proper functioning habitat conditions is unlikely to be appreciably reduced.

2.5.6 Effects to Spotted Owls

The USFWS analyzed whether effects related to habitat changes (i.e., habitat effects) and effects related to increased noise and smoke (i.e., disturbance/ disruption effects) 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 only three spotted owl nest sites per administrative unit annually for any five-year span during this programmatic consultation.

a. Habitat Effects

The USFWS 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 USFWS 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 BO does not cover timber harvest activities, there are a limited number of aquatic restoration actions that involve non-commercial vegetation treatments (conifer and/or hardwood thinning in riparian areas and limited uplands impacting riparian conditions, and controlled burns), removal of non-nest trees for stream enhancement, riparian area invasive plant treatment, and riparian area vegetation planting. This consultation involves very little tree removal (e.g., non-commercial thinning, select removal for LW placement). 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. These actions are intended to benefit aquatic species but will also contribute to overall watershed health by reducing fuel loads within the riparian area and 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 (General Conservation Measures and Project Design Criteria NSO4 and 5). Therefore, consulted on activities 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. The BO provides PDCs to support that determination (listed under: 22. e. Tree Removal for LW Projects).

Aside from the commitment to design projects to not have adverse effects on spotted owls through habitat modification, there are additional factors enabling us to concur with the BA's NLAA determination. 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, PDCs for LWD placement, state that conifers will only be felled in the riparian area for in-channel LW placement when conifers are fully stocked and felling is consistent with PDCs in vegetation treatment categories. Secondly, some projects may potentially benefit spotted owls. For example, although vegetation plantings are designed for aquatic restoration purposes (e.g., provide shade and reduce run-off to water bodies), projects may add 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 and a small portion of California. 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, which is generally edge habitat (or edge non-habitat). Most spotted owls nest in interior stands, however, they may forage nocturnally closer to edges.

In the period spanning from 2007-2011 the Action Agencies reported a total of 640 projects across the action area (see Table 2). The USFWS assumes that 40% would involve some thinning of trees. That results in 256 projects (40% x 640 projects = 256) that could involve some thinning of trees. Approximately 20% of the action area falls within the range of the spotted owl. Therefore, 20% of the 256 projects (20% x 256 projects = 51.2) results in approximately 51 projects that would thin trees to some extent within the range of the spotted owl in a five-year period. The USFWS estimates that the number of projects may increase in the future due to increased interest in aquatic restoration, and also due to the increased number of activity categories presented in ARBO II. It is estimate that the number of projects will increase by 50% over those levels presented in Table 2. This equates to (1.5 x 51 projects = 76.8) approximately 77 projects over any five-year period. While the size of these thinning will vary greatly (from single trees to 0.5 acres) by site-specific location the USFWS will estimate an average size of 0.25 acres. Thus, thinning of (77 projects x 0.25 acres = 19.1 acres) spotted owl habitat over any five-year period will be less than 20 acres on average.

Summaries of potential effects to spotted owl habitat from the 20 actions are included in Table 29. Activities that do not involve intentional vegetation modification are grouped together.

. Table 29 Summary of habitat effects from the 20 proposed actions to spotted owls.

Activity	Effects	Rationale for Effects Determination
Fish passage Restoration; Dam, Tide gate, and Legacy Structure Removal; Channel Reconstruction/Relocation; Off- and Side-Channel Habitat Restoration; Streambank Restoration; Set-back or Removal of Existing Berms, Dikes, and Levees; Livestock Fencing, Stream Crossing and Off-Channel Livestock Watering; Piling and other Structure Removal; In-channel Nutrient Enhancement; Road and Trail Erosion Control and Decomissioning; Bull trout Protection; Beaver Habitat Restoration; and Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic 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. If riparian vegetation plantings are incorporated into project design, then effects will be similar to those listed under “riparian vegetation planting” in this table. 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
LW, Boulder, and Gravel Placement	NLAA	The BA describes several PDCs: 1) Suitable nest trees over 36" dbh will not be removed; 2) A wildlife biologist will choose trees to remove in areas burned by wildfire; 3) Individual or small groups of trees (<5) may be taken from edges of permanent (roads, etc.) or non-permanent openings (plantations, along recent clear-cuts, etc.); 4) The first two lines of trees along edges may only have one tree removed from each line; 5) Trees selected for restoration will be spaced at least one site potential tree height apart and at least one crown width from any trees with potential nesting structure for spotted owls; and 6) Conifers will not be felled in the riparian area for in-channel LW placement unless conifers are fully stocked and are consistent with PDC in vegetation treatment categories. 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).
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.
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.

Activity	Effects	Rationale for Effects Determination
Riparian vegetation treatment (controlled burning)	NLAA	Actions include low to moderate severity burns in small areas. Pre-burn tree thinning (consistent with PDC to not remove/downgrade/reduce the function of habitat) will occur when needed to reduce fuel loads to levels that will ensure low-moderate severity burns. Since most fires are of low (with some moderate) intensity levels, they will burn patchily leaving project areas with understory. Most actions will occur in disturbed, non-habitat. Where there is suitable habitat, it will not be removed or downgraded and its function will be maintained. Projects are intended to maintain or restore late-seral conditions (e.g., potential nesting habitat). The PDCs will ensure that habitat will not be removed or downgraded and its function will be maintained. It follows that projects in NRF, dispersal, or critical habitat will not alter the function of critical habitat. (i.e., understory removal will not downgrade spotted owl foraging habitat).
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.
Sudden Oak Death Treatments	NLAA	This activity involves removing diseased trees and associated understory. As large areas of diseased trees do not provide the canopy cover preferred by spotted owls, it is advantageous to prevent this disease spreading on the landscape. Sites will be replanted to help restore plant species composition and structure that would occur under natural disturbance regimes. The PDCs will ensure that habitat will not be removed or downgraded at the stand/landscape level and its function will be maintained. It follows that projects in NRF, dispersal, or critical habitat will not alter the function of critical habitat. (i.e., understory removal will not downgrade spotted owl foraging habitat).

b. Disturbance/Disruption Effects

There is a potential of injury to spotted owl young from disturbance/disruption effects 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.

The likelihood of injury is greatly reduced because only a limited number of actions (of all actions implemented under this programmatic consultation) will adversely affect spotted owls via disturbance/disruption effects because of the limited number of cases where work would be necessary during the critical breeding period (see Section 1.4). Aquatic restoration projects may disturb or disrupt spotted owls only when 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 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 distance (Table 9).

There are nineteen units containing spotted owl habitat, including: Columbia River Gorge NSA, Deschutes NF, Fremont/Winema NF, Gifford Pinchot NF, Mt. Baker-Snoqualmie NF, Mt. Hood NF, Okanogan/Wenatchee NF, Olympic NF, Rogue/Siskiyou NF, Siuslaw NF, Umpqua NF, Willamette NF, Coos Bay BLM, Eugene BLM, Lakeview BLM, Medford BLM, Roseburg BLM, Salem BLM, and Coquille Tribal lands.

After making all attempts to avoid or minimize adverse effects by changing project timing or location, each administrative unit will only disrupt up to three spotted owl nests per five-year period. Since we only anticipate disturbance that rises to the level of injury or death to spotted owl young (two per nest since eggs may be disturbed by lack of incubation and/or increased likelihood of predation), injury or death of an average of six young translates to three nests per five years, per administrative unit. Because one-half of a nest cannot be disrupted (unless there is only one progeny in the nest), allowable disturbance may be distributed as three nests disrupted during any five-year period, per administrative unit. This limitation of disruption is based on past monitoring forms from Aquatic restoration projects during the past 6 years. The USFWS therefore anticipates, over the entire action area, disruption of up to six birds (3 nests) per administrative unit per five years multiplied by 19 occupied administrative units divided by five years= 23 birds (11.4 nests) annually, on average.

When a protocol spotted owl survey is completed, the amount of site-specific adverse effects will be easier to quantify (i.e., where adverse effects equal the number of young per nest that is disrupted). However, some projects may occur in suitable, unsurveyed spotted owl habitat. The size and shape of action areas is not specified for all actions, and it is possible for some projects to overlap into more than one active nest location. Therefore, we quantified the amount of action area (including disturbance buffers) by province where we might reasonably expect to locate one spotted owl nest in unsurveyed, suitable habitat.

Our methodology is to be used as a guide to help determine a project size where we anticipate finding one nest in continuous suitable spotted owl habitat. This does not replace site-specific nest analyses required for pre-project planning, but is a tool for the USFWS to determine the probable extent of effects. A wildlife biologist during project design can determine whether suitable spotted owl habitat within the project area is likely to be occupied as part of the nest analysis. This type of information would be provided by Action Agencies to Level 1 teams through pre-project notification. The USFWS assumes that project areas containing suitable habitat are likely to have a nesting spotted owl, until an effects determination from the Action Agency (based on nest analysis and/or protocol survey) determines otherwise (i.e., project level effects determinations will be done by Action Agencies as projects are developed).

c. Methodology to Predict Effects in Unsurveyed, Suitable Habitat

When habitat modeling for spotted owl use is not available the follow method will be used for estimating spotted owl nest impacted.

When estimating the maximum project size where we expect to impact one nest, we consider both total acres and project length. This is because different action area shapes could potentially cover more than one spotted owl territory. For example, a 15 mile linear project may potentially impact more owls than a circular project of the same area, merely because of how spotted owls space themselves on a landscape. Our complete analysis is available in the administrative record for this consultation, but a summary of our methodology and results are provided here:

To quantify the length of a project area where we anticipate one spotted owl nest will be within the disruption distance of an action, we considered the following: 1) spotted owl home ranges may overlap up to 25 percent; 2) the median home range radii and size as listed in the status of the species section (when home ranges are represented by circular areas) by province; 3) we assume that spotted owls occur at maximum possible density levels within a project area; and 4) we assume that owls are relatively evenly distributed/packed in at maximum densities across the range in suitable habitat. The USFWS also uses the maximum buffer for noise and smoke, 0.25 miles, since activities disturbing spotted owls could consist of any combination of the 20 activity types. The USFWS estimated project length by multiplying home range radii by 1.5 to account for potential overlap between the two home ranges. The resulting number is the minimum length of a linear project in miles where we would expect to encounter two spotted owl nests. The length of a linear project that falls below this threshold is where we would expect to encounter one nest. Results by province are displayed in Table 30.

To calculate the maximum area where we expect to disrupt one spotted owl nest, we started with the area of a median home range for a province (described in the status of species), subtracted the area of expected home range overlap (25 percent of total home range), and subtracted the area of a disturbance buffer (based on the highest potential disturbance buffer, 0.25 miles). The USFWS subtracted the overlap and disturbance buffer because actions occurring within these areas may impact two nests, instead of one. The USFWS can reasonably expect to find one spotted owl nest (or two young) within these calculated areas where projects do not exceed the corresponding length in Table 30.

Based on monitoring Aquatic restoration projects for the past six years we anticipate that units will implement 0-1 projects per year within disruption distances of spotted owls during the spotted owl critical breeding season. The USFWS therefore anticipates, over the entire action area, disruption of one nest per administrative unit per two years. However, to allow for flexibility in funding levels and variation in high priority restoration projects, project impacts will be averaged over a larger period, with no five year period exceeding disruption to three nests. This assumes that project size (area and length) in unsurveyed, suitable habitat does not exceed values listed in Table 30, or, if they do, that the pre-notification form provided to Level 1 teams includes information on the site-specific analysis that documents otherwise.

Table 30. Maximum acreage and linear project length[1] where activities are reasonably certain to encounter spotted owl nests in ***unsurveyed, suitable spotted owl habitat*** by province[1].

Province	One nest		Two nests		May include all or part of the following administrative units
	Maximum Acres	***Maximum Project Length (mi)***	***Maximum Acres***	***Maximum Project Length (mi)***	
Olympic Peninsula (WA)	.01-9,947	.01 – 4.04	9,948-19,894	4.05 – 8.09	Olympic NF
Western Washington Cascades	.01-4,545	.01 – 2.69	4,546-9,091	2.70 – 5.39	Mt. Baker-Snoqualmie NF, Gifford Pinchot NF, Columbia River Gorge NSA
Eastern Washington Cascades	.01-4,545	.01 – 2.69	4,546-9,091	2.70 – 5.39	Okanogan-Wenatchee NF, Gifford Pinchot NF, Columbia River Gorge NSA
Western Oregon Cascades	.01-893	.01 – 1.79	894-1,786	1.80 – 3.59	Mt. Hood NF, Umpqua NF, Willamette NF, Rogue-Siskiyou NF, Columbia River Gorge NSA, Eugene BLM, Medford BLM, Salem BLM, Roseburg BLM
Eastern Oregon Cascades	.01-893	.01 – 1.79	894-1,786	1.80 – 3.59	Deschutes NF, Fremont-Winema NF, Mt. Hood NF, Columbia River Gorge NSA, Lakeview BLM
Oregon Coast Range	.01-3,196	.01 – 2.24	3,197-6,392	2.25 – 4.49	Siuslaw NF, Coquille Tribe, Salem BLM, Roseburg BLM, Coos Bay BLM, Eugene BLM,
Klamath Mountains Oregon	.01-2,188	.01 – 1.94	2,189-4,376	1.95 – 3.89	Umpqua NF, Rogue-Siskiyou NF, Medford BLM, Roseburg BLM, Coos Bay BLM,
Klamath Mountains California	.01-2,188	.01 – 1.94	2,189-4,376	1.95 – 3.89	Rogue-Siskiyou NF

[1] This excludes Willamette Valley (OR) and Western Lowlands (WA) provinces.

d. Description of Anticipated Disturbance/Disruption Effects

The remainder of our effects analysis relates to disturbance/disruption effects that may occur to the six spotted owls (three nests) per administrative unit every five years, on average.

The USFWS anticipates disturbance from noise, human presence, and smoke 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, human presence and smoke disturbances as threats. However, based on anecdotal information and documented effects to other bird species (Platt 1977, 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 2005b, USFWS 2003e), disturbance to individuals is negatively related to stimulus distance and positively related to noise levels.

Noise above ambient levels and excessive smoke may adversely affect spotted owls by creating a likelihood of injury during the nesting season. These activities may cause flushing of individuals, which would leave eggs or young exposed to predation; causing a juvenile to prematurely fledge, which 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 USFWS 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 2003e), or premature fledging, or predation.

Other disruption effects are expected to 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 that may be 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 USFWS believes injury is likely to occur when adults or juveniles are flushed from nests, young fledge prematurely, or when feeding attempts are disrupted (USFWS 2003e) 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 USFWS previously developed a list of distances at which various activities may affect spotted owl behavior (USFWS 2003e, USFWS 2005b). 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 9.

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 smoke and 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.

Disturbance and disruption distances (Table 9) 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 2003e). According to experts cited in the 2003 Olympic NF BO (USFWS 2003e), 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 percent 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 USFWS anticipates the possibility of injury or death is to spotted owl young. Based on adult foraging information mentioned above (i.e., nocturnal foraging, diurnal project effects), the USFWS 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 eggs or 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 results from prescribed burn actions and chainsaws and heavy equipment may be used in all 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 because flight paths are unlikely to cross over adult nests because they are at low density across the landscape, 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 USFWS 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 USFWS 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 BO is low. While the 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 BO to three per administrative unit over any 5-year period. 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 helicopter use is unlikely to occur frequently. Helicopters are often expensive and/or unavailable (due to high priority use by fire crews). Second, only three (17 percent) of the activity types (not counting surveys since they are in support of the other 18 actions) may use helicopters. Of these three actions, helicopters will only be used in a small percent of the actions. Third, we base our assumption of relatively low levels of future helicopter use based on relatively low levels of past helicopter-use. Again, while there is not a limit to the amount of helicopter use, the likelihood of helicopter-caused disturbance is probably much lower than 17 percent (but the exact likelihood is uncertain).

Potentially negative effects from helicopters are also greatly minimized because there will be no hovering or lifting of ICS Type I helicopters within 500 feet (0.1 miles) of occupied habitat during their breeding season (General Conservation Measure NSO1). Activities may still use Type II, III, and IV helicopters for hovering and lifting within 0.1 miles, and Type I for hovering and lifting between 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.

Smoke also has a large disturbance buffer for spotted owls (0.25 miles). Like other disturbances, we expect the likelihood of injury (or mortality) to increase when prescribed burns occur closer to nests, or when they are larger in scale. Dense smoke, which tends to gather along depressions such as stream corridors, can cause adult flushing, may reduce foraging ability, can temporarily cause non-lethal lung irritation, or may cause debilitating or lethal lung damage. Negative impacts of smoke have been observed following wildfires and at least one prescribed burn/fuel treatment, but other accounts have described cases where smoke did not appear to alter spotted owl behavior. There is little published information on smoke effects, particularly from prescribed burns. Based on the PDC for controlled burns and PDC to protect spotted owls described in the BA, the likelihood of injury is low (and mortality negligible) from prescribed burns (smoke) covered under this consultation. Fires will be planned and carried out under carefully measured conditions by experienced personnel and within a contained area. Prescribed burns will be low to moderate intensity levels, and designed such that fires will not remove spotted owl habitat (i.e., nest trees or foraging habitat). Therefore, we do not anticipate fires will occur at intensity levels that are likely to cause spotted owl mortality.

Smoke associated with prescribed burns covered in this consultation will alter air quality. However we anticipate a low likelihood that air quality will be changed to the point of creating the likelihood of injury, and even less likely mortality. Smoke contains small particles of ash, partly consumed fuel, and liquid droplets. Invisible gases (i.e., carbon monoxide, carbon dioxide, hydrocarbons, and small quantities of nitrogen oxides) from prescribed burns generally occur in negligible amounts. Nitrogen oxides are usually produced at higher temperatures than we would expect in a controlled low-moderate intensity burn. Also, forest fuels (except for organic soils which are not generally consumed in prescribed burns) contain little sulfur, so oxides of sulfur are not considered a likely problem (USDA 1989). Some of these compounds are known to be carcinogenic to laboratory animals, but there is no evidence to show that prescribed fire is increasing levels of these compounds in the environment to dangerous levels (Wade 1984).

The USFWS assumes adult spotted owls are capable of flushing from smoke disturbance/poor air quality, which may leave eggs and young vulnerable to injury or death via predation or premature fledging. However, the likelihood that an adult will flush during a controlled burn covered under this BO is low given the low fire intensity, closely monitored fire conditions, and the need to avoid spotted owl habitat removal/degradation. Furthermore, burns are not conducted when wind speeds are high or significantly changing, so we expect smoke plumes to occur generally in one direction. If we assume four nautical directions, then there is a one-quarter chance that wind may blow smoke toward a nest. The actual probability that smoke will blow toward an active nest decreases as the distance been a burn and a nest increases.

The USFWS presumes that any disturbances 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 percent 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 percent 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 (see Section 1.4). 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 2004e).

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. USFWS 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, USFWS 2004f). While most spotted owl discussion has centered on habitat loss or alteration (i.e., broken trees), and weather effects on diet (USFWS 2004e), 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 USFWS 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 USFWS 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 USFWS also assumes that helicopter work will only cause the likelihood of injury to spotted owls.

Summaries of potential disruption effects to spotted owls (three/unit/year) from the 20 actions are included in Table 31. 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.

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 31**.** Summary of disturbance effects from the 20 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 – 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 – 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 being displaced.
Helicopters	Mar 1 - 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.
	Jul 16 – 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 as skilled flyers yet are potentially more susceptible to predation.
Smoke (prescribed burns)	Mar 1 - Jul 15	LAA	Controlled burns will occur in the understory and will not remove or reduce the function of habitat. Burns will be low-moderate intensity and are not likely to cause mortality. Smoke should mostly travel in one direction since burns are conducted when winds are fairly low and not highly variable. Assuming four nautical directions, there is a ¼ chance of smoke continuously flowing toward nests (likelihood decreases further from nest). The 0.25-mile buffer is for a worst-case scenario. USFWS does not anticipate direct mortality to spotted owls from smoke/fire, but injury to young is possible if adults temporarily move from area, leaving eggs or young exposed to predation.
	Jul 15 – 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 being displaced.
On-ground Human presence	Mar 1 – Sept 30	NLAA	Spotted owls have not shown any flushing from a nest due to human presence on the ground.

Disturbance Type	Time Period*	Effect	Rationale for Effects Determination
In-canopy human presence	Mar 1 - 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 2003e).
	Jul 15 – 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.			

While there is a potential for large-scale disturbance from the proposed action, it is significantly reduced by the PDCs outlined in the BA. Action Agencies will use disturbance and disruption guidelines listed in Table 9 and 31 to determine whether projects are likely to adversely affect spotted owls. Most activities will result in NLAA or NE determinations for spotted owl disturbance since the agencies will implement most actions outside of critical nesting period and/or outside of disturbance or disruption distance from spotted owl nests and unsurveyed suitable habitat. The following provides assurances that most projects will not rise to the level of a LAA determination (General Conservation Measure and Project Design Criteria, 6 Birds).

All suitable spotted owl habitat is considered occupied until a protocol survey (USFWS 1992c) shows otherwise. Furthermore, Action Agencies will utilize existing roads to travel to and from work sites, and work sites will generally be in areas with higher levels of human activity (relative to more remote areas of the NFs and BLM lands), or within the road prism.

e. Provincial and Range-wide Effects

The anticipated disruption (Table 32) 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 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 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 the Northwest Forest Plan (NWFP) or spotted owl critical habitat at the Provincial or range-wide scales.

Table 32. Estimated percent of nesting spotted owls that will have adverse effects to two spotted owls young per pair of spotted owls by province and range-wide.

Province	**Adverse effects expected to 3 spotted owl pairs nesting per 5 years**
	Estimated adverse effect to spotted owl pairs per year (# administrative units x 0.6 spotted owl pairs per year)
Olympic Peninsula (WA)	0.6
Western Washington Cascades	1.8
Eastern Washington Cascades	1.8
Western Oregon Cascades	5.4
Eastern Oregon Cascades	3
Oregon Coast Range	3.6
Klamath Mountains Oregon	3
Klamath Mountains California	0.6
All of Above Provinces	19

2.5.7 Effects to Marbled Murrelets

The USFWS analyzed whether effects related to habitat changes (i.e., habitat effects) and effects related to increased noise and smoke (i.e., disturbance/disruption effects) are likely to cause murrelet injury or mortality. The primary focus is disturbance effects, since this consultation does not cover projects that may adversely affect murrelets via habitat changes, or that adversely affect their critical habitat. Furthermore, disturbance is limited in the proposed action to only five murrelets per administrative unit annually for any five-year period under this programmatic consultation.

a. Habitat Effects

The USFWS describes 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.

The USFWS assumes that 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 consultation. This includes suitable habitat and potential nest structures, which are defined on page 50 of the BA. 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 primary constituent elements. In other words, adverse effects to primary constituent elements [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)."] will not be covered by this BO.

Therefore activities will not harm (i.e., significantly change habitat such that it results in death or injury) murrelets by habitat loss (see Section 22-e).

The greatest potential for adverse impacts to murrelet habitat would be from vegetation modification (i.e., vegetation treatments, prescribed burns, etc.), but these are not likely to affect murrelets for several reasons. First, murrelets forage at sea and only use stands within the action area for nesting structure, which is not dependent upon shrubs and small trees. Second, only non-nest trees may be removed for restoration projects such as LW. Third, non-nest tree thinning will occur in limited quantities over a dispersed area. As no suitable, potential or critical marbled murrelet habitat is to be removed or downgraded as part of this action (General Conservation Measure and Project Design Criteria, 6 Birds, c. Marbled Murrelet, MM3), if a hazard tree needs to be removed that is also a potentially marbled murrelet nest tree, it will be removed under an emergency consultation separate from this BO.

b. Disturbance/Disruption Effects

There is an increased likelihood of injury to murrelet young from disturbance/disruption effects related to the proposed action. This likelihood is created because some projects will occur within disruption distances of occupied or suitable-unsurveyed murrelet areas during the murrelet breeding season. The Action Agencies proposed to implement aquatic restoration projects within disruption distances during their breeding season. While most projects will avoid disturbing murrelets, the Action Agencies anticipate some projects near nesting murrelets that can only be implemented during the murrelet breeding period.

Likelihood of injury is greatly reduced because only a limited number of actions will adversely affect murrelets via disturbance/disruption effects. Aquatic 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 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.

After making all attempts to avoid or minimize adverse effects by changing project timing or location, each administrative unit will only disrupt up to three murrelets averaged over any five-year period. In other words, there may be three projects that disrupt one murrelet each, or one action that disrupts three murrelets, etc. in any five-year period. There are eleven units containing marbled murrelet habitat, including: Gifford Pinchot NF, Mt. Baker-Snoqualmie NF, Olympic NF, Rogue/Siskiyou NF, Siuslaw NF, Coos Bay BLM, Eugene BLM, Medford BLM, Roseburg BLM, Salem BLM, and Coquille Tribe lands. While proposed actions may temporarily alter adult behavior, actions are not likely to increase the likelihood of adult injury or mortality or significantly disrupt normal behavioral patterns. The USFWS presumes that adults are capable of maneuvering around disturbances. However, the disturbance of adults may increase the likelihood of injury to young through missed feeding attempts or temporary nest abandonment (i.e., exposure to predators and inclement weather). Actions may also potentially cause premature fledging. Since we only anticipate adverse effects to murrelet young (one per nest), adverse effects to three young per 11 units per five years translates to 6.6 young adversely affected annually.

When the potential for injury exists, the USFWS needs to determine if the projects and nesting murrelets will occur within proximity (disruption distances) of each other (both spatially and temporally), but the actual project locations and nest locations are unknown for these proposed actions. Even when a murrelet survey is completed, the amount of site-specific adverse effects are not necessarily easier to quantify (i.e., since active nests are difficult to locate). Also, some projects may occur in suitable, unsurveyed murrelet habitat, which further complicates quantification of adverse effects.

Since murrelets can be very difficult to locate we also developed a method to analyze expected adverse effects in unsurveyed, suitable habitat. This requires some site-specific or estimated knowledge of the likelihood of encountering a nest (i.e., density or home range size) within the project area. The size and shape of action areas is not specified for all actions, and it is possible for some projects to overlap into more than one potential active nest location. Consequently, we quantified the amount of action area (including disturbance buffers) where we might reasonably expect to locate one murrelet nest in unsurveyed, suitable habitat.

Our methodology is to be used as a guide, to help determine a project size where we anticipate finding one nest in continuous suitable murrelet habitat. This does not replace site-specific analysis, but is a tool for the USFWS to determine the probable extent of effects. A wildlife biologist during project design will determine whether there is suitable murrelet habitat or potential nest trees within the project area, which is part of the nest analysis required for pre-project planning (General Conservation Measures and Project Design Criteria 1, c.). This type of information would be provided by Action Agencies to Level 1 teams through pre-project notification. The USFWS assumes that project areas containing suitable habitat are likely to have a nesting murrelet, until an effects analysis from the Action Agency (based on nest analysis and/or protocol survey) determines otherwise (i.e., project level effects determinations will be done by Action Agencies as projects are developed).

c. Methodology to predict effects in unsurveyed and occupied, suitable habitat

In cases of uncertainty such as unsurveyed habitat, it is USFWS policy to give the benefit of the doubt to the listed species. On that basis, the USFWS considers occupied and unsurveyed stands with murrelet nesting structure to be occupied. The USFWS determined the number of acres of occupied or unsurveyed habitat where we would anticipate finding a pair of nesting murrelets. A nest density study for the Washington and Oregon does not exist. Accordingly, we are unable to estimate the actual number of murrelets that would be exposed to noise and visual disturbance during the proposed action. Instead, our analysis uses an estimation of individuals exposed based on acres and stands disturbed as a surrogate for the actual number of individual murrelets disturbed.

The latest estimate comparing the murrelet population to the amount of inland suitable habitat results in an average of 186 acres of habitat per murrelet (Huff et al. 2006, page 141). The sex ratio is believed to be equal for murrelets in all Recovery Zones and juvenile murrelets are estimated to be eight percent of the population (McShane et al. 2004, p 3-45). Efforts to determine the proportion of adults breeding have resulted in estimates of 31 to 95 percent, potentially varying based on food availability (McShane et al. 2004, pp. 3-39 and 40). Therefore, the assumption that murrelets occur inland at a density of 372 acres (2 x 186) per pair would be a conservative assessment for the species as this number does not factor out the non-breeding murrelets. It also must be noted that although the USFWS is estimating the potential for murrelets, they are not territorial nor are they documented as colonial (seeking out nest sites based on the location of others nest site – an attracting factor[29]). Therefore, the USFWS estimates that one to zero murrelet pair is nesting at each site/stand smaller than 372 acres of habitat.

Therefore, one project (including an action area) in up to 372 acres of potential, unsurveyed murrelet habitat is expected to impact one young from one murrelet nest. Because the probability of encountering one nest differs between one continuous area of habitat compared to multiple fragments of habitat distributed across the landscape (since actual murrelet densities vary throughout the landscape), two spatially separated projects in unsurveyed suitable habitat (even if their total acreage amounts to 372 acres) is expected to affect two young from two separate nests. Project length impacts the likelihood of encountering multiple nests (i.e., 15 miles of channel work versus 5 miles of channel and associated riparian to upland area). Multiplying number of nests likely to be disturbed by acres of potential habitat where we expect to find one nest (i.e., 372), we can expect to find one nest in 0.01-372 acres, two nests in 373-744 acres, three in 745-1,116 acres, four in 1,117-1,488 acres, and five in 1,489-1,860 acres of unsurveyed potential habitat. Results are displayed in Table 33.

To quantify the project length for linear restoration project in which we would expect to encounter a murrelet nest, we considered or assume the following: 1) for simplicity we assume a linear project area (e.g., linear stream); 2) the range-wide density estimate of one nest per 372 acres; 3) murrelets occur at range-wide density levels within a project area; 4) murrelets are relatively evenly distributed across the range in suitable habitat (since we do not have site-specific information and cannot predict distribution at the local-level/within a stand); and 5) a project area will generally occur within 300 feet of the stream on either side of the bank (which is consistent with PACFISH/INFISH). The USFWS also uses the buffer for noise and smoke, 0.25 miles, in our estimates since this is the maximum level of potential effect.

Based on these assumptions, a project's action area (with noise buffers) may extend 0.25 miles + 300 feet from a stream. The USFWS multiplies this by two (to account for work along both sides of the stream bank), and divide this into 372 acres to obtain project length. This length is the maximum project length, for projects that do not exceed 372 acres, where we anticipate disturbance to only one murrelet young. However, the projected project length where we expect to encounter one nest is 0.95 miles in marbled murrelet habitat (i.e., for every 0.95 miles of linear project ~ 600 feet wide the USFWS expects to encounter one marbled murrelet nest). Multiplying this by number of nests, we generally anticipate projects will encounter one nest within 0.01-0.95 miles, two in 0.96-1.92 miles, three in 1.93-2.85 miles, four in 2.86-3.81miles, and five in 3.82-4.77 miles of stream within suitable, unsurveyed habitat. Results are displayed in Table 33.

[29] It is to be noted that Nelson and Wilson (2002, page 107) calculated murrelet nesting densities of 0.1 to 3.0 nests per hectare (or 1 nest per 24.21 to 0.83 acres). Murrelets in the study were nesting in patches of suitable habitat, and the density of nests at the stand scale is likely lower (Nelson and Wilson 2002, page 107). In general nests are spaced far apart (Nelson and Wilson 2002, page 107).

Table 33. Acreage and project length of action areas where activities are likely to encounter active marbled murrelet nests in unsurveyed, suitable murrelet habitat.

Estimated number of active murrelet nests	Project Area (acres)	Maximum Project Length (in miles)
1	0.01-372	0.01-0.95
2	373-744	0.96-1.92
3	745-1,116	1.93-2.85
4	1,117-1,488	2.86-3.81
5	1,489-1,860	3.82-4.77

To determine what level of disruption is anticipated from the proposed project, we looked at the past six years of aquatic restoration projects. Based on aquatic restoration project monitoring reports for the past six years, we anticipate that units will implement 0-1 projects per year within disruption distances of marbled murrelets during the marble murrelet critical breeding season in Oregon. USFWS therefore anticipates disturbance of one nest per administrative unit per two years, on average, in Oregon. However, to err on the side of caution, and to allow for flexibility in funding levels and variation in high priority restoration projects, project impacts will be averaged over a larger period with no five-year period exceeding disruption to three nests. However, the Mt. Baker-Snoqualmie NF and the Olympic NF anticipate they will conduct five projects per year within the disruption distances of marbled murrelet during the breeding season. Gifford Pinchot NF will have two projects per year within the disruption distances of marbled murrelet during the breeding season. To allow for flexibility in funding levels and variation in high priority restoration projects, project impacts will be averaged over a larger period with no five-year period exceeding disruption to 25 nests for Mt. Baker-Snoqualmie NF and the Olympic NF and 10 nests for Gifford Pinchot NF.

Based on our above quantification, we generally anticipate that in total the units will implement 16.8 projects (up to 372 acres in size) per year within disruption distances of murrelets during their breeding season. This assumes that project size (area and length) in unsurveyed, suitable habitat does not exceed values listed in Table 33, or, if they do, that the pre-notification form provided to Level 1 teams includes information on the site-specific analysis that documents otherwise.

d. Description of anticipated effects

The remainder of our effects analysis relates to disturbance/disruption effects that may occur to the 0.6 murrelet per administrative unit annually.

Noise and human intrusion are one of many threats to this species (McShane et al. 2004). The USFWS considers excessive smoke from controlled burns as a source of human intrusion. Effects to murrelets from noise, human intrusion, and smoke-related disturbance 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. 1999a), the USFWS has concluded that significant noise, smoke, 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 2003e). Additionally groups of people are known to attract corvids, which temporarily increase the likelihood of young or eggs being preyed on by corvids in the action area.

An effect to murrelet behavior may occur when activities covered under this BO occur within the disturbance/disruption distance of active murrelet nests. The disturbance and disruption distances were developed utilizing the best available scientific information (Table 10). Loud noises at distances greater than identified in Table 34 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 – September 23, while in Oregon the Service considers the murrelet nesting season to span from April 1 – September 15. The differences in applied nesting seasons are due to internal evaluations of murrelet biology and nesting season data, which are on-going.

Although the USFWS 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 disturbances 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 marbled 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. Please refer to your Level 1 Teams for current recommendations. 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.

Smoke, human presence (including increase in corvids) or excessive noise levels within close proximity to individuals may cause nesting adults to flush and leave their eggs exposed to predation or increase the risk of predation to a chick. These disturbances can also cause delayed feeding attempts by adults which may reduce the fitness of the young. They may also cause premature juvenile fledging, potentially reducing their fitness due to having sub-optimal energy reserves before leaving the nest. A murrelet that may be disturbed when it flies into the stands for other reasons than nest exchange or feeding young is presumably capable of moving away from disturbance without a significant disruption of its own behavior. As stated in the Status of the Species section, murrelets feed at sea and only rely on forest habitat for nesting.

Disturbance from proposed actions that are conducted: 1) outside of the breeding period (between September 24 and March 31 for WA and between September 16 and March 31 for Oregon); 2) greater than 0.25 mile (or greater than 1 mile for burning) from occupied or unsurveyed suitable habitat during the breading season; or 3) within 0.25 mile (or 1 mile for burning) of surveyed unoccupied habitat during any time of the year, *is not expected to 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.

Within its nesting period in Oregon the USFWS considers two distinct periods: the critical nesting season between April 1 – August 5, and the late nesting season between August 6 and September 15. In Washington the USFWS does not incorporate a late nesting period into its management evaluations. During the late nesting season in Oregon, activities other than helicopters, pile driving and rock crushing 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.*

In the late breeding period, we believe the likelihood that disturbance will cause injury declines because most murrelets are finished incubating and either have completed nesting (about half of 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, the Action Agencies will prohibit disturbance activities for the two hours after sunrise and two hours before sunset (between Aug 6-Sept 15), when most food deliveries to young are made. This restriction thus reduces the likelihood of nest abandonment or significant alteration of breeding success, therefore the likelihood of injury by annoying it to such an extent as to significantly disrupt normal behavior patterns, which includes but are not limited to, breeding feeding or sheltering has been minimized. However, some data indicate that murrelets are making more food deliveries during the day than previously assumed and that predation pressures on eggs and chicks is throughout the entire breeding period. Two-hour daily timing restrictions are still recommended minimization measures.

Due to greater noise, disturbance and rotor wash produced by helicopters, pile driving and rock crushing, these 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 (April 1 – September 15 for Oregon and April 1-September 23 for Washington) (Tables 34 and 35).

As the breeding season progresses there are fewer nesting murrelets as nests either fledge or fail. Therefore, projects that start during the end of the nesting season reach a point where the likelihood of a nearby nest site still being active is discountable. For Washington, after September 4th 97.72 percent of all nests are estimated to have fledged (B. Tuerler, *in litt.*). Therefore, in Washington, 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.

Table 34. Summary of disturbance effects from the proposed actions 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, pile driving and rock crushing (*i.e., all actions except surveys*)	Apr 1 - Sept 4	LAA	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 PDCs 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.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent 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-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, and noise associated with pile driving and rock crushing (*i.e., some culvert/bridge, nutrient enhancement, LW placement actions*).	Apr 1 - Sept 4	LAA	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 300 feet from the ground and ferry logs at 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 (328-984 feet), which did not flush any of the incubating adults (USFWS 2003).
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent 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-March 31	NE	This time period is outside of the murrelet breeding season.
Smoke (*i.e., controlled burns*)	Apr 1 - Sept 4	LAA	Prescribed (Rx) burns will occur in the understory and will not remove or reduce the function of the habitat. Burns will be low-moderate intensity. Smoke should mostly travel in one direction since Rx burns occur when winds are fairly low and not highly variable. Assuming four directions, there is a ¼ chance of smoke continuously flowing toward nests (likelihood decreases further from nest). The 0.25-mile buffer is for a worst-case scenario. USFWS does not anticipate direct mortality from smoke/fire, but injury to young is possible if adults temporarily leave eggs or young exposed to predation.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent 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.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
	Sept 24- March 31	NE	This time period is outside of the murrelets breeding season.
On-the-ground human presence (*i.e., all actions*)	Apr 1 - Sept 4	LAA	Murrelets are susceptible to an increase in predation levels within an action area when groups of humans attract corvids.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent 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- 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 - Sept 4	LAA	Murrelets have been known to flush from a nest due to human presence in the tree canopy.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent 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- March 31	NE	This time period is outside of the murrelet breeding season.

[1] - All activities in the breeding season affecting murrelet habitat will have 2-hour timing restrictions applied.

Table 35. Summary of disturbance effects from the proposed actions when active marbled murrelet nests are within the disruption distances of actions within Oregon State.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
Noise other than helicopters, pile driving and rock crushing (*i.e., all actions except surveys*)	Apr 1 - Aug 5	LAA	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 PDCs 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 2003e).
	Aug 6 – Sept 15	NLAA[1]	In this period nests have been established, most of incubation is complete and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16- 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, and noise associated with pile driving and rock crushing (*i.e., some culvert/bridge, nutrient enhancement, LW placement actions*).	Apr 1 – Aug 5	LAA	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 300 feet from the ground and ferries logs at 500 feet for safety purposes. Also, helicopters will not hover within 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 100-300 m (328-984 feet), which did not flush any of the incubating adults (USFWS 2003e).
	Aug 6 – Sept 15	LAA	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-March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
Smoke (*i.e., controlled burns*)	Apr 1 – Sept 5	LAA	Prescribed (Rx) burns will occur in the understory and will not remove or reduce the function of the habitat. Burns will be low-moderate intensity. Smoke should mostly travel in one direction since Rx burns occur when winds are fairly low and not highly variable. Assuming four directions, there is a ¼ chance of smoke continuously flowing toward nests (likelihood decreases further from nest). The 0.25-mile buffer is for a worst-case scenario. USFWS does not anticipate direct mortality from smoke/fire, but injury to young is possible if adults temporarily leave eggs or young exposed to predation.
	Aug 6 – Sept 15	NLAA[1]	In this period nests have been established, most incubation is complete and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
	Sept 16-March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
On-ground human presence (*i.e., all actions*)	Apr 1–Aug5	LAA	Murrelets are susceptible to an increase in predation levels within an action area when groups of humans attract corvids.
	Aug 6-Sept 15	NLAA[1]	In this period nests have been established, most incubation is complete and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16-30	NLAA	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-Aug 5	LAA	Murrelets have been known to flush from a nest due to human presence in the tree canopy.
	Aug 6 – Sept 15	NLAA[1]	In this period nests have been established, most of incubation is completed and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16-March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.

NLAA[1] - The activity is NLAA because 2-hour timing restrictions will be applied.

The potential for large-scale disturbance is greatly reduced by the PDCs outlined in the BA. The Action Agencies will use disturbance and disruption guidelines listed in Tables 10 and 35 to determine whether projects are likely to adversely affect murrelets. Many activities will result in NE 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 NLAA determinations for disturbance since 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 assurances contained in General Conservation Measure and Project Design Criteria, Section 1.4-6 Birds ensure that most projects will not rise to the level of an LAA determination.

Furthermore, Action Agencies will utilize existing roads to travel to and from work sites, and work sites will generally be in areas with higher levels of human activity (relative to more remote areas of the NFs and BLM lands), or within the road prism.

e. Effects at the Conservation Zone and Range-wide

It is likely that some nesting murrelets exposed to these disturbances will still nest successfully. We anticipate marbled 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 Action Agencies have incorporated a daily operating restriction that will avoid project activities during the murrelet's 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.

We anticipate marbled murrelet nesting habitat in the action area will be subjected to the mechanical disruption from rotor wash (excessive wind) during implementation of the proposed action, 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.

We anticipate marbled murrelet nesting habitat in the action area will be subjected to the concussive noise disruption from pile driving and rock crushing during implementation of the proposed action, and that all murrelets associated with occupied or unsurveyed nesting habitat would have a significant behavioral response to these disturbances that results in an increased likelihood of injury. Potential murrelet responses to this disturbance include being injured from excessive concussive noise causing damage to the birds hearing with implications for reduced individual fitness. These behavioral disruptions create a likelihood of injury by increasing the risk of reduced fitness of nestlings as a result of excessive noise. Adults are able to move away from these activities, greatly reducing their exposure risk. These behavioral disruptions create a likelihood of injury by increasing the risk of a nestlings losing functional hearing. We do expect this concussive noise disturbance will result in actual reduced fitness and creates a likelihood of injury that can indirectly result in reduced fitness of individuals.

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, smoke, 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.

f. Critical Habitat

As the proposed projects are not likely to adversely affect marbled murrelet habitat or their critical habitat, the proposed projects will not affect the marbled murrelet critical habitat at the NWFP, Conservation Zones or range-wide scales.

2.6 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 river 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 river 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 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 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 successful spawning, production of offspring, and migratory access necessary for adult fish to swim upstream to reach spawning areas, and have reduced the quality and quantity of rearing areas for juvenile fish. Without those features, the species cannot successfully spawn, produce offspring and survive. 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. Likewise the Action Agencies have adopted more protective standards, as is evidenced by the extensive conservation measures included with the proposed action, but which were unknown or in uncommon use until even a few years ago.

While natural resource extraction within northwest Federal lands 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 2000 and 2010, the combined population of Oregon and Washington grew from 9.3 to 10.5 million, an increase of approximately 13.3%. Washington grew somewhat faster than Oregon, 14.1% and 12.0%, respectively (U.S. Census Bureau 2010). By 2020, the population of Oregon and Washington is projected to grow to 11.8 million (Oregon Office of Economic Analysis 2011; Washington Office of Financial Management 2010). Most of the population centers in Oregon and Washington occur west of the Cascade Mountains. USFWS assumes that future private, state, and Federal actions will continue within the action areas, increasing as population rises.

The most common private activity likely to occur in the action areas addressed by this consultation is unmanaged recreation. Although the Action Agencies manage recreational activities to some degree (i.e., campgrounds, trailheads, off-road-vehicle trails), a considerable amount of dispersed unmanaged recreation occurs. Expected impacts to ESA-listed fish from this type of recreation include minor releases of suspended sediment, impacts to water quality, short-term barriers to fish movement, and minor changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated.

Some recreational mining, primarily small-scale suction dredging that has not until recently been subject to regulation by the action agencies also occurs on Federal lands. This mining causes releases of suspended sediment, disturbance of spawning gravels, minor riparian disturbance, and harassment ESA-listed fish. The intensity of mining is somewhat dependent on the price of precious metals, but occurs at low levels in most areas.

Recreational fishing within the action area is expected to continue to be subject to ODFW and WDFW regulations. The level of take of ESA-listed fish within the action area from angling is unknown, but is expected to remain at current levels. Unauthorized take of bull trout from fishing is a concern in some areas (J. Waldo pers. comm. 2003), but the USFWS doesn’t believe that this will preclude recovery of the species.

When considered together, these cumulative effects 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). Similarly, the condition of critical habitat PCEs will be slightly degraded by the cumulative effects.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step of the USFWS 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 2.5) and the cumulative effects (section 2.6) to the status of the species (Section 2.3)and the environmental baseline (section 2.4) to formulate the agency’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 2.3).

2.7.1 Species at the Population Scale

The scores of 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 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 design criteria 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 (see Table 3), 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.

As described in section 2.4, 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. USFWS identified many factors associated with the life cycle of ESA-listed fish 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 2.6 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.

2.8 Conclusion

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 USFWS’s biological opinion that the proposed action is not likely to jeopardize the continued existence of bull trout, Lost River suckers, shortnose suckers, Modoc suckers, Warner suckers, Foskett speckled dace, Oregon chub, Lahontan cutthroat trout, spotted owls, or marbled murrelets, or result in the destruction or adverse modification of critical habitat that has been designated for any of these species.

3.0. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act 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 attempt to engage in any such conduct. Harm is further defined by the USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, take that is incidental to and not intended as part of the agency action is not considered to be a prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

3.1 Amount or Extent of Take

Work necessary to construct and maintain the restoration projects that will be authorized or carried out each year under this BO will take place adjacent to and within aquatic habitats that are reasonably certain to be occupied by individuals of one or more of the 10 ESA-listed species considered in this BO. 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.

All life history stages of fish will be captured during work area isolation necessary to minimize construction-related disturbance of streambank and channel areas caused by fish passage restoration; dam, tide gate, and legacy structure removal; 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 will be harmed by construction-related disturbance of upland, riparian and in-stream areas for actions related to LW, boulder, and gravel placement; streambank restoration; reduction/relocation of recreation impacts; livestock fencing, stream crossings and off-channel livestock watering; piling and other structure removal; in-channel nutrient enhancement; road and trail erosion control and decommissioning; non-native invasive plant control; juniper removal; riparian vegetation treatment (controlled burning); riparian vegetative planting; bull trout protection; 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 will also harm adult and juvenile fish as described above. Herbicide applications will 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 will 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. Incidental take that meets the terms and conditions of this incidental take statement will be exempt from the taking prohibition.

a. Capture of Fish During In-water Work Area Isolation

Under the 2007 ARBO (2008-2012), the Action Agencies completed 364 projects (171 in-channel, 100 fish passage, 0 estuary, 71 road treatment, and 22 vegetation treatment); with an average of about 73 projects per year. Because there are additional activity categories in ARBO II, USFWS assumes that a somewhat greater average number of projects will be completed annually under this BO than the 73 projects per year under the 2007 BO. USFWS assumes that double the number of actions per year would be funded or carried out in the future for a total of 146 projects per year. In anticipation of increased interest in aquatic restoration the USFWS will further increase the expected number of projects in some areas. The vast majority of these projects will be done within the Columbia River IRU. During the 2007 ARBO period, there were only about two projects (Streambank and channel disturbance, and fish passage) per year (2008-2012) in the Coastal Puget Sound IRU. With increased interest in aquatic restoration in the region, the number of projects will likely increase to more than double, that done under the 2007 ARBO period in this IRU. The USFWS estimates than an additional six projects per year (10 total, per year) could be implemented on average in the Coastal Puget Sound IRU. The USFWS will also increase the expected number of projects to six per year for all species in the Klamath IRU plus six additional projects per year on average intended mainly to benefit suckers to meet possible increased interest in restoration work in the Klamath IRU, two per year in the Warner Basin, and one per year in the SE Oregon basins. Therefore, under ARBO II, we anticipate about 171 projects could be completed across the action area annually. The USFWS assumes that 60% of those projects (*i.e.*, 103 actions per year) will require in-water work involving fish capture. Projects under ARBO II, such as channel reconstruction, will have a larger footprint than projects under the 2007 ARBO, as this consultation contains many more categories of work. Therefore, we have used capture data from projects completed by USFWS and NOAA-Restoration Center from 2010 to 2012 under their respective opinions (NMFS 2009c; NMFS 2009d), which included larger projects such as dam removals and stream channel restoration, as a guide to estimate the number of fish we anticipate being captured and handled. USFWS and NOAA-Restoration Center had an average capture of approximately 132 ESA-listed salmon and steelhead per project, where isolation and dewatering was required.

i. *Bull Trout*

It is estimated that 162 of the 171 projects implemented on average per year could occur within the range of the bull trout. While the majority of ESA-listed fish captured under these projects would be salmon and steelhead some portion of these fish are likely to be bull trout.

In the absence of empirical data, the USFWS relies on informed professional judgment to formulate what is believed to be a reasonable ratio. The USFWS believes the ratio of bull trout to other salmonids across the action area would be quite low probably somewhere between 3-4% (see Section 2.5.1). Although there will be wide variation by specific location. The majority of work anticipated under the proposed action will most likely occur during the months of July and August, when water quality becomes limited, and bull trout start to move upstream into SR habitat 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 SR habitat 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 FMO habitat 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 USFWS will estimate that a ratio of bull trout to salmon and steelhead of 5% exists on average across the action area. Therefore based on an anticipated capture of 132 salmon and steelhead described previously the USFWS anticipates the average capture of 7 bull trout for projects where isolation and dewatering would be required.

Based on discussions made in Section 2.5.1, the USFWS anticipates injury or mortality to 5% of the fish that the Action Agencies capture and releases, with the remainder (95%) likely to survive with no long-term adverse effects. Actual data presented in Section 2.5.1 suggests that the injury/mortality number is more likely only around 2% for those fish captured and handled. Nonetheless, the USFWS chooses to err on the side of caution and use the more expansive 5% figure to account for unforeseen circumstances relating to fish health at the time of capture. Thus, USFWS anticipates that up to 686 see Section 2.5.1) individual bull trout (when separated by IRU and rounded up) considered in the consultation will be captured, on average per year, and up to 35 (rounded up by IRU) individuals will be injured or killed, on average per year, (*i.e.*, 60% of 162 projects x 7 bull trout = 681 [686 when rounded up by IRU]; and 5% of 686 = 35 whole fish (rounded up) as a result of fish capture necessary to isolate in-water construction areas. This larger percentage is used here to allow for variations in fish health, environmental conditions and work conditions. USFWS will, however, allocate this take proportionally across IRUs , as it is more practical to predict where projects will occur in these defined areas. To increase the utility of this BO this take indicator will average annual take number over any five-year period. Consultation must be reinitiated if the amount or extent of take is exceeded for any IRU over any five-year period (see Table 37).

Thus, the effects of work-area isolation on the abundance of bull trout in any IRU or population are likely to be small. Table 36 displays the expected take due to harm and capture of bull trout per year by IRU. Table 37 describes the maximum take due to harm and capture allowed in any five-year period, which if exceeded in any IRU would trigger reinitiation. Almost all of these fish are anticipated to be juveniles, but some number of adults could possibly be captured. Under ARBO 2007 only one adult bull trout was reported as harmed. For utility of operation the USFWS will not separate actual take numbers between juveniles, sub-adults and adults, but will assume that most (95-99%) of the capture would be juveniles. Adult equivalents (see Section 2.5.1) are included to show the likely effect on the bull trout population across the action area. These represent what effect the number of fish killed or injured (assuming these were all juveniles) would have on the adult population.

Table 36**.** Estimate of the amount of average capture, per year, for projects authorized or carried out under ARBO II, by IRU or affected basin ("n" means the estimated number of projects per year that will require work area isolation).

Type of take	IRU		
	Columbia River n=60	Coastal Puget Sound n=4	Klamath n=4
fish captured	616	42	28
fish killed or injured	31	2	2
"Adult equivalents" killed or injured (population effects)	0.6	0.04	0.03

Table 37. Estimate of the average take, per five-year period, for projects authorized or carried out under ARBO II, by IRU or affected basin ("n" means the estimated number of projects per five-year period that will require work area isolation).

Type of take	IRU		
	Columbia River n=440	Coastal Puget Sound n=30	Klamath n=20
fish captured	3,080	210	140
fish killed or injured	154	11*	10
*Calculated on 5-year increment			

If the number of bull trout captures or injury/mortality exceeds the figures listed in Table 37 in any five-year period the Action Agencies must reinitiate consultation *ii.* *Lahontan Cutthroat Trout*

While there were no projects completed under the 2007 ARBO in Lahontan cutthroat trout habitat, the USFWS will assume that one project will be done each year on average that could require the capture of fish. 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 need to be salvaged. Therefore we will assume that no more than five Lahontan cutthroat trout will be captured in any one project. This would equate to a total number of 25 over any five-year period. Mortality or injury is also expected to be low. Based on the 5% figure used above (5% x 25 fish = 1.25 fish) the USFWS would estimate that no more than two (rounded up to the whole fish) Lahontan cutthroat trout would be harmed in any five-year period. If more than 25 Lahontan cutthroat trout are captured, or more than two Lahontan cutthroat trout are harmed in any five-year period, the Action Agencies must reinitiate consultation.

iii. *Lost River and Shortnose Suckers*

Lost River and Shortnose suckers could be exposed to an average of four projects per year that would require capture. Based on past experience approximately 20 of either species could be captured during any project that requires de-watering. This equates to an average of 120 fish per year, and a total of 600 suckers in any five-year period in the action area. Using an injury/mortality rate of 5% the USFWS estimates that 30 suckers could be killed or injured during any five-year period. If more than 600 Lost River or Shortnose suckers are captured, or more than 20 are injured or killed during any five-year period the Action Agencies must reinitiate consultation.

iv. *Modoc Sucker*

Modoc suckers could be exposed to an average of four projects per year that would require capture. Based on past experience, around 20 Modoc suckers could be captured during any project that requires de-watering. This equates to an average of 120 fish per year, and a total of 600 suckers in any five-year period in the action area. Using an injury/mortality rate of 5% the USFWS estimates that 20 suckers could be killed or injured during any five-year period. If more than 600 Modoc suckers are captured, or more than 30 are injured or killed during any five-year period the Action Agencies must reinitiate consultation.

v. *Warner Sucker*

Warner suckers could be exposed to an average of two projects per year that would require capture. Based on past experience, around 20 Warner suckers could be captured during any project that requires de-watering. This equates to an average of 40 fish per year, and a total of 200 suckers in any five-year period in the action area. Using an injury/mortality rate of 5% the USFWS estimates that 10 suckers could be killed or injured during any five-year period. If more than 200 Warner suckers are captured, or more than 10 are injured or killed during any five-year period the Action Agencies must reinitiate consultation.

vi. Foskett Speckled Dace

Foskett speckled dace could be exposed to an average of two projects per year that would require capture on average. The actual numbers of individuals varies widely between local populations. The USFWS is unable to predict how many individuals may be captured in any one project. Therefore, the USFWS will simply estimate that no more than 5% of any local population will be captured during any project that requires de-watering, and that no more than 0.25% of any local population will be injured or killed. The Action Agencies must work directly with their local USFWS representative and the appropriate Level 1 Team to determine the proper number of Foskett Speckled dace that may be handled or harmed on a site-specific basis to ensure compliance with this BO. The amount of anticipated take of Foskett Speckled Dace is not calculated on a 5-yr average like the other fish species addressed herein.

vii. Oregon Chub

Oregon chub were only exposed to one project under ARBO 2007 during the five-year period of 2008-2012. The USFWS will estimate that Oregon chub may be exposed to the effects of three projects during any five-year period under this BO. The USFWS estimates that up to 50 Oregon chub may be captured during any project that requires de-watering within their habitat. That equates to the capture of 150 Oregon chub during any five-year period. Using an injury/mortality rate of 5% the USFWS estimates that that eight Oregon chub will be injured or killed in any five-year period. If more than 150 Oregon chub are captured, or more than eight are injured or killed during any five-year period as a result of activities covered under this BO, the Action Agencies must reinitiate consultation.

b. Harm due to habitat-related effects

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 action area 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 USFWS 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, USFWS 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.

i. *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 fish to move away from the action area. ESA-listed fish exposed to suspended sediment are likely to experience gill abrasion, decreased feeding, stress, or be temporarily unable to use the area adjacent to the project work, depending on the severity of the suspended sediment release. ESA-listed fish 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. Construction activities will also cause an increase in fine sediment levels in downstream substrates, temporarily reducing the value of that habitat for spawning and rearing.

Because of the wide variability of project types, locations and site-specific conditions it is not possible to fully quantify the effects to ESA-listed fish or their habitat. Some projects may contribute sediment to the stream that could have some degree of adverse effects on fish for great distances below the actual project work-site. Because so many variable factors are involved, the USFWS believes that monitoring turbidity to insure that projects remain compliant with EPA direction and State water quality standards will provide a reasonable basis for limiting adverse effects to ESA-listed fish from sediment arising from construction projects. Therefore, for projects involving near- and in-water construction, the measured 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 turbidity expected to produce adverse effects that will extend downstream will be proportional to the size of the stream. The extent of take will be exceeded if the turbidity plume generated by construction activities is visible above background levels (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). Therefore, the extent of take for this category is as follows – a visible increase in suspended sediment (as estimated using turbidity measurements, as described below) up to 50 feet from the project area in streams that are 30 feet wide or less, up to 100 feet from the discharge point or nonpoint source of runoff for streams between 30 and 100 feet wide, up to 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, or up to 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour.

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 an appropriately and regularly calibrated 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 100 feet upstream from the project area, or 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 50 feet downstream from the project area in streams that are 30 feet wide or less, 100 feet from the project area for streams between 30 and 100 feet wide, 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, and 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 is/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 pollutant level returns to background.

If monitoring or inspections show that the pollution controls are ineffective, immediately mobilize work crews to repair, replace, or reinforce controls as necessary.

ii. *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 and harassment that each action is likely to cause through short-term degradation of water quality and physical habitat. Based on the number of in-channel project miles affected during the five year period from 2008-2012 under the 2007 ARBO ($\bar{X}$ = 245 miles/5 years = 49 miles per year). With the additional activity categories in this BO, USFWS assumes that the Action Agencies will affect up to 74 stream miles average per year under this opinion (49 miles x 2 = 98 miles rounded up). Therefore, the extent of take based on this group of actions at 98 linear stream miles, or 517,440linear feet, of in-channel projects per year on average, and should not exceed 370 miles or 1,953,600 linear feet during any five-year period. This region-wide take is allocated per IRU or affected basin in Table 37.

iii. *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. This take will occur primarily as harm caused by 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 temporarily 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 take by harassing fish sufficiently to flush 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.

The extent of take is best identified by the total number of road miles and vegetation acres treated in each IRU or affected basin (Table 3) with a factor of increase (50%) in activity per year. Based on the 2008-2012 activity levels, the extent of take would be 128 miles per year on average (64 miles x 2), or 675,840 linear feet, and, 12,438 acres (6,219 acres x 2) of road and vegetation treatment per year on average, respectively. However the Action Agencies have requested additional take as follows: For the Coastal Puget Sound IRU and additional 150 miles of linear road and trail work will be anticipated on average each year. For the Klamath IRU an additional 10 miles of linear road and trail work will be anticipated each year on average, as will 200 additional acres of vegetation treatment. Therefore the extent of take of road treatment is 288 miles or 1,520,640 linear feet per year on average (128 miles + 150 miles + 10 miles), and the extent of take of vegetation treatment is 12,638 acres per year on average (12,438 acres + 200 acres). Thus construction and vegetation treatment related disturbance of upland, wetland and estuary areas should not exceed 1,440 miles, or 63,190 acres in any five-year period as represented in Table 38.

iv. *Invasive and non-native plant control*.

Application of manual, mechanical, biological 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, the burden of the use of those measurements in this take statement as an extent of take indicator 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 best available indicators for the extent of take due to the proposed invasive plant control is the extent of treated areas,(i.e., less than, or equal to, 10% of the acres in a Riparian Reserve or RHCA within a 6^{th-}field HUC watershed/year) as described in the PDC 33.a.

v. Summary of Incidental Take for ESA-listed Fish

The amount and extent of authorized incidental take differs by the six "extent of take" indicators and the different IRUs or affected basins except for the visible suspended sediment (turbidity) extent of take indicator (Table 37). The indicators for visible suspended sediment (turbidity) and invasive and non-native plant control do not vary by location. While the USFWS has attempted to determine maximum average impacts by year the take threshold for most of the indicators has been set at a five-year total rather than annually in order to allow more flexibility in application. The exceptions to this five-year average approach include capture and handling of Foskett Speckled Dace, the application of the visible suspended sediment indicators which are applicable by individual project, and invasive and non-native plant control which is applicable annually. In summary, the best available indicators for the extent of take for these proposed actions for ESA-listed fish are as follows (Table 37):

- Capture of fish during in-water work area isolation – the amount of take is:
  3,430 bull trout per five-year period (injury/mortality of 175)
  25 Lahontan cutthroat trout per five-year period (injury/mortality of 2)
  600 Lost River or Shortnose suckers per five-year period (injury/mortality of 30)
  600 Modoc suckers per five-year period (injury/mortality of 30)
  200 Warner suckers per five-year period (injury/mortality of 10)
  150 Oregon chub per five-year period (injury/mortality of 8)
  5% of any Foskett Speckled dace local population per project (injury/mortality of 0.25% of affected local population)
- Visible suspended sediment (turbidity) – the extent of take indicator for suspended sediments and contaminants is no more than a 10% increase in natural stream turbidity visible beyond the discharge point or nonpoint source of runoff.
- Streambank and channel alteration – the extent of take indicator construction-related disturbance of streambank and channel is no more than 490 linear stream miles, or 2,587,200 linear stream feet, of streambank or channel alteration per five-year period.
- Upland vegetation disturbance – the extent of take indicators for construction-related disturbance of upland and wetland areas, or piling removal are:

a. No more than 1,440 miles of road treatment per five-year period, and
b. No more than 63,190 acres of vegetation treatment per five-year period.

- Invasive and non-native plant control – the extent of take indicator for invasive and non-invasive plant control is treatment of no more than 10% of the acres within a Riparian Reserve under the Northwest Forest Plan or RHCA under PACFISH/INFISH, within a 6^{th-}field HUC/year

USFWS assumes that the proposed actions will continue to be distributed among the IRUs or affected basins in a similar proportion as in the past (Table 3) and has assigned take indicators for isolation/capture, near/instream construction, and harassment/harm to individual IRUs or affected basins (Table 37). The Action Agencies shall reinitiate consultation on the entirety of this consultation if they cover more fish captures, stream miles, turbidity plume distance, road miles, or acres of vegetation treatment , as described above in any IRU or affected basin (see Table 37), or exceed mortality or injuries in any IRU or affected basin (see Table 39).

Table 38. Extent of take indicators for projects authorized or carried out under the ARBO II, by IRU or affected basin, per applicable timeframe

Extent of Take Indicator	IRU or Affected Basins				
	Columbia River IRU	Coastal Puget Sound IRU	Klamath IRU[a]	Warner Basin	SE Oregon Basins
ESA-listed fish captured (number salvaged all species in this BO per five-year period)	3,230	210	1,340	200[b]	25
Visible suspended sediment (turbidity)	10% visible increase in natural stream turbidity				
Streambank/channel alteration (miles per five-year period)	375	50	40	15	10
Road/trail treatment/decommissioning (miles per five-year period)	633	750	50	4	3
Upland vegetation treatment (acres per five-year period))	59,709	628	1,000	1,225	628
Invasive/non-native plant control (acres/HUC6)	10% of any given Riparian Reserve or RHCA				
a: includes habitat outside of the actual IRU for Lost River, shortnose and Modoc suckers. b:handling of Foskett speckled dace not included in this number.					

Table 39 Maximum injury or mortalities by species and IRU or affected basin per five-year period.

ESA-listed Fish Species	Columbia River IRU	Coastal Puget Sound IRU	Klamath IRU	Warner Basin	SE Oregon Basins
Bull trout	154	11	10	N/A	N/A
Lahontan cutthroat trout	N/A	N/A	N/A	N/A	2
Lost River and Shortnose sucker	N/A	N/A	30	N/A	N/A
Modoc sucker	N/A	N/A	30	N/A	N/A
Warner sucker	N/A	N/A	N/A	10	N/A
Oregon chub	8	N/A	N/A	N/A	N/A
Foskett speckled dace	N/A	N/A	N/A	0.25% of local population affected by project*	N/A
*appropriate number determined by USFWS at time of implementation.					

The proposed action addressed in this consultation includes projects that will replace or relocate an existing irrigation diversion structure, or modify an existing irrigation diversion structure so that it will meet NMFS's fish screen criteria. However, the proposed action does not include the issuance of any easement, permit, or right-of-way that would authorize construction of new diversion structures, or conveyance of water across Federal land by the USFWS. Those types of action require an individual consultation under section 7 of the ESA whenever they may affect an ESA-listed species or designated critical habitat. Moreover, any take that may be due to the use of an existing irrigation diversion structure to withdraw water, or to the use of a water system to convey water across Federal land, is not incidental to the proposed action, and is not exempted from the ESA's prohibition against take by the ITS of this document.

c. Disruption Take of Spotted Owls and Marbled Murrelets

i. Spotted owls

Take of spotted owls will occur from disruption related to project activities within the proposed action. The USFWS anticipates that up to three spotted owl nests may be disrupted during any five-year period on each of the 19 administrative units (National Forests, BLM Districts or the Coquille Tribal Nation). This will result in a maximum harassment through injury (reduced fitness or greater risk of predation) to 114 owls (3 owl sites x 2 owls per nest x 19 administrative units) per five-year period.

ii. Marbled murrelets

Take of marbled murrelets will occur from disruption related to project activities within the proposed action. In Oregon USFWS anticipates that up to three marbled murrelet nests may be disrupted during any five-year period on each of the eight administrative units (National Forests, BLM Districts or the Coquille Tribal Nation). In Washington USFWS anticipates that up to two marbled nests per year may be disrupted during any five-year period on the Gifford Pinchot NF and up to five marbled nests per year may be disrupted during any five-year period on each of the Mt. Baker-Snoqualmie NF and the Olympic NF. This will result in the harassment (reduced fitness or greater risk of predation through disrupting normal behavioral patterns) to 84 marbled murrelets (3 murrelet sites/stands x 1 chick or egg per nest x8 administrative units in Oregon=24 + (2 murrelet sites/stands x 1 chick or egg per nest x 5 years x 1 administrative units= 10) +(5 murrelet sites/stands x 1 chick or egg per nest x 5 years x 2 administrative units=50) =) per five-year period.

3.2 Effect of the Take

In the accompanying BO, USFWS determined that the level of incidental take summarized in Tables 36 and 37, and Section 3.2 -c is not likely to result in jeopardy to the listed species, and is not likely to result in adverse modification of the critical habitat of any listed species analyzed under the BO.

3.3 Reasonable and Prudent Measures and Terms and Conditions

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). "Terms and conditions" implement the reasonable and prudent measures (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply. The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed action.

The Action Agencies shall:

1. Minimize incidental take from administration of this opinion by ensuring that the PDC proposed by the Action Agencies are used in all actions funded or carried out under this opinion.
2. Ensure completion of a comprehensive monitoring and reporting program regarding all actions funded or carried out by the Action Agencies under this opinion.

The measures described below are non-discretionary, and must be undertaken by the Action Agencies or, if an applicant is involved, must become binding conditions of any funding provided to the applicant, 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 an applicant to adhere to the terms and conditions of the incidental take statement through funding conditions, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Action Agencies must report the progress of the action and its impact on the species to USFWS as specified in the incidental take statement.

1. To implement reasonable and prudent measure #1 (PDC), the Action Agencies shall:
   a. Administer every action funded or carried out under this opinion in a manner consistent with PDC 1 through 9.
   b. For each action with a general construction element, apply PDC 10 through 20.
   c. For specific types of actions, apply PDC 21 through 40 as appropriate. If aquatic restoration activities have complementary actions, follow the associated PDC and conservation measures for each complementary action.
   d. Implement the CMs described in Section 1.4 for each species as described.

2. To implement reasonable and prudent measure #2 (monitoring and reporting), the Action Agencies shall:
   a. The Action Agencies will submit a monitoring report to USFWS by February 15 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 funded or carried out under this opinion, and any other data or analyses the Action Agencies deems necessary or helpful to assess habitat trends as a result of actions completed under this opinion.
   b. The Action Agencies will attend an annual coordination meeting with USFWS by April 30 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.

3.4 Conservation Recommendations

The USFWS recommends that the Action Agencies consider biological needs of lamprey spp. 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.

4.0 REINITIATION OF CONSULTATION

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal action 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 on listed species or designated 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 on the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that are likely to be affected by the action.

If monitoring and reporting are not done in accordance with the description of the proposed action, the FS/BLM/BIA 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 BO. To reinitiate consultation, contact the Oregon State Office of the USFWS and refer to the Reference Number 01EOFW00-2013-F-0090.

LITERATURE CITED

Ainley, D.G., S.G. Allen, and L.B, Spear. 1995. Offshore occurrence patterns of marbled murrelets in central California. Pages 361-369 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and Conservation of the Marbled Murrelet. General Technical Report. PSW-GTR-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Allen, C., A. Atkins, and M. Stern. 1994. Status and Recolonization of the Warner sucker (Catostomus warnerensis) and other fishes in the Warner Lakes in Southeast Oregon, 1994. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 22 pp.

Allen, C. 1996. Personal communication between Chris Allen (The Nature Conservancy, Fishery Biologist), and Alan Mauer, USFWS biologist), Portland, Oregon,

Allen, C., K. Hartzell, M. Stern and A. Munhall. 1995a. Status of the Warner sucker (Catostomus warnerensis) and other fishes in the Warner Basin in Southeast Oregon, 1995. Unpublished report to the Fish and Wildlife Service. 35 pp.

Allen, C., M. Stern, and A. Munhall. 1995b. Monitoring of the Warner sucker and other fishes in the Warner Basin in 1994 and 1995. Unpublished report to the Fish and Wildlife Service. 4 pp.

Allen, C., K. Hartzell, and M. Stern. 1996. Warner sucker progress report - 1996 findings. Unpublished report to Bureau of Land Management. 55 pp.

Allendorf, F.W. and N. Ryman. 2002. The role of genetics in population viability analysis. Pages 50-85 in S.R. Beissinger and D.R. McCullough (eds). Population Viability Analysis. The University of Chicago Press, Chicago, IL

Andersen, D. E., O.J. Rongstad, and W. R. Mytton. 1989. Response of nesting red-tailed hawks to helicopter overflights. The Condor 91:296-299.

Anderson, D.R. and K.P. Burnham. 1992. Demographic analysis of northern spotted owl populations. Pages 66-75 in Draft final recovery plan for the northern spotted owl: Appendix C. USDI Fish and Wildlife Service, Portland, Oregon.

Andreasen, J. K. 1975. Systematics and status of the Family Catostomidae in southern Oregon. Ph.D. Thesis, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon.

Anthony, R.G., and L.S. Andrews. 2004. Summary Report – Winter habitat use by spotted owls on USDI Bureau of Land Management Medford District Lands within the boundaries of the Timbered Rock Fire. Unpublished report, OCWRU, OSU, Corvallis, Oregon. 29 pages.

Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J. Nichols, J.E. Hines, G.S. Olson, S.H. Ackers, S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutiérrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A. Reid, and S.G. Sovern. 2006. Status and trends in demography of northern spotted owls, 1985-2003. Status and trends in demography of northern spotted owls, 1985–2003. Wildlife Monograph No. 163.

Anthony, R.G., and L.S. Andrews. 2004. Summary Report – Winter habitat use by spotted owls on USDI Bureau of Land Management Medford District Lands within the boundaries of the Timbered Rock Fire. Unpublished report, OCWRU, OSU, Corvallis, Oregon. 29pages.

Ardren, W.R., P. Scheerer, P. DeHaan, and R. Rhew. 2008. Landscape Genetics and Conservation of Oregon chub (Oregonichthys crameri). Abstract from Presentation for the 2008 Western Division American Fisheries Society Meeting. Portland, Oregon. May, 2008.

Ardren, W. R., J. Baumsteiger , C. S. Allen. 2009. Genetic Analysis of Threatened Foskett Spring Speckled Dace. U.S. Fish and Wildlife Service, Abernathy Fish Technology Center. Longview, WA.

Awbrey, F.T., and A.E. Bowles. 1990. The effects of aircraft noise and sonic booms on raptors: a preliminary model and a synthesis on the literature on disturbance. U.S. Air Force, Patterson Air Force Base, Ohio.

Azuma, D.L., B.A. Hiserote, and P.A. Dunham. 2005. The western juniper resource of eastern Oregon, 1999. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Resource Bulletin PNW-RB-249. Portland, Oregon. http://www.fs.fed.us/pnw/pubs/pnw_rb249.pdf.

Bangs, B.L., P.D. Scheerer, S. Clements. 2012. Oregon chub investigations. Oregon Department of Fish and Wildlife Annual Progress Report. Oregon Department of Fish and Wildlife, Salem, Oregon. 23 pp. plus appendices.

Bailey, L.L., J.A. Reid, E.D. Forsman, and J.D. Nichols. 2009. Modeling co-occurrence of northern spotted and barred owls: accounting for detection probability differences. Biological Conservation. 142: 2983-2989.

Banish, N. P., B. J. Adams, R. S. Shively, M. M. Mazur, and D. A. Beauchamp. 2009. Distribution and habitat associations of radio-tagged adult Lost River suckers and shortnose suckers in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 138:153-168.

Barlow, G.W. 1995. The relevance of behavior and natural history to evolutionarily significant units. Pages 169-175 in J. L. Nielsen editor. Evolution and the Aquatic Ecosystem. American Fisheries Society Symposium 17. Bethesda, Maryland.

Barnard, B. 2011. Deer Lagoon Alternatives Analysis. Washington Department of Fish and Wildlife. http://wildfishconservancy.org/projects/deer-lagoon-restoration-assessment/DeerLagoonalternativeanalysis_website.pdf.

Barnett, T. P., D. W. Pierce, H. G. Hidalgo, C. Bonfils, B. D. Santer, T. Das, G. Bala, A. W. Wood, T. Nozawa, A. A. Mirin, D. R. Cayan, and M. D. Dettinger. 2008. Human-induced changes in the hydrology of the western United States. Science 319:1080-1083.

Barrowclough, G.F. and R. J. Gutiérrez. 1990. Genetic variation and differentiation in the spotted owl. Auk 107:737-744.

Barrowclough, G.F., R.J. Gutiérrez, and J.G. Groth. 1999. Phylogeography of spotted owl (Strix occidentalis) populations based on mitochondrial DNA sequences; gene flow, genetic structure, and a novel biogeographic pattern. Evolution 53(3):919-931.

Barrowclough, G.F., J.G. Groth, and R.J. Gutiérrez. 2005. Genetic structure, introgression and a narrow hybrid zone between northern and California spotted owls (Strix occidentalis). Molecular Ecology 14:1109–1120.

Barrows, C.W., and K. Barrows. 1978. Roost characteristics and behavioral thermoregulation in the spotted owl. Western Birds 9:1-8.

Barrows, C.W. 1981. Roost selection by Spotted Owls: an adaptation to heat stress. Condor 83: 302-309.

Barry, P. M., B. S. Hayes, E. C. Janney, R. S. Shively, A. C. Scott, and C. D. Luton. 2007. Monitoring of Lost River (Deltistes luxatus) and shortnose (Chasmistes brevirostris) suckers in Gerber and Clear Lakes, 2005-2006, Klamath Falls, Oregon.

Barry, P. M., E. C. Janney, D. A. Hewitt, B. S. Hayes, and A. C. Scott. 2009. Population dynamics of adult Lost River (Deltistes luxatus) and shortnose (Chasmistes brevirostris) suckers in Clear Lake, California, 2006-2008: Open File Report 2009-1109. U.S. Geological Survey, Reston, Virginia.

Bart, J. 1995. Amount of suitable habitat and viability of northern spotted owls. Conservation Biology 9 (4):943-946.

Bart, J., and E.D. Forsman. 1992. Dependence of northern spotted owls Strix occidentalis caurina on old-growth forests in the western USA. Biological Conservation 62:95-100.

Batt, P.E. 1996. State of Idaho bull trout conservation plan. Office of the Governor, Boise, ID. 20pp.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America.

Batt, P.E. 1996. State of Idaho bull trout conservation plan. Office of the Governor, Boise, ID. 20pp.

Baxter, J.S., E.B. Taylor, R.H. Devlin, J. Hagen and J.D. McPhail. 1997. Evidence for natural hybridization between Dolly Varden (*Salvelinus malma*) and bull trout (*S. confluentus*) in a northcentral British Columbia watershed. Canadian Journal of Fisheries and Aquatic Sciences 54:421-429.

Baxter, C.V. 2002. Fish Movement and Assemblage Dynamics in a Pacific Northwest Riverscape. Ph.D. Dissertation, Oregon State University, Corvallis, OR. 174 pp.

Beauchamp, D.A. and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-16.

Bêche, L.A., S.L. Stephens, and V.H. Resh. 2005. Effects of prescribed fire on a Sierra Nevada (California, USA) stream and its riparian zone. Forest Ecology and Management 218:37-59.

Becker, B.H. 2001. Effects of oceanographic variation on marbled murrelet diet and habitat selection. Ph.D. dissertation, University of California, Berkeley, California.

Becker, B.H., and S.R. Beissinger. 2006. Centennial decline in the trophic level of an endangered seabird after fisheries decline. Conservation Biology 20(2):470-479.

Becker, B.H., M.Z. Peery, and S.R. Beissinger. 2007. Ocean climate and prey availability affect the trophic level and reproductive success of the marbled murrelet, an endangered seabird. Marine Ecology Progress Series 329:267-279.

Behnke, R. J. & D. E. Benson, 1980. Endangered and threatened fishes of the upper Colorado River Basin. Colorado State University Cooperative Extension Service Bulletin 503A, Fort Collins, Colorado, USA

Beissinger, S.R 1995. Population trends of the marbled murrelet projected from demographic analyses. Pp. 385-393 In: Ecology and conservation of the marbled murrelet (C.J. Ralph, G.L. Hunt, M.G. Raphael and J. F. Piatt, editors). Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA.

Beissinger, S.R., and N. Nur. 1997. Appendix B: Population trends of the marbled murrelet projected from demographic analysis. Pp. B1-B35 In: U.S. Fish and Wildlife Service.

Beissinger, S.R., and M.Z. Peery. 2003. Range-wide analysis of juvenile ratios from marbled murrelet monitoring programs: implications for demographic analyses. Unpublished report, University of California, Dept. of Environmental Science, Policy, and Management, Berkeley, California.

Beissinger, S.R., and M.Z. Peery. 2007. Reconstructing the historic demography of an endangered seabird. Ecology 88(2):296-305.

Bendire, C. E. 1889. The Lost River sucker. Forest and Stream 32:444-445.

Berg, W. J. 1991. Selected observations and interpretations on the life-history of the Warner sucker (Catostomus warnerensis): conservation genetic management. Unpublished report to the Warner Sucker Working Group. 11 pp.

Berg, R. K. and E. K. Priest. 1995. Appendix Table 1: A list of stream and lake fishery surveys conducted by U.S. Forest Service and Montana Fish, Wildlife and Parks fishery biologists in the Clark Fork River drainage upstream of the confluence of the Flathead River the 1950's to the present. Montana Fish, Wildlife, and Parks, Job Progress Report, Project F-78-R-1, Helena, Montana.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 *in* E.D. Salo and T.W. Cundy (eds). Streamside Management Forestry and Fisheries Interactions. Institute of Forest Resources, University of Washington, Seattle, Washington, Contribution No. 57.

Beschta, R.L., and W.J. Ripple. 2010. Recovering riparian plant communities with wolves in Northern Yellowstone, U.S.A. Restoration Ecology 18(3):380-389.

Bienz, C.S. and J.S. Ziller. 1987. Status of three lacustrine sucker species (Catostomidae). Report to the U.S. Fish and Wildlife Service, Sacramento, California.

Bigley, R. and J. Franklin. 2004. Habitat trends. In: Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Bilby, R.E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82:609-613.

Bills, F.T. 1977. Taxonomic status of isolated populations of tui chub referred to Gila bicolor oregonensis (Snyder). Master's thesis. Oregon State University, Corvallis, Oregon. 116 pp.

Bingham, B.B, and B.R. Noon. 1997. Mitigation of habitat "take": application to habitat conservation planning. Cons. Biology. 11(1): 127-139.

Bisson, P.A., B.E. Rieman, C. Luce, P.F. Hessburg, D.C. Lee, J.L. Kershner, G.H. Reeves, and R.E. Gresswell. In Press. Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. Forest Ecology and Management.

Blakesley, J.A. 2004. Habitat Associations. Chapter 5 in S.P. Courtney, J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff and L. Sztukowski. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, Oregon.

Bloxton, T.D., and M.G. Raphael. 2005. Breeding ecology of the marbled murrelet in Washington State: 2004 Season Summary, A report to the U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington; Pacific Northwest Research Station, U.S. Forest Service, Olympia, Washington. 14 pp.

Bloxton, T.D., and M.G. Raphael. 2006. At-sea movements of radio-tagged marbled murrelets in Washington. Northwestern Naturalist 87(2):162-162.

Boag, T.D. 1987. Food habits of bull char (*Salvelinus confluentus*), and rainbow trout (*Salmo gairdneri*), coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1):56-62.

Bond, C.E. and C.I. Coombs. 1985. Characteristics and life history of Catostomus warnerensis. Proc. Desert Fishes Council. 13:40-53.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 *in* P.J . Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Bond, M.L., R.J. Gutierrez, A.B. Franklin, W.S. LaHaye, C.A. May, and M.E. Seamans. 2002. Short-term effects of wildfires on spotted owl survival, site fidelity, mate fidelity, and reproductive success. Wildlife Society Bulletin 30(4):1022-1028.

Bond, M.L., D.E. Lee, R.B. Siegel, and J.P. Ward, Jr. 2009. Habitat use and selection by spotted owls in a postfire landscape. Journal of Wildlife Management 73(7):1116-1124.

Bonneau, J.L., and D.L. Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125:628-630.

Bosse, S.E., D. Hartzel, C. Allen, M. Stern, and A. Munhall. 1997. Warner Sucker Progress Report-1997 Findings. Unpublished Report to Bureau of Land Management. 78pp.

Bowman, R., and G.W. Woolfenden. 2002. Nest site selection by Florida scrub-jays in natural and human-modified habitats. Wilson Bulletin 114(1): 128-135.

Boyd, M., S. Kirk, M. Wiltsey, and B. Kasper. 2002. Upper Klamath Lake drainage total maximum daily load (TMDL) and water quality managment plan (WQMP). Department of Environmental Quality, State of Oregon, Portland, Oregon.

Bradley, R.W. 2002. Breeding ecology of radio-marked marbled murrelets (Brachyramphus marmoratus) in Desolation Sound, British Columbia. Department of Biological Sciences. Burnaby, BC, Simon Fraser University, 86 pp.

Bradley, R.W., F. Cooke, L.W. Lougheed, and W.S. Boyd. 2004. Inferring breeding success through radiotelemetry in the marbled murrelet. Journal of Wildlife Management 68(2):318-331.

Bragg, J. 2001. The truth about suckers. The Herald and News. Tuesday, May 8, 2001.

Brenkman, S.J. and S.C. Corbett. 2005. Extent of Anadromy in Bull Trout and Implications for Conservation of a Threatened Species. North American Journal of Fisheries Management. 25:1073–1081.

Brewin, P.A., M.K. Brewin, and M. Monita. 1997. Distribution maps for bull trout in Alberta. Pages 206-216 *in* W.C. Mackay, M.K. Brewin, and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Brown, L.G. 1994. The zoogeography and life history of Washington native charr. Report # 94-04. Washington Department of Fish and Wildlife, Fisheries Management Division, Olympia, WA, November, 1992, 47 pp.

Brown, K. (compiler and producer). 2011. Oregon Blue Book: 2011-2012. Oregon State Archives, Office of the Secretary of State of Oregon. Salem, Oregon. http://bluebook.state.or.us/.

Brown, J.N., S.R. Gooneratne, and R.B. Chapman. 2000. Herbicide spray drift odor: Measurement and toxicological significance. Archives of Environmental Contamination and Toxicology 38:390-397.

Buchanan, J., E. Hanson, D. Hays, and L.Young. 1994. An evaluation of the Washington Forest Practices Board Wildlife Committee preferred alternative for a spotted owl protection rule. Washington Forest Practices Board Spotted Owl Scientific Advisory Group. Olympia, Washington.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by spotted owls in the eastern Washington Cascades. Journal of Wildlife Management 59:301-310.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout, distribution, life history, limiting factors, management considerations, and status. Report to Bonneville Power Administration. Contract No. 1994BI34342, Project No. 199505400 (BPA Report DOE/BP-34342-5). Oregon Department of Fish and Wildlife, Portland, OR. 185pp.

Buchanan, D.M., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 1-8 *in* W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force(Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Buchanan, J.B. 2004. Managing habitat for dispersing northern spotted owls – are the current management strategies adequate? Wildlife Society Bulletin 32:1333–1345.

Buchanan, J.B. and P. Swedeen. 2005. Final briefing report to the Washington State Forest Practices Board regarding spotted owl status and forest practices rules. Washington Department of Fish and Wildlife, Olympia. 84 pp.

Buck, J. 2003. A preliminary investigation of nutrients and isotopic nitrogen in Oregon chub habitat adjacent to Oakridge Sewage Treatment Plant. USFWS, Oregon Fish and Wildlife Office, Portland, OR. 21 pp.

Buettner, M. and G. Scoppettone. 1990. Life history and status of Catostomids in Upper Klamath Lake, Oregon: Completion report. Reno Field Station, National Fisheries Research Center, U.S. Fish and Wildlife Service, U.S. Department of Interior, Reno, Nevada.

Buettner, M. and C. Scoppettone. 1991. Distribution and Information on the Taxonomic Status of the Shortnose Sucker, *Chasmistes brevirostris*, and Lost River Sucker, *Deltistes luxatus*, in the Klamath Basin, California. Completion Report. CDFC Contract FC-8304. 101 pp.

Burdick, S. M., H. A. Hendrixson, and S. P. Vanderkooi. 2008. Age-0 Lost River Sucker and Shortnose Sucker nearshore habitat use in Upper Klamath Lake, Oregon: A patch occupancy approach. Transactions of the American Fisheries Society 137:417-430.

Burdick, S. M., C. Ottinger, D.T Brown, S.P. VanderKooi, L. Robertson, and D. Iwanowicz. 2009. Distribution, health, and development of larval and juvenile Lost River and shortnose suckers in the Williamson River Delta restoration project and Upper Klamath Lake, Oregon. Open File Report 2009-1287. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station. 76 p.

Burdick, S.M., and S.P. VanderKooi. 2010. Temporal and spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper Klamath Lake, Oregon—2008 annual data summary: U.S. Geological Survey Open-File Report 2010-1051, 46 p. (Also available at *http://pubs.usgs.gov/of/2010/1051/*.)

Burkett, E.E. 1995. Marbled murrelet food habits and prey ecology. Pages 223-246 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55:75-81.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541.

Burger, A.E. 1995. Marine distribution, abundance, and habitats of marbled murrelets in British Columbia. Pp. 295-312 In: Ecology and conservation of the marbled murrelet (Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds.). U.S. Forest Service, General Technical Report PSW-GTR-152, Pacific Southwest Research Station, Albany, California.

Burger, A.E. 2001. Using radar to estimate populations and assess habitat associations of marbled murrelets. Journal of Wildlife Management 65:696-715.

Burger, Alan E. 2002. Conservation assessment of marbled murrelets in British Columbia, a review of biology, populations, habitat associations and conservation. Pacific and Yukon Region, Canadian Wildlife Service. 168 pages.

Burnham, K.P., D.R. Anderson, and G.C. White. 1994. Estimation of vital rates of the northern spotted owl. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, Colorado, USA.

Buettner, M. and G. Scoppettone. 1990. Life history and status of Catostomids in Upper Klamath Lake, Oregon: Completion report. Reno Field Station, National Fisheries Research Center, U.S. Fish and Wildlife Service, U.S. Department of Interior, Reno, Nevada.

California Department of Forestry and Fire Protection. 2007. California Forest Practices Rules: 2001. Title 14, California Code of Regulations, Chapters 4, 4.5, and 10. Sacramento, California.

Cam, E., L.W. Lougheed, R.W. Bradley, and F. Cooke. 2003. Demographic assessment of a marbled murrelet population from capture-recapture data. Conservation Biology 17(4):1118-1126.

Campbell-Craven Environmental Consultants. 1994. Draft evaluation of fish passage alternatives for water diversions in Honey Creek, tributary to Hart Lake, Lake County, Oregon. Prepared for Oregon Department of Fish and Wildlife. Portland, Oregon. 16 pp.

Campbell, N. A. 1990. Biology. The Benjamin/Cummings Publishing Company, Inc. Redwood City, California.

Cannon, K. 2008. Email from Ken Cannon, Oregon Department of Transportation transmitting ODOT 2007 Fish Salvage Report. Personal Communication to Marc Liverman, National Marine Fisheries Service. July 29, 2008.

Cannon, K. 2012. Email from Ken Cannon, Oregon Department of Transportation transmitting ODOT 2012 Fish Salvage Report. Personal Communication to Marc Liverman, National Marine Fisheries Service. February 4, 2012.

Carey, A.B., J.A. Reid, and S.P. Horton. 1990. Spotted owl home range and habitat use in southern Oregon coast ranges. Journal of Wildlife Management 54:11–17.

Carey, A. B., S.P. Horton, and B.L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. Ecological Monographs 62(2):223-250.

Carey, A.B. and K.C. Peeler. 1995. Spotted owls: resource and space use in mosaic landscapes. Journal of Raptor Research 29(4):223-239.

Carmona-Catot, G., P.B. Moyle, E. Aparicio, P.K. Crain, L.C. Thompson, and E. García-Berthou. 2010. Brook trout removal as a conservation tool to restore Eagle Lake rainbow trout. North American Journal of Fisheries Management 30:1315–1323.

Carpenter, K.D., S. Sobieszczyk, A.J. Arnsberg, and F.A. Rinella. 2008. Pesticide Occurrence and Distribution in the Lower Clackamas River Basin, Oregon, 2000–2005. U.S. Geological Survey Scientific Investigations Report 2008-5027:98 p.

Carsia, R. V., and S. Harvey. 2000. Adrenals. Chapter 19 in G. C. Whittow, editor. Sturkie's Avian Physiology. Academic Press, San Diego, CA.

Carter, H.R., and S.G. Sealy. 1986. Year-round use of coastal lakes by marbled murrelets. Condor 88:473-477.

Carter, H.R., and S.G. Sealy. 1990. Daily foraging behavior of marbled murrelets. Studies in Avian Biology 14:93-102.

Carter, H.R., and R.A. Erickson. 1992. Status and conservation of the marbled murrelet in California, 1892-k1987. In: H.R. Carter and M.L. Morrison (eds). Status and conservation of the marbled murrelet in North America. Proceedings of the Western Foundation for Vertebrate Zoology 5.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckley), from the American northwest. California Fish and Game 64: 139-174.

CCR (Crescent Coastal Research). 2008. Population and productivity monitoring of marbled murrelets in Oregon during 2008, Final Report to USFWS Oregon State Office, Portland, Oregon. December 2008. 13 pp.

CCR (Crescent Coastal Research). 2012. Marbled murrelet productivity measures at sea in northern California during 2011: an assessment relative to Redwood National and State Park lands. Final annual report to USFWS Arcata Fish and Wildlife Office, Arcata, California. February 2012. 18 pp.

Cederholm, C.J., L.G. Dominguez, and T.W. Bumstead. 1997. Rehabilitating stream channels and fish habitat using large woody debris. Pages 8-1 to 8-28. In: Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. P.A. Slaney, and D. Zaldokas (editors). British Columbia Ministry of Environment, Lands and Parks. Vancouver, British Columbia.

Chamberlain, T. W., R. D. Harr, and F. H. Everest. 1991. Timber harvesting, silviculture and watershed processes. Pages 181-205 *in* W. R. Meehan (ed). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19

Chan, I.A. 1998. Aquatic macroinvertebrates of small streams in the Mineral King Region of Sequoia National Park: Baseline communities and response to prescribed fire. University of California, Davis. http://books.google.com/books?id=6WAfOAAACAAJ.

Chen, J, J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clearcut, edge and interior old-growth Douglas fir forest. Agric. and For. Meteorology 63:219-237.

Chi, T., A. Henke, J. Smith, and C. Brinegar. 2004. Spotted owl mitochondrial DNA haplotyping. San Jose State University. Unpublished results submitted to U.S. Fish and Wildlife Service.

Chutter, M.J., I. Blackburn, D. Bonin, J. Buchanan, B. Costanzo, D. Cunnington, A. Harestad, T. Hayes, D. Heppner, L. Kiss, J. Surgenor, W. Wall, L. Waterhouse, and L. Williams. 2004. Recovery strategy for the northern spotted owl (Strix occidentalis caurina) in British Columbia. British Columbia Ministry of Environment, Victoria. 74 pp.

CLI (Climate Leadership Initiative) and NCCSP (National Center for Conservation Science and Policy). 2009. Preparing for climate change in the Upper Willamette River Basin of western Oregon: Co-Beneficial Planning for Communities and Ecosystems. Unpublished report. 47 pp. Available at http://www.nccsp.org/files/climate-change/Upper Willamette Basin Report 3-24-09 FINAL.pdf

Cohen, Joel E. 1977. Ratios of prey to predators in community food webs. Nature, Volume 270, Number 5633 165-167, MacMillan Journals Ltd.

Compton, J.E., C.P. Andersen, D.L. Phillips, R. Brooks, M.G. Johnson, M.R. Church, W.E. Hogsett, M.A. Cairns, P.T. Rygiewicz, B.C. McComb, and C.D. Shaff. 2006. Ecological and water quality consequences of nutrient addition for salmon restoration in the Pacific Northwest. Frontiers in Ecology and the Environment 4(4):18-26.

Conley, J.M. 1993. Bull trout management plan. Idaho Department of Fish and Game, Boise. April 1993.

Coombs, C. I., C. E. Bond, and S. F. Drohan. 1979. Spawning and early life history of the Warner sucker (Catostomus warnerensis). Unpublished report to Fish and Wildlife Service. 52 pp.

Coombs, C.I., and C.E. Bond. 1980. Report of investigations on Catostomus warnerensis, fall 1979 and spring 1980. Unpublished report to Fish and Wildlife Service. 32 pp.

Cooperman, M. and D.F. Markle, 2003. Rapid out-migration of lost river and shortnose sucker larvae from in-river spawning beds to in-lake rearing grounds. Trans. Am. Fish. Soc. 132(6):1138-1153

Cooperman, M. S. and D. F. Markle. 2004. Abundance, size, and feeding success of larval shortnose suckers and Lost River suckers from different habitats of the littoral zone of Upper Klamath Lake. Environmental Biology of Fishes 71:365-377.

Cope, E. D. 1879. Fishes of Klamath Lake, Oregon. American Naturalist 13:784-785.

Cope, E.D. 1883. On the fishes of the recent and Pliocene lakes of the western part of the Great Basin, and the Idaho Pliocene Lake. Proc. Acad. Nat. Sci. Philadelphia. 1883:134-166.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, *Salvelinus confluentus* (Pisces: Salmonidae). Evolution. 57(2):328-344.

Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Courtney, S., and R. Gutiérrez. 2004. Chapter 11 in S. Courtney (editor), Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, Oregon.

Craig, S.D., and R.C. Wissmar. 1993. Habitat conditions influencing a remnant bull trout spawning population, Gold Creek, Washington (draft report). Fisheries Research Institute, University of Washington. Seattle, Washington.

Cramer, M.L. (editor). 2012. Stream habitat restoration guidelines. Co-published by the Washington Departments of Fish and Wildlife, Natural Resources, Transportation and Ecology, Washington State Recreation and Conservation Office, Puget Sound Partnership, and the U.S. Fish and Wildlife Service. Olympia, Washington.

Crandall, J. D., L. B. Bach, N. Rudd, M. Stern, and M. Barry. 2008. Response of larval Lost River and shortnose suckers to wetland restoration at the Williamson River Delta, Oregon. Transactions of the American Fisheries Society 137:402-416.

Cullen, S.A. 2002. Using radar to monitor populations and assess habitat associations of marbled murrelets within the Sunshine Coast Forest District. Surrey, BC, Ministry of Water, Land and Air Protection, 25 pp.

Dahm, C. N., M. A. Baker, D. I. Moore, and J. R. Thibault. 2003. Coupled biogeochemical and hydrological responses of streams and rivers to drought. Freshwater Biology 48:1219-1231.

Dambacher, J.M., A.G. Talabere, D.L. Hill, and D.F. Markle. 1997. Foskett speckled dace investigations. Fish Research Progress Report. Oregon Department of Fish and Wildlife and Oregon State University.

Darnell, R.M. 1976. Impacts of construction activities in wetlands of the United States. U.S. Environmental Protection Agency, Environmental Research Laboratory. Ecological Research Series, Report No. EPA-600/3-76-045. U.S. Environmental Protection Agency, Environmental Research Laboratory. Corvallis, Oregon.

Davidson, J.M., A.C. Wickland, H.A. Patterson, K.R. Falk, and D.M. Rizzo. 2005. Transmission of Phytophthora ramorum in mixed-evergreen forest in California. Ecology and Epidemiology. 95(5)587-596.

Davis, B. and R. Miller. 1967. Brain patterns in minnows of the genus Hybopsis in relation to feeding habits and habitats. Copeia 1967: 1-39.

Davis, Raymond J.; Dugger, Katie M.; Mohoric, Shawne; Evers, Louisa; Aney, William C. 2011. Northwest Forest Plan—the first 15 years (1994–2008): status and trends of northern spotted owl populations and habitats. Gen. Tech. Rep. PNWGTR-850. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 147 p.

Day, R.H. and D.A. Nigro. 2000. Feeding ecology of Kittlitz's and marbled murrelets in Prince William Sound, Alaska. Waterbirds 23(1):1-14.

DeHaan, P., P. Scheerer, R. Rhew. 2010. Analysis of genetic variation in natural and re-introduced populations of Oregon chub (Oregonichthys crameri). Final Report to Oregon Fish and Wildlife Office, Portland, Oregon. 42 pp.

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

Delaney, D.K., T.G. Grubb, and P. Beier. 1999b. Activity patterns of nesting Mexican spotted owls. The Condor 101: 42-49.

Delaney, D.K., and T.G. Grubb. 2001. Effects of off-highway vehicle noise on northern spotted owls: sound data results. A report to the Mendocino National Forest. A report to the Mendocino National Forest, Contract Number 43-91Z9-0-0055.

Dechesne, S. B. C., and J. L. Smith. 1997. Wildlife inventory Queen Charlotte Islands/Haida Gwaii 1994-1996. Husby Group of Companies. 49 pages.

Desjardins, M. and D. F. Markle. 2000. Distribution and biology of suckers in lower Klamath Reservoirs. Technical Report to Portland, Oregon.

Dicken, S. N. and E. F. Dicken. 1985. The legacy of ancient Lake Modoc: a historical geography of the Klamath Lakes Basin Oregon and California.

Dietrich, W.E., T. Dunne, N. Humphrey, and L. Reid. 1982. Construction of sediment budgets for drainage basins. Pages 2-23. In: Workshop on sediment budgets and routing in forested drainage basins. F.J. Swanson, R.J. Janda, T. Dunne, and D.N. Swanston (editors). U.S. Dept. of Agriculture - Forest Service - Pacific Northwest Forest and Range Experiment Station. Portland, Oregon.

Diller, L.V. and D.M. Thome. 1999. Population density of northern spotted owls in managed young-growth forests in coastal northern California. Journal of Raptor Research 33: 275–286.

DiTomaso, J.M., G.B. Kyser, and M.J. Pitcairn. 2006. Yellow starthistle management guide. California Invasive Plant Council. Berkley, California. Cal-IPC Publication 2006-03. 78 p. http://www.cal-ipc.org.

Donald, D.B., and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology/Revue Canadien de Zoologie 71:238-247.

Dooling, R.J. and A.N. Popper. 2007. The Effects of Highway Noise on Birds. Report to: The California Department of Transportation, Division of Environmental Analysis, Sacramento, CA. 74 pp.

Dosskey, M.G., P. Vidon, N.P. Gurwick, C.J. Allan, T.P. Duval, and R. Lowrance. 2010. The Role of Riparian Vegetation in Protecting and Improving Chemical Water Quality in Streams. Journal of the American Water Resources Association:1-18.

Dowling, T. 2005. Conservation genetics of endangered Lost River and shortnose suckers. Technical Report .

Dowling, T.E. 2005. Conservation genetics of Modoc sucker. Final report to U.S. Fish and Wildlife, Klamath Falls, OR; Contract # 114500J516. 15 pp.

Doyle, M.W., and F.D. Shields. 2012. Compensatory mitigation for streams under the Clean Water Act: Reassessing science and redirecting policy. Journal of the American Water Resources Association 48(3):494-509.

Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. The Condor 107:863-878.

Dunbar, D.L., B.P. Booth, E.D. Forsman, A.E. Hetherington, and D.J. Wilson. 1991. Status of the spotted owl, Strix occidentalis, and barred owl, Strix varia, in southwestern British Columbia. Canadian Field Naturalist 105:464-468.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655.

Dunham,J., B. Rieman & G. Chandler. 2003. Influences of Temperature and Environmental Variables on the Distribution of Bull Trout within Streams at the Southern Margin of Its Range. *North American Journal of Fisheries Management* 2003;23:894–904.

Dwire, K.A., and J.B. Kaufmann. 2003. Fire and riparian ecosystems in the landscapes of the western USA. Forest Ecology and Management 178:61-74.

Ebersole, J.L., W.J. Liss, and C.A. Frissell. 1997. Restoration of stream habitats in the Western United States: Restoration as reexpression of habitat capacity. Environmental Management 21(1):1-14.

Ellsworth, C. M., M. C. Belk, and C. J. Keleher. 2010. Residence time and drift patterns of larval June sucker Chasmistes liorus in the lower Provo River as determined by otolith microstructure. Journal of Fish Biology 77:526-537.

Evans, D.E., W.P. Ritchie, S.K. Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer. 2003. Methods for surveying marbled murrelets in forests: a revised protocol for land management and research. Pacific Seabirds Group unpublished document available at http://www.pacificseabirdgroup.org.

Falxa, G., J. Baldwin, D. Lynch, S.L. Miller, S.K. Nelson, S.F. Pearson, M.G. Raphael, C. Strong, T. Bloxton, B. Galleher, B. Hogoboom, M. Lance, and R. Young. 2011. Marbled effectiveness monitoring, Northwest Forest Plan: 2009 and 2010 summary report. 26 p.

Falxa, G.A. 2013. Murrelet population survey 2000-2012 unpublished data, transmitted by email, USFWS, Arcata, CA.

Feist, B.E., J.J. Anderson, and R. Miyamoto. 1996. Potential impacts of pile driving on juvenile pink (Oncorhynchus gorbuscha) and chum (O. keta) salmon behavior and distribution. Fisheries Research Institute Report No. FRI-UW-9603:66 pp. School of Fisheries, University of Washington. Seattle.

FEMAT. 1993. Forest ecosystem management: An ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT). 1993-793-071. U.S. Government printing Office.

Ferguson, J.W., G.M. Matthews, R.L. McComas, R.F. Absolon, D.A. Brege, M.H. Gessel, and L.G. Gilbreath. 2005. Passage of adult and juvenile salmonids through federal Columbia River power system dams. U.S. Dept. of Commerce. NOAA Technical Memorandum NMFS-NWFSC-64. 160 p.

Fishbase 2011. http://www.fishbase.org/summary/SpeciesSummary.php?genusname = Salvelinus&speciesname=confluentus

Fitzgerald, S. 2010. Ecology of Quaking Aspen In: Land Manager's Guide to Aspen Management in Oregon. N. Strong, T. Welch, B. Littlefield, and D. Stringer (editors). Oregon State University Extension Service and Forest Restoration Partnership.

Folliard, L. 1993. Nest site characteristics of northern spotted owls in managed forest of northwest California. M.S. Thesis. University of Idaho, Moscow, Idaho.

Foott, J.S. 1997. Results of histological examination of sucker tissues. Memorandum 1997. U.S. Fish and Wildlife Service, Fish Health Center, Anderson, California.

Ford, T. 1977. Status summary report on the Modoc sucker. U.S.F.S., Modoc National Forest, unpubl. Technical report. 44 pp.

Forsman, E.D. 1975. A preliminary investigation of the spotted owl in Oregon. M.S. thesis, Oregon State University, Corvallis. 127 pp.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs 87:1-64.

Forsman, E.D., S. DeStefano, M.G. Raphael, and R.J. Gutierrez, (editors). 1996. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithology Society.

Forsman, E.D., I.A. Otto, S.G. Sovern, M. Taylor, D.W. Hays, H. Allen, S.L. Roberts, and D.E. Seaman. 2001. Spatial and temporal variation in diets of spotted owls in Washington. Journal of Raptor Research 35(2):141-150.

Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thrailkill, F.F. Wagner, and D. E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. Wildlife Monographs 149:1-35.

Forsman, E.D., R.G. Anthony, E.C. Meslow, and C.J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. Journal of Raptor Research 38(3):214-230.

Forsman, E.D., T.J. Kaminski, J.C. Lewis, K.J. Maurice, S.G. Sovern, C. Ferland, and E.M. Glenn. 2005. Home range and habitat use of northern spotted owls on the Olympic Peninsula, Washington. Journal of Raptor Research 39(4):365-377.

Forsman, Eric D., Robert G. Anthony, Katie M. Dugger, Elizabeth M. Glenn, Alan B. Franklin, Gary C. White, Carl J. Schwarz, Kenneth P. Burnham, David R. Anderson, James D. Nichols, James E. Hines, Joseph B. Lint, Raymond J. Davis, Steven H. Ackers, Lawrence S. Andrews, Brian L. Biswell, Peter C. Carlson, Lowell V. Diller, Scott A. Gremel, Dale R. Herter, J. Mark Higley, Robert B. Horn, Janice A. Reid, Jeremy Rockweit, Jim Schaberl, Thomas J. Snetsinger, and Stan G. Sovern. 2011. Population Demography of Northern Spotted Owls: 1985–2008. Studies in Avian Biology, Monograph No. XX, 2011. Cooper Ornithological Society.

Fowler, H.W. 1913. Notes on catostomid fishes. Proceedings of the Academy of Natural Sciences of Philadelphia 65: 45-60.

Fox, W.W. 1992. Stemming the tide: Challenges for conserving the nation's coastal fish habitat. Pages 9-13. In: Stemming the tide of coastal fish habitat loss. R.H. Stroud (editor). National Coalition for Marine Conservation, Inc. Savannah, Georgia.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout *(Salvelinus confluentus)* in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Franklin, A.B. 1992. Population regulation in northern spotted owls: theoretical implications for management. Pp. 815-827 in D. R. McCullough and R. H. Barrett (eds.). Wildlife 2001: populations. Elsevier Applied Sciences, London, England.

Franklin, A.B., K.P. Burnham, G.C. White, R.J. Anthony, E.D. Forsman, C. Sanchez, J.D. Nicols and J. Hines. 1999. Range-wide status and trends in northern spotted owl populations. Colorado Coop. Fish and Wildl. Res. Unit, Fort Collins, Colorado and Oregon Coop. Fish and Wildl. Res. Unit, Corvallis, Oregon. Unpublished report.

Franklin, A.B., D.R. Anderson, R.J. Gutiérrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs, 70(4): 539-590.

Franklin, I.R. and R. Frankham. 1998. How large must populations be to retain evolutionary potential? Animal Conservation 1:69-70.

Freyer, F., and M.C. Healey. 2003. Fish community structure and environmental correlates in the highly altered southern Sacramento-San Joaquin Delta. Environmental Biology of Fishes 66:123-132.

Frissell, C.A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. The Pacific Rivers Council, Eugene, Oregon

Frissell, C.A. 1997. A Spatial Approach to Species Viability: Conservation of Fishes in the Columbia River Basin. Open File Report. Flathead Lake Biological Station. The University of Montana, Polson.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File Report Number 156-99. Flathead Lake Biological Station, University of Montana, Polson, MT, 46 pp.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. American Fisheries Society Special Publication 19:297-323.

Gaines, W.L., R.A. Strand, and S.D. Piper. 1997. Effects of the Hatchery Complex Fires on northern spotted owls in the eastern Washington Cascades. Pages 123-129 in Dr. J.M. Greenlee, ed. Proceedings of the First Conference on Fire Effects on Rare and Endangered Species and Habitats, November 13-16, 1995. International Association of Wildland Fire. Coeur d'Alene, ID.

Gamett, B.L. 2002. Telephone conversation 06/20/02 with Shelley Spalding, U.S. Fish and Wildlife Service, re: relationship between water temperature and bull trout distribution and abundance in the Little Lost River, Idaho.

Gancz, A. Y., I. K. Barker, R. Lindsay, A. Dibernardo, K. McKeever, and B. Hunter. 2004. West Nile virus outbreak in north American owls, Ontario, 2002. Emerging infectious diseases 10:2135-2142.

Garmendia, A.E., H.J. Van Kruiningen, R.A. French, J.F. Anderson, T.G. Andreadis, A. Kumar, and A.B. West. 2000. Recovery and identification of West Nile virus from a hawk in winter. Journal of Clinical Microbiology 38:3110-3111.

Gergel, S.E., M.D. Dixon, and M.G. Turner. 2002. Consequences of human-altered floods: Levees, floods, and floodplain forests along the Wisconsin River. Ecological Applications 12(6):1755-1770.

Gerking, S.D. 1994. Feeding ecology of fish. Academic Press, San Diego, California. 51 pp.
Hoelscher, B. and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

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.

Giannico, G.A., and J.A. Souder. 2004. The effects of tide gates on estuarine areas and migratory fish. Oregon Sea Grant, Oregon State University. Corvallis, Oregon. Report. 9 p. http://seagrant.oregonstate.edu/sites/default/files/sgpubs/onlinepubs/g04002.pdf.

Giannico, G.A., and J.A. Souder. 2005. Tide gates in the Pacific Northwest: Operation, types and environmental effects. Oregon Sea Grant. ORESU-T-05-001. Corvallis, Oregon. Report. http://www.cooswatershed.org/Publications/tidegates_PACNW.pdf.

Gilbert, C. H. 1898. Fishes of the Klamath River Basin. Bulletin of the U. S. Fish Commission for 1897, Article 1. 1-13pp.

Gilliom, R.J., J.E. Barbash, C.G. Crawford, P.A. Hamilton, J.D. Martin, N. Nakagaki, L.H. Nowell, J.C. Scott, P.E. Stackelberg, G.P. Thelin, and D.M. Wolock. 2006. Pesticides in the nation's streams and ground water, 1992-2001. U.S. Geological Survey Circular 1291:172 p.

Gilpin. 1997. Connectivity on the Clark Fork – The Bigger Picture. Faxed letter to Shelly Spalding, Montana Dept. Fish, Wildlife and Parks, from Mike Gilpin, University of California. 5p.

Girard, C. 1857. Researches upon the cyprinoid fishes inhabiting the fresh waters of the United States of America, west of the Mississippi Valley, from specimens in the museum of the Smithsonian Institution. Proceedings of the Academy of Natural Sciences of Philadelphia 8: 165-213.

Glenn, E.M, M.C. Hansen, and R.G. Anthony. 2004. Spotted owl home-range and habitat use in young forests of western Oregon. Journal of Wildlife Management 68(1):33-50.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, literature review. U.S. Forest Service, Willamette National Forest, Eugene, Oregon.

Goetz, F.A. 1994. Distribution and juvenile ecology of bull trout (*Salvelinus confluentus*) in the Cascade Mountains. M.S. thesis. Oregon State University, Corvallis.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, Washington, June, 2004, 396 pp.

Goheen, E.M., E.M. Hansen, A. Kanaskie, M.G. Williams, N. Oserbauer, and W. Sutton. 2002. Sudden oak death caused by Phytophthora ramorum in Oregon. Plant Disease 86:441.

Golden, M.P. 1969. The Lost River sucker. Oregon Game Comm. Admin. Report No. 1-69.

Golightly, R. T., P. N. Hebert, and D. L. Orthmeyer. 2002. Evaluation of human-caused disturbance on the breeding success of marbled murrelets (Brachyramphus marmoratus) in Redwood National and State Parks, California. Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, California Department of Fish and Game, and California Department of Parks and Recreation. Arcata, CA. 61 pages.

Gregory, R.S. 1988. Effects of turbidity on benthic foraging and predation risk in juvenile Chinook salmon. Pages 64-73. In: Effects of dredging on anadromous Pacific coast fishes. C.A. Simenstad (editor). Washington Sea Grant Program, Washington State University. Seattle.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

Gremel, S. 2005. Factors controlling distribution and demography of northern spotted owls in a reserved landscape. M.S. thesis, University of Washington, Seattle. 49 pp.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

Grubb, T.G., and R.M. King. 1991. Assessing human disturbance of breeding bald eagles with classification tree models. Journal of Wildlife Management 55: 500-511.

Grubb, T.G., D.K. Delaney, W.W. Bowerman, and M.R. Wierda. 2010. Golden eagle indifference to heli-skiing and military helicopters in northern Utah. Journal of Wildlife Management 74: 1275-1285.

Gucinski, H., M.J. Furniss, R.R. Ziemer, and M.H. Brookes. 2001. Forest roads: A synthesis of scientific information. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-509. Portland, Oregon. May. 103 p. http://www.fs.fed.us/pnw/pubs/gtr509.pdf.

Gutermuth, B., C. Watson, and J. Kelly. 2000. Link River hydroelectric project (east and westside powerhouses) final entrainment study report. Unpublished report prepared by Cell Tech and PacificCorp Environmental Services.

Gutiérrez, R.J. 1989. Hematozoa from the spotted owl. Journal of Wildlife Diseases 24:614–618.

Gutiérrez, R.J. 1996. Biology and distribution of the northern spotted owl. Pages 2-5 in E.D. Forsman et al., editors. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithological Society.

Gutiérrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted owl (Strix occidentalis) in: A. Poole and F. Gill, editors. The birds of North America, No. 179. The Academy of Natural Sciences and The American Ornithologists' Union, Washington, D.C. 28 pages.

Gutiérrez, R. J., M. Cody, S. Courtney, and A. Franklin. 2007. The Invasion of Barred Owls and its Potential Effect on the Spotted Owl: a Conservation Conundrum. Biological Invasions 9:181-196.

Haas, G.R., and J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Canadian Journal of Fisheries and Aquatic Sciences 48:2191-2211.

Haas, G.R., and J.D. McPhail. 2001. The post-Wisconsin glacial biogeography of bull trout (Salvelinus confluentus): a multivariate morphometric approach for conservation biology and management. Canadian Journal of Fisheries and Aquatic Sciences 58:2189-2203.

Haig, S.M., R.S. Wagner, E.D. Forsman, E.D., and T.D. Mullins. 2001. Geographic variation and genetic structure in spotted owls. Conservation Genetics 2(1):25-40.

Haig, S.M., T.D. Mullins, E.D. Forsman, P. Trail, and L. Wennerberg. 2004. Genetic identification of spotted owls, barred owls, and their hybrids: legal implications of hybrid identity. Conservation Biology 18:1347-1357.

Hamer, T.E., S.G. Seim, and K.R. Dixon. 1989. Northern spotted owl and northern barred owl habitat use and home range size in Washington: preliminary report. Washington Department of Wildlife, Olympia, Washington.

Hamer, T.E., E.D. Forsman, A.D. Fuchs, and M.L. Walters. 1994. Hybridization between barred and spotted owls. Auk 111(2):487-492.

Hamer, T.E., D.L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of northern barred owls and northern spotted owls in an area of sympatry. Journal of Raptor Research 35(3):221-227.

Hamer, T.E. and S.K. Nelson. 1995a. Nesting chronology of the marbled murrelet. In Ralph, C.J., G.L. Hunt, jr., M.G. Raphael, J.F. Piatt, tech. eds. 1995. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Hamer, T.E. and Nelson, S.K. 1995b. Characteristics of marbled murrelet nest trees and nesting stands. In Ralph, C.J., G.L. Hunt, M.G. Raphael, J.F. Piatt, tech. eds. 1995. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

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

Hamer, T.E., S.K. Nelson, and T.I. Mohagen II. 2003. Nesting chronology of the marbled murrelet in North America. Unpubl.

Hamlet, A. F., P. W. Mote, M. P. Clark, and D. P. Lettenmaier. 2005. Effects of temperature and precipitation variability on snowpack trends in the western United States. Journal of Climate 18:4545-4561.

Hanson, E., D. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted Owl Habitat in Washington: A Report to the Washington Forest Practices Board. Washington Forest Practices Board, Spotted owl Advisory Group. Final Report: December 20, 1993. Olympia, Washington. 116 pages.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17: 304-326.

Harestad, A., J. Hobbs, and I. Blackburn. 2004. Précis of the Northern Spotted Owl in British Columbia. Pages. 12-14 in Zimmerman, K., K. Welstead, E. Williams, J. Turner, (editors). Northern Spotted Owl Workshop Proceedings. Forrex Series (online No. 14), Vancouver, British Columbia, Canada.

Hari, R. E., D. M. Livingstone, R. Siber, P. Burkhardt-Holm, and H. Guttinger. 2006. Consequences of climatic change for water temperature and brown trout populations in alpine rivers and streams. Global Change Biology 12:10–26.

Harris, P. 1996. Personal Communication between P. Harris (Oregon State University) and Alan Mauer (USFWS), Corvallis, OR.

Hartzell, K. E, and K. Popper. 2002. Warner Sucker Progress Report-2001 Findings. Unpublished Report to Bureau of Land Management.36pp.

Hayes, J.P. 1980. Fish of the Warner Valley. Pages 131-137 in C. Gilman and J.W. Feminella, editors. Plants and animals associated with aquatic habitats of the Warner Valley. Oregon State University, Corvallis, Oregon.

Hayes, B.S., R.S. Shively, E.C. Janney, and G.N. Blackwood. 2002. Monitoring of Lost River and Shortnose suckers at shoreline spawning areas in Upper Klamath Lake, Oregon. Annual report 2001. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station, Klamath Falls, Oregon.

Hayes, B. 2011. Personal Communication with Haynes, M. Fertilizer Specialist, Oregon Department of Agriculture, Salem, Oregon. Telephone conversation with Kim Garner, U.S. Fish and Wildlife Service, Portland, Oregon, in July 2011 regarding the regulation of fertilizers in Oregon.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-84.

Hebert, P.N., and R.T. Golightly. 2006. Movements, nesting, and response to anthropogenic disturbance of marbled murrelets (Brachyramphus marmoratus) in Redwood National and State Parks, California. California Department of Fish and Game, 2006-02, Sacramento, California, May, 2006. 321 pp.

Heck, M.P. P.D. Scherer, S.L. Gunkel, and S.E. Jacobs. 2008. Status and distribution of native fishes in the Goose Lake Basin. Oregon Department of Fish and Wildlife, Fish Division. Information Reports 2008-02.

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil: Part II. Increased mortality of pink salmon (Oncorhynchus gorbuscha) embryos incubating downstream from weathered Exxon Valdez crude oil. Environmental Toxicology and Chemistry 18:494-503.

Hedrick, P.W. and S. T. Kalinowski. 2000. Inbreeding depression in conservation biology. Annual Review of Ecology and Systematics 31:139-162.

Hendrixson, H. A., S. M. Burdick, B. L. Herring, and S. P. Vanderkooi. 2007a. Nearshore and offshore habitat use by endangered, juvenile Lost River and shortnose suckers in Upper Klamath Lake, Oregon. Technical Report to Klamath Falls, Oregon.

Hendrixson, H. A., A. X. Wilkens, S. M. Burdick, and S. P. Vanderkooi. 2007b. Water quality in near-shore and open waters of Upper Klamath Lake, Oregon. Technical Report to Klamath Falls, Oregon.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt, and E. Beckwitt. 1994. Interim protection for late-successional forests, fisheries, and watersheds. National forests east of the Cascade Crest, Oregon, and Washington. A report to the Congress and President of the United States Eastside Forests Scientific Society Panel. American Fisheries Society, American Ornithologists Union Incorporated, The Ecological Society of America, Society for Conservation Biology, The Wildlife Society. The Wildlife Society Technical Review 94-2.

Henke, A.L., T.Y. Chi, J. Smith, C. Brinegar. Unpublished Draft. Microsatellite Analysis of Northern and California Spotted Owls in California. Conservation Genetics Laboratory, Department of Biological Sciences, San Jose State University, San Jose, California.

Henkel, L.A., E.E. Burkett, and J.Y. Takekawa. 2003. At-sea activity and diving behavior of a radio-tagged marbled murrelet in central California. Waterbirds 26(4):9-12.

Hershey, K.T., E.C. Meslow, and F.L. Ramsey. 1998. Characteristics of forests at spotted owl nest sites in the Pacific Northwest. Journal of Wildlife Management 62(4):1398-1410.

Herter, D.R., and L.L. Hicks. 2000. Barred owl and spotted owl populations and habitat in the central Cascade Range of Washington. Journal of Raptor Research 34(4): 279-286.

Herter, D.R., L.L. Hicks, H.C. Stabins, J.J. Millspaugh, A.J. Stabins, and L.D. Melampy. 2002. Roost site characteristics of northern spotted owls in the nonbreeding season in central Washington. Forest Science 48(2):437-446.

Hewitt, D.A. and E.C. Janney. 2011. Personal Communication.

Hewitt, D. A., E. C. Janney, B. S. Hayes, and A. C. Harris. 2012. Demographics and run timing of adult Lost River (Deltistes luxatus) and shortnose (Chasmistes brevirostris) suckers in Upper Klamath Lake, Oregon, 2011. Klamath Falls Field Station, Western Fisheries Research Station, U.S. Geological Survey, U.S. Department of Interior, Reston, Virginia.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedell. 1991. Responses of salmonid to habitat change. Pages 483-518. In: Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan (editor). American Fisheries Society. Bethesda, Maryland.

Hoberg, E.P., G.S. Miller, E. Wallner-Pendleton, and O.R. Hedstrom. 1989. Helminth parasites of northern spotted owls (Strix occidentalis caurina). Journal of Wildlife Diseases 25:246–251

Hobson, K.A. 1990. Stable isotope analysis of marbled murrelets: evidence for fresh water feeding and determination of trophic level. Condor 92:897-903.

Hodge, J. and M. Buettner. 2009. Sucker population monitoring in Tule Lake and lower Lost River, 2006 - 2008. Completion Report. Klamath Falls Fish and Wildlife Office, U.S. Fish and Wildlife Service, U.S. Department of Interior, Klamath Falls, Oregon.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

Holt, R. 1997. Upper Klamath Lake fish disease exam report. Oregon Department of Fish and Wildlife, State of Oregon, Corvallis, Oregon.

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

Howe, C. B. 1969. Ancient tribes of the Klamath country. Bindfords and Mort, Portland, Oregon.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Hubbs, C.L. and R. R. Miller. 1934. Field notes - Rush Creek, 16 August 1934, Station M34-134. 2 pp. Unpublished.

Huff, Mark H., M.G. Raphael, S.L. Miller, K.S. Nelson, and J. Baldwin, tech. coords. 2006. Northwest Forest Plan—The first 10 years (1994-2003): status and trends of populations and nesting habitat for the marbled murrelet. General Technical Report PNW-GTR-650. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 149 pp.

Hull, C.L., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intraspecific variation in commuting distance of marbled murrelets (Brachyramphus marmoratus): ecological and energetic consequences of nesting further inland. Auk 118:1036-1046.

Hunt, J.H. 1964. The Warner Valley stock company - a geographic study. M.S. thesis, Oregon State University, Corvallis, Oregon. 116 pp.

Incardona, J.P., T.K. Collier, and N.L. Scholz. 2004. Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. Toxicology and Applied Pharmacology 196:191-205.

Incardona, J.P., M.G. Carls, H. Teraoka, C.A. Sloan, T.K. Collier, and N.L. Scholz. 2005. Aryl hydrocarbon receptor-independent toxicity of weathered crude oil during fish development. Environmental Health Perspectives 113:1755-1762.

Incardona, J.P., H.L. Day, T.K. Collier, and N.L. Scholz. 2006. Developmental toxicity of 4-ring polycyclic aromatic hydrocarbons in zebrafish is differentially dependent on AH receptor isoforms and hepatic cytochrome P450 1A metabolism. Toxicology and Applied Pharmacology 217:308-321.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. In: Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council. Portland, Oregon.

ISRP (Independent Scientific Review Panel). 2005. Current risk of extinction of the Lost River and shortnose suckers. Unpublished report submitted to the U.S. Fish and Wildlife Service, U.S. Department of Interior, Klamath Falls, Oregon.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. Available: www.ipcc.ch. (February 2007).

Irwin, L.L., D.F. Rock, and G.P. Miller. 2000. Stand structures used by northern spotted owls in managed forests. Journal of Raptor Research 34(3):175-186.

Iverson, W.F. 1993. Is the barred owl displacing the spotted owl in western Washington? M.S. Thesis, Western Washington University, Bellingham, Washington.

Iverson, W.F. 2004. Reproductive success of spotted owls sympatric with barred owls in western Washington. Journal of Raptor Research 38(1):88-91.

Janney, E. C. and R. S. Shively. 2007. An updated analysis on the population dynamics of Lost River suckers and shortnose sucker in Upper Klamath Lake and its tributaries, Oregon. Klamath Falls Field Station, Western Fisheries Research Station, U.S. Geological Survey, U.S. Department of Interior, Klamath Falls, Oregon.

Janney, E. C., R. S. Shively, B. S. Hayes, and P. M. Barry. 2008. Demographic Analysis of Lost River Sucker and Shortnose Sucker Populations in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 137:1812-1825.

Johnson, G. L. 1990. Bull trout species management plan. Nevada Division of Wildlife, Reno, Nevada. Federal Aid Project No. F-20-26, Job No. 207.4. 17 pp.

Johnson, D.H. 1992. Spotted owls, great horned owls, and forest fragmentation in the central Oregon Cascades. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Johnson, C.L., and R.T. Reynolds. 2002. Responses of Mexican spotted owls to low-flying military jet aircraft. USDA USFS, Rocky Mountain Research Station, Research Note RMRS-RN-12, January 2002. 4 pp.

Johnson, K. N., J. F. Franklin, J. W. Thomas, and J. Gordon. 1991. Alternatives for management of late successional forests of the Pacific Northwest. A report to the Agriculture and Merchant and Marine Fisheries Committees of the U.S. House of Representative. Scientific Panel on Late Successional Forest Ecosystems, Washington, D.C.

Joint Fire Science Program. 2009. Wildfire, Prescribed Fire, and Peak Stream Flow: Understanding Effects on Stream Habitats and Communities. Fire Science Brief 77. November. http://www.firescience.gov/.

Jones, J.A., F.J. Swanson, B.C. Wemple, and K.U. Snyder. 2000. Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. Conservation Biology 14(1):76-85.

Keen, F. P. 1937. Climatic cycles in eastern Oregon as indicated by tree rings. Monthly Weather Review 65 (5):175-188.

Keller, E.A., A. Macdonald, T. Tally, and N.J. Merrit. 1985. Effects of large organic debris on channel morphology and sediment storage in selected tributaries of Redwood Creek, Northwest California. Geomorphic processes and aquatic habitat in the Redwood Creek basin, Northwestern California. U.S. Geological Survey. Professional Paper 1454-P. P1-P29. http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_1/2003/ref962.pdf.

Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls replacing spotted owls? The Condor 105:45-53.

Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between barred owls (Strix varia) and northern spotted owls (S. occidentalis caurina). Auk 121:806-810.

Kennedy, T.B. and J.F. North. 1993. 1992 Report: Drift behavior and distribution of Warner sucker (Catostomus warnerensis) and preliminary assessment of stream habitat conditions in the Warner Valley, Oregon. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 25 pp.

Kennedy, T.B. and M. Olsen. 1994. Drift ecology of Warner sucker larvae (Catostomus warnerensis) and lake recolonizations by native and exotic fishes of the Warner Valley, Oregon. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 42 pp.

Kerns, S.J. and D. Allwardt. 1992. Proximity of Human Activity to Northern Spotted Owl Nesting Pairs on Lands of the Pacific Lumber Company. Report to: The Pacific Lumber Company, Scotia, CA. 15 pp.

Kettratad, J. 2001. Systematic study of Modoc suckers (Catostomus microps) and Sacramento suckers (Catostomus occidentalis) in the upper Pit River system, California. M.S. Thesis, Humboldt State University, Arcata, California. 79 pp.

Kiely, T., D. Donaldson, and A. Grube. 2004. Pesticides industry sales and usage 2000 and 2001 market estimates. U.S. Environmental Protection Agency, Biological and Economic Analysis Division. http://www.epa.gov/opp00001/pestsales/01pestsales/market_estimates2001.pdf.

King, G.M., K.R. Bevis, M.A. Rowe, E.E. Hanson. 1998. Spotted owls use of habitat impacted by 1994 fires on the Yakama Indian Reservation: three years post fire. Unpub. report.

Kirk, S., D. Turner, and J. Crown. 2010. Upper Klamath and Lost River subbasins total maximum daily loads (TMDL) and water quality management plan. Department of Environmental Quality, State of Oregon.

Kitaysky, A., J.C. Wingfield and J.F. Piatt. 2001. Corticosterone facilitates begging and affects resource allocation in the black-legged kittiwake. Behavioural Ecology 12: 619-625.Knight, R.L., and K.L. Gutzwiller, eds. 1995. Wildlife and recreationists: coexistence through management and research. Island Press, Washington, D.C.

Knapp, P.A., P.T. Soulé and H.D. Grissino-Mayer. 2004. Occurrence of sustained droughts in the interior Pacific Northwest (A.D. 1733-1980) inferred from tree-ring data. Journal of Climate 17:140-150.

Knight, R.L., and K.J. Gutzwiller, eds. 1995. Wildlife and recreationists: coexistence through management and research. Island Press, Washington, D.C.

Knight, R.L., and S.K. Skagen. 1998. Effects of recreational disturbance on birds of prey: a review. Pages 355-359 in R.L. Glinski et al., editors. Proceedings of the Southwest Raptor Management Symposium and Workshop, National Wildlife Federation, Washington, D.C.

Knowles, N., M. D. Dettinger, and D. R. Cayan. 2006. Trends in snowfall versus rainfall in the western United States. Journal of Climate 19:4545-4559.

Knox, J.C. 2006. Floodplain sedimentation in the Upper Mississippi Valley: Natural versus human accelerated. Geomorphology 79:286-310.

Kobetich, G. C. 1977. Report on survey of Warner Valley Lakes for Warner suckers, Catostomus warnerensis. Unpublished report to Fish and Wildlife Service. 6 pp.

Koch, D.L., J.J. Cooper, G.P. Contreras, and V. King. 1975. Survey of the fishes of the Clear Lake Reservoir drainage. Proj. Rept. 37. Center for Water Resources Research, Desert Research Institute, University of Nevada, Reno, Nevada.

Korson, C., T. J. Tyler, and C. A. Williams. 2008. Link River Dam fish ladder fish passage results, 2005-2007. Klamath Basin Area Office, U.S. Bureau of Reclamation, U.S. Department of Interior, Klamath Falls, Oregon.

Kuletz, K.J., and J.F. Piatt. 1999. Juvenile marbled murrelet nurseries and the productivity index. Wilson Bulletin 111(2):257-261.

Kuletz, K.J. 2005. Foraging behavior and productivity of a non-colonial seabird, the marbled murrelet (Brachyramphus marmoratus), relative to prey and habitat. Ph.D. dissertation, University of Victoria, Victoria, British Columbia.

Kyger, C. and A. Wilkens. 2010. Endangered Lost River and shortnose sucker distribution and relative abundance in Lake Ewauna, and use of the Link River dam fish ladder, Oregon: Annual Report 2010. Klamath Basin Area Office, Bureau of Reclamation, U.S. Department of Interior, Klamath County, Oregon.

LaHaye, W.S., R.J. Guiterrez, and J.R. Dunk. 2001. Natal dispersion of the spotted owl in southern California: dispersal profile of an insular population. The Condor 103:691-700.

Lafferty, K.D., D. Goodman, C.P. Sandoval. 2006. Restoration of breeding by snowy plovers following protection from disturbance. Biodiversity and Conservation 15: 2,217-2,230.

Laidig, K.J., and D.S. Dobkin. 1995. Spatial overlap and habitat association of Barred Owls and Great Horned Owls in southern New Jersey. Journal of Raptor Research 29:151–157.

Laird, I.W. 1971. The Modoc Country. Lawton and Kennedy Printers, Alturas, CA.

Lank, David B., Nadine Parker, Elizabeth A. Krebs, and Laura McFarlane Tranquilla. 2003. Geographic distribution, habitat selection, and population dynamics with respect to nesting habitat characteristics, of marbled murrelets. Centre for Wildlife Ecology, Simon Fraser University, Burnaby, Canada. 66 pages.

Larkin, R. P. 1994. Effects of military noise on wildlife: a literature review. Final Report to U.S. Army Construction Engineering Research Laboratory, November 1994, 87 pp.

Lassettre, N.S., and R.R. Harris. 2001. The geomorphic and ecological influence of large woody debris in streams and rivers. University of California-Berkeley. Department of Lands and Environmental Planning. Report. 68 p. http://frap.cdf.ca.gov/publications/lwd/lwd_paper.pdf.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] **7** 856-865.

Leary, R.F., and F.W. Allendorf. 1997. Genetic confirmation of sympatric Bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leathe, S.A., and P. Graham. 1982. Flathead Lake fish food habits study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study. Contract R008224-01-4 to Montana Department of Fish, Wildlife, and Parks.

Lee, D.C., J.R. Sedell, B.E. Reiman, R.F. Thurow, and J.E. Williams. 1997. Broadscale assessment of aquatic species and habitats. Pages 1058-1496. In: An Assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins. T.M. Quigley, and S.J. Arbelbide (editors). U.S. Forest Service. General Technical Report PNW-GTR-405. Portland, Oregon.

Leskiw, T., and R.J. Gutiérrez. 1998. Possible predation of a spotted owl by a barred owl. Western Birds 29:225–226.

Liebezeit, J.R., and T.L. George. 2002. A summary of predation by Corvids on threatened and endangered species in California and management recommendations to reduce Corvid predation. California Department of Fish and Game, Species Conservation and Recovery Program Report 2002-02, Sacramento, CA. 103 pp.

Light, J., L. Herger, and M. Robinson. 1996. Upper Klamath basin bull trout conservation strategy, a conceptual framework for recovery. Part one. The Klamath Basin Bull Trout Working Group

Lint, J., technical coordinator. 2005. Northwest Forest Plan – the first 10 years (1994-2003): status and trends of northern spotted owl populations and habitat. PNW-GTR-648, USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Livezey, K.B. 2005. Iverson (2004) on spotted owls and barred owls: comments on methods and conclusions. Journal of Raptor Research 39(1):102-103.

Long, L.L., and C.J. Ralph. 1998. Regulation and observations of human disturbance near nesting marbled murrelets. 35 pp.

Long, L.L., S.L. Miller, C.J. Ralph, and E.A. Elias. 2008. Marbled murrelet abundance, distribution, and productivity along the coasts of Northern California and Southern Oregon, 2005-2007, Report to USFWS and Bureau of Land Management, Arcata, California, 2008. 49 pp.

Luginbuhl, J. M., J. M. Marzluff, J. E. Bradley, M. G. Raphael, and D. E. Varland. 2001. Corvid survey techniques and the relationship between corvid relative abundance and nest predation. Journal of Field Ornithology 72(4):556-572.

Lynch, M. and R. Lande. 1998. The critical effective size for a genetically secure population. Animal Conservation 1:70-72.

Madej, M.A. 2001. Erosion and sediment delivery following removal of forest roads. Earth Surface Processes and Landforms 26:175-190.

Magoulick, D. D. and R. M. Kobza. 2003. The role of refugia for fishes during drought: a review and synthesis. Freshwater Biology 48:1186-1198.

Malheur National Forest and the Keystone Project. 2007. Beaver Management Strategy.

Manley, I. A. 1999. Behavior and habitat selection of marbled murrelets nesting on the Sunshine Coast. Masters of Science Thesis. Department of Biological Sciences, Simon Fraser University, Burnaby, Canada. 163 pages.

Manley, I.A., A. Harfenist, and G. Kaiser. 2001. Marbled murrelet telemetry study on Queen Charlotte Islands/Haida Gwaii. Smithers, BC, Ministry of Environment, Lands and Parks, 24 pp.

Malheur National Forest and the Keystone Project. 2007. Beaver Management Strategy.

Marcot, B.G., C.S. Allen, S. Morey, D. Shively, and R. White. 2012. An expert panel approach to assessing potential effects of bull trout reintroduction on federally listed salmonids in the Clackamas River, Oregon North American Journal of Fisheries Management 32:450-465.

Marine, K. R. and M. Gorman. 2005. Monitoring and evaluation of the A-canal fish screen and bypass facility. Unpublished report submitted to the Bureau of Reclamation, U.S. Department of Interior, Klamath Falls, Oregon.

Marine, K. R. and P. Lappe. 2009. Link River Dam surface spill experiment: evaluation of differential juvenile sucker downstream passage rates. Unpublished report submitted to the Bureau of Reclamation, U.S. Department of Interior, Klamath Falls, Oregon.

Markle, D.F. and D.C. Simon. 1993. Preliminary studies of systematics and juvenile ecology of Upper Klamath Lake suckers. Annual report. Oregon State University. Department of Fisheries and Wildlife, Corvallis, OR, 151 pp.

Markle, D. F. and L. K. Dunsmoor. 2007. Effects of Habitat Volume and Fathead Minnow Introduction on Larval Survival of Two Endangered Sucker Species in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 136:567-579.

Marra, P.P., S. Griffing, C. Caffrey, A.M. Kilpatrick, R. McLean, C. Brand, E. Saito, A.P. Dupuis, L. Kramer, and R. Novak. 2004. West Nile Virus and wildlife. BioScience 54(5):393-402.

Marshall, K.N., N.T. Hobbs, and D.J. Cooper. 2013. Stream hydrology limits recovery of riparian ecosystems after wolf reintroduction. Proceedings of the Royal Society Biological Sciences 280:20122977.

Markle, D., T. Pearsons and D. Bills. 1991. Natural history of Oregonichthys (Pisces: Cyprinidae), with a description of a new species from the Umpqua River of Oregon. Copeia (2): 277-293.

Markle, D. F. and M. S. Cooperman. 2002. Relationship between Lost River and shortnose sucker biology and management of Upper Klamath Lake. Pages 93-117 in Water Allocation in the Klamath Reclamation Project, 2001: An assessment of natural resource, economic, social, and institutional issues with a focus on the Upper Klamath Basin, B. Braunworth and T. Welch, editors. Oregon Sate University and University of California. Corvallis.

Markle, D. F., M. R. Cavalluzzi, and D. C. Simon. 2005. Morphology and taxonomy of Klamath Basin suckers (Catostomidae). Western North American Naturalist 65:473-489.

Martin, M. 1967. The distribution and morphology of the North American catostomid fishes of the Pit River system, California. M.A. thesis, Sacramento State Univ., Sacramento, California. 67 pp.

Martin, M. 1972. Morphology and variation of the Modoc sucker, Catostomus microps Rutter, with notes on feeding adaptations. Calif. Dept. Fish and Game 58(4):277 284.

Mason, A., A.E. Burger, and B. Hansen. 2002. At-sea surveys of marbled murrelets in Clayoquot Sound, 1996-2000. In Burger, A., and T.A. Chatwin, eds., Multi-scale studies of populations, distribution and habitat associations of marbled murrelets in Clayoquot Sound, British Columbia: Victoria, British Columbia, Ministry of Water, Land and Air Protection, p 15-33.

Materna, E.J. and J. Buck. 2007. Assessment of impacts to aquatic organisms from pesticide use on the Willamette Valley National Wildlife Refuge Complex. U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland. 83 pp.

Mathews, N.J.C., and A.E. Burger. 1998. Diving depth of a marbled murrelet. Northwestern Naturalist 79:70-71.

Matthews, W.J. and E. Marsh-Matthews. 2003. Effects of drought on fish across axes of space, time, and ecological complexity. Freshwater Biology 48:1232-1253.

MBTRT (Montana Bull Trout Restoration Team). 2000. Restoration plan for bull trout in the Clark Fork River basin and Kootenai River basin, Montana. Montana Fish, Wildlife and Parks, Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995a. Upper Clark Fork River drainage bull trout status report (including Rock Creek). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995b. Bitterroot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995c. Blackfoot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995d. Flathead River drainage bull trout status report (including Flathead Lake, the North and Middle forks of the Flathead River and the Stillwater and Whitefish River). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995e. South Fork Flathead River drainage bull trout status report (upstream of Hungry Horse Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996a. Swan River drainage bull trout status report (including Swan Lake). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996b. Lower Clark Fork River drainage bull trout status report (Cabinet Gorge Dam to Thompson Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996c. Middle Clark Fork River drainage bull trout status report (from Thompson Falls to Milltown, including the lower Flathead River to Kerr Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996d. Lower Kootenai River drainage bull trout status report (below Kootenai Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996e. Middle Kootenai River drainage bull trout status report (between Kootenai Falls and Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996f. Upper Kootenai River drainage bull trout status report (including Lake Koocanusa, upstream of Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

McCaffery, M., T.A. Switalski, and L. Eby. 2007. Effects of Road Decommissioning on Stream Habitat Characteristics in the South Fork Flathead River, Montana. Transactions of the American Fisheries Society 136:553-561.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42. Seattle. 156 p.

McGarigal, K., R.G. Anthony, and F.B. Issacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildlife Monographs 115:1-47.

McHenry, M., G. Pess, T. Abbe, H. Coe, J. Goldsmith, M. Liermann, R. McCoy, S. Morley, and R. Peters. 2007. The physical and biological effects of engineered logjams (ELJs) in the Elwha River, Washington. Salmon Recovery Funding Board and Interagency Committee for Outdoor Recreation. Report. April. http://www.fws.gov/wafwo/fisheries/Publications/Elwha%20ELJ%20Monitoring%20Final%20Report-final.pdf.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 Years, 1935 to 1992. General Technical Report PNW-GTR-321. USDA Forest Service, Pacific Northwest Research Station.

McMichael, G.A., A.L. Fritts, and T.N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management 18:894-904.

McPhail, J.D. and C. Murray. 1979. The early life history and ecology of Dolly Varden (*Salvelinus malma*) in the upper Arrow Lakes. Rpt to the BC Columbia Hydro and Power Authority and Kootenay Dept of Fish and Wildlife.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout *(Salvelinus confluentus)* life-history and habitat use in relation to compensation and improvement opportunities. Department of Zoology, University of British Columbia. Fisheries Management Report No. 104. Vancouver, British Columbia, Canada.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished report. EDAW, Inc. Seattle, Washington. Prepared for the U.S. Fish and Wildlife Service, Region 1. Portland, Oregon.

Meehan, W.R. 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19.

Meekins, D. J., and T. E. Hamer. 1998. Use of radar to monitor marbled murrelets at inland sites in the North Cascades of Washington: Preliminary Report. USDA Forest Service. 16 pages.

Meffe and Vrijenhoek 1988. Conservation Genetics in the Management of Desert Fishes. Conservation Biology. Volume 2. Issue 2. Page 157-169, June 1988.

Meffe, G.K., and C.R. Carroll. 1994. Principles of conservation biology. Sinauer Associates, Inc. Sunderland, Massachusetts.

Merz, J.E., and L.K.O. Chan. 2005. Effects of gravel augmentation on macroinvertebrate assemblages in a regulated California river. River Research Application 21:61-74.

Merriman, D. and L. Soutter. 1933. Field notes: Branch of Bauer’s Creek, Lake County, Oregon. August 27, 1933 (field number M-10-33). Unpublished.

Metro. 2010. Urban Growth Report: 2009-2030, Employment and Residential. Metro. Portland, Oregon. January. http://library.oregonmetro.gov/files/ugr.pdf.

Metro. 2011. Regional Framework Plan: 2011 Update. Metro. Portland, Oregon. http://library.oregonmetro.gov/files//rfp.00_cover.toc.intro_011311.pdf.

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

Meyer, J.S., L.L. Irwin, and M.S. Boyce. 1998. Influence of habitat abundance and fragmentation on northern spotted owls in western Oregon. Wildlife Monographs 139: 1-51.

Meyer, J. S. and J. A. Hansen. 2002. Subchronic toxicity of low dissolved oxygen concentrations, elevated pH, and elevated ammonia concentrations to Lost River suckers. Transactions of the American Fisheries Society 131:656-666.

Millar, R.G., and M.C. Quick. 1998. Stable width and depth of gravel-bed rivers with cohesive banks. Journal of Hydraulic Engineering 124:1005-1013.

Miller, R.R. and G.R. Smith. 1981. Distribution and evolution of Chasmistes (Pisces: Catostomidae) in western North America. Occasional Papers of the Museum of Zoology, University of Michigan, Ann Arbor. Number 696. 46 pp.

Millar, R.G., and M.C. Quick. 1998. Stable width and depth of gravel-bed rivers with cohesive banks. Journal of Hydraulic Engineering 124:1005-1013.

Miller, R. R. and G. R. Smith. 1967. New fossil fishes from Plio-Pleistocene Lake Idaho. Occasional Papers of the Museum of Zoology, University of Michigan 654:1-24.

Miller, G.S., S.K. Nelson, and W.C. Wright. 1985. Two-year-old female spotted owl breeds successfully. Western Birds 16:69-73.

Miller, G.S. 1989. Dispersal of juvenile spotted owls in western Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Miller, G.S., R.J. Small, and E.C. Meslow. 1997. Habitat selection by spotted owls during natal dispersal in western Oregon. Journal of Wildlife Management 61(1):140-150.

Miller, R.F., J.D. Bates, T.J. Svejcar, F.B. Pierson, and L.E. Eddleman. 2005. Biology, ecology, and management of western juniper (Juniper occidentalis). Oregon State University Technical Bulletin 152. Corvallis, Oregon.

Miller, S.L., M.G. Raphael, G.A. Falxa, C. Strong, J. Baldwin, T. Bloxton, B.M. Galleher, M. Lance, D. Lynch, S.F. Pearson, C.J. Ralph, and R.D. Young. 2012. Recent population decline of the marbled murrelet in the Pacific Northwest. The Condor 114(4):771-781.

Mills, T.J. 1980. Life history, status, and management of the Modoc sucker, Catostomus microps Rutter in California, with a recommendation for endangered classification. Calif. Dept. Fish Game, Inland Fisheries Endangered Species Program Spec. Publ. 80 6. 35 pp.

Minshall, G.W., and J.T. Brock. 1991. Observed and anticipated effects of forest fire on Yellowstone stream ecosystems. In: The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage. R.B. Keiter, and M.S. Boyce (editors). Yale University Press. New Haven, Connecticut.

Minshall, G.W. 2003. Responses of stream benthic macroinvertebrates to fire. Forest Ecology and Management 178:155-161.

Moberg, G.P. 2000. Biological response to stress: Implications for animal welfare. Pages 1-21. In: The biology of animal stress - basic principles and implications for animal welfare. G.P. Moberg, and J.A. Mench (editors). CABI Publishing. Cambridge, Massachusetts.

Moen, C.A., A.B. Franklin, and R.J. Gutiérrez. 1991. Age determination of subadult northern spotted owls in northwest California. Wildlife Society Bulletin 19:489-493

Moeur, M., T.A. Spies, M. Henstrom, J.R. Martin, J. Alegria, J. Browning, J. Cissel, W.B. Cohen, T.E. Demeo, S. Healey, R. Warbington. 2005. Northwest Forest Plan–The first 10 years (1994-2003): status and trend of late-successional and old-growth forest. Gen. Tech. Rep. PNW-GTR-646. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 142 p.

Morace, J. L. 2007. Relation between selected water-quality variables, climatic factors, and lake levels in Upper Klamath and Agency Lakes, Oregon, 1990-2006: Scientific Investigations Report 2007-5117. U.S. Geological Survey, Reston.

Moyle, P.B. and A. Marciochi. 1975. Biology of the Modoc sucker, Catostomus microps, in northeastern California. Copeia 1975(3):556 560.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California.

Moyle, P.B. and R.A. Daniels. 1982. Fishes of the Pit River system, McCloud River system, and Surprise Valley region. Univ. Calif. Publ. Zool. 115:1 82.

Moyle, P. B. 2002. Inland Fishes of California: Revised and Expanded. University of California Press, Berkeley.

Moyle, P.B., and J.A. Israel. 2005. Untested assumptions: Effectiveness of screening diversions for conservation of fish populations. Fisheries 30(5):20-29.

Murota, T. 2003. The marine nutrient shadow: A global comparison of anadromous salmon fishery and guano occurrence. In: Nutrients in Salmonid Ecosystems: Sustaining production and

Biodiversity. J. Stockner (editor). American Fisheries Society. Symposium 34. Bethesda, Maryland.

Murphy, B.R., and D.W. Willis (editors). 1996. Fisheries techniques, 2nd edition. Bethesda, Maryland. 732 p.

Murphy, M.L., and W.R. Meehan. 1991. Stream ecosystems. Pages 17-46. In: Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan (editor). American Fisheries Society. Bethesda, Maryland.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska -- requirements for protection and restoration. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Coastal Ocean Office. October. http://www.cop.noaa.gov/pubs/das/das7.pdf.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds. Peer review summary prepared for U.S. Fish and Wildlife Service.

Nagasaka, A., Y. Nagasaka, K. Ito, T. Mano, M. Yamanaka, A. Katayama, Y. Sato, A.L. Grankin, A.I. Zdorikov, and G.A. Boronov. 2006. Contributions of salmon-derived nitrogen to riparian vegetation in the northwest Pacific region. Journal of Forestry Research 11:377-382.

National Fire Plan. 2000. The National Fire Plan. Web Page. U.S. Department of Agriculture, Forest Service, Forests and Rangelands. Washington, DC. www.forestsandrangelands.gov/resources/overview.

Neary, D.G., K.C. Ryan, and L.F. DeBano (editors). 2005. (revised 2008). Wildland fire in ecosystems: effects of fire on soils and water. In: General Technical Report RMRS-GTR-42, Vol. 4. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Ogden, Utah. 250 p.

Negrini, R. M. 2002. Pluvial lake sizes in the northwestern Great Basin throughout the Quaternary Period. Pages 11-52 in Great Basin aquatic systems history, R. Hershler, D. B. Madsen, and D. R. Currey, editors. Smithsonian Institution Press, Washington, D.C.

Nehlsen, W., J. Williams, and J. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(02):4-21.
Nelson, K. 1997. Marbled Murrelet (Brachyramphus marmoratus). In: Birds of North America, No. 276 (A. Poole and G. Gill, eds.). Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC.

Nelson, S.K., and T.E. Hamer. 1995. Nest success and the effects of predation on marbled murrelets. Pp. 89-97. In: Ecology and conservation of the marbled murrelet (C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds). U.S. Forest Service, Gen. Tech. Rep. PSW-GTR-152, Albany, California.

Nelson, S. K., and A. K. Wilson. 2002. Marbled murrelet habitat characteristics on state lands in western Oregon. Corvallis, OR: Oregon Cooperative Fish and Wildlife Research Unit, OSU, Department of Fisheries and Wildlife. 151 pages.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16:693-727.

Newman, J.S., E.J. Rickley, T.L. Bland, and K.R. Beattie. 1984. Noise measurement flight test for Boeing Vertol 234/CH 47-D helicopter: Data/analyses. Federal Aviation Administration, Office of Environment and Energy, Washington D.C. 192 pp.

Newton, J.A., and S. Pribyl. 1994. Bull trout population summary: Lower Deschutes River subbasin. Oregon Department of Fish and Wildlife, The Dalles, Oregon. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996.

NMFS. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. National Marine Fisheries Service. Portland, Oregon and Santa Rosa, California. http://swr.nmfs.noaa.gov/sr/Electrofishing_Guidelines.pdf.

NMFS. 2008c. Reinitiation of the Endangered Species Act Section 7 Formal Programmatic Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Fish Habitat Restoration Activities in Oregon and Washington, CY2007-CY2012 (June 27, 2008) (Refer to NMFS Nos.: FS: 2008/03505, BLM: 2008/03506, BIA: 2008/03507).

NMFS. 2009c. Programmatic biological and conference opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for restoration actions funded or carried out by the NOAA Restoration Center in the Pacific Northwest using the Damage Assessment, Remediation and Restoration Program and the Community-based Restoration Program (October 22, 2009) (Refer to NMFS No.: 2007/09078). https://pcts.nmfs.noaa.gov/pls/pcts-pub/sxn7.pcts_upload.download?p_file=F14516/2009_10-22_NOAARC_200709078.pdf.

NMFS. 2009d. Programmatic biological and conference opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for restoration actions funded or carried out by the U.S. Fish and Wildlife Service in Oregon and Southwest Washington using the Partners for Fish and Wildlife, Coastal, and Recovery Programs (October 21, 2009) (Refer to NMFS No.:2008/03791). https://pcts.nmfs.noaa.gov/pls/pcts-pub/sxn7.pcts_upload.download?p_file=F18485/2009_10-21_usfws_restoration_200803791.pdf.

NMFS. 2010. Endangered Species Act Programmatic Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations for Vegetation treatments Using Herbicides on Bureau of Land Management

(BLM) Lands Across Nine BLM Districts in Oregon (September 1, 2010) (Refer to NMFS No: 2009/05539).

NMFS. 2011d. Endangered Species Act Section 7 Consultation biological opinion on the Environmental Protection Agency registration of pesticides 2,4-D, triclopyr BEE, diuron, linuron, captan, and chlorothalonil. Endangered Species Division of the Office of Protected Resources, National Marine Fisheries Service. Silver Spring, Maryland. http://www.epa.gov/espp/litstatus/final-4th-biop.pdf.

NMFS. 2011e. Anadromous salmonid passage facility design. NMFS, Northwest Region, Portland, Oregon. http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf.

NMFS. 2011f. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Reinitiation of the Payette National Forest Noxious Weed Management Program; Hells Canyon (17060101), Little Salmon River (17060210), Lower Salmon (17060209), South Fork Salmon (17060208), Middle Salmon-Chamberlain (17060207), Lower Middle Fork Salmon (17060206), and Upper Middle Fork Salmon (17060205) Subbasins; Idaho, Valley, Adams, and Custer Counties, Idaho (October 12, 2011) (Refer to NMFS No: 2011/03919). https://pcts.nmfs.noaa.gov/pls/pcts-pub/sxn7.pcts_upload.download?p_file=F8361/201103919_weeds_reinitiation_10-12-2011.pdf.

NMFS. 2012e. Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Invasive Plant Treatment Project on Deschutes National Forest, Ochoco National Forest and Crooked River National Grassland, Oregon. (February 2, 2012) (Refer to NMFS No: 2009/03048).

NMFS (National Marine Fisheries Service). 2013. Reinitiation of the Endangered Species Act Section 7 Formal Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Aquatic Restoration Activities in the States of Oregon and Washington (ARBO II). Portland, OR.

Noon, B.R. and J.A. Blakesley. 2006. Conservation of the northern spotted owl under the Northwest Forest Plan. Conservation Biology 20:288–296.

North, M.P., J.F. Franklin, A.B. Carey, E.D. Forsman, and T. Hamer. 1999. Forest structure of the northern spotted owl's foraging habitat. Forest Science 45(4):520-527.

North, M.P., G. Steger, R. Denton, G. Eberlein, T. Munton, and K. Johnson. 2000. Association of weather and nest-site structure with reproductive success in California spotted owls. Journal of Wildlife Management 64(3):797-807.

NPS (National Park Service). 1994. Report of effects of aircraft overflights on the National Park System. Prepared pursuant to public law 100-91, The National Parks Overflight Act of 1987.

NRC. 2004. Endangered and threatened fishes in the Klamath River basin: Causes of decline and strategies for recovery. National Academy Press, Washington, D.C.

Olson, G.S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management 68(4):1039-1053.

Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effects of barred owls. Journal of Wildlife Management 69(3):918-932.

ODEQ (Oregon Department of Environmental Quality). 1995. 1992-1994 Water quality standards review: Dissolved oxygen - Final issue paper. Oregon Department of Environmental Quality, Portland, OR.

ODEQ (Oregon Department of Environmental Quality). 2003. Alvord Lake subbasin total maximum daily load (TMDL) & water quality management plan (WQMP). Oregon Department of Environmental Quality, Portland, OR.

ODEQ. 2012. Oregon's 2010 Integrated Report – Assessment Database and 303(d) List. Oregon Department of Environmental Quality. Portland, Oregon. http://www.deq.state.or.us/wq/assessment/assessment.htm.

Oregon Department of Forestry. 2007. Forest Practices Administrative Rules and Forest Practices Act. Salem, Oregon.

ODFW. 2008. Oregon guidelines for timing of in-water work to protect fish and wildlife resources. Oregon Department of Fish and Wildlife. http://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_work2008.pdf.

Oregon Office of Economic Analysis. 2011. Oregon economic and revenue forecast. Appendix C: Population forecast by age and sex. http://www.oregon.gov/DAS/OEA/docs/economic/appendixc.pdf.

Oregon. 1996. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996.
Oregon. 1997. Coastal Salmon Restoration Initiative. The Oregon Plan. State of Oregon.

Palmerston, M., G. Tranah, and B. May. 2001. Report on genetics of Modoc sucker, Catostomus microps. Submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office; Univ. Calif., Davis, California.

Parmesan C. and G. Yohe. 2003. A Globally Coherent Fingerprint of Climate Change Impacts Across Natural Systems.

Paton, P. W. C., C. J. Ralph, and R. A. Erickson. 1992. Use of an inland site in northwestern California by marbled murrelets. Proceedings of the Western Foundation of Vertebrate Zoology 5:109-116.

Pearsons, T.N. 1989. Ecology and decline of a rare western minnow: the Oregon chub (Oregonichthys crameri). Master of Science Thesis. Oregon State University, Corvallis, Oregon. 86 pp.

Pearson, R.R., and K.B. Livezey. 2003. Distribution, numbers, and site characteristics of spotted owls and barred owls in the Cascade Mountains of Washington. Journal of Raptor Research 37(4):265-276.

Peery, M.Z., S.R. Beissinger, S.H. Newman, E.B. Burkett, and T.D. Williams. 2004. Applying the declining population paradigm: diagnosing causes of poor reproduction in the marbled murrelet. Conservation Biology 18(4):1088-1098.

Peery, M.Z., L.A. Hall, J.T. Harvey, and L.A. Henkel. 2008. Abundance and productivity of marbled murrelets off central California during the 2008 breeding season. Final Report Submitted to California State Parks, Half Moon Bay, CA. September 2008. 10 pp.

Peery, M.Z., and R.W. Henry. 2010. Abundance and productivity of marbled murrelets off central California during the 2009 breeding season. Final Report. California State Parks, Half Moon Bay, California, February 2010. 16 pp.

Perkins, D. L., J. Kahn, and G. G. Scoppettone. 2000a. The role of poor water quality and fish kills in the decline of endangered Lost River and shortnose suckers in Upper Klamath Lake. U.S. Geological Survey, Reno, Nevada.

Perkins, D. L., G. G. Scoppettone, and M. Buettner. 2000b. Reproductive biology and demographics of endangered Lost River and shortnose suckers in Upper Klamath Lake, Oregon. Technical Report to Reno.

Pfrender M.E., J. Hicks, and M. Lynch. 2003. Biogeographic patterns and current distribution of molecular-genetic variation among populations of speckled dace, Rhinichthys osculus (Girard). Molecular Phylogenetics and Evolution, 30(3), 490-502.

Piatt, J.F., K.J. Kuletz, A.E. Burger, S.A. Hatch, V.L. Friesen, T.P. Birt, M.L. Arimitsu, G.S. Drew, A.M.A. Harding, and K.S. Bixler, 2007, Status review of the Marbled Murrelet (Brachyramphus marmoratus) in Alaska and British Columbia: U.S. Geological Survey Open-File Report 2006-1387, 258 p.

Pico, Y., C. Blasco, and G. Font. 2004. Environmental and food applications of LC-tandem mass spectrometry in pesticide-residue analysis: An overview. Mass Spectrometry Reviews 23:45-85.

Pierce, D.J., J.B. Buchanan, B.L. Cosentino, and S. Snyder. 2005. An assessment of spotted owl habitat on non-federal lands in Washington between 1996 and 2004. Wildlife Department of Wildlife Research Report.

Poff, N.L., and D.D. Hart. 2002. How dams vary and why it matters for the emerging science of dam removal. BioScience 52:659-668.

Pollock, M.M., T.J. Beechie, and C.E. Jordan. 2007. Geomorphic changes upstream of beaver dams in Bridge Creek, an incised stream channel in the interior Columbia River basin, eastern Oregon. Earth Surface Processes and Landforms 32:1174–1185.

Pollock, M.M., J. Wheaton, N. Bouwes, C. Jordan, and N. Weber. 2012. Using beaver to reconnect floodplains and restore riparian habitat in an incised stream. American Water Resources Association 2012 Summer Specialty Conference, Riparian Ecosystems IV: Advancing Science, Economics and Policy, Denver, Colorado. June 27-29, 2012.

Poole, A.F. 1989. Ospreys: a natural and unnatural history: Cambridge University Press. Pp. 161-164 In: Larkin, R. P. 1994. Effects of military noise on wildlife: a literature review. Final Report to U.S. Army Construction Engineering Research Laboratory, November 1994, 87 pp.

Porter, M. and M. Nelitz. 2009. A future outlook on the effects of climate change on bull trout (*Salvelinus confluentus*) habitats in the Cariboo-Chilcotin. Prepared by ESSA Technologies Ltd. for Fraser Salmon and Watersheds Program, B.C. Ministry of Environment, and Pacific Fisheries Resource Conservation Council.

Portz, D.E. 2007. Fish-holding-associated stress in Sacramento River Chinook salmon (Oncorhynchus tshawytscha) at South Delta fish salvage operations: Effects on plasma constituents, swimming performance, and predator avoidance. PHD Dissertation. University of California, Davis.

Poston, T. 2001. Treated wood issues associated with overwater structures in marine and freshwater environments. Olympia, Washington. Report. E. Washington Departments of Fish and Wildlife, and Transportation. April. http://wdfw.wa.gov/publications/00053/wdfw00053.pdf.

PPIC [Public Policy Institute of California]. 2008. Preparing California for a changing climate. 28 pp.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game in cooperation with the Pend Oreille Idaho Club

Pratt, K.L. 1992. A review of Bull trout life history. Pages *5-9 in* P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in Lake Pend Oreille and the lower Clark Fork River. Draft report. Prepared for the Washington Water Power Company, Spokane, Washington.

Peck, B. 2000. Radio telemetry studies of adult shortnose and Lost River suckers in Upper Klamath Lake and tributaries. Klamath Basin Area Office, U.S. Bureau of Reclamation, U.S. Department of Interior, Klamath Falls, Oregon.

Perkins, D. L., J. Kahn, and G. G. Scoppettone. 2000a. The role of poor water quality and fish kills in the decline of endangered Lost River and shortnose suckers in Upper Klamath Lake. U.S. Geological Survey, Reno, Nevada.

Perkins, D. L., G. G. Scoppettone, and M. Buettner. 2000b. Reproductive biology and demographics of endangered Lost River and shortnose suckers in Upper Klamath Lake, Oregon. Technical Report to Reno.

Quigley, T.M., and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: volume III. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol.

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. 1995. Chapter 1: Ecology and conservation of the marbled murrelet. Within: U.S. Forest Service, General Technical Report PSW-GTR-152, Pacific Southwest Research Station, Albany, California. 3-22.

Raphael, M.G., D. Evans Mack, and Brian A. Cooper. 2002. Landscape-scale relationships between abundance of marbled murrelets and distribution of nesting habitat. Condor 104(2), 331-342.

Raphael, M.G., J.M. Olson, and T. Bloxton. 2007a. Summary report of field observation of marbled murrelets in the San Juan Islands, Washington. USDA Forest Service, Pacific NW Research Station, Olympia, Washington. 25 pp.

Raphael, M.G., J. Baldwin, G.A. Falxa, M.H. Huff, M. Lance, S.L. Miller, S.F. Pearson, C.J. Ralph, C. Strong, and C. Thompson. 2007b. Regional population monitoring of the marbled murrelet: field and analytical methods. General Technical Report. NNW-GTR-716. Pacific Northwest Research Station, U.S. Forest Service, Portland, Oregon. 70 pp.

Rasmussen, J.E. 2011. Status of the Lost River sucker and shortnose sucker. Western North American Naturalist 71(4):442-455.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 *in*: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Reeves et al. 1991.

Reid, S.B. 2007a. Surveys for the Modoc sucker, Catostomus microps, in the Goose Lake Basin, Oregon - 2007. Final Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office, Cooperative Agreement No. 81450-6-J533.

Reid, S.B. 2007b. Management and monitoring of non-native fishes in the Turner Creek Drainage (Modoc Co.), Critical Habitat for the Modoc sucker, Catostomus microps – 2007. Annual Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office. Cooperative Agreement No. 81450-6-J532.

Reid, S.B. 2008a. Conservation Review - Modoc sucker, Catostomus microps.
Final Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office. Version date: 31 December 2008.

Reid, S.B. 2008b. Survey protocol for monitoring distribution and population sizes of Modoc sucker, Catostomus microps. Report submitted to U.S. Fish and Wildlife Service, Klamath Falls Field Office. Cooperative Agreement No. 81450-6-J532 (partial).

Reiser, D. W., M. Loftus, D. Chapman, E. Jeanes, and K. Oliver. 2001. Effects of water quality and lake level on the biology and habitat of selected fish species in Upper Klamath Lake. Technical Report to Klamath Falls, Oregon.

Rhymer, J.M. and D. Simberloff. 1996. Extinction by hybridization and introgression. Annual Review of Ecology and Systematics 27:83-109.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. M.S. Thesis, Montana State University, Bozeman, Montana.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rieman, B.E., and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124:285-296.

Rieman, B.E., and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B., and J. Clayton. 1997a. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997b. Distribution, status and likely future trends of Bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764. American Fisheries Society, Bethesda, Maryland.

Rieman, B.E., D. Lee, D. Burns, R. Gresswell, M. Young, R. Stowell, J. Rinne, P. Howell. 2003. Status of native fishes in the western United States and issues for fire and fuels management. Forest Ecology and Management, Vol. 178, Issues 1-2, p197-211.

Rieman, B.E., J.T. Peterson and D.L. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences. Vol. 63, No. 1, pp. 63–78(16)

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136:1552-1565.

Richter, D.D., C.W. Ralston, and W.R. Harms. 1982. Prescribed fire: Effects on water quality and forest nutrient cycling. Science 215:661-663.

Rinella, F.A., and M.L. Janet. 1998. Seasonal and spatial variability of nutrients and pesticides in streams of the Willamette Basin, Oregon, 1993–95. U.S. Geological Survey Water-Resources Investigations Report 97-4082-C:57 p.

Rinne, J.N. 1996. Short-term effects of wildfires on fishes and aquatic macroinvertebrates on fishes and aquatic macroinvertebrates in the southwestern United States. North American Journal of Fisheries Management 16:653-658.

Rivera , Ray 2011, Fish Biologist, Willamette National Forest, conversation on 05/05/2011with Paul Bridges, U.S Fish and Wildlife Service, re: relationship between water temperature and bull trout spawning in the Upper McKenzie Watershed.

Rizzo, D.M., M. Garbeloto, J.M. Davidson, G.W. Slaughter, and S.T. Koike. 2002. Phytophthora ramorum as the cause of extensive mortality of Quercus spp. and Lithocarpus densiflorus in California. Plant Disease 86:205-214.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.H. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication 12, Bethesda, Maryland.

Robinson, A. T., P. P. Hines, J. A. Sorensen, and S. D. Bryan. 1998. Parasites and fish health in a desert stream, and management implications for two endangered fishes. North American Journal of Fisheries Management 18:599-608.

Rode, M. 1990. Bull trout, *Salvelinus confluentus suckley*, in the McCloud River: status and recovery recommendations. Administrative Report Number 90-15. California Department of Fish and Game, Sacramento, California.

Rodway, M. S., H. M. Regehr, and J. P. L. Savard. 1993. Activity patterns of marbled murrelets in old-growth forest in the Queen-Charlotte-Islands, British Columbia. Condor 95:831-848.

Rodway M. S., and H. M. Regehr. 2002. Inland activity and forest structural characteristics as indicators of marbled murrelet nesting habitat in Clayoquot Sound. Pages 57-87 in A. E. Burger and T. A. Chatwin, editors: Multi-scale studies of populations, distribution and habitat associations of marbled murrelets in Clayoquot Sound, British Columbia. Ministry of Water, Land and Air Protection, Victoria, British Columbia, Canada.

Roni, P., and T.P. Quinn. 2001a. Density and size of juvenile salmonids in response to placement of large woody debris in western Oregon and Washington streams. Canadian Journal of Fisheries and Aquatic Science 58:282-292.

Roni, P., and T.P. Quinn. 2001b. Effect of wood placement on movements of trout and juvenile coho salmon in natural and artificial stream channels. Transactions of the American Fisheries Society 130(4):675-685.

Roni, R., T.J. Beechie, R.E. Bilby, F.E. Leonetti, M.M. Pollock, and G.R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management 22:1-20.

Roni, P., T. Bennett, S. Morely, G.R. Pess, K. Hasnon, D. Van Slyke, and P. Olmstead. 2006. Rehabilitation of bedrock stream channels: The effects of boulder weir placement on aquatic habitat and biota. River Research and Applications 22:967-980.

Roper, B.B., J.J. Dose, and J.E. Williams. 1997. Stream restoration: Is fisheries biology enough? Fisheries 22(5):6-11.

Rosenberg, D.K. and R.G. Anthony. 1992. Characteristics of northern flying squirrel populations in young second- and old-growth forests in western Oregon. Can. J. Zool. 70:161-166.

Rosenberg, D.K., K.A. Swindle, and R.G. Anthony. 2003. Influence of prey abundance on northern spotted owl reproductive success in western Oregon. Canadian Journal of Zoology 81:1715-1725.

Rosenberger, A.E., J.B. Dunham, J.M. Buffington, and M.S. Wipfli. 2011. Persistent effects of wildfire and debris flows on the invertebrate prey base of rainbow trout in Idaho streams Northwest Science 85(1):55-63.

Rosetta, T. 2005. Technical basis for revising turbidity criteria (draft). Oregon Department of Environmental Quality, Water Quality Division. Portland, Oregon. October.

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22:169-199.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Inc. Pagosa Springs, Colorado.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bulletin of the U.S, Bureau of Fisheries 27:103-152.

Saiki, M. K., D. P. Monda, and B. L. Bellerud. 1999. Lethal levels of selected water quality variables to larval and juvenile Lost River and shortnose suckers. Environmental Pollution 105:37-44.

Sapolsky, R. M., L. M. Romero, and A. U. Munck. 2000. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocrine Reviews 21:55-89.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5:18-32

Sargeant, D., E. Newell, P. Anderson, and A. Cook. 2013. Surface Water Monitoring Program for Pesticides in Salmon-Bearing Streams, 2009-2011 Triennial Report, A Cooperative Study by the Washington State Departments of Ecology and Agriculture. Washington State Departments of Ecology and Agriculture. Olympia, Washington. February.

Scheerer, P., and G.D. Apke. 1998. Oregon Chub Research. Middle Fork Willamette and Santiam River Drainages. Annual Progress Report (E96970022). 53 pp.

Scheerer, P.D. and P.J. McDonald. 2000. Oregon chub research: Middle Fork Willamette and Santiam River Drainages. Unpublished. Oregon Department of Fish and Wildlife, Fish Research Project October 1999-September 2000. Annual Progress Report, Portland. 90 pp.

Scheerer, P.D. and P.J. McDonald. 2003. Age, growth, and timing of spawning of an endangered minnow, the Oregon chub (Oregonichthys crameri), in the Willamette Basin, Oregon. Northwestern Naturalist 86:68-79.

Scheerer, P.D. and S.E. Jacobs. 2005. Hutton Spring tui chub and Foskett Spring speckled dace investigations. Oregon Department of Fish and Wildlife, Salem, Oregon.

Scheerer, P.D., P.S. Kavanagh, B.L. Bangs, and S.E. Jacobs. 2006. Oregon chub Investigations. Oregon Department of Fish and Wildlife, Fish Research Project E-2-44. Annual Progress Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon 22 pp plus appendix.

Scheerer, P.D. and S.E. Jacobs. 2007a. Hutton Spring tui chub and Foskett Spring speckled dace investigations. Oregon Department of Fish and Wildlife, Salem, Oregon.

Scheerer, P.D., P.S. Kavanagh, B.L. Bangs, and S.E. Jacobs. 2007b. Oregon chub investigations. Oregon Department of Fish and Wildlife, Fish Research Project E-2-45. Annual Progress Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon 18 pp plus appendix.

Scheerer, P.D. 2007c. Unpublished data. Population Abundance Trends for Oregon chub 1997-2007. Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Scheerer, P.D., and Jacobs, S.E. 2009. 2009 Foskett Spring Speckled Dace Investigations; Annual Progress Report, Fish Research Project, Oregon. Oregon Department of Fish and Wildlife. 12 pgs.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14:448-457.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho

Schmidt, K. 2006. Northern spotted owl monitoring and inventory, Redwood National and State Parks, 2005 annual report. Redwood National and State Parks, Orick, California.

Scoppettone, G.G., S. Shea, and M.E. Buettner. 1995. Information on population dynamics and life history of shortnose suckers (*Chasmistes brevirostris*) and Lost River suckers *(Deltistes luxatus*) in Tule and Clear Lakes. National Biological Service, Reno Field Station.

Scoppettone, G. and P. Rissler 2001. Distribution of Cowhead Lake Tui Chub, Twelvemile Creek, Oregon. Final Report to Fish and Wildlife Service, Oregon State Office. Unpublished.

Sedell, J.R., and F.H. Everest. 1991. Historic changes in poo1 habitat for Columbia River Basin salmon under study for TES listing. Draft U.S. Department of Agriculture Report, Pacific Northwest Research Station, Corvallis, Oregon.

SERA. 2001. Sethoxydim [Poast] - Human Health and Ecological Risk Assessment - Final Report. USDA, Forest Service, Forest Health Protection. SERA TR-01-43-01-01c. Riverdale, Maryland. http://www.fs.fed.us/foresthealth/pesticide/pdfs/100202_sethoxydim_ra.PDF.

SERA. 2004a. Imazapic - Human Health and Ecological Risk Assessment – Final Report. USDA, Forest Service Forest Health Protection. SERA TR 04-43-17-04b. Arlington, Virginia. http://www.fs.fed.us/foresthealth/pesticide/pdfs/122304_Imazapic.pdf.

SERA. 2004b. Chlorsulfuron - Human Health and Ecological Risk Assessment - Final Report. USDA, Forest Service Forest Health Protection. SERA TR 04-43-18-01c. Arlington, Virginia. http://www.fs.fed.us/foresthealth/pesticide/pdfs/112104_chlorsulf.pdf.

SERA. 2004c. Dicamba - human health and ecological risk assessment – Final report. Submitted to: Forest Health Protection, USDA Forest Service. Arlington, Virginia.

SERA. 2004d. Sulfometuron Methyl - Human Health and Ecological Risk Assessment - Final Report. USDA, Forest Service, Forest Health Protection. SERA TR-03-43-17-02c. Arlington, Virginia.

SERA. 2007. Aminopyralid human health and ecological risk assessment – final report. Submitted to: USDA-Forest Service, Southern Region. Atlanta, Georgia. . http://www.fs.fed.us/foresthealth/pesticide/pdfs/062807_Aminopyralid.pdf.

SERA. 2011a. Triclopyr - Human Health and Ecological Risk Assessment - Final Report. USDA, Forest Service, Forest Health Protection. SERA TR-052-25-03a. Atlanta, Georgia. http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-25-03aTriclopyr.pdf.

SERA. 2011b. Glyphosate - Human Health and Ecological Risk Assessment - Final Report. USDA, Forest Service, Forest Health Protection. SERA TR-052-22-03b. Atlanta, Georgia. http://www.fs.fed.us/foresthealth/pesticide/pdfs/Glyphosate_SERA_TR-052-22-03b.pdf.

SERA. 2011c. Imazapyr Human Health and Ecological Risk Assessment – final report. Submitted to: USDA-Forest Service, Southern Region. Syracuse Environmental Research Associates, Inc. Report. S.R. USDA/Forest Service. December. http://www.fs.fed.us/foresthealth/pesticide/pdfs/Imazapyr_TR-052-29-03a.pdf.

SERA. 2011d. Picloram - human health and ecological risk assessment – final report. Submitted to: USDA-Forest Service, Southern Region. Atlanta, Georgia. . http://www.fs.fed.us/foresthealth/pesticide/pdfs/Picloram_SERA_TR-052-27-03a.pdf.

Servizi, J.A., and D.W. Martens. 1991. Effects of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 49:1389-1395.

Sexauer, H.M., and P.W. James. 1997. Microhabitat use by juvenile trout in four streams located in the eastern Cascades, Washington. Pages 361-370 *in* W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Shreck, C.B. 2000. Accumulation and long-term effects of stress in fish. Pages 147-158. In: The biology of animal stress - basic principles and implications for animal welfare. G.P. Moberg, and J.A. Mench (editors). CABI Publishing. Cambridge, Massachusetts.

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

Sigler, J.W. 1988. Effects of chronic turbidity on anadromous salmonids: recent studies and assessment techniques perspective. Pages 26-37. In: Effects of Dredging on Anadromous Pacific Coast Fishes. C.A. Simenstad (editor). Washington Sea Grant Program, Washington State University. Seattle.

Simenstad, C.A., and R.M. Thom. 1996. Assessing functional equivalency of habitat and food web support in a restored Gog-Le-Hi-Te estuarine wetland. Ecological Applications 6:38-56.
Simon, D.C., G.R. Hoff, D.J. Logan, and D.F. Markle. 1996. Larval and juvenile ecology of Upper Klamath Lake suckers. Annual report: 1995. Oregon State University, Department of Fisheries and Wildlife, Corvallis, OR. 61 pp.

Simon, D.C., D.F. Markle, and M.R. Terwilliger. 1998. Larval and juvenile ecology of Upper Klamath Lake suckers. Annual report 1997. Report by Oregon Cooperative Research Unit, Department of Fisheries and Wildlife, Corvallis, Oregon, for U.S. Bureau of Reclamation, Klamath Project. 63 pp.

Simon, D. C., and D. F. Markle. 2001. Ecology of Upper Klamath Lake shortnose and Lost River suckers. Annual survey of abundance and distribution of age 0 shortnose and Lost River suckers in Upper Klamath Lake. Annual report: 2000. Oregon Cooperative Research Unit. Department of Fisheries and Wildlife, Corvallis.

Simon, D.C. and D.F. Markle. 2004. Larval and juvenile ecology of shortnose and Lost River suckers: data summaries of annual surveys of Upper Klamath Lake, 1995- 2003. Pages 15 – 106 *in* Larval and juvenile ecology of Upper Klamath Lake suckers: 1998-2003. Annual report submitted to the U.S. Bureau of Reclamation. Corvallis, OR.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, Idaho.

Singer, S. W., D. L. Suddjian, and S. A. Singer. 1995. Fledging behavior, flight patterns, and forest characteristics at marbled murrelet tree nests in California. Northwestern Naturalist 76:54-62.

Singleton, P., J.F. Lehmkuhl, W.L. Gaines, and S.A. Graham. 2010. Barred owl space use and habitat selection in the eastern Cascades, Washington. Journal of Wildlife Management. 74(2): 285-294.

Sisco, C.L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. M.S. Thesis. Humboldt State University, Arcata, California.

Slaney, P.A., B.R. Ward, and J.C. Wightman. 2003. Experimental nutrient addition to the Keogh River and application to the Salmon River in Coastal British Columbia. In: Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. J. Stockner (editor). American Fisheries Society Symposium 34. Bethesda, Maryland.

Slijepcevic, A., and L. Fogarty. 1998. Reducing the influence of helicopter rotor wash on fire behaviour. New Zealand Forest Research Institute, Fire Technology Transfer Note, Number 16, February 1998. 12 pp.

Smith, G. R. 1966. Distribution and evolution of the North American catostomid fishes of the subgenus Pantosteus, genus Catostomus. Miscellaneous Publications of Zoology. University of Michigan 129:1-132.

Smith, G.R., T. Steinback, and G. Pampush. 1984. Distribution, foraging relationships and colony dynamics of the American white pelican (Pelecanus erythrorhynchos) in southern Oregon and northeastern California. Oregon Department of Fish and Wildlife Nongame Wildlife Program Technical Report 83-0-04.

Smoker, W.W., I.A. Wang, A.J. Gharrett, and J.J. Hard. 2004. Embryo survival and smolt to adult survival in second-generation outbred coho salmon. Journal of Fish Biology 65 (Supplement A):254-262.

Snyder, J.O. 1908. Relationships of the fish fauna of the lakes of southeastern Oregon. Bulletin of the Bureau of Fisheries 17:69-102.

Snyder, D.E. 2003. Electrofishing and its harmful effects on fish. Information and Technology Report USGS/BRD/ITR-2003-0002. U.S. Government Printing Office. Denver, Colorado. 149 p. http://www.fort.usgs.gov/Products/Publications/21226/21226.pdf.

Solis, D.M., and R.J. Gutiérrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. The Condor 92:739-748.

Sovern, S.G., E.D. Forsman, B.L. Biswell, D.N. Rolph, and M. Taylor. 1994. Diurnal behavior of the spotted owl in Washington. The Condor 96(1):200-202.

Speckman, S.G. 1996. Marbled murrelet distribution and abundance in relation to the marine environment. Master's Thesis, University of Alaska, Fairbanks, Alaska, August 1996.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc. Corvallis, Oregon. Report. National Marine Fisheries Service, Portland, Oregon.

Spencer, C.N., K.O. Gabel, and F.R. Hauer. 2003. Wildfire effects on stream food webs and nutrient dynamics in Glacier National Park, USA. Forest Ecology and Management 178:141-154.

Sprague, J.B., and D.E. Drury. 1969. Avoidance reactions of salmonid fish to representative pollutants. Pages 169-179. In: Advances in Water Pollution Research. Proceedings of the Fourth International Conference, Prague. S.H. Jenkins (editor). Pergamon Press. New York.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of Bull trout populations. Ecology of Freshwater Fish 8:114-121.

Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda, and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4:17-29

Stednick, J.D. 2010. Effects of fuel management practices on water quality. In: Cumulative Watershed Effects of Fuel Management in the Western United States. USDA Forest Service. RMRS-GTR-231.

Stehr, C.M., T.L. Linbo, D.H. Baldwin, N.L. Scholz, and J.P. Incardona. 2009. Evaluating the effects of forestry herbicides on fish development using rapid phenotypic screens. North American Journal of Fisheries Management 29(4):975-984.

Stenstrom, M.K., and M. Kayhanian. 2005. First flush phenomenon characterization. California Department of Transportation, Division of Environmental Analysis. CTSW-RT-05-73-02.6. Sacramento, California. August. http://149.136.20.66/hq/env/stormwater/pdf/CTSW-RT-05-073-02-6_First_Flush_Final_9-30-05.pdf.

Stern, T. 1966. The Klamath Tribes: a people and their reservation. University of Washington Press, Seattle. 356 pp.

Steventon, J.D., and N.L. Holmes. 2002. A radar-based inventory of marbled murrelets (Brachyramphus marmoratus), northern Mainland Coast of British Columbia. Prince Rupert Forest Region, British Columbia Ministry of Forests, 40 pp.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate 18:1136-1155.

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (*Salvelinus confluentus*). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801. Department of Fisheries and Oceans, Winnipeg, MB, Canada, 2007, 54 pp.

Stine, P. A. 1982. Preliminary status report - Lost River sucker, Draft. Unpublished report.

Strachan, G., M. McAllister, and C.J. Ralph. 1995. Marbled murrelet at-sea foraging behavior. Pages 247-253 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Strong, C.S., B.K. Keitt, W.R. McIver, C.J. Palmer, and I.Gaffney. 1995. Distribution and population estimates of marbled murrelets at sea in Oregon during the summers of 1992 and 1993. Pages 339-352 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Swanston, D.N. 1991. Natural processes. Pages 139-179. In: Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan (editor). American Fisheries Society. Bethesda, Maryland.

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

Swenson, S.C. 1978. Report of investigations on Catostomus warnerensis during spring 1978. Unpublished report to the U.S. Fish and Wildlife Service. 27 pp.

Tait, C.K. and E.J. Mulkey. 1993a. Assessment of biological and physical factors limiting distribution of stream-resident Warner suckers (Catostomus warnerensis). Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 35 pp.

Tait, C. and E. Mulkey. 1993b. Estimation of stream-resident Warner sucker abundance and total habitat area in two basins using a statistically valid sampling design. Unpublished report to U.S. Bureau of Land Management and Oregon Department of Fish and Wildlife.

Taylor, B.E., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (*Salvelinus confluentus*) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170.

Tempel, D. J. and R. J. Gutiérrez. 2003. Fecal corticosterone levels in California spotted owls exposed to low-intensity chainsaw noise. Wildlife Society Bulletin 31:698-702.

Tempel, D. J. and R. J. Gutiérrez. 2004. Factors related to fecal corticosterone levels in California spotted owls: implications for assessing chronic stress. Conservation Biology 18:538-547.

Thiessen, G., and E. A.G. Shaw. 1957. Acoustic irritation threshold of ring-billed gulls. Journal of the Acoustical Society of America 29: 1,307-1,309.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Unpublished interagency document. 458 pages.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Thomas, J.W., and M.G. Raphael (Eds.). 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT). July 1993. Portland, OR: USDA Forest Service and the USDI Bureau of Land Management.

Thomas, J.W., M.G. Raphael, R.G. Anthony, E.D. Forsman, A.G. Gunderson, R.S. Holthausen, B.G. Marcot, G.H. Reeves, J.R. Sedell, and D.M. Solis. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. USDA Forest Service, Portland, Oregon.

Thomas, S.A., T.V. Royer, G.W. Minshall, and E. Snyder. 2003. Assessing the historic contributions of marine-derived nutrients to Idaho streams. In: Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. J. Stockner (editor). American Fisheries Society. Symposium 34. Bethesda, Maryland.

Thomas, J.W., J.F. Franklin, J. Gordon, and K.N. Johnson. 2006. The Northwest Forest Plan: origins, components, implementation experience, and suggestions for change. Conservation Biology 20:277–287.

Thome, D.M., C.J. Zabel and L.V. Diller. 1999. Forest stand characteristics and reproduction of northern spotted owls in managed north-coastal California forests, Journal of Wildlife Management 63:44–59.

Topinka, J.R. 2006. Chapter 3. Hybridization between sympatric endemic species? The case of the Modoc (Catostomus microps) and Sacramento (Catostomus occidentalis) suckers. Ph.D. Dissertation, University of California, Davis. 39 pp.

Traill, L.W., B.W. Brook, R.R. Frankham, and C.J.A. Bradshaw. 2009. Pragmatic population viability targets in a rapidly changing world. Biological Conservation 143(1):28-34.

Trombulak, S.C., and C.A. Frissell. 2000. Review of the ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(1):18-30.

Tyler, T. J. 2007. Link River 2006 screw trap assessment. Klamath Basin Area Office, U.S. Bureau of Reclamation, U.S. Department of Interior, Klamath Falls, Oregon.
USBR (U.S. Bureau of Reclamation). 1994. Klamath Project. Biological assessment on long-term operations of the Klamath Project, with special emphasis on Clear Lake operations.

U.S. Census Bureau. 2010. 2000 census and 2010 census by state. Web Page. http://www.census.gov.

U.S. EPA. 1993. Reregistration Eligibility Decision (RED) Glyphosate. U.S. Environmental Protection Agency. EPA 738-R-93-014. Washington D.C. http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf.

U.S. EPA. 1999. Diflufenzopyr, Pesticide Fact Sheet. U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances. Arlington, Virginia.

U.S. EPA. 2003. No effect determination for dicamba for Pacific anadromous salmonids. U.S. Environmental Protection Agency. Washington, D.C. March 27.

U.S. EPA. 2009. Risks of 2,4-D use to the Federally threatened California red-legged frog (Rana aurora draytonii) and Alameda whipsnake (Masticophis lateralis euryxanthus). Environmental Protection Agency, Environmental Fate and Effects Division, Office of Pesticide Programs. Washington, D.C.

USDA-Forest Service 1989. A Guide for Prescribed Fire in Southern Forests. United States Department of Agriculture, Forest Service Southern Region, February 1989; Technical Publication R8-TP 11.

USDA-Forest Service. 1995. Inland Native Fish Strategy, Environmental Assessment. Intermountain, Northern, and Pacific Northwest Regions.

USDA-Forest Service. 2006. 2,4-D human health and ecological risk assessment final report. Forest Health Protection, USDA-Forest Service. Arlington, Virginia.

USDA-Forest Service. 2008a. Stream simulation: An ecological approach to providing passage for aquatic organisms at road crossings. Forest Service Stream-Simulation Working Group, National Technology and Development Program in partnership with U.S. Department of Transportation, Federal Highway Administration Coordinated Federal Lands Highway Technology Implementation Program.

USDA-Forest Service. 2008b. Sound Measurements of Helicopters During Logging Operations. USDA Forest Service, San Dimas Technology & Development Center, San Dimas, CA. 43 pp. http://www.fs.fed.us/eng/techdev/IM/sound_measure/helo_index.shtml

USDA-Forest Service, Pacific Northwest Region, USDI-Bureau of Land Management, Oregon State Office, and USDI-Bureau of Indian Affairs. 2013. Biological Assessment for fish habitat restoration activities affecting ESA-Listed animal and plant species and their designated or proposed critical habitat and designated essential fish habitat under MSA found in Oregon, Washington and parts of California, Idaho and Nevada. January 28.

USDA, and USDI. 1994a. Final supplemental environmental impact statement on management of habitat for late successional and old-growth forest related species within the range of the northern spotted owl (Northwest Forest Plan). U.S. Department of Agriculture and U.S. Department of Interior. February.

USDA Forest Service and USDI Bureau of Land Management. 1994b. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Portland, Oregon. Two vols. and appendices.

U.S. Department of Agriculture and U.S. Department of Interior (USDA and USDI). 1995a. Decision of Notice and Finding of No Significant Impact for the Inland Native Fish Strategy: Interim Strategies for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (INFISH).

U.S. Department of Agriculture and U.S. Department of Interior (USDA and USDI). 1995b. Decision Notice/Decision Record for Interim Strategies for Managing Anadromous Fish-Producing Watersheds on Federal Lands in Eastern Oregon and Washington, Idaho and Portions of California (PACFISH).

USDA and USDI (Forest Service and Bureau of Land Management). 2001. Decision Record for Amendments to Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines.

USDA and USDI (Forest Service and Bureau of Land Management).2011. Memorandum concerning the 2011 Settlement Agreement in Litigation over the Survey and Manage Mitigation Measure. In *Conservation Northwest et al. v. Sherman et al.*, Case No. 08-1067-JCC (W.D. Wash.). 1900/2600 (FS)/1736 (BLM) (OR931) P, July 21, 2011. Portland, OR.

USDA and USDI (Forest Service, Bureau of Land Management and Bureau of Indian Affairs) 2013. Biological Assessment for USDA Forest Service (Pacific Northwest Region),

USDI Bureau of Land Management (Oregon State Office) and the Bureau of Indian Affairs Fish Habitat Restoration Activities Affecting ESA-Listed Animal and Plant Species and their Designated or Proposed Critical Habitat and Designated Essential Fish Habitat under MSA found in Oregon, Washington and parts of California, Idaho and Nevada. Portland, OR.

USDI-BLM. 2003. Biological assessment for proposed resource management plan/ final environmental impact statement. Lakeview District Office, Lakeview, Or. 60 pp.

USDI-BLM. 2005a. Diflufenzopyr Ecological Risk Assessment, Final Report. USDI-Bureau of Land Management. ENSR Document Number 09090-020-650. Reno, Nevada.

USDI-Bureau of Land Management. 2005b. Salmonid Effects Determination Criteria, Northwest National Fire Plan Project Design and Consultation Process. BLM Oregon State Office. Portland, Oregon. January. http://www.blm.gov/or/fcp/salmonid.php.

USFWS and NMFS (U.S.) Fish and Wildlife Service and National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook: Procedures for conducting consultation and conference activities under section 7 of the Endangered Species Act.

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

USFWS (Fish and Wildlife Service). 1975. Threatened status for three species of trout. Federal Register 40:29863-29864. July 16, 1975.

USFWS (Fish and Wildlife Service). 1983a. Endangered and threatened species listing and recovery priority guidelines. Federal Register 48:43098–43105.

USFWS (Fish and Wildlife Service). 1983b. Endangered and threatened species listing and recovery priority guidelines: correction. Federal Register 48:51985.

USFWS (Fish and Wildlife Service). 1984. An action plan for the recovery of the Modoc sucker (Catostomus microps), revised April 27, 1983. Signatories: Calif. Dept. Fish and Game, U.S. Forest Service (Modoc National Forest), and U.S. Fish and Wildlife Service. 14 pp.

USFWS (Fish and Wildlife Service). 1985. Endangered and threatened wildlife and plants: Determination of endangered status for the Modoc sucker. Federal Register 50 (112):24526-24530.

USFWS (Fish and Wildlife Service). 1985a. Endangered and threatened wildlife and plants; Determination that the Warner Sucker is a threatened species and designation of critical habitat. Federal Register 50(188):39117-39123.

USFWS (Fish and Wildlife Service). 1985b. Endangered and threatened wildlife and plants: Determination of threatened status for Hutton tui chub and Foskett speckled dace. Federal Register 50(60):12302-12306.

USFWS (Fish and Wildlife Service).1985c. Endangered and threatened wildlife and plants; Determination of threatened status for Hutton tui chub and Foskett speckled dace. *Federal Register* 50:12302-12306.

USFWS (Fish and Wildlife Service). 1988. Final Rule: Endangered and threatened wildlife and plants: determination of endangered status for the shortnose sucker and Lost River sucker. Federal Register 53:27130-27134.USFWS (Fish and Wildlife Service). 1989. The northern spotted owl; a status review supplement. USDI Fish and Wildlife Service, Portland, Oregon.

USFWS (Fish and Wildlife Service). 1990a. Endangered and Threatened Wildlife and Plants; determination of threatened status for the northern spotted owl. Fed. Reg. Vol. 55. 123: 26114-26194. June 26, 1990.

USFWS (Fish and Wildlife Service). 1990b. The 1990 status review: northern spotted owl: Strix occidentalis caurina. Report to the U.S. Fish and Wildlife Service, Portland, Oregon. 95 pages.

USFWS (Fish and Wildlife Service). 1992a. Endangered and Threatened Wildlife and Plants; determination of critical habitat for the northern spotted owl. Fed. Reg. Vol. 57. 10:1796-1838. January 15, 1992.

USFWS (Fish and Wildlife Service). 1992b. Draft final recovery plan for the northern spotted owl. USDI Fish and Wildlife Service. 2 Volumes. Portland, Oregon.

USFWS (Fish and Wildlife Service). 1992c. Endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon, and California population of the marbled murrelet, final rule. Fish and Wildlife Service, Federal Register 50 CFR 17: 45328-45337.

USFWS (Fish and Wildlife Service). 1993a. Recovery plan for the lost river sucker and the shortnose sucker. USDI Fish and Wildlife Service. Portland, Oregon.

USFWS (Fish and Wildlife Service). 1993b. Determination of Endangered Status for the Oregon Chub. FR (58):53800-53804.

USFWS (Fish and Wildlife Service). 1994a. Letter from D.C. Frederick (USFWS) to J. Belcher (Washington Department of Natural Resources) dated February 1, 1994, regarding correction to spotted owl home-range data for the Olympic Peninsula. USFWS, Olympia, Washington.

USFWS (Fish and Wildlife Service). 1994b. Final biological opinion for the preferred alternative of the Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. In: USDA Forest Service, and USDI Bureau of Land Management. 1994. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl: Appendix G. Portland, Oregon, USA.

USFWS (Fish and Wildlife Service). 1995. Endangered and threatened wildlife and plants; proposed special rule for the conservation of the northern spotted owl on non-federal lands. Federal Register 60:9483–9527.

USFWS (Fish and Wildlife Service). 1995a. Lahontan cutthroat trout, Oncorhynchus clarki henshawi, Recovery Plan. Portland, Oregon. 147 pp.

USFWS (Fish and Wildlife Service). 1995b. Endangered and threatened wildlife and plants; proposed special rule for the conservation of the northern spotted owl on non-federal lands. Federal Register 60:9483–9527.

USFWS (Fish and Wildlife Service). 1996. Endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet; final rule. Federal Register, 50 CFR 17: 26256-26320.

USFWS (Fish and Wildlife Service). 1997. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Fish and Wildlife Service, Portland, Oregon. 203 pp.

USFWS (Fish and Wildlife Service). 1998a Bull Trout Facts. Portland, OR

USFWS (Fish and Wildlife Service). 1998b. Recovery Plan for the Native Fishes of the Warner Basin and Alkali Subbasin. Portland, Oregon. 86pp.

USFWS (Fish and Wildlife Service). 1998c. Recovery Plan for the Oregon Chub. Portland, OR. 86pp.

USFWS (Fish and Wildlife Service). 1998d. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Klamath River and Columbia River District Population Segments of Bull Trout. Federal Register 63: 31647-31674.

USFWS (Fish and Wildlife Service). 1999a (Revised). A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale (Matrix of Pathways and Indicators). Portland, OR. 52pp.

USFWS (Fish and Wildlife Service). 1999b. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Jarbidge River Population Segment of Bull Trout. Federal Register 64: 17110-17125.

USFWS (Fish and Wildlife Service). 1999c. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminus United States. Federal Register 64: 58910-58933.

USFWS (Fish and Wildlife Service). 2001. A range wide baseline summary and evaluation of data collected through section 7 consultation for the northern spotted owl and its critical habitat: 1994-2001. Portland, Oregon. Unpublished document. 41 pages.

USFWS (Fish and Wildlife Service). 2002a. Memorandum from S. Williams (USFWS) to USFWS Regional Directors dated June 25, 2002, regarding the solicitor's review of the Arizona Cattle Growers Association case. USFWS, Washington D.C.

USFWS (U.S. Fish and Wildlife Service). 2002b. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 1: Introduction. U.S. Fish and Wildlife Service, Portland, Oregon, October, 2002, 137 pp.

USFWS (U.S. Fish and Wildlife Service). 2002c. Bull trout (*Salvelinus confluentus*) draft recovery plan - chapter 2 Klamath River. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2002d. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 25 Saint Mary- Belly River. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2002e. Chapter 20 of the bull trout (Salvelinus confluentus) draft recovery plan: Lower Columbia Recovery Unit, Washington. USFWS, Region 1, Portland, Oregon, 102 pp.

USFWS (U.S. Fish and Wildlife Service). 2002f. Chapter 9 of the bull trout (Salvelinus confluentus) draft recovery plan: John Day Recovery Unit, Washington. USFWS, Region 1, Portland, Oregon, 102 pp.

USFWS. 2002g. Biological/conference opinion regarding the effects of the U.S. Bureau of Reclamation's proposed 10-year operation plan for the Klamath Project and its effect on the endangered Lost River sucker (*Deltistes luxatus*), endangered shortnose sucker (*Chasmistes brevirostris*), threatened Bald Eagle (*Haliaeetus leucocephalus*), and proposed critical habitat for the Lost River and shortnose suckers.*in* Klamath Falls Fish and Wildlife Office, U.S. Fish and Wildlife Service, U.S. Department of Interior, editor., Klamath Falls, Oregon.

USFWS (U.S. Fish and Wildlife Service). 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 (U.S. Fish and Wildlife Service). 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 (U.S. Fish and Wildlife Service). 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 (U.S. Fish and Wildlife Service) 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 (U.S. Fish and Wildlife Service). 2003e. Appendix 1: Estimates of distances at which incidental take of murrelets and spotted owls due to harassment are anticipated from sound-generating, forest-management activities in Olympia National Forest, from the Biological Opinion and Letter of Concurrence for effects to bald eagles, marbled murrelets, northern spotted owls, bull trout, designated critical habitat for marbled murrelets and northern spotted owls from Olympic National Forest program of activities for August 5, 2003 to December 31, 2008 (FWS reference number 1-3-03-F-0833).

USFWS (U.S. Fish and Wildlife Service). 2004a. Memorandum from M. Jones (USFWS) to USFWS Regional Directors dated December 9, 2004, regarding the application of the "Destruction or Adverse Modification" standard under section 7(a)(2) of the Endangered Species Act. USFWS, Washington D.C.

USFWS (Fish and Wildlife Service). 2004b. Northern Spotted Owl: Five Year Review Summary and Evaluation. USDI Fish and Wildlife Service, Portland, Oregon. 73 pages.

USFWS (Fish and Wildlife Service). 2004c. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (Fish and Wildlife Service). 2004d. Draft Recovery Plan for the Jarbidge Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (Fish and Wildlife Service). 2004e. Marbled murrelet 5-year review process: overview. Portland, Oregon. 28 pp.

USFWS (Fish and Wildlife Service). 2005a. Chapter 5, Willamette River Recovery Unit, Oregon. 147 p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

USFWS (Fish and Wildlife Service). 2005b. Draft: Disturbance and Disruption Distances for Northern Spotted Owls. Portland, OR. 8pp.

USFWS (Fish and Wildlife Service). 2005c. Bull Trout: Five Year Review Summary and Evaluation. USDI Fish and Wildlife Service, Portland, Oregon. 55 pages.

USFWS (Fish and Wildlife Service). . 2007a. Lost River sucker (Deltistes luxatus) 5-year review: Summary and evaluation. U.S. Department of Interior, Klamath Falls, Oregon.

USFWS. (Fish and Wildlife Service) 2007b. Shortnose sucker (Chasmistes brevirostris) 5-year review: Summary and evaluation. U.S. Department of Interior, Klamath Falls, Oregon.

USFWS (Fish and Wildlife Service). 2008a. Bull trout draft core area templates - complete core area by core area analysis. W. Fredenberg and J. Chan, *editors*. U. S. Fish and Wildlife Service. Portland, Oregon. 1,895 pages.

USFWS (Fish and Wildlife Service). 2008b. 5-Year Status Review, Oregon chub (Oregonichthys crameri) . Portland, OR. 34 pp.

USFWS (Fish and Wildlife Service). 2008c. Biological opinion on the continued operation and maintenance of the Willamette River Basin Project and Effects to Oregon chub, bull trout, and bull trout critical habitat designated under the Endangered Species Act. Oregon Fish and Wildlife Office, Portland, Oregon. 205 pp.

USFWS (U.S. Fish and Wildlife Service). 2008d. 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 (U.S. Fish and Wildlife Service). 2008e. Observations of Smoke Effects on Northern Spotted Owls. Oregon Fish and Wildlife Office, Portland, Oregon. 7 pp.

USFWS. 2008f. Biological/conference opinion regarding the effects of the U.S. Bureau of Reclamation's proposed 10-year operation plan (April 1, 2008 - March 31, 2018) for the Klamath Project and its effects on the endangered Lost River and shortnose suckers. Klamath Falls Fish and Wildlife Office, U.S. Fish and Wildlife Service, U.S. Department of Interior, Klamath Falls, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2008g. Final Recovery Plan for the Northern Spotted Owl (Strix occidentalis caurina). Portland, Oregon.

USFWS [U.S. Fish and Wildlife Service]. 2009a. Modoc Sucker (Catostomus microps) 5-Year Review, Summary and Evaluation. Klamath Falls Fish and Wildlife Office. 34 pp.

USFWS (Fish and Wildlife Service). 2009b. Programmatic Safe Harbor Agreement for the Oregon Chub. Portland, Oregon. 29 pp.

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

USFWS (U.S. Fish and Wildlife Service). 2009d. Marbled Murrelet (*Brachyramphus marmoratus*) 5 year review. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, WA, June 12, 2009. 108 pages.

USFWS (Fish and Wildlife Service). 2010a. Final Rule: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Oregon chub (Oregonichthys crameri). Federal Register 75: 11010-11067.

USFWS (Fish and Wildlife Service). 2010b. Final Rule, Correction: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Oregon chub (Oregonichthys crameri). Federal Register 75: 18107-18110.

USFWS (Fish and Wildlife Service). 2010c. Final Rule: Endangered and Threatened Wildlife and Plants; Reclassification of the Oregon Chub from Endangered to Threatened. Federal Register 75: 21179-21189.

USFWS (U.S. Fish and Wildlife Service). 2010d. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for Bull Trout in the Coterminus United States. Federal Register 75: 63898-64070.

USFWS (U.S. Fish and Wildlife Service). 2010e. Best management practices to minimize adverse effect to Pacific Lamprey. http://www.fws.gov/columbiariver/publications/BMP_Lamprey_2010.pdf

USFWS (U.S. Fish and Wildlife Service). 2011a. Northern Spotted Owl: Five Year Review Summary and Evaluation. USDI Fish and Wildlife Service, Portland, Oregon. 7 pages.

USFWS (U.S. Fish and Wildlife Service). 2011b. Revised Recovery Plan for the Northern Spotted Owl, Strix occidentalis caurina. U.S. Fish and Wildlife Service, Portland, Oregon. 277 p.

USFWS (Fish and Wildlife Service). 2011c. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E065

USFWS. 2011d. Draft revised recovery plan for the Lost River sucker (Deltistes luxatus) and shortnose sucker (Chasmistes brevirostris). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California.

USFWS (U.S. Fish and Wildlife Service). 2011e. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Marbled Murrelet: Final Rule. Federal Register 76: 61599-61621.

USFWS (U.S. Fish and Wildlife Service). 2012a. Endangered and threatened wildlife and plants; proposed revised designation of critical habitat for the northern spotted owl. Federal Register 77:14062-14165.

USFWS (Fish and Wildlife Service). 2012b. Designation of Critical Habitat for Lost River Sucker and Shortnose Sucker. Federal Register 77:73739-73768.

USFWS 2012c. Biological Opinion: Sudden Oak Death Eradication Activities on the Rogue River-Siskiyou National Forest and Coos Bay District Bureau of Land Management Lands. 110 pages. Roseburg, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2012d. Revised in-air disturbance analysis for marbled murrelets. Washington Fish and Wildlife Office, Lacey, WA. 16 pp.

USFWS (U.S. Fish and Wildlife Service). 2013. Revised recovery plan for the Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes breirostris*). Sacramento, CA. 148 pp.

USFWS (Fish and Wildlife Service). 2013. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 44 Species in Oregon, Hawaii, Guam, and the Northern Mariana Islands. Federal Register 78: 8185-8187.

USGS (U.S. Geological Survey). 2010. Algal Toxins in Upper Klamath Lake, Oregon: Linking Water Quality to Juvenile Sucker Health. Fact Sheet 2009-3111. Western Fisheries Research Center, Seattle, Washington.

VanderKooi, S.P., Burdick, S.M., Echols, K.R., Ottinger, C.A., Rosen, B.H., and Wood, T.M., 2010, Algal toxins in Upper Klamath Lake, Oregon—Linking water quality to juvenile sucker health: U.S. Geological Survey Fact Sheet 2009-3111, 2 p. (Also available at http://pubs.usgs.gov/fs/2009/3111/.)

Wade, D.D. 1984. Prescribed fire and smoke management in the South: conference proceedings. September 12-14, 1984.

Wagman, D.W. and D.F. Markle. 2000. Use of anonymous nuclear loci to assess genetic variation in Catostomus microps and C. occidentalis from California (Catostomidae). Final report to U.S. Fish and Wildlife Service, Klamath Falls, Oregon. 22 p.

Wagner, F.F., E.C. Meslow, G.M. Bennett, C.J. Larson, S.M. Small, and S. DeStefano. 1996. Demography of northern spotted owls in the southern Cascades and Siskiyou, Mountains, Oregon. Pages: 67-76 In: Forsman, E.D., S. DeStefano, M.G. Raphael, and R.J. Gutierrez, (editors). 1996. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithology Society.

Waldo, J. 2003. Personal communication. Discussions between Wallowa-Whitman South Zone Fish Biologist Joel Waldo and Paul Bridges (USFWS) at the Powder River Bull Trout Recovery Group meeting in Baker City, OR, concerning harvest of bull trout by angling.

Walters, A.W., D.M. Holzer, J.R. Faulkner, C.D. Warren, P.D. Murphy, and M.M. McClure. 2012. Quantifying cumulative entrainment effects for Chinook salmon in a heavily irrigated watershed. Transactions of the American Fisheries Society 141(5):1180-1190.

Ward, D.L. and R.A. Fritzsche. 1987. Comparison of meristic and morphometric characters among and within subspecies of the Sacramento sucker (Catostomus occidentalis Ayres). Calif. Fish and Game 73(3):175 187.

Ward, J. W. Jr. 1990. Spotted owl reproduction, diet and prey abundance in northwest California. M.S. Thesis. Humboldt State University, Arcata, California.

Ward, J. W. Jr., R.J. Gutiérrez, and B.R. Noon. 1998. Habitat selection by northern spotted owls: the consequences of prey selection and distribution. The Condor 100:79-92.

Ward, B.R., D.J.F. McCubbing, and P.A. Slaney. 2003. Evaluation of the addition of inorganic nutrients and stream habitat structures in the Keogh River watershed for steelhead trout and coho salmon J. Stockner (editor). American Fisheries Society. Symposium 34.

Washington Forest Practices Board. 1996. Permanent rules for the northern spotted owl. Washington Department of Natural Resources, Olympia, Washington.

Washington Office of Financial Management. 2010. Forecast of the State Population, November 2010 Forecast. http://www.ofm.wa.gov/pop/stfc/stfc2010/stfc_2010.pdf.

WCB (Workers' Compensation Board of British Columbia). 2005. Safe work practices for helicopter operations in the forest industry. Human Resources Skills Development Canada – Labour Program, Vancouver, B.C. 44 pp.

WDFW (Washington Department of Fish and Wildlife). 1997. Grandy Creek trout hatchery biological assessment. FishPro Inc., and Beak Consultants.

WDFW (Washington Department of Fish and Wildlife). 1998. Washington State Salmonid Stock Inventory: Bull Trout/Dolly Varden. Washington Department of Fish and Wildlife, Fish Management. 437 pp.

Washington State Department of Agriculture. 2003. Imazapyr Fact Sheet. Report. http://www.spartina.org/referencemtrl/ImazapyrFactSheet.pdf.

WDFW. 2010. Times when spawning or incubating salmonids are least likely to be within Washington state freshwaters. Washington Department of Fish and Wildlife. May. http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times_28may2010.pdf.

WDFW, and USDA-Forest Service. 2012. Memorandum of understanding between the Washington Department of Fish and Wildlife and the USDA, Forest Service Pacific Northwest Region: Hydraulic projects conducted by the U.S. Forest Service NFS 12-MU-11062754-005, WDFW 11-1949.

Wasser, S. K., K. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11:1019-1022.

Waterhouse, F. L., R. Bradley, J. Markila, F. Cooke, and L. Lougheed. 2002. Use of airphotos to identify, describe, and manage forest structure of marbled murrelet nesting habitat at a coastal British Columbia site. British Columbia Forest Service, Nanaimo, Canada. 19 pages.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: and investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252.

WDOE (Washington Department of Ecology). 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oxygen: Draft discussion paper and literature summary. Publication Number 00-10-071. Washington Department of Ecology, Olympia, WA, 90 pp.

Weathers, W.W., P.J. Hodum and J.A. Blakesley. 2001. Thermal ecology and ecological energetics of the California spotted owl. The Condor 103(4):678.

Wesemann, T., and M. Rowe. 1987. Factors influencing the distribution and abundance of burrowing owls in Cape Coral, Florida. In: Integrating man and nature in the metropolitan environment. Proceedings of the national symposium on urban wildlife, eds., L.W. Adams and D.L. Leedy, 129-137. National Institute for Urban Wildlife, Columbia, Maryland, USA.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science 313:940-943.

White, C. M., and T. L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. The Condor 87:14-22.

White, R.K., T.R. Hoitsma, M.A. Stern, and A.V. Munhall. 1990. Final report on investigations of the range and status of the Warner sucker, Catostomus warnerensis, during Spring and Summer 1990. Unpublished report to Bureau of Land Management, Oregon Department of Fish and Wildlife, and Fish and Wildlife Service. 66 pp.

White, R.K., T.L. Ramsey, M.A. Stern, and A.V. Munhall. 1991. Salvage operations and investigations of the range and stream habitat characteristics of the Warner sucker, Catostomus warnerensis, during spring and summer 1991. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 44 pp.

Whiteley, A., P. Spruell, and F. W. Allendorf. 2003. Population genetics of Boise Basin bull trout (Salvelinus confluentus). Final Report to Bruce Rieman, Rocky Mountain Research Station. University of Montana Wild Trout and Salmon Genetics Lab, Missoula, Montana.

Whitesel, T.A. et.al. 2004. Bull trout recovery planning: A review of the science associated with population structure and size. Science Team Report #2004-01, U.S. Fish and Wildlife Service, Portland, Oregon. 41 pp plus lit cited and appendices.

Whitworth, D.L., S.K. Nelson, S.H. Newman, G.B. Van Vliet, and W.P. Smith. 2000. Foraging distances of radio-marked marbled murrelets from inland areas in southeast Alaska. Condor 102(2):452-456.

Williams, J.E., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye. 1985. Endangered Aquatic Ecosystems in North American Deserts with a List of Vanishing Fishes of the Region. Journal of the Arizona-Nevada Academy of Science 20:1-62.

Williams, J.E., M.A. Stern, A.V. Munhall, and G.A. Anderson. 1990. Conservation status of the threatened fishes of the Warner Basin, Oregon. Great Basin Naturalist 50(3):243-248.

Williams, D.D., and B.W. Feltmate. 1992. Aquatic Insects. CAB International. Wallingford, UK.

Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sandford, D.M. Marsh, R.A. McNatt, and S. Achord. 2005. Effects of the Federal Columbia River Power System on salmon populations. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-63. 150 p.
http://www.nwfsc.noaa.gov/assets/25/6061_04142005_152601_effectstechmemo63final.pdf.

Willmore, Greg. 1995. Fish Biologist, Wallowa-Whitman National Forest, conversation in July 1995 with Paul Bridges concerning the extreme sensitivity of bull trout to fine sediments in granitic systems.

Wilson, G.A., K.I. Ashley, R.W. Land, and P.A. Slaney. 2003. Experimental enrichment of two oligiotrophic rivers in south coastal British Columbia. In: Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. American Fisheries Society. Symposium 34. Bethesda, Maryland.

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves, and J.R. Sedell. 1994. Ecological health of river basins in forested regions of eastern Washington and Oregon. General Technical Report PNW-GTR-326, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon.

Wood, C. 1995. Life history variation and population structure in sockeye salmon. Pages 195-216 in J.L. Nielsen, Editor. Evolution and the aquatic ecosystem. American Fisheries Society symposium 17. American Fisheries Society, Bethesda, Maryland.

Wood, T.M. 2001. Herbicide use in the management of roadside vegetation, western Oregon, 1999-2000: Effects on the water quality of nearby streams. U.S. Geological Survey. Water-Resources Investigations Report 01–4065. Portland, Oregon. http://or.water.usgs.gov/pubs_dir/Pdf/01-4065.pdf.

Wood, T. M., G. R. Hoilman, and M. K. Lindenberg. 2006. Water-quality conditions in Upper Klamath Lake, Oregon, 2002-04: Scientific Investigations Report 2006-5209. U.S. Geological Survey, Reston.

Wooton, R.J. 1990. Ecology of Teleost Fishes. Chapman and Hall, London, England. 404 pp.

WWF (World Wildlife Fund). 2003. Buying time: a user's manual for building resistance and resilience to climate change in natural systems. Editors: L.J. Hansen, J.L Biringer, and J.R. Hoffman.

Zabel, C. J., K.M. McKelvey, and J.P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (Strix occidentalis caurina). Canadian Journal of Zoology 73:433-439.

Zabel C.J., S.E. Salmons, and M. Brown. 1996. Demography of northern spotted owls in southwestern Oregon. Pages 77-82 in E.D. Forsman et al., editors. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithology Society.

Zabel, C. J., J.R. Dunk, H.B. Stauffer, L.M. Roberts, B.S. Mulder, and A. Wright. 2003. Northern spotted owl habitat models for research and management application in California (USA). Ecological Applications 13(4): 1027-1040.

Zedler, J.B. 1996. Ecological issues in wetland mitigation: An introduction to the forum. Ecological Applications 6(1):33-37.

Ziller, J. S. 1992. Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon. Pages 18-29 *in* P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Appendix A: Descriptions of Species Not Likely to be Adversely Affect under ARBO II

A. Mammals

1. Canada Lynx (*Lynx canadensis*)

Listing Status and Description – The Canada lynx was listed as threatened in the contiguous United States on March 24, 2000 (USFWS 2000). Canada lynx are specialized predators and their distribution coincides with the snowshoe hare. Studies in the southern portion of lynx range (Koehler 1990; Apps 2000; Squires and Laurion 2000) documented starvation as a primary cause of adult lynx mortality. The same studies reported low kitten survival. The LCAS provided guidance on maintenance of young, dense conifer vegetation to support higher densities of snowshoe hare. The LCAS also discussed the importance of mature, multiple-storied conifer vegetation that has dense horizontal cover at snow/ground level to snowshoe hare. Murray et al. (1994), Buskirk et al. (2000), Parker et al. (1983), and Dolbeer and Clark (1975) also described this condition. These two vegetation conditions, young, dense conifer and older, multi-storied stands, are very important to lynx because they support conditions suitable to higher densities of snowshoe hare.

Population Trends and Distribution – Historically and currently, lynx were and are present in Alaska and Canada from the Yukon and Northwest Territories east to Nova Scotia and New Brunswick and south into the continental U.S. Records document lynx occurrence in 24 states, including Washington and Oregon (McKelvey 2000). In Region 6 of the Forest Service, lynx habitat has been identified on the Okanogan/Wenatchee, Colville, Mt. Baker-Snoqualmie, Malheur, Wallowa-Whitman, Umatilla and Deschutes National Forests. Each National Forest maintains a map of lynx habitat.

Reasons for Decline – In the final listing rule, the USFWS concluded that the single factor threatening the population was the inadequacy of existing regulatory mechanisms, specifically the lack of guidance for conservation of lynx in National Forest Land and Resource Management Plans and the BLM Land Use Plans.

Recovery Measures – The Canada lynx was listed as threatened in the contiguous United States on March 24, 2000 (USFWS 2000). In the final rule, the USFWS concluded that the single factor threatening the population was the inadequacy of existing regulatory mechanisms, specifically the lack of guidance for conservation of lynx in National Forest Land and Resource Management Plans and the BLM Land Use Plans.

2. Gray Wolf *(Canis lupus)*

Listing Status and Description – The gray wolf was listed as endangered in 1978. Wolves generally live in packs made up of 2 to 12 or more family members and individuals, led by a dominant male and female. In other locations, denning by wolves generally occurs between April and June. Den sites often have forested cover nearby and are distant from human activity. The pups remain at the den site for the first 6 to 8 weeks, and then they move to a rendezvous site until they are large enough to accompany the adults on a hunt (Peterson 1986). Once the pups are large enough to go hunting, the pack travels throughout its territory.

Population Trends and Distribution – Recent observations indicate that wolves exist in Washington, likely in small numbers, and mostly as individuals. Several family units have been documented, indicating that some level of recolonization has occurred recently (Almack and Fitkin 1998). Olterman and Verts (1972) considered wolves to have been extirpated from Oregon since the last animal was presented for bounty in 1946. However, single animals from the experimental population in Idaho have been sighted in northeastern Oregon within the last five years (including a radio-collared animal). At present, wolves from the Snake River, Imnaha, and Umatilla Packs are known to occur in Oregon.

Reasons for Decline – In 1930, it was believed that breeding populations of wolves in Washington were extinct because of fur trading pressure in the 1800's followed by the establishment of bounties on all predators in 1871 in the Washington Territory (Young and Goldman 1944). In Oregon a bounty of $3 on wolves was established in the Willamette Valley in 1843. The Oregon State Game Commission began offering a $20 wolf bounty in 1913 in addition to the regular $5 paid by the state at the time. During the period 1913-1946, 393 wolves were presented for payment in Oregon (Olterman and Verts 1972). Many of these wolves were taken prior to the mid -1930s and no more than two wolves per year were bountied after 1937. The last record of a wolf submitted for bounty in Oregon was in 1946 for an animal killed in the Umpqua National Forest in southwest Oregon (ODFW 2005).

Recovery Measures – A recovery plan was signed on August 3, 1987. The State of Oregon developed and released a wolf conservation and management plan in 2005, which was updated in 2010. The State of Washington followed releasing their conservation and management plan in December of 2011.

3. Grizzly bear *(Ursus arctos horribilis)*
Listing Status and Description – The grizzly bear was listed as a threatened species in the conterminous United States in 1975.

Population Trends and Distribution – Historically, in North America, the grizzly's range extended from the mid-plains westward to the California coast and south into Texas and Mexico (USFWS 1993a). In Washington, the grizzly's range is limited to the North Cascades and the Selkirk mountains (Mt Baker-Snoqualmie, Okanogan/Wenatchee and Colville NFs). In Oregon, the grizzly bear is considered extirpated (Verts and Carraway 1998). Little is known about the grizzly bears residing in the North Cascades. It is suspected that their habits are similar to bears from other areas.

Reasons for Decline – Livestock depredation control, habitat deterioration, commercial trapping, unregulated hunting, and protection of human life were leading cause of the decline of grizzly bears (USFWS 1993a). Human disturbance, usually increased with road access into grizzly habitat, is known to affect bear use of seasonal habitat components. In general, roads increase the probability of bear-human encounters and human induced mortality.

Recovery Measures – Two of the six ecosystems identified in the grizzly bear recovery plan (USFWS 1993a) are in Washington, the Northern Cascades Recovery Zone and the Selkirks

Recovery Zone. Almack et al. (1993) estimated the 1991 grizzly bear population in the North Cascades recovery area at less than 50, and perhaps as low as 5 to 20.

4. Woodland Caribou *(Rangifer tarandus caribou)*

Listing Status and Description – The woodland caribou was federally listed as endangered in 1983. Woodland caribou are generally found on moderate slopes above approximately 1,200 m (4,000 feet) elevation in the Selkirk Mountains in Englemann spruce/subalpine fir and western red cedar/western hemlock forest types (USFWS 1994a). Caribou use streams, bogs, basins, and other areas that are no more than 35 percent slope and are composed of mature or old-growth timber (Freddy 1974; Simpson and Woods 1987).

Population Trends and Distribution – Prior to 1900, woodland caribou were distributed throughout much of Canada and the northeastern, north-central, and northwestern coterminous United States. Since the 1960's, the woodland caribou population has restricted its range to the Selkirk Mountains of northeastern Washington, northern Idaho and southeastern British Columbia. In Washington State, caribou are found east of the Pend Oreille River in Pend Oreille County.

The recovery area for caribou in the South Selkirk Mountains is comprised of approximately 5,700 km2. About 47 percent of the area lies in British Columbia and 53 percent lies in the United States. The United States portion includes the Salmon-Priest Wilderness and other portions of the Colville and Idaho Panhandle National Forests, Idaho Department of Lands holdings, and scattered private parcels (USFWS 1994a). As recently as the 1950s, the South Selkirk Mountains population consisted of an estimated 100 animals (Evans 1960). However, by the early 1980s, the population had declined to 25-30 animals whose distribution centered on Stagleap Provincial Park, British Columbia (Scott and Servheen 1985). Stagleap is a small park located a few miles north of the U.S. - Canadian border.

Reasons for Decline – Habitat fragmentation and loss, predation, poaching, and disease have all contributed to the decline of woodland caribou in North America. The small, South Selkirk Mountains population is extremely vulnerable to predation, accidental deaths and poaching (USFWS 1994a). Predation from mountain lions (*Puma concolor*) may have contributed to the decline of the last population of endangered mountain caribou (*Rangifer tarandus caribou*) in the United States (Katnik 2002).

Recovery Measures – The U.S. population was augmented in 1987, 1988, and 1990 by transplanting a total of 60 animals from central British Columbia into northern Idaho. In 1996-1998, a total of 43 woodland caribou were transplanted into northeast Washington and Stagleap Provincial Park. The current population estimate for the ecosystem is 37 animals (Audet pers. comm. 2002). Since the late 1980s, habitat for caribou in the ecosystem has been managed according to guidelines developed by the U.S. Forest Service, B.C. Ministry of Environment, and Idaho Department of Lands, which were developed in an attempt "to minimize the effects of logging on caribou and…to develop silvicultural standards that may enhance habitat over the long term." (USFWS 1994a). The potential for habitat loss due to large wildfires or insect/disease attack is an ongoing management concern.

B. Plants

1. Howell's spectacular thelypody (*Thelypodium howellii ssp. spectabilis*)

Listing Status and Description– Howell's spectacular thelypody (thelypody) was federally listed on May 26 1999 without Critical Habitat designation. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan was finalized for Howell's spectacular thelypody on June 3, 2002 (USFWS 2002a).

Howell's spectacular thelypody is an herbaceous biennial that reaches approximately 60 cm (24 in) tall, with branches arising from near the base of the stem. The basal leaves are approximately 5 cm (2 in) long with wavy edges and are arranged in a rosette. Stem leaves are shorter, narrow, and have smooth edges. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 in) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986a).

The plant flowers in May, fruits in June and goes dormant in August. It is a root forming plant and is pollinated by insects. 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. 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 1986a). Soils are pluvial-deposited alkaline clays mixed with recent alluvial silts, and are moderately well-drained (Kagan 1986a). The thelypody may be dependent on periodic flooding since it appears to rapidly colonize areas adjacent to streams that have flooded (Kagan 1986a). In addition, this taxon does not compete well with encroaching weedy vegetation such as *Dipsacus fullonum* (teasel) (Davis and Youtie 1995).

Population Trends and Distribution – This taxon was thought to be extinct until rediscovered by Kagan in 1980 near North Powder (Kagan 1986a). The 11 recently discovered sites containing the thelypody are located near the communities of North Powder, Haines, and Baker. The North Powder thelypody population contains five sites; the largest is subject to a conservation easement 41.4 ac (16.8 ha). Until recently, one site near the town of North Powder, less than 2.3 ac (0.8 ha) in size, had a plant protection agreement between the landowner and The Nature Conservancy. The Haines plant population currently consists of three small sites located in or near the town of Haines. Since the publication of the proposed rule, an additional site in Haines was identified (B. Russell, consultant, in litt. 1998) and one previously known site in Haines was apparently extirpated by development (P. Brooks, Forest Service, in litt. 1998). A 1.8 ac (0.7 ha) site west of Baker is within a 20 ac (8 ha) pasture adjacent to a road. Another site north of Baker 0.08 ac (0.03 ha) exists in a small remnant of meadow habitat surrounded by farmland. One site approximately 8 km (5 mi) north of North Powder is located on private land at Clover Creek (Kagan 1986a).

Reasons for Decline – The thelypody has been extirpated from about one-third of known historic sites, including the type locality in Malheur County. 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 1986a).

Within the City of Haines, all remaining habitat containing thelypody is being impacted by residential construction, trampling, and other activities. In 1994, a large section of habitat formerly occupied by thelypody at the Haines rodeo grounds was destroyed when a parking lot was constructed. In 1998, an estimated 5,000 to 10,000 thelypody plants were reduced to fewer than 300 plants due to additional disturbances that occurred at the rodeo. Most of the extant plants in the population now occur outside the rodeo grounds. It is possible that the thelypody population may recover from this disturbance, but it is not likely.

Recovery Measures – 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, four populations of thelypody receive protection from development and are managed for conservation. The BLM has managed a population for several years until recently near North Powder on private land under a conservation easement. Three populations are managed by ODOT under a SMA (N. Testa, pers. comm. 2006). Another population near North Powder was leased by TNC for 15 years, but lease negotiations were not renewed.

The Service has funded the ODA to develop cultivation and out-planting methods for several years and in the process several populations have been re-introduced.

2. MacFarlane's Four-O'clock (*Mirabilis macfarlanei*)

Listing Status and Description – MacFarlane's Four-O'clock was first listed as endangered in 1979, and was reclassified to threatened in 1996 due to improvement in the status of the species and discovery of additional populations (USFWS 1996b). Federal listing did not include critical habitat. A recovery plan was completed for the species in 1985 and updated in 2000.

Macfarlane's four-o'clock is a member of the four-o'clock family (Nyctinaceae). It was first described in 1936 from specimens collected along the Snake River (Service 2000). Macfarlane's four-o'clock is a long-lived herbaceous perennial with a thickened taproot that is very deep in relation to the above ground portion of the plant. This species typically blooms from May through June. The bright pink flowers are conspicuous, up to one inch long by one inch wide.

The flowers occur in inflorescences, consisting of a group of three to seven flowers subtended by a five-lobed involucre (saucer-shaped bract). Each flower has the potential to produce one fruit and one seed (USFWS 2000a). The flowers are funnel-shaped with a widely expanding limb. Leaves are opposite, somewhat succulent, and broadly lanceolate (spear-shaped) to ovate (egg-shaped) (USFWS 2000a). Individual stems have been observed to live over 20 years. Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring. Seed germination and establishment may be infrequent and may be dependent upon a specific suite of environmental conditions (USFWS 2000a). In addition to reproducing by seed, plants reproduce clonally from a thick, woody tuber that sends out many shoots.

Population Trends and Distribution – MacFarlane's Four-o'clock (*Mirabilis macfarlanei*) is endemic to portions of the Snake, Salmon, and Imnaha river canyons in west-central Idaho and adjacent northeastern Oregon, an area approximately 29 miles (47 km) by 18 miles (29 km). The population in the Snake River Unit occurs on Wallowa-Whitman National Forest lands, with the majority of the plants in the Hells Canyon National Recreation Area. It is currently found in 13 Element Occurrences (EOs) in Idaho and Oregon (2 in the Imnaha, 3 in the Snake, and 8 in the Salmon drainages). [An Element Occurrence (EO) is an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location (USFWS 2008). The population size for all Macfarlane's four-o'clock populations in Idaho and Oregon was previously considered to range from 1,500 to 3,000 individuals (7,500 to 15,000 stems), based on estimates of clonal size (USFWS 2000a) and on population estimates for Macfarlane's four-o'clock sites in Idaho and Oregon (USFWS 2000a). However, recent information and survey data suggest that the total population size for this species is approximately 8,000 to 9,000 individuals (39,000 to 44,000 stems) (USFWS 2000a).

There are approximately 6,000 plants, twelve occurrence site locations of the plant on the Wallowa-Whitman National Forest (in the action area), 325 known acres; and there is a 39,090 acres of modeled potential habitat in the Hells Canyon National Recreation Area (HCNRA) of the forest.

Reasons for Decline – The Revised Recovery Plan for Macfarlane's four-o'clock (USFWS 2000a) extensively discusses the reasons for Federal Listing and the threats to this species. The invasion of non-native plant species and the effects of wildfire continue to be the two main threats to Macfarlane's four-o'clock and its habitat. At least six of the known 13 Macfarlane's four-o'clock EOs have burned since 1990 and one or more species of invasive non-native plants, such as cheatgrass (*Bromus tectorum*), yellow starthistle (*Centaurea solsitialis*), and dalmation toadflax (*Linaria dalmatica*), have been documented at all Idaho EOs. Other notable potential threats to this species include tramping and grazing by both native herbivores and domestic livestock, herbicide and pesticide spraying, and recreation and off-highway vehicles (OHVs) (USFWS 2009).

Recovery Measures – Recovery actions that have occurred to data include; 1) Establishment of an interagency technical work group, 2)Surveys for this species on the Wallowa-Whitman National Forest within the Hells Canyon National Recreation Area from 2006 to present, 3)Development and Implementation of a range-wide monitoring strategy (Mancuso 2011), 4)

Survey and treatment of invasive non-native weeds, and 5)Planning for the reintroduction of Macfarlane's four-o'clock through seed collection, storage, and propagation (Berry Botanical Garden).

5. Spalding's Catchfly (*Silene spaldingii*)

Listing Status and Description – Spalding's Catchfly was listed as threatened in October 2001 (USFWS 2001b). Designation of critical habitat was determined to be prudent; however, it will not be designated until available resources and priorities allow (66 FR 51598, USFWS 2001b). The recovery plan was finalized on September 6, 2007 (USFWS 2007).

It is a regional endemic found predominantly in bunchgrass grasslands and sagebrush-steppe, and occasionally in open pine communities, in eastern Washington, northeastern Oregon, west-central Idaho, western Montana, and barely extending into British Columbia, Canada.

Spalding's catchfly (Silene spaldingii) is an herbaceous perennial plant, a plant that withers to the ground every fall and emerges again in spring. 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 centimeters (8 to 24 inches) in height, occasionally up to 76 centimeters (30 inches). 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 centimeters (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 [defined below]) 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 meter [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 centimeter (0.5 inch) 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 millimeters [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 millimeter [0.02 inch]) appendages, the same color as the blades. Seeds are small (2 millimeters [0.08 inch]), wrinkled, flattened, winged, and light brown when mature (USFWS 2007).

Population Trends and Distribution –There are currently 99 known populations of Spalding's catchfly, with two thirds of these (66 populations) composed of fewer than 100 individuals each. There are an additional 23 populations with at least 100 or more individuals a piece, and the ten largest are each made up of more than 500 plants. Additional plants are continuing to be found, therefore, these numbers are likely to change with additional surveys. The recovery plan 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.

This species occurs on the Umatilla National Forest and Wallowa-Whitman National Forest in Washington and Oregon (in the action area). There is one population and 12 site locations of this species on the Umatilla National Forest to date, and there are three populations and eleven occurrence site locations on the Wallowa-Whitman National Forest for 43.1 acres.

Reasons for Decline – The Recovery Plan for Spalding's catchfly (USFWS 2007) discuss the reasons for Federal Listing, and the threats to this species. A summary of the threats from the Recovery Plan are provided here. The effects of invasive nonnative plants, problems associated with small, geographically isolated populations, changes in the fire regime and fire effects, land conversion associated with urban and agricultural development, adverse livestock grazing and trampling, herbicide and insecticide spraying, adverse grazing (herbivory) and trampling by wildlife species, off-road vehicle use, insect damage and disease, impacts from prolonged drought and climate change, and inadequacy of existing regulatory mechanisms have been implicated as current threats and reasons for the decline of Spalding's catchfly.

Recovery Measures – Surveys and invasive plant inventories at Deadhorse Ridge on the Wallowa-Whitman National Forest located new populations. This is within the Blue Mountains Basin. Plant surveys performed as part of the Lower Imnaha Allotments analysis on the Wallowa-Whitman National Forest located a new population of approximately 300 Spalding's catchfly plants (within the canyon grasslands). BLM located its first population in Oregon in 2011, within the canyon grasslands on a ridge near the Grande Ronde River (Redmond Grade). Approximately 22 plants were documented at this new Oregon BLM site; habitat is good so there is potential for more plants. The Umatilla National Forest to date is conducting a fire treatment monitoring program and is finding new occurrences (potentially subpopulations). Draft consistent range-wide long-term monitoring methods for Spalding's catchfly developed and presented to technical team in 2012.

6. Ute Ladies'- Tresses (*Spiranthes diluvialis*)

Listing Status and Description – *Spiranthes diluvialis* was federally listed as threatened in 1992 (USFWS 1992) when it was only known from Colorado, Utah, and Nevada. *Spiranthes diluvialis* is a perennial, terrestrial orchid that is endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams (USFWS 1995). The species is found in a variety of soil types ranging from fine silt/sand to gravels and cobbles, and has also been found in highly organic or peaty soils. The species has not been found in heavy or tight clay soils or in extremely saline or alkaline soils (pH>8.0) (USFWS 1995). It is generally intolerant of shade, preferring open grass and forb-dominated sites.

Population Trends and Distribution – *Spiranthes diluvialis* has been found in Wyoming, Montana, Nebraska, Idaho and Washington. The species is located in Okanogan and Chelan Counties in Washington State, but has not been documented on federal land, although it is suspected to occur on the Okanogan-Wenatchee NF, and also on the Wallowa-Whitman NF in Oregon.

Reasons for Decline – The main threat factors cited for listing were loss and modification of habitat and the hydrological conditions of existing and potential habitat. 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.

Recovery Measures – A draft recovery plan for *Spiranthes diluvialis* was developed by the USFWS (1995), but has not been finalized. This 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
3. Protecting and managing Ute ladies'-tresses populations in wet meadow, seep, and spring habitats.

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 *Spiranthes diluvialis* (USFWS 2005a). Baseline inventories have been completed for sites in Colorado, Utah, and Wyoming that were not known when the plan was drafted and for new occurrences discovered since 1995 in Idaho, Montana, Nebraska, and Washington. The known habitat of *Spiranthes diluvialis* has broadened with the discovery of riverine populations in Utah, Idaho, and Washington, as has the 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 *Spiranthes diluvialis* 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 Army Corps of Engineers. (USFWS 2005a).

7. Water Howellia (*Howellia aquatilis*)
Listing Status and Description – *Howellia aquatilis*, a wetland plant, was listed as a threatened species in July 1994 (USFWS 1994b). *Howellia aquatilis* is an aquatic annual plant that is restricted to small vernal, freshwater, ephemeral wetlands which have an annual cycle of filling up with water over the fall, winter and early spring, followed by drying during the summer months. The species grows in firm consolidated clay and organic sediments that occur in wetlands associated with ephemeral glacial pothole ponds and former river oxbows. The plant's microhabitats include shallow water and the edges of deep ponds that are partially surrounded by deciduous trees.

Population Trends and Distribution – The historic range of this species included California, Idaho, Montana, Oregon and Washington, but the range has subsequently been reduced to Idaho, Montana and Washington (USFWS 1994b). It has been reported from Clackamas, Marion, and

Multnomah Counties in Oregon, and from Mason, Thurston, Clark and Spokane Counties in Washington. It is believed to have been extirpated from California and Oregon, and from Mason and Thurston Counties in Washington. Extant populations occur in Washington in Spokane and Clark Counties. The species has not been documented on any Forest included in this BA, but is suspected based on presence of potential habitat on the Gifford Pinchot and Okanogan-Wenatchee NFs.

Reasons for Decline – *Howellia aquatilis* has narrow ecological requirements and subtle changes in its habitat could affect a population. 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 1994b).

Recovery Measures – None to date.

8. Wenatchee Mountains Checker-Mallow (*Sidalcea oregana* var. *calva*)

Listing Status and Description – The Wenatchee Mountains Checker-Mallow was federally listed as endangered in 1999 (USFWS 1999c). Critical habitat was designated in 2001 (USFWS 2001a). *Sidalcea oregana* var. *calva* 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 centimeters in length. Pink flowers begin to appear in middle June and peaks in the middle to end of July. Fruits are ripe by August (USFWS 1999c).

Population Trends and Distribution – Although the species *Sidalcea oregana* (Oregon checker-mallow) occurs throughout the western United States, *S. oregana* var. *calva* is known only to occur at six sites (populations) in the mid-elevation wetlands and moist meadows of the Wenatchee Mountains in central Washington state (USFWS 2001a). The only unit included in this BA where the species has been documented is the Okanogan-Wenatchee NF. *Sidalcea oregana* var. calva is most abundant in moist meadows that have surface water or saturated upper soil profiles during spring and early summer. 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. Populations are found at elevations ranging from 1,900 to 4,000 feet. Soils are typically clay-loam and silt-loams with low moisture permeability.

Reasons for Decline – The primary threats to this species include alterations of hydrology, rural residential development and associated activities, competition from native and alien plants, recreation, fire suppression, and activities associated with fire suppression. To a lesser extent threats include livestock grazing, road construction, and timber harvesting and associated impacts including changes in surface-runoff in the small watersheds in which the plant occurs (USDI 1999c).

Recovery Measures – The area designated as critical habitat for the Wenatchee Mountains Checker-Mallow includes all of the lands that have the primary constituent elements below 1,000 m (3,300 ft) within the Camas Creek watershed and in the small tributary within Pendleton Canyon before its confluence with Peshastin Creek, and includes: (1) The entire area encompassed by the Camas Meadow Natural Area Preserve, which is administered by the WDNR; (2) two populations located on Forest Service land; (3) the small drainage north of the Camas Land, administered by the WDNR; (4) the population on private property located in Pendleton Canyon; and (5) the wetland complex of these watersheds necessary for providing the essential habitat components on which recovery and conservation of the species depends (USFWS 2001a). Portions of the designated critical habitat are presumably unoccupied by *Sidalcea oregana* var. *calva* at present, although the entire area has not been recently surveyed. Soil maps indicate that the entire area provides suitable habitat for the species, and there may be additional, but currently unknown, populations present (USFWS 2001a).

9. Rough Popcornflower (*Plagiobothrys hirtus*)

Listing Status and Description –The rough popcornflower was federally listed as endangered in January, 2000. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan was published for the species on July 28, 2003 (USFWS 2003a).

Rough popcornflower can be a perennial, growing to 70 cm tall, with dozens of flowering stems and hundreds of flowers, or can be a diminutive annual with only a few flowers (Amsberry 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 one percent 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.

This herb is endemic to seasonal wetlands in the interior valley of the Umpqua River in southwestern Oregon between Yoncalla and Wilbur, Oregon. Known occurrences for the plant are associated with Calapooya, Sutherlin, and Yoncalla creek drainage systems in Douglas County. Rough popcornflower habitat has been characterized as open seasonal wetlands at elevations ranging from 30 to 270 m (98 to 886 ft). 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 2000b). Seasonal flooding and fire are natural ecological functions considered necessary for long term population viability of the plant. These processes maintain the open habitat upon which the species is dependent and limit competition from invasive native and non-native species.

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*). Bottomland riparian ash woodland along Sutherlin, Calapooya, and Yoncalla creeks provides cover for abundant Columbia white-tail deer (*Odocoileus virginianus leucurus*).

Population Trends and Distribution – Rough popcornflower occurs in only 17 isolated patches of habitat in the vicinity of Sutherlin and Yoncalla, Douglas County, Oregon. A total of 20,147 plants are estimated to occur on approximately 16 ha (40 ac). Fifteen of the 17 patches are on private or commercial land, including three patches managed by The Nature Conservancy. Two patches occur on state land managed by ODOT and are conserved under State law. The Nature Conservancy, ODOT, and ODA Plant Conservation Program have initiated monitoring, life history studies, and transplantation experiments with the objective to increase population sizes on habitat patches. Two additional populations have been introduced on the Roseburg District, BLM lands. Monitoring and enhancement is on-going for these populations. The BLM intends to introduce at least one more population of rough popcornflower within suitable habitat. These introduced populations will need to persist for at least five years before they will be considered successfully established.

Reasons for Decline – 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 declines 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 2003b); wetland destruction due to urban development (USFWS 2000b); heavy spring and summer grazing by cattle and sheep while limited grazing may help to control exotic weeds and remove thatch buildup (USFWS 2000b); invasive exotic weeds such as teasel (*Dipsacus fullonum*), knapweed (*Centaurea sp*.), Eurasian blackberry (*Rubus discolor*), and pennyroyal (*Mentha pulegium*) (USFWS 2000b); fire suppression resulting in encroaching native oaks and ash trees which shade Plagiobothrys hirtus ssp. hirtus (USFWS 2000b); reduced gene flow due to habitat fragmentation (USFWS 2000b). Rough popcornflower is threatened by habitat loss or degradation, livestock grazing, and competition from native and non-native plant species.

Recovery Measures – Ten populations of rough popcornflower are currently protected from development. One 5,000 plant strong population is on land owned and managed by Douglas County Soil and Water Conservation District. Four occur on ODOT right-of-ways, one on an ODOT-owned mitigation property, and two occur on land managed by The Nature Conservancy at the Popcorn Swale Preserve. One population recently estimated to have nearly 3,000 plants, occurs on the City of Sutherlin's festival grounds. Three populations were introduced to Roseburg BLM. A recent inventory for new and known populations was conducted throughout the range in 2005 by ODA. Documentation of the distribution and abundance of rough popcornflower began in 1995 and has continued annually, except for 2001 for the TNC and the BLM populations. In June 2003, TNC counted 13,065 plants at Popcorn Swale Preserve, but by June 2012 the number was down to about 1,000 plants. The introduced Westgate population on BLM land has remained above 10,000 individuals since then (K. Amsberry, pers. comm. 2012).

10. Macdonald's Rockcress (*Arabis mcdonaldiana Eastwood)*

Listing Status and Description – McDonald's rock-cress was federally listed as endangered without critical habitat in 1978. A recovery plan was published for the California populations in 1990. *Arabis macdonaldiana* is one of several closely related endemic species (species restricted to a well-defined geographic area) which have evolved in the Siskiyou Mountains region of southwest Oregon and northwest California. This species was not discovered in Oregon until 1980.

Arabis macdonaldiana is s perennial species in the mustard family (*Brassicaceae*). This species has a branched caudex (short, vertical, often woody stem at or just beneath the ground surface) and several simple stems that measure 5-20 cm (2-8 in) in height. The lower leaves are in rosettes (a cluster of leaves in a circle), are spatulate (rounded above and narrowed to the base), measure 1-2 cm (0.4-0.8 in) long and 4-7 mm (0.2-0.3 in) wide, are toothed, and are essentially smooth. The petals are rose or purple in color and measure 9-11 mm (0.35-0.43 in) long. The fruits are siliques (elongate, dry, and open at maturity) that measure 3-4 cm (1.2-1.6 in) long. Flowering typically occurs from late April through June. This species is distinguished from other rock-cress species by being almost glabrous (without hairs or glands) and by possessing spatulate basal leaves 1-2 cm (0.4-0.8 in) long. *Arabis macdonaldiana* occurs on serpentine soils (high in magnesium, iron, and certain toxic metals). This species is found below 1500 m (4920 ft) elevation in dry, open woods or brushy slopes, with sanicles (*Sanicula spp.)*, violets (*Viola spp*.), and onions (*Alium spp*.). It is an attractive plant, as are many of the endemic rock-cress species of the Siskiyou Mountains. Taxonomic studies are currently underway to investigate the relationship of the Oregon population to those in California.

Population Trends and Distribution – There have been various population monitoring studies for *Arabis macdonaldiana*. The species is restricted to Red Mountain in Mendocino County, California, on U.S. Forest Service and private land (High Siskiyous), in adjacent Del Norte County, California (North Smith River), and in Curry County in Oregon. The population periodically trends up and down depending on weather patterns, degree of vegetation succession, and human-caused disturbance.

Reasons for Decline – Mining activities, vegetation succession, and human-caused disturbance have contributed to the decline of this species.

Recovery Measures – The results of a genetics study that will soon be completed will elucidate, at a minimum, the relationship between the Red Mountain, North Fork of the Smith River, and High Siskiyou populations. If the current taxonomy is determined to be justified based on genetic considerations, a downgrade in status would be considered. However, if the genetics study indicates the Red Mountain population is the sole population of *A. macdonaldiana*, then an assessment should be conducted of the current threats to that population, and whether it warrants continued protection under the ESA.

11. Gentner's fritillary (*Fritillaria gentneri*)

Listing Status and Description – *Fritillaria gentneri* was federally listed as endangered on December 10, 1999 (64 FR 237) 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. *Fritillaria gentneri* 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 2003b). *Fritillaria gentneri* 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*).

Fritillaria gentneri emerges from the ground in early February, flowers from mid-April to early June, and is dormant from mid-August to mid-January. 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.

Recent research (Amsberry and Meinke 2002) has documented erratic and extremely low seed production in the species. This research has indicated that the plant is largely reproducing asexually. Pollination studies by the ODA and Oregon State University (Amsberry and Meinke, 2002) conducted in the Jacksonville Woodlands and the Jacksonville Cemetery did not produce a single viable seed.

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), it is estimated that each flowering fritillary located in a population represents an estimated 40 plants from all three life stages.

Fritillaria gentneri occurs in a variety of 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*). 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 2003c). The soil types most commonly supporting the plant are Vannoy and Vannoy-Voorhies complex.

Population Trends and Distribution – There are approximately 90 populations of *Fritillaria gentneri*. The largest single documented occurrence to date for *F. gentneri* (Pilot Rock Lower, Cascade Siskiyou National Monument, Medford District BLM) contained 600 flowering plants in 2004. The larges area occupied by *Fritillaria gentneri* is at the Jacksonville Woodlands with plants distributed sparsely over approximately 100 acres. The smallest population known is one plant. A total of 1952 flowering plants were observed on BLM lands in 2004. Seven new populations were found during the field season of 2003 on Medford BLM lands. Currently perilously small, widely scattered populations with one to five flowering adult each comprise an estimated 80 percent of the entire population.

Fritillaria gentneri occurs in Jackson and Josephine counties in Oregon and in northern Siskiyou County in California and is often associated with open oak woodlands. The range of this species extends from just below the California border in Siskiyou County to Applegate Lake and Pilot Rock north to the communities of Butte Falls, Sunny Valley, and Galice. Most known sites on federal land occur near the communities of Jacksonville, Ruch, Rogue River, Gold Hill, Sam's Valley, Grants Pass, and Merlin. Large areas of suitable habitat on private lands within the range have not been surveyed and may be occupied.

Reasons for Decline – Habitat loss is the main threat to this species. Habitat loss due to ongoing or future development may occur at 42 percent of the known occupied sites (64 FR 237, 1999). *Fritillaria gentneri* 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 (64 FR 237, 1999). These activities primarily occur on private lands. Between 1941 and the present, the plant has been extirpated from eight of 114 known populations due to developmental expansion.

Recreational collection of plants could adversely affect the species, especially along roads, where the plant is more observable and most vulnerable. Because the species occurs in small, isolated clusters, an entire patch could be decimated in one gathering, extirpating the plant from that area.

Fritillaries appear to be a strongly preferred food choice by deer, which go to great lengths to eat flower stalks. 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 (64 FR 237, 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 2003b).

Private land owners are not required to protect State or federally listed plant species, except where projects are associated with federal funds or permits. As a result the plant receives nearly no protection from its State or federal status as endangered on private lands.

Fire exclusion has altered suitable habitat for the plant by permitting open oak woodland habitats to become more thickly wooded and less grassy. This transition can result in partial to total exclusion of 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.

Of 40 monitored plant populations in 2003 by BLM contracts, 36 have less than 100 flowering individuals and 23 have zero to two flowering plants. 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. *Fritillaria gentneri* 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.

Recovery Measures –Most *Fritillaria gentneri* populations occur on Federal lands and are protected from development. The Medford BLM manages the majority of known *Fritillaria gentneri* sites by performing annual monitoring, funding research to determine life history dynamics and funds 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 *Fritillaria gentneri*. The BLM will protect or conserve any listed plants that are located on BLM administered land.

ODOT also manages two *Fritillaria gentneri* site on highway right-of-ways and has designated Special Management Areas (SMA) at the two locations. 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 *Fritillaria gentneri* for presence of new populations prior to ground disturbing activities.

The City of Jacksonville has developed a management plan to address restoration of a *Fritillaria gentneri* population due to accidental construction of a road through the middle of a populations and subsequent infestation of the noxious weed, *Centaurea solstitialis* (yellow star thistle). Currently the yellow starthistle is nearly under control and the population is being carefully monitored.

12. Nelson's checkermallow (*Sidalcea nelsoniana*)

Listing Status and Description – Nelson's checkermallow was listed as Threatened on February 12, 1993 (58 FR 8242) without designated critical habitat. This species is also on the state of Oregon's State Threatened Plant list. A recovery plan for the species was finalized on May 20, 2010.

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 - 150 cm (19.2 – 48 in) tall at the end of short stalks. 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 percent to 100 percent loss of pre-dispersal seed.

Population Trends and Distribution – 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. The species is known to occur in 65 occurrences within five relict population centers in Oregon and Washington and occupy approximately 273 acres (110 hectares) (USFWS 1998a).

Reasons for Decline – 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 (Franklin and Dyrness 1973, Johannessen et al. 1971; Kuykendall and Kaye 1993).

Habitats occupied by Nelson's checker-mallow contain native grassland species and numerous introduced taxa. 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 Scotch 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 Scotch 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. 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. 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 and land use faced by the 29 populations on private lands which are not subject to state and federal laws governing listed plant species. 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 (CH2M Hill 1996) 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.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf) for recovery goals, objectives, and criteria.

13. Western lily (*Lilium occidentale*)

Listing Status and Description –Western lily was listed as federally endangered on August 17, 1994 (59 FR 42176). Critical habitat has not been designated for the species. This species is also on the state of Oregon’s State Endangered Plant list. A recovery plan for the species was published on March 31, 1998.

Western lily was first collected by Carl Purdy from headlands around Humboldt Bay, California. He subsequently described the plant in 1897. Western lily, an herbaceous perennial in the lily family (*Liliaceae*), grows from a short unbranched, rhizomatous bulb, reaching a height of up to 2.4 m (8 ft). Leaves grow along the stem singly or in whorls and are up to 19 cm (7.5 in) long and pointed. The nodding flowers are red, sometimes deep orange, with yellow to green centers in the shape of a star and spotted with purple. The six petals (tepals) are 3 to 4 cm (1 to 1.5 in) long and curve strongly backwards. Fruit capsules become erect and may produce over 100 seeds when mature. This species can be distinguished from similar native lilies by the combination of pendent red flowers with yellow to green centers in the shape of a star, highly reflexed petals, non-spreading stamens closely surrounding the pistil.

Like other lilies, the western lily has hermaphroditic flowers (producing both pollen and seeds). The plant 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 leaf emerges the following spring. In cultivation, lilies may take 4 to 5 years to flower for the first time (Schultz 1989), and may live for 25 years or more (Kline 1984). Populations of non-flowering lilies may persist for many years under closed forest canopies.

In nature, western lily shoots emerge from the ground anywhere from late March to late May, with emergence occurring generally two to three weeks later in the northern part of the range compared to farther south. From June to July, green buds turn red for 3 to 5 days, open over a period of 1 to 2 days, and the nodding flowers will last for 7 to 10 days. After the floral parts have fallen off, 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-ft) radius. Usually in September, the above ground portion of the plants die back and individuals become dormant 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 stresses the importance that the flowers are suitably presented 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 the sites with more than 200 plants, the majority of plants were non-flowering, which is probably an indication of stress (Schultz 1989).

Genetic differentiation is highly probable in lily populations. Throughout the range of the lily, populations are often small and liable to be subject to random genetic drift, are geographically isolated, 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.

Lily populations appear to have been maintained in the past by occasional fires, at least at some sites in Oregon, and by grazing. Among the most serious current threats is loss of habitat due to ecological succession facilitated by aggressive fire exclusion and removal of grazing. What effects these vegetation changes have had on hydrological aspects of lily habitat, and vice versa, are not well understood.

The lily is found at the edges of sphagnum bogs, in forest or thicket openings along the margins of ephemeral ponds and small channels, coastal prairies, scrublands, and forest openings near the ocean where fog is common. Bogs where the plant is often found are composed of poorly drained, slightly acidic, highly organic soils, usually underlain by an iron pan, or poorly permeable clay layer.

Population Trends and Distribution – Western lily appears to be declining across much of its range (D. Imper, pers. comm. 2005). Of the 62 recorded historical lily populations, nearly half (29) of the sites appears to have been extirpated. Of the remaining 33 reported sites, five have not been surveyed recently and thus it is unknown if plants are still present. Only two sites have as many as 1,000 individuals, 14 sites have between 100 and 999, and 12 sites had 99 or fewer (D. Imper, pers. comm. 2005). Most locations of known lily occurrences and population counts are described in the western lily recovery plan (USFWS 1998b). Several sites have been added and others updated since the recovery plan publication date, for example, since 1989, an estimated 1,000 to 2,000 flowering plants were discovered at a site near Crescent City, California, where none were previously known (D. Imper, pers. comm. 2005).

Western lily populations are found at low elevations, from almost sea level to about 100 m (328 ft) in elevation, and from ocean-facing bluffs to about 6 kilometers (4 miles) inland. The lily is distributed along the coast from Hauser, Coos County, Oregon to Loleta, Humboldt County, California. The Hauser Bog is the northernmost population of western lily and is part of Recovery Area 1 (USFWS 1998b). The plant is currently known from 7 widely separated regions, and has been reported from 62 mostly small, isolated, densely clumped populations (D. Imper, pers. comm. 2005).

Reasons for Decline – The primary threat to the lily is human modification or destruction of habitat. The lily is limited to coastal habitat which is currently undergoing intense development pressure. The species' bog and coastal prairie/scrub habitat occurs on level marine terraces that are desirable for coastal development because of the gentle topography and proximity to the ocean.

From the 1940s to the present, conversion of bog habitat to cranberry farms, roads, and residential dwellings has eliminated suitable lily habitat as well as some populations of the plant in the area from Bandon south to Cape Blanco (Schultz 1989). In the Bandon area alone, 1,600 acres have been converted to cranberry farms, much of them in low depressions with Bandon Silty Loam soils, and therefore could be suitable for the western lily (Bandon, Oregon 2005). The largest known population and three smaller populations near Crescent City, California are currently threatened by habitat degradation due to watershed development. Other threats include forest succession and livestock grazing. These activities primarily occur on private lands. Clearing and draining along the Elk and Six Rivers for livestock grazing have eliminated many of the once numerous populations there. As recently as 1992, a lily population within the city of Brookings was inadvertently destroyed.

Recreational collection of lilies could adversely affect the species, especially along roads, where it is more observable and most vulnerable. Because the species occurs in small, isolated clusters, a collector could decimate an entire clump in one gathering, extirpating the plant from that area.

Years of fire exclusion have led to changes in lily habitat structure and composition. Fire exclusion has altered suitable habitat for the lily by permitting open coastal prairie and wetland habitats to become more thickly wooded. This transition can result in partial to total exclusion of lilies. Removal of livestock has had the same effects. At the same time, the increase of homes in the area makes prescribed burning difficult. This has removed suitable habitat for the lily and has simultaneously produced a less-than-optimal habitat condition that is also susceptible to catastrophic fire. Gorse is a highly fire prone and aggressive noxious weed, occurring in coastal habitat, that threatens not only to replace lily populations, but chemically and ecologically alter suitable habitat.

Although probably not as serious as other threats, grazing by vertebrates (elk, deer, voles, and domestic cattle) and invertebrates (beetle, moth, or butterfly larvae) has been documented for the lily. Of these grazers, deer may represent a major threat, at least in California. Even if not lethal, deer remove a considerable fraction of flowers and fruit, thus seriously reducing the reproductive output at many sites. Deer herbivory has occurred at nearly all sites, and has numerous times eliminated over half a population's annual seed production.

The threat of extinction due to naturally occurring demographic and environmental events reduces the viability of the species as a whole. Because most lily 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. Many lily 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.

Recovery Measures – In California, private individuals, in conjunction with Humboldt State University and the California Department of Fish and Game, have had a formal management plan in place since 1987 for the Table Bluff Ecological Reserve. Since that time, considerable work has been done to recover the lily at Table Bluff and an extensive yearly monitoring record has been generated at this site and three nearby sites (USFWS 1998b). Various experimental habitat manipulations and monitoring are occurring in California at Table Bluff and in the vicinity of Humboldt Bay.

In Oregon, The Nature Conservancy has monitored and managed a small population at Bastendorff Bog since 1985. ODOT has also managed a population in their right-of-way near Hauser by improving habitat through vegetation control. Oregon Parks and Recreation Department has begun restoration of a lily population near Brookings, Curry County, by improving habitat through vegetation control. The Coos Bay BLM has updated a 1995 management plan that now includes provisions for the restoration of lily habitat at the New River ACEC that includes implementing conservation measures and public outreach activities as recommended in the 1998 lily recovery plan. The Coos Bay BLM also has funded a lily propagation study on the New River ACEC in conjunction with the Berry Botanic Garden (Guerrant pers. comm. 2004).

14. Willamette Valley Daisy (*Erigeron decumbens var. decumbens*)

Listing Status and Species Description – The Willamette Valley daisy was listed as endangered, without critical habitat, on January 25, 2000 (USFWS 2000c). This species is also on the state of Oregon's State Endangered Plant list. A recovery plan for the species was published on May 20, 2010. A critical habitat determination was proposed for the species on November 2, 2005 (USFWS 2005).

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 in) 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 (Ingersoll *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 in) 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).

Population Trends and Distribution – 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, and has since been identified at 48 sites on 93.6 ac (37.9 ha).

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 percent of the original measured population between 1993 and 1999 (Clark 2000; Ingersoll 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.

The Willamette daisy is primarily found in wet prairie grasslands, but is also found at a few 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.

Reasons for Decline – 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 USFWS (USFWS 2000c) estimated that habitat loss is occurring at 80 percent of remaining 84 remnants of native prairies occupied by Willamette daisy and Kincaid's lupine. The USFWS (USFWS 2000c) 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 from 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 ac (3.5 ha) (USFWS 2000b). Given the predominance of privately-owned populations, land ownership represents a serious obstacle to conservation and recovery of Willamette daisy.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf) for recovery goals, objectives, and criteria.

Extensive research has been conducted on the ecology and population biology of the Willamette daisy, effective methods for habitat enhancement, and propagation and reintroduction techniques (Clark et al. 1995;, Ingersoll et al. 1995; Clark et al. 1997; Clark 2000; Leininger 2001; Kaye et al. 2003). The results of these studies have been used to direct the management of Willamette daisy populations at Baskett Slough NWR, Eugene BLM, and Willamette Valley TNC preserves.

Several studies have investigated the feasibility of growing 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 2001b). Stem and rhizome cuttings have also been used successfully to establish plants in the greenhouse (Clark et al. 1995). Attempts to establish Willamette daisy at new sites has shown that transplanting cultivated plants is much more effective than sowing seeds directly.

The USFWS's Partners for Wildlife Program works with private landowners to restore and conserve wildlife habitat. During the 2004 fiscal year, the Partners program worked on eight projects in Benton and Marion Counties, Oregon that restored 340 ac (137.6 ha) of wet prairie, oak savannah and upland prairie habitats, some of which will benefit Willamette daisy (A. Horstman, pers. comm. 2004).

15. 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. This species is also on the state of

Oregon's State Endangered Plant list. A recovery plan for the species was published on May 20, 2010 (USFWS 2010).

Bradshaw's lomatium is a member of the Apiaceae (*Umbelliferae*) or the umbel or parsley family. 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 flowering period peaks around the middle of April and beginning of May, but flowers may be observed as early as the first week of April through the end of May (Kagan 1980). The plant sets seed towards the middle of May and produces seed until dormancy in mid-June. Over 30 species of bees, flies, wasps and beetles have been observed visiting the flowers (Kaye and Kirkland 1994). 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. Research has demonstrated that Bradshaw lomatium seed does not persist long in a seed bank and will usually germinate in one season (Kaye 1992).

Bradshaw's lomatium is restricted to wet prairie habitats often associated with tufted-hairgrass (*Deschampsia caespitosa*). In wetter areas, Bradshaw's lomatium occurs on the edges of tufted-hairgrass 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. These sites have heavy, sticky clay 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. The population patterns appear to follow seasonal, microchannels in the tufted-hairgrass prairies, but whether this is due to dispersal or habitat preference in not clear (Kaye 1992; Kaye and Kirkland 1994).

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 increase following fires (Caswell and Kaye 2001), although monitoring showed the effects to be temporary, dissipating after 1 to 3 years. Frequent burns may be required to sustain population growth, as determined from population models (Caswell and Kaye 2001).

Population Trends and Distribution – Bradshaw's lomatium was never widely collected, 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. Since 1980, over 40 new sites have been discovered, including three large populations.

For many years Bradshaw's lomatium was considered a Willamette Valley 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 Clark County, Washington. The Oregon Natural

Heritage Information Center (ORNHIC) currently lists 47 occurrences of Bradshaw's lomatium in three populations centers located in Benton, Lane, Linn, and Marion Counties, Oregon on 324 acres (131 ha). Most of these occurrences are small, ranging from about 10 to 1,000 individuals, although the largest site contains over 100,000 plants. The two Washington occurrences are larger in population size, with one site estimated to have over 800,000 individuals.

Reasons for Decline –The remaining Bradshaw's lomatium populations are threatened by development, pesticides, encroachment of woody and invasive species, herbivory, and grazing. The majority of Oregon's Bradshaw's lomatium populations are located within a 16-km (10-mile) 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). 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 (Siddall and Chambers 1978). Many Bradshaw's lomatium populations occur near roadways and other areas that are sprayed with pesticides. There is concern that these pesticides will 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).

One of the most significant threats is the continued encroachment by woody vegetation. Historically, Willamette valley prairies were periodically burned, either by wildfires or by fires set by Native Americans (Johannessen et al. 1971). Since Euro-American settlers arrived, fire suppression has allowed shrubs and trees to invade grassland habitat, which will ultimately replace the open prairies.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf for recovery goals, objectives, and criteria.

Extensive research has been conducted on the ecology and population biology of Bradshaw's lomatium (Kagan 1980; Kaye 1992; Kaye and Kirkland 1994; Caswell and Kaye 2001; Kaye and Kuykendall 2001). The results of these studies have been used to direct effective methods for habitat enhancement, propagation, and reintroduction techniques for management of the species at wet prairie sites.

Studies of the effects of cattle grazing on Bradshaw's lomatium populations show mixed results. 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). It is possible that the increase in seedlings may be due to small disturbances in the soil, a reduction of shading by nearby plants, and reduced herbivory by small mammals.

During the 2003 and 2004 fiscal years, the Partners program worked on 10 projects in Benton, Lane, Polk and Marion Counties, Oregon that restored 295 acres of wet prairie habitats, some of which will benefit Bradshaw's lomatium and other native prairie species (A. Horstman, pers. comm. 2004).

16. Cook's Lomatium (*Lomatium cookii)*

Listing Status and Description – Cook's lomatium (also known as Cook's desert-parsley) was listed as federally endangered without critical habitat designation on December 7, 2002 (USFWS 2002b 67 FR 68004). This species was also listed on the state of Oregon's State Endangered Plant list. A recovery outline for this species was finalized on June 12, 2003.

Cook's lomatium is a small perennial plant in the parsley family (Apiaceae). James Kagan first collected Cook's lomatium in 1981 from vernal pools in the Agate Desert, Jackson County, Oregon, and subsequently described the species (Kagan 1986b).

Cook's lomatium is an upright 15 to 50 centimeter (cm) (6 to 30 inch [in]) tall perennial herb with a slender, twisted taproot. The taproot often branches at or below ground level, forming multiple stems. The leaves are smooth, minutely inter-divided, glossy bluish-green, and strictly basal. The pale yellow flowers are clustered into small umbels (flower clusters). Each flowering stalk produces either primarily male or female flower clusters. An umbel of female flowers will develop boat-shaped fruits 0.8 to 1.3 cm (0.3 to 0.5 in) long with thickened margins. The flowering stalk very rarely forms leaves, unlike the closely associated *Lomatium utriculatum* (foothills-parsely). The branching taproot distinguishes Cook's lomatium from Bradshaw's lomatium (indigenous to wet prairies from southern Willamette Valley, Oregon to southwest Washington) and *Lomatium humile* (alkali desert parsely) (found in vernal pools in northern California) (Kagan 1986b).

Cook's lomatium flowers from late March to May and is pollinated entirely by insects. The plant produces abundant viable seeds that will often drop within close proximity to the parent plant. A single large adult plant has occasionally been found with up to 100 seedlings growing within 30 cm (11.8 in) of its leaf base (M. Sullivan, pers. comm. 2004). As seeds are buoyant, a probable mode of seed dispersion is via surface water flow. Other possible modes of dispersal are through gopher and mole subsurface excavations, ingestion by birds, insects, and small mammals, and human associated transportation of seeds via muddy shoes, tires, and farm equipment. It is likely that a majority of Cook's lomatium seed germinates each year.

Fire has played a significant historical role in the shaping of Klamath Mountain grassland habitats. Such woody early successional shrubs as *Ceanothus cuneatus* (wedge-leaved buckbrush), *Arctostaphylos spp*. (manzanita), and the exotic Cytissus spp. (broom) compete for space and sunlight with Cook's lomatium in the Illinois Valley. Eventually these shrubs will completely shade out populations of Cook's lomatium and effectively fragment habitat or displace the plant entirely. An historical fire cycle had most likely prevented such shrubs from colonizing the majority of the species' habitat in the past.

Population Trends and Distribution – In the Illinois Valley the 24 extant populations of Cook's lomatium are closely associated with seasonal wet meadows, stream banks, and forest openings on the lower valley floor. Populations range from the Selma area south to the French Flat area. Throughout the Illinois Valley range of Cook's lomatium, 16 populations occur on BLM administered land. Eight of these populations occur at the French Flat Area of Critical Environmental Concern (ACEC), four near Eight Dollar Mountain, and four near Rough and Ready Botanical Area. Two populations of Cook's lomatium overlap both BLM and State lands in the Illinois Valley. Four populations of Cook's lomatium overlap both BLM and private lands. Two populations of Cook's lomatium occur on State land.

In the Rogue Valley, 12 Cook's lomatium populations are located primarily in the central Agate Desert area with one large population occurring near the Rogue Valley Airport.

Cook's lomatium in the Illinois Valley grow 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 Cook's lomatium 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, Cook's lomatium 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 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 Cook's lomatium 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 Cook's lomatium in the Illinois Valley are *Senecio hesparius* (western senecio) and *Microseris howellii* (Howell's microseris).

Reasons for Decline –Specific threats to Cook's lomatium are 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 2002b). Off-road vehicle tires create large ruts and can fracture the clay hardpan layer when soils are moist. This allows water to drain, and compromises plant survival. It is estimated that off-road vehicle use has caused the drainage of 6 hectares (15 acres) from French Flat in 2000 (USFWS 2002b) and by 2004 has drained an additional 4 hectares (10 acres) (M. Mousseaux, pers. comm. 2004).

Recovery Measures – Of the four Cook's lomatium populations on Oregon Department of Transportation (ODOT) administered land, one has become extirpated. ODOT has developed three Special Management Areas. The largest known plant populations are at The Nature Conservancy's Agate Desert Preserve and at the Medford Airport. The largest locations of Cook's lomatium in the Illinois Valley occur at French Flat.

Seeds from three locations in the Rogue River Valley and two locations in Josephine County (French Flat) are stored at the Berry Botanic Garden. Germination requirements of the plant are largely unknown. Initial attempts by the Berry Botanical Garden were inconclusive. Protocols for propagation and reintroduction are likely similar to Bradshaw's lomatium, but still need to be developed. One site in French Flat is designated as an ACEC by the BLM. A section 6 grant was awarded to the ODA in 2005 to investigate cultivation and reintroduction techniques for this plant.

The Nature Conservancy protects Cook's lomatium at two preserves. Stabilization and expansion of endangered plants has been a conservation objective at the Agate Desert and Whetstone Savanna Preserve. Monitoring for effects of burning and mowing are performed annually at the two preserves (D. Borgias, pers. comm. 2004).

ODOT protects a Cook's lomatium population near Cave Junction by limiting maintenance activities during the growing season, restricting herbicide use, and finding solutions to anticipated maintenance impacts to the plants (K. Cannon, pers. comm. 2002).

17. Large-flowered Woolly Meadowfoam (*Limnanthes floccosa ssp. grandiflora*)

Listing Status and Description – Large-flowered woolly meadowfoam was listed as federally endangered on December 7, 2002 (USFWS 2002b 67 FR 68004) without designated critical habitat. This species is also on the state of Oregon's State Endangered Plant list. A recovery outline for this species was finalized on June 12, 2003.

The plant is a 3 to 15-cm (2 to 6-in) tall herbaceous annual; with 1 to 5 cm (0.2 to 2 in) leaves divided into 5 to 9 segments. 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 in) 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 (D. Borgias, pers. comm. 2004).

Nutlets of meadowfoam apparently are dispersed by water; they can remain afloat for up to three days. 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).

Population Trends and Distribution – 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. 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 *Limnanthes floccosa ssp. grandiflora*, may fluctuate more widely than those of perennial plants, such as Cook's lomatium. The year 2000 was a productive year for the species due to the wet conditions, but in 2001, a dry year, population numbers of the plant declined in many areas. In 2000, with average winter precipitation, numbers of plants recorded at selected vernal pools in the Agate Desert Preserve totaled 68,111, but in 2001, with an unusually dry winter, numbers of recorded plants dropped to 39,031. However, in 2002, average rainfall figures were still below normal, the population increased to 63,752 plants (D. Borgias, pers. comm. 2004). Year-to-year changes of this magnitude may be within the normal range of variation for this annual plant, but if the habitat is reasonably protected from degradation or fragmentation and the seed source protected, a population should persist.

Meadowfoam is endemic to the Rogue River Plains of Jackson County at elevations of 366 - 400 m (1,200-1,310 ft), within a 20,510 ac (8,300 ha) landform within the Agate Desert, and within the vicinity of Eagle Point and White City, Oregon.

The plant occupies the Upper and the Middle Rogue sub basins (fourth-field Hydrologic Unit Codes) of the Rogue River. Meadowfoam has no significant ecological, genetic, or geographic barriers separating its 21 extant populations apart from development and road systems. 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 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. In the Agate Desert, all known populations of meadowfoam comprise 80 hectares (198 acres). Three new locations were identified in the spring 2004, all at wetland mitigation sites.

Reasons for Decline – 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 2002b). Recently a known meadowfoam population in the Agate Desert near Table Rocks Road was destroyed due to disposal of contaminants (perhaps herbicide) that removed native vegetation from a 0.75 acre (0.3 ha) portion of vernal pools. The source of the spill has not yet been determined. Recreational off-road vehicle activities have impacted two meadowfoam populations in the White City area.

Recovery Measures –Through conservation easements and agreements with various parties, protection of meadowfoam and its habitats is currently being pursued. The TNC owns and manages two preserves in the area and manages a conservation easement for a third site. The Agate Desert Preserve, the Whetstone Savanna Preserve, and the Rogue River Plains Preserve total 346 ac (140 ha) in the Agate Desert, of which 252 ac (102 ha) are vernal pool habitat (D. Borgias, pers. comm. 2004). At each of the sites the TNC performs annual monitoring and performs periodic restoration activities such as burning, mowing, and controlled grazing.

Large flowered woolly meadowfoam populations occurring on two ODOT SMAs in the Agate Desert and at the Denman Wildlife Area, owned by the ODFW are protected from development.

Meadowfoam seed collected from several areas in the Agate Desert is currently stored at the Berry Botanical Garden. However, the plant is not yet a sponsored species and not fully funded for germination trials or range-wide seed collection (E. Geurrant, pers. comm. 2004).

18. Applegate's Milk-vetch (*Astragalus applegatei)*

Listing Status and Description – Applegate's milk-vetch was federally listed as endangered without critical habitat in 1993 (USFWS 1993). A recovery plan was published in 1998 (USFWS 1998). A 5-year status review was completed by USFWS in 2009 (USFWS 2009).

Applegate's milk-vetch is a tap-rooted, herbaceous perennial in the pea family (Fabaceae), with numerous trailing stems 3-8 dm (12-33 inches) long. The leaves are typically 3.5-7 cm (1.4-2.8 inches) long with 7-11 leaflets. Racemes, produced from June to October, typically have 5-20 or more small, pea-like flowers with lavender, pink, or white petals measuring up to 7 mm (0.3 inches) long that can change color as they age. Seed pods are 8-13 mm (0.4-0.6 inches) long, compressed, and have green or purple speckled valves, and contain 1-10 black seeds, each about 2 mm in diameter. Dehiscence (pod opening at maturity) starts at the top of the pod and continues downward.

Population Trends and Distribution –Applegate's milk-vetch occurs in flat-lying, seasonally moist, strongly alkaline soils sometimes dominated by greasewood (*Sarcobatus vermiculatus*), but also with rubber rabbitbrush (*Ericameria nauseosa*), and with sparse, native bunch grasses and patches of bare soil. The proximity of most sites to the Klamath River floodplain suggests flooding may have been a common occurrence historically. All sites have been invaded to varying degrees by exotic grasses and other nonnative plants that compete for space, water and nutrients with the milk-vetch.

This species was historically known from only four sites, near the city of Klamath Falls in Klamath County, Oregon, approximately 1250 m (4,100 feet) above sea level. Believed extinct until its rediscovery in 1983, it is currently know from six sites near Klamath Falls and totals approximately 30,000 plants. The largest populations are at the Klamath Falls airport, the Collins tract located along the Klamath River between Klamath Falls and Keno, and the Lake Ewauna Preserve, located in Klamath Falls, and owned by The Nature Conservancy. Population trends are only known for the Lake Ewauna Preserve site. Between 1988 and 1991, that site was estimated to contain approximately 30,000 milk-vetch plants, but by 2008, the number of plants had precipitously declined to approximately 2,000.

Reasons for Decline – Urban development, agriculture, weeds, fire suppression, flood control and land reclamation have contributed to the decline of this species. Development and competition with exotic plants is believed to be the major current threats. Another concern is the species slow reproductive rate, probably due to low survival of seedlings.

Malheur Wire-lettuce (*Stephanomeria malheurensis*)
Listing Status and Description – Malheur wirelettuce was federally listed as endangered with critical habitat in 1982. A recovery plan was published in 1991 (USFWS 1991).

Population Trends and Distribution – Malheur wirelettuce occurs at only one location on approximately 70 acres of public lands managed by the BLM. The first discovery of Malheur wirelettuce was in 1966 when seeds of this species were collected with those from a population of its ancestral plant, small wirelettuce. This species is an annual and its numbers vary greatly from year to year, depending largely on the amount of precipitation prior to and during the spring growing season. In 1974, the population was estimated at 228 plants and in 1975 the numbers grew to 1,050. During the 1980's, very low numbers of plants were found, and in 1985, 1986 and 1999, no plants were observed. During this time when the species numbers dwindled to zero, cheatgrass (*Bromus tectorum*) an extremely aggressive non-native grass species dramatically increased at the site. A reintroduction program was begun in April 1987 and 1000 seedlings obtained from the Berry Botanic Garden were transplanted into study plots at the site. Of these plants, 412 survived and one wild plant was found. During subsequent years, efforts have been undertaken to remove cheatgrass from around existing plants and study plots; however, numbers of Malheur wirelettuce remain low.

Malheur wirelettuce is an annual plant in the composite family (*Asteraceae*). It can reach 5 dm (20 inches) in height. This species forms a rosette of hairless leaves that arise from its base. The single stems are many-branched with scale-like leaves. Flower heads are either numerous and clustered, or solitary on short stems. The strap-shaped petals are pink, white, or rarely orange-yellow. Flowering typically occurs in July and August.

The Malheur wirelettuce is co-located with an ancestral relative, small wirelettuce (*Stephanomeria. exiqua ssp. coronaria*); however, the two species do not interbreed. While the Malheur wirelettuce is self-pollinating, its ancestral relative is not.

Malheur wirelettuce occurs in the high desert of the northern portion of the Great Basin and is located in an area south of Burns, Oregon. It occurs on top of a dry, broad hill on volcanic soil intermixed with layers of limestone. Dominant plants at the site are big sagebrush (*Artemisia tridentata*), gray rabbitbrush (*Chrysothamnus nauseosus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and, more recently, cheatgrass. Malheur wirelettuce may be one of the few species able to survive on and around the otherwise barren harvester ant hills at the site.

Reasons for Decline – Malheur wirelettuce is in great danger of extinction due to its small population size. Natural fluctuations in population numbers that occur in response to variations in annual rainfall and spring frosts are particularly problematic for small populations. The species is also vulnerable to habitat alteration; surface mining for zeolite was a potential threat at the time of listing. Other immediate threats include competition from cheatgrass and predation by native herbivores such as black-tailed jackrabbits.

Recovery Measures – Critical habitat for Malheur wirelettuce was designated at the time of listing in 1982. This designation identifies the specific area containing the necessary physical and biological requirements for the conservation of the species. The designation of critical habitat provides additional protection for the species. The area within the designated critical habitat was set aside to allow for natural expansion of the population and to provide a buffer against potential adverse impacts from activities on adjacent lands. In 1984, the Bureau of Land Management (BLM) designated the known location of Malheur wirelettuce as the South Narrows Area of Critical Environmental Concern. The 160-acre area has been fenced since 1974 to prevent grazing by livestock. Monitoring of Malheur wirelettuce population is regularly conducted by BLM botanists. In 1986 USFWS completed the Malheur Wirelettuce Recovery Plan which identified various tasks that are necessary to recover the species. The primary tasks are to maintain and enhance existing populations and habitat, conduct systematic searches for new populations, secure any newly found populations, and develop management and monitoring programs for the species. The U.S. USFWS, in cooperation with the BLM, developed the "Study Plan for *Stephanomeria malheurensis*" to identify research needs and management options for the maintenance of a viable self-perpetuating population of Malheur wirelettuce.

20. Golden paintbrush (*Castilleja levisecta*)

Listing Status and Description – Golden paintbrush was federally listed as endangered, 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. Additional recovery guidelines are provided in *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington*:
http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.
Golden paintbrush is a perennial herb that often forms 5-15 un-branched stems. The plant grows up to 51 cm (20 in) cm tall and is covered with soft, slightly sticky hairs. Golden paintbrush flowers are mostly hidden by showy golden-yellow bracts, hence its name. The plant flowers from April to June. Fire is thought to have historically played a key role in the maintenance of the seasonally wet open prairie habitats occupied by this species.

Population Trends and Distribution – The taxon is a regional endemic with a historic range west of the Cascade Mountain Range from the southern tip of Vancouver Island, Canada to Linn County, Oregon. In Washington, the species occurs in the Puget Trough physiographic province. The taxon is believed to be extirpated from the Willamette Valley physiographic province of Oregon. Historically, golden paintbrush was found as far north as the Puget Trough of Washington and British Columbia, and as far south as the Willamette Valley of Oregon. Most populations are found on the islands that make up the San Juan Islands. The southern-most extant occurrence of golden paintbrush is in Thurston County, Washington.

Reasons for Decline – Prairie destruction due to residential, commercial, or agricultural use is a threat at five of the six privately owned sites (USFWS 2000d). Many populations have destroyed by the conversion of its native prairie habitat to agricultural, residential, and commercial uses. The decline of golden paintbrush is also correlated with fire exclusion. Fire disturbance is an integral component of the prairie ecosystem, maintaining grassland by preventing the successional encroachment of woody shrubs and trees. As a direct consequence of these land-use changes, golden paintbrush has not been seen in Oregon for over 40 years and is now endangered in Washington. High intensity, hot-burning fires resulting from years of fire suppression and plant material build-up can completely eliminate plants and to some extent a seed bank. In communities evolved to periodic fire conditions, hot-burning fires may kill the plants (USFWS 2000d). Competition from non-native, invasive species such as Hieracium pilosella (mouse-ear hawkweed), *Cytisus scoparius* (Scotch broom) and *Leucocephalum vulgare* (ox-eye daisy), and other non-native plants can severely degrade golden paintbrush habitat (Wentworth 1998). An increasing cover of native shrubs is also of concern at some sites. Herbivory by rabbits and deer, and trampling by recreationists can retard flower output during the growing season and undermine seed production (Wentworth 2000).

In the absence of active management, fairly vigorous populations of *Castilleja levisecta* have rapidly declined to extinction within a few decades. Alarmingly, these declines did not result from overt habitat destruction, but from the 'invisible' threats associated with low population numbers, in-breeding depression, fire-suppression and weed invasion. Presently, no site contains enough golden paintbrush individuals to be immune to drastic, irreversible declines.

Recovery Measures – Both federal agencies and private parties are vital in the conservation of the nine remaining populations in Washington and two remaining populations in British Columbia. Whidbey Island Naval Air Station monitors and manages a large population on its land. A private landowner, Robert Pratt, specified in his will that 147 acres of his estate, which contained a significant golden paintbrush population, would go to a nonprofit conservation group. Upon his death in 1999, The Nature Conservancy acquired this land and worked with the National Park Service to purchase another 380 adjoining acres. Congress appropriated funds for the Pratt reserve, and The Nature Conservancy borrowed the remaining money needed to expedite this purchase. In southern Vancouver Island, the Garry Oak Ecosystems Recovery Team is working to save over 100 endangered species, including golden paintbrush. These efforts are essential for the continued survival of golden paintbrush. Steps to increase population sizes and establish new populations are necessary to ensure long term survival of golden paintbrush. The University of Washington's Center for Urban Horticulture, also a Participating Institution of the Center for Plant Conservation, is actively involved in these efforts.

Monitoring and management occurs regularly at Whidbey Island Naval Air Station. A large golden paintbrush population is monitored and managed by The Nature Conservancy 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 2000d). Recently studies to assess the potential for golden paintbrush to establish in the Willamette Valley, conducted in the Willamette Valley in Oregon, concluded that establishment could be successful following specific propagation prescriptions (Lawrence 2005).

21. Kincaid’s lupine (*Lupinus sulphureus ssp. kincaidii*)
Listing Status and Description – Kincaid’s lupine was listed as threatened, on January 25, 2000 (USFWS 2000c). This species is also on the state of Oregon’s State Threatened Plant list.

Designated critical habitat was proposed for Kincaid's lupine on November 2, 2005 (USFWS 2005b). A recovery plan was finalized for this species on May 20, 2010.

Kincaid's lupine is a long-lived perennial species with a maximum reported age of 25 years. Individual plants are capable of spreading by rhizomes, producing clumps of plants exceeding 20 meters (m) (33 feet [ft]) 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 in) tall. The flowering period has been reported from May to July (Eastman 1990) and from April to June (Hitchcock *et al.* 1961), but generally occurs during May and June. Above-ground portions of the plant usually wither and die by mid-August (USFWS 2005b). Self-incompatible, Kincaid's lupine must obtain pollen from another individual plant to produce fertile seeds and is therefore, dependent on solitary bees and flies for pollination. Seed set and seed production are low, with few flowers producing fruit from year to year and each fruit containing an average of 0.3 to 1.8 seeds. Seeds are dispersed from fruits that open explosively upon drying. Kincaid's lupine is the primary host food plant for Fender's blue caterpillars, and the two species are currently known to co-occur at 25 sites on approximately 279 ac (113 ha) across their ranges.

Population Trends and Distribution – Kincaid's lupine occurs in 76 remnant upland prairie occurrences, totaling approximately 1,150 ac (465 ha) in size, scattered across six counties (Lewis County, Washington, and Yamhill, Polk, Benton, Lane, and Douglas Counties, Oregon). Within the Willamette Valley, Kincaid's lupine occupies 86 habitat patches totaling approximately 345 ac (140 ha) in size. In the Umpqua Valley, Douglas County, Oregon, Kincaid's lupine occupies eight small patches, averaging 14 ac (5.7 ha) in size, and in Lewis County, Washington, three tiny patches, totaling approximately 0.49 ac (0.2 ha) in size.

Reasons for Decline – Prairie has been lost due to fire suppression and subsequent woodland succession. Most Willamette Valley prairies are thought to be early seral habitats, requiring natural or human- induced disturbance, particularly fire, for their maintenance (Franklin and Dyrness 1973). Before European settlement, the native Kalapuya people are attributed with maintaining prairie habitats through prescribed burning (Boyd 1986). A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. Without active management, the natural succession of prairie to shrub/forest by the invasion of native species, such as Oregon ash (*Fraxinus latifolia*), Douglas hawthorn (*Crataegus douglasii*), Nutka rose (*Rosa nutkana*) and Douglas spiraea (*Spiraea douglasii*), will lead to the eventual loss of these prairie sites (Hammond and Wilson 1993; Kuykendall and Kaye 1993). The presence of invasive non-native woody species, such as Himalayan blackberry (*Rubus discolor*), multiflora rose (*Rosa multiflora*) and Scotch broom (*Cytisus scoparius*), exacerbate this problem. Shrub and tree intrusion has been documented on most of the relic prairie sites occupied by Kincaid's lupine and Fender's blue butterfly (USFWS 2005b).

Over 80 percent of the remaining upland prairies (mostly in the Willamette Valley) where these species is known to occur are threatened by agriculture and forest practices, development, grazing, and road construction and maintenance. Kincaid's lupine is thought to have originally been widely distributed on upland prairie habitats throughout the Willamette Valley, with the lupine extending into the Umpqua Valley, Oregon.

Kincaid's lupine is generally associated with native fescue upland prairies that are characterized by heavier soils, with mesic to slightly xeric soil moisture levels. At the southern limit of its range, the subspecies occurs on well-developed soils adjacent to serpentine outcrops where the plant is often found under scattered oaks (Kuykendall and Kaye 1993). Within the Willamette Valley Kincaid's lupine occurs in generally open upland prairie and open oak savannah. Kincaid's lupine is thought to have historically colonized areas along the edge of oak woodlands throughout upland prairies. Schultz (1998) theorizes that lupine patches were historically distributed no greater than 0.5 kilometers (km) (0.3 miles [mi] apart, allowing dispersal of Fender's blue butterfly between lupine patches.

Fence rows, pastures, and intervening strips of land along agricultural fields and roadsides are often the only remaining refugia for native upland prairie plants. Therefore, native endemic plants often occur in small and fragmented populations. Generally, the direct and indirect effects of small population size on most species of plants and animals include decreased dispersal ability, decreased rate of genetic exchange, a resultant loss of population viability and vigor, and a hastening towards extinction (Gilpin and Soule 1986).

The modern use of herbicides for highway or roadway maintenance, farming practice, or other land uses for weed control and landscape maintenance purposes is further exacerbating the precarious survival of these remnant plant populations. That is, some of the remnant Kincaid's lupine populations occur within weedy sites, and spraying nonspecific contact herbicides eliminates all existing plant species.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010b; http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf) for recovery goals, objectives, and criteria.

C. Insects and Mollusks

Fender's Blue Butterfly

Listing Status and Description – Listed as endangered in 2000 with critical habitat designated in 2006, Fender's blue butterfly is known to use Kincaid's lupine as its primary larval food plant but is also known to use spur lupine *(Lupinus laxiflorus = L. arbustus)* and sickle-keeled lupine *(L. albicaulis*) as secondary host plants. Female Fender's blue butterflies lay their eggs on lupine foliage in late May or early June; and larvae emerge to feed on foliage during late June. In July, larvae crawl to the base of the plant and enter diapause. From this point until the larvae emerge and begin feeding on foliage again the following April, the larvae remain at the base of the senescent plant, or in the litter immediately adjacent to the lupine stem. Fender's blue butterfly density has been positively correlated with the number of Kincaid's lupine flowering racemes, and more recently, to nectar production in native flowering species used as nectar sources by Fender's blue butterfly. Survivorship of larvae to adult butterflies has been estimated at 0.025 to 0.060 percent (Schultz and Crone 1998).

Research (Schultz and Dlugosh 1999) indicates that native wildflowers in the Willamette Valley prairies provide more nectar than nonnative flowers for adult butterflies, and that Fender's blue butterfly population density is positively correlated with the density of native wildflowers. In Lane County, key native flowers include: wild onion, (*Allium amplectans*), cat's ear mariposa lily (*Calachortus tolmiei*), common camas (*Camassia quamash*), Oregon sunshine (*Eriophyllum lanatum*), and rose checkermallow (*Sidalcea virgata)* (Schultz and Dlugosch 1999). Tall oatgrass (*Arrenatherum elatius*) and other non-native grasses can out-compete these native forb species (Hammond 1996). The abundance of exotic grasses can effectively preclude butterflies from using a Kincaid's lupine occurrence (Hammond 1996).

The Primary Constituent Elements for Fender's Butterfly critical habitat are (1) Early seral upland prairie, oak savanna habitat with undisturbed subsoils that provides a mosaic of low growing grasses and forbs, and an absence of dense canopy vegetation allowing access to sunlight needed to seek nectar and search for mates; (2) Larval host-plants: *Lupinus sulphureus* ssp. *kincaidii*, L. *arbustus*, or *L. albicaulis*; (3) Adult nectar sources, such as: *Allium acuminatum* (tapertip onion), *Allium amplectens* (narrowleaf onion), *Calochortus tolmiei* (Tolmie's mariposa lilly), *Camassia quamash* (small camas), *Cryptantha intermedia* (clearwater cryptantha), *Eriophyllum lanatum* (woolly sunflower), *Geranium oreganum* (Oregon geranium), *Iris tenax* (toughleaf iris), *Linum angustifolium* (pale flax), *Linum perenne* (blue flax), *Sidalcea campestris* (Meadow checkermallow), *Sidalcea virgata* (rose checker-mallow), *Vicia cracca* (bird vetch), *V. sativa* (common vetch) and *V. hirsuta* (tiny vetch); (4) Stepping stone habitat: Undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie, oak/savanna plant community (well drained soils), within and between natal lupine patches (~1.2 miles (~2 km)), necessary for dispersal, connectivity, population growth, and, ultimately, viability.

Population Trends and Distribution – Censuses of Fender's blue butterfly were started in 1991; most of the 22 census units have been surveyed every year since 1993 (Hammond and Wilson 1993; Hammond 1994, 1996, and 1998; Schultz 1998).
Total range-wide population numbers (once most occurrences were monitored) of Fender's blue butterflies have ranged from a low of 1,384 adults in 1998 to a high of 3,492 adults in 2000 (Appendix A2). Although population size appears to have increased between 1998 and 2000, this may be a result of poor weather conditions in 1998, and thus poor flight conditions. It may also be an artifact of increasing survey effort at these occurrences. However, some of this increase may be attributed to habitat enhancement activities, such as tree and shrub removal from lupine occurrences (USFWS 2005b).

Fender's blue butterfly is a Willamette Valley endemic subspecies that was considered to be extinct until rediscovered by Dr. Paul Hammond in 1989 in McDonald Forest, Benton County, Oregon. The historical distribution of Fender's blue butterfly is not precisely known, due to the limited information collected on this species before its description in 1931. Recent surveys have determined that Fender's blue butterfly is confined to 33 habitat occurrences in Yamhill, Polk, Benton, and Lane counties, Oregon. One population at TNC's Willow Creek Preserve in Eugene, Lane County, Oregon is found in wet *Deschampsia*-type prairie, while the remaining occurrences are generally found on drier upland prairies characterized by fescue species. The

Willow Creek aggregate of populations is the largest of the south valley occurrences (USFWS 2005b).

Reasons for Decline – Anecdotal evidence indicates that under ideal conditions adult Fender's blue butterflies may disperse as far as 5 to 6 km (3.1 to 3.7 mi) from their natal lupine occurrences (Hammond and Wilson 1992). Hammond (1998) reports recolonization of a site by Fender’s blue butterfly from a distance of approximately 3 km (1.9 mi). Schultz (1997) further theorizes that Fender’s blue butterfly originally had a high probability of dispersing between occurrences that were historically located an average of 0.5 km (0.3 mi) apart. Current distribution of lupine occurrences range well beyond this distance, and barriers to migration between close occurrences may be present (USFWS 2005b).

Today, remnant upland prairie acreage is extremely fragmented and remaining Fender’s blue butterfly populations are so small that migration processes are not expected to maintain the population over time. Extirpation of remaining small populations is expected from localized events and low genetic diversity of very small populations. The low availability of host lupine occurrences and fragmentation of habitat are seen today as the major ecological factors limiting reproduction, dispersal, and subsequent colonization of new habitat (Hammond 1994; Schultz and Dugosch 1999).

Recovery Measures – Many partners have grouped together to improve habitat for the butterfly. On May 20, 2010 a Recovery Plan ws signed which lays out general direction for activities to enhance survival and recovery of the species. The Eugene BLM is currently developing a Resource Management Plan (RMP) to guide further management activities on their land in the West Eugene Wetlands.

D. Fish

Borax Lake chub

Listing Status and Description – The Borax Lake chub (*Gila boraxobius*). was listed as endangered in 1980 by an emergency rule and again by a final rule listing it as endangered with 640 acres of critical habitat designated at the time of listing (47 FR 43957) on October 5, 1982. In 1983 the BLM designated 520 acres of public land surrounding Borax Lake as an Area of Environmental Concern. The Nature Conservancy acquired 160 acres of privately owned land which Borax lake is situated upon. The Recovery Plan was approved in 1987 (USFWS 1987). A status review was completed via contract by The AuCoin Institute For Ecological, Economic and Civic Studies, and submitted to USFWS on September 30, 2003 (Williams and McDonald 2003).

The Borax Lake chub is endemic to Borax Lake and adjacent wetlands in the Alvord Basin, Harney County, Oregon. The Borax Lake chub is a species of the genus *Gila* (a wide-spread desert minnow) related to *G. alvordensis*, the Alvord chub. Adults typically range in length from 33 to 50 mm (1.3-2 inches) standard length (SL), with a maximum recorded size of 93 mm (3.6 in) SL. This species has a large, concave head, and large eyes. It is olive green on the upper part of the head and body, and is speckled with small melanophores that extend nearly to the ventral surface. A dark line also extends along the length of the dorsal midline. Pharyngeal teeth are uniserial and well-hooked. Males have longer fins, nuptial tubercles are only found in males longer than 28mm and are restricted to the body and paired fins (Williams and Bond 1980). The Borax lake chub is an opportunistic omnivore (Williams and Williams 1980). Juveniles and adults eat essentially the same things including aquatic insects; terrestrial insects; algae; mollusks and mollusk eggs; aquatic worms; fish scales; spiders; and seeds.

Critical habitat was designated at the time of listing (47 FR 43957). The PBFs of the habitat for Borax Lake chub are the constant temperature and flow of water into Borax Lake and the natural flow of water out of Borax Lake into associated aquatic environs and the aquatic and terrestrial food organisms of the Borax Lake ecosystem.

Population Trends and Distribution – This species is endemic to Borax Lake, Harney County, Oregon. Borax Lake is a 10.2 acre lake fed by subsurface hot springs, with several marshy and wetland areas associated with the outflows of the lake. The vast majority of chubs reside in Borax Lake, with portions of the population occupying the marsh areas at the outflows. Fourteen population estimates of the chub in Borax Lake ranged from 3,934 to 13,319 during sample years from 1986 to 2006 (Scheerer and Jacobs 2006). Preliminary results from sampling conducted in 2007 estimate the population at 9,384 fish (Scheerer 2007). The fluctuation in population appears to be natural for this species that is relatively short lived and reproduces annually. Lower Borax Lake, which may have contained several thousand chubs during wet years in the mid-1980's, was observed to be dry from 1989 to 1991 and again in 2005 and 2006. Observations made in other years have not been recorded, so are not known at this time. Outlet streams to the north of Borax Lake also are inhabited by Borax Lake chub. Observations have not been made to determine if chub survive through the winter in these small fragmented habitats.

Reasons for Decline – The perched nature of the lake in which the Borax Lake chub is found makes it extremely susceptible to human disturbance. In 1980, a modification of the perimeter of the lake diverted water from the lake and lowered its level by approximately one foot. The lower lake level adversely affects the chub by decreasing habitat and increasing water temperature. A second major threat to the Borax Lake chub is geothermal development, which involves water diversion that causes loss of habitat and exposes the chub to higher water temperatures.

Recovery Measures – Numerous recovery measures implemented since the listing of Borax Lake chub have contributed to improvements in the conservation status of the species (Williams and McDonald 2003). Protection afforded by the Endangered Species Act has curtailed exploratory drilling for geothermal energy development by creation of a zone of no surface disturbance around the most sensitive habitats. The Nature Conservancy, a private conservation organization, purchased a 65 ha (160 ac) parcel of private land including Borax Lake in 1993. An area of 260 ha (640 ac) has been designated as Critical Habitat by the U.S. USFWS, which affords additional protection from actions by federal agencies. The Steens Mountain Cooperative Management and Protection Act of 2000 (Public Law 106-399) has withdrawn the Borax Lake area from geothermal and mineral development.

BLM and TNC are currently working to use a fence and information signs to implement a closure of the designated critical habitat area to vehicle entry and limit disturbance related to camping and recreating. An additional conservation action in progress includes assessing whether geothermal development on nearby privately owned land threatens the Borax Lake ecosystem. The ODFW conducts annual monitoring of fish, and habitat characteristics.

Literature:

Almack, J.A., W.L. Gaines, P.H. Morrison, J.R. Eby, R.H. Naney, G.F. Wooten, M.C. Snyder, S.H. Fitkin, and E.R. Garcia. 1993. North Cascades Grizzly Bear Ecosystem Evaluation: Final Report. Interagency Grizzly Bear Committee, Denver, CO.

Almack, J.A. and S.H. Fitkin. 1998. Grizzly bear and gray wolf investigations in Washington State 1994-1995. Final Progress Report. Washington Dept. of Fish and Wildlife, Olympia, WA. 80 pp.

Amsberry, K. 2001. Pers. comm. Oregon Department of Agriculture, Corvallis, Oregon.

Amsberry K. and R.J. Meinke. 2002. Reproductive Ecology of *Fritillaria gentneri*. Report from Oregon Department of Agriculture. Portland (OR): US Fish and Wildlife Service. 41 p.

Amsberry, K. 2012. Pers. comm. Oregon Department of Agriculture, Corvallis, Oregon.

Apps, C.D. 2000. Space-use diet, demographics, and topographic associations of lynx in the Southern Canadian Rocky Mountains: a study. Pages 351-371 *In*: Ruggerio et al Ecology and conservation of lynx in the United States. GTR-30WWW University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Audet, Suzanne. 2002. Pers. Comm. Wildlife Biologist, USDI Fish and Wildlife Service, Spokane, WA.

Borgias, D. 2004. Pers. comm.

Boyd, R. 1986. Strategies of Indian burning in the Willamette Valley. Canadian Journal of Anthropology 5:67-86.

Brock, R., and B. Knapp. 2000. *Fritillaria gentneri* demographic study plots at Jacksonville Woodlands, 2000 data, second year. Unpublished report submitted to the Bureau of Land Management, Medford District. 12 p

Buskirk, S.W. L.F. Ruggiero, K.B. Aubry, D.E. Pearson, J.R. Squired, and K.S. McKelvey. 2000. Comparative ecology of lynx in North America. Pages 397-417 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, and others. Ecology and conservation of lynx in the United States. Univ. Press of Colorado. 480 pp.

Cannon, K. 2002. Pers. comm.

Caswell, H. and T.N. Kaye. 2001. Stochastic demography and conservation of an endangered perennial plant (*Lomatium bradshawii*) in a dynamic fire regime. Advances in Ecological Research 32:1-51.

CH2M Hill. 1996. Studies of *Sidalcea nelsoniana.* Unpublished annual research reports and technical memoranda prepared by CH2M Hill for McMinnville Water and Light, submitted to the Service.

Clark, D. L. 2000. Demographic analysis of *Erigeron decumbens var. decumbens*, an endangered plant species of the Willamette Valley, Oregon: 1999 Field Studies. U.S. Fish and Wildlife Service, Western Oregon NWR Refuge Complex. Order No. 1448-13590-9-M047A.

Clark, D.L., Finley, K.K., C.A. Ingersoll. 1993. Status report for Erigeron decumbens var. decumbens. Unpublished report prepared for the Conservation Biology Program, Oregon Department of Agriculture. p.55+.

Clark, D. L., K. K. Finley, C. A. Ingersoll. 1995. Regeneration biology of *Erigeron decumbens var. decumbens*, an endangered plant of the Willamette Valley. Report to the Oregon Department of Agriculture

Clark, D.L., C. A. Ingersoll, C.A., and K. K. Finley. 1997. Regeneration of *Erigeron decumbens var. decumbens (Asteraceae)*, the Willamette daisy. Pages 41-47 in T. N. Kaye et al. (eds.), Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon

Davis, J.S. and B. Youtie. 1995. Site information and analysis: North Powder *Thelypodium howellii ssp. spectabilis* preserve.Prepared for The Nature Conservancy, Oregon Field Office, Portland, OR.

Dolbeer, R.A. and W.R. Clark. 1975. Population ecology of snowshoe hares in the central Rocky Mountains. Journal of Wildlife Management 39: 535-549.

Drew, A. D. 2000. Effects of livestock grazing and small mammal populations on endangered Bradshaw's desert parsley (*Lomatium bradshawii*) at Oak Creek, Willamette Valley, Oregon. M.S. Thesis. University of Oregon, Eugene. 65 pp.

Eastman, D.C. 1990. Rare and Endangered Plants of Oregon. Beautiful America Publishing Company. 194p

Evans, H.F. 1960. A preliminary investigation of caribou in the northwestern United States. M.S . Thesis, Montana State Univ., Missoula. 145 pp.

Franklin J. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Freddy, D.J. 1974. Status and management of the Selkirk caribou herd, 1973.

Unpublished M.S. Thesis, University of Idaho, Moscow, ID.

Gilpin, M.E. and M.E, Soule. 1986. Minimum viable populations: Processes of species extinction. In Conservation Biology: The Science of Scarcity and Diversity, ed. M.E. Soule, pp 19-34. Sinauer, Sunderland, Mass.

Guerrant, E. O. Jr. 1996. Designing populations: Demographic, Genetics, and Horticultural Dimensions. In Falk, D. A., C. I. Miller, and M. Olwell (eds.). Restoring Diversity: Strategies for Reintroduction of Endangered plants. Island Press, New York.

Hammond, P. C. 1994. 1993 study of the Fender's blue butterfly (Icaricia icarioides fenderi) in Benton, Polk and Yamhill Counties. U.S. Fish and Wildlife Service, Portland, Oregon.

Hammond, P. C. 1996. 1995 study of the Fender's blue butterfly (Icaricia icarioides fenderi) in Benton, Polk and Yamhill Counties. U.S. Fish and Wildlife Service, Portland, Oregon.

Hammond, P. C. 1998. 1997 study of the Fender's blue butterfly (Icaricia icarioides fenderi) in Benton, Polk and Yamhill Counties, Oregon. U.S. Fish and Wildlife Service, Portland, Oregon.

Hammond, P.C. and M.V. Wilson. 1993. Status of the Fender's blue butterfly, Unpublished report on file at U.S. Fish and Wildlife Service, Oregon State Office. 66pp.

Helm, B. P. 1998. Biogeography of Eight Large Branchiopods Endemic to California, in Witham, C. W., Bauder, E. T., Belk, D., Ferren Jr., W. R., and Ornduff, R. (eds.), Ecology, conservation, and management of vernal pool ecosystems, California Native Plant Society, Sacramento, CA.

Hitchcock, C. L. et al. 1955–1969. Vascular plants of the Pacific Northwest.

Horstman, A. 2004. Pers. comm.

Imper, D. K., and J. 0. Sawyer. 1994 (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1994 Monitoring Report Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/California Department of Fish and Game. With 2 attachments.

Imper, D.K. 2005. Pers. comm.

Ingersoll, C.A.; Finley, K.K.; Clark, D.L. 1995. Demography and Reproduction of *Erigeron decumbens var. decumbens*, 1993-1994 Field Studies. Prepared for the Oregon Department of Agriculture, Plant Conservation Biology Program. p.28.

Jain, S.K. 1978. Local dispersal of *Limnanthes* nutlets: an experiment with artificial vernal pools. Canadian Journal of Botany 56: 1995-1997.

Johannessen, C.L., W.A. Davenport, A. Millet, and S. McWilliams. 1971. The vegetation of the Willamette Valley. Ann. Assoc. Am. Geogr. 61:286-302.

Kagan, J.S. 1980. The biology of *Lomatium bradshawii* (*Apiaceae*), a rare plant of Oregon. M.S. thesis, University of Oregon, Eugene.

Kagan, J.S. 1986a. Status report for *Thelypodium howellii ssp. spectabilis*. Oregon Natural Heritage Data Base, Portland, Oregon.

Kagan, J.S. 1986b. A new species of *Lomatium* (Apiaceae), from southwestern Oregon. Madroño 33: 71-75b.

Kagan, J.S. and S. Yamamoto. 1987. Status Report for Erigeron *decumbens subsp. decumbens* (Draft). Oregon Natural Heritage Data Base. p.30+.

Katnik, D.D. 2002 Predation and habitat ecology of mountain lions (*Puma concolor)* in the southern Selkirk Mountains. Doctoral Dissertation Washington State University. 240 pp.

Kaye, T. 1992. Bradshaw's desert-parsley: population monitoring and pollination biology. Unpublished manuscript submitted to Kalmiopsis, from Restoration and Conservation Biology Cooperative Project (OSU and ODA), Corvallis, OR.

Kaye, T.N. and M. Kirkland. 1994. *Cimicifuga elata*: status, habitat analysis, monitoring, inventory, and effects of timber management. Final report. A Cooperative ChallengeCost Share Report between Oregon Department of Agriculture, U.S. Bureau of Land Management, and U.S. Forest Service.

Kaye, T.N.; Kuykendall, K.; Nelson, C. 2000. Seedling and transplanting rare Willamette Valley prairie plants for population restoration. Challenge Cost Share Project funded jointly by the Bureau of Land Management, Eugene District and the Institute for Applied Ecology. p.42.

Kaye, T.N. and K. Kuykendall. 2001. Germination and propagation techniques for restoring rare Pacific Northwest prairie plants. In, Reichard, S.H., P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg, D.L. Salstrom, editors. Conservation of Washington's Native Plants and Ecosystems. Washington Native Plant Society, Seattle, Washington.

Kaye, T.N., M.V. Wilson, T. Erhart, P.C. Hammond, K. Kuykendall, A. Liston, A.F. Robinson, Jr., C.B. Schultz, and P.M. Severns. 2003. Biology of Kincaid's lupine (Lupinus sulphureus ssp. kincaidii [Smith] Phillips), a threatened species of western Oregon native prairies. Natural Areas Journal 23:72-83

Kaye, T. N., and A. Brandt. 2005. Seeding and transplanting rare Willamette Valley prairie plants for population restoration. Unpublished report to the Eugene District BLM. Institute for Applied Ecology, Corvallis, Oregon.

Kline, B. 1984. Cultivating West coast lilies. Journal of the North American Lily Society. 38(3): 11-13

Koehler, G.M. 1990. Population and habitat characteristics of lynx and snowshoe hares in north central Washington. Canadian Journal of Zoology 68:845-851

Kuykendall, K. and T.N. Kaye. 1993. *Lupinus sulphureus ssp. kincaidii* survey and reproduction studies. U.S. Bureau of Land Management, Roseburg District, Roseburg, Oregon and Oregon Department of Agriculture, Salem, Oregon. 44 pp.

Lawrence, B. A. 2005. Studies to facilitate the reintroduction of golden paintbrush (*Castilleja levisecta*) to the Willamette Valley, Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Leininger, S. 2001. Promoting and restoring Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*) and Willamette daisy (*Erigeron decumbens var. decumbens*) at Baskett Slough NWR. Senior honors Thesis, Oregon State University

Mancuso M. 2011. A range-wide monitoring program for Macfarlanes's Four-o-Clock (Mirabilis macfarlanei), a threatened plant species in Idaho and Oregon. Report prepared by Mancuso Botanical Services for Snake River Fish and Wildlife Office, Boise, Idaho.

McKelvey K.S. 2000. History and distribution of lynx in the contiguous United States. *In:* Ruggerio et al. Ecology and conservation of lynx in the United States. University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Meinke, R.J. 1982. Threatened and endangered vascular plants of Oregon: an illustrated guide. Unpublished report by the Oregon Department of Agriculture for the U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. 352 pp.

Mousseaux, M. 2004. Pers. comm.

Murray, D.L., S. Boutin and O'Donoghue. 1994. Winter habitat selection by lynx and coyotes in relation to snowshoe hare abundance. Canadian Journal of Zoology 72:1444-1451.

Olterman, J.H. and B.J. Verts. 1972. Endangered plants and animals of Oregon *IV. Mammals.* Oregon State University, Agricultural Experiment Station, Special Report, 364:1-47

Oregon Department of Fish and Wildlife (ODFW). 2005. Oregon Wolf Conservation and Management Plan. 189 pages. Portland, Oregon

Parker, G.R., J.W. Maxwell, L.D. Morton, and G.E.J. Smith. 1983. The ecology of the lynx (*Lynx canadensis*) on Cape Breton Island. Can. J. Zoology 61:770-786.

Peterson, R.O. 1986. Gray Wolf. *In* R.L. Di Silvestro, ed., Audubon Wildlife Report 1986. National Audubon Soc., New York

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. 2000. Ecology and conservation of lynx in the United States. Univ. Press of Colorado and USDA Rocky Mountain Research Station. 480 pp.

Scheerer, P. D., and S. E. Jacobs. 2006. 2006 Borax Lake chub investigations. Annual progress report. Fish Division, Oregon Department of Fish and Wildlife. Salem, Or.

Scheerer, P. D. 2007. Email from Scheerer describing the preliminary results of the 2007 Borax Lake chub investigations. Fish Division, Oregon Department of Fish and Wildlife. Salem, Or.

Schultz, C. B. 1997. Status of the Fender's blue butterfly (Icaricia icarioides fenderi) in Lane County, Oregon: population estimates and site evaluations. U.S. Fish and Wildlife Service, Portland, Oregon.

Schultz, C. B. 1998. Dispersal behavior and its implications for reserve design in a rare Oregon butterfly. Conservation Biology 12:284-292.

Schultz, S. T. 1989 (September). Status Report on *Lilium occidentale Pard*. Unpublished report prepared for the Endangered Species Program, Plant Division, Oregon State Department of Agriculture, Salem, Oregon.

Schultz, C. B., and E. E. Crone. 1998. Burning prairie to restore butterfly habitat: a modeling approach to management tradeoffs for the Fender's blue. Restoration Ecology 6:244–252.

Schultz, C. B., and K.M. Dlugosch. 1999. Nectar and hostplant scarcity limit populations of and endangered Oregon butterfly. Oecologia 119:231-238.

Scott, M.D. and G. Servheen. 1985. Caribou Ecology. Job Comp. Report, Proj. No. W-160-R11. Idaho Dept. of Fish and Game, Boise. 136 pp.

Siddall, J.L.; Packard, P.L.; Chambers, K.L. 1978. Status Report for *Mentzelia packardiae*. Unpublished report. p.9

Simpson, K. and G.P. Woods. 1987. Movements and habitats of caribou in the mountains of southern British Columbia. Ministry of Environment and Parks Wildlife Bull. No. 8-57.

Skinner, M. W. 1988 (June). Comparative Pollination Ecology and Floral Evolution in Pacific Coast Lilium. Unpublished thesis. Harvard University, Cambridge, MA.

Squires, J.R. and T. Laurion. 2000. Lynx home range and movements in Montana and Wyoming: preliminary results. Pages 337-349 In: Ruggerio et al Ecology and conservation of lynx in the United States. GTR-30WWW University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Sullivan, M. 2004. Pers. comm.

Testa, N. 2006. Pers. comm.

USFWS (U.S. Fish and Wildlife Service). 1987. Recovery plan for the Borax Lake chub, Gila boraxobius. U.S. Fish and Wildlife Service, Portland, Oregon. 61 pp.

USFWS (U.S. Fish and Wildlife Service). 1991. Stephanomeria malheurensis (Malheur Wirelettuce) Recovery Plan. Portland, Oregon. 34pp. http://ecos.fws.gov/docs/recovery_plans/1991/910321.pdf

USFWS (U.S. Fish and Wildlife Service). 1992. Endangered and threatened wildlife and plants; final rule to list the plant *Spiranthes diluvialis* (Ute Ladies'-Tresses) as a threatened species. Final Rule. Fed. Reg.57(12): 2048-2054. January 17, 1992.

USFWS (U.S. Fish and Wildlife Service). 1993a. Grizzly bear recovery plan. Missoula, MT.

USFWS (U.S. Fish and Wildlife Service). 1993d. Determination of Endangered status for the plant *Astragalus applegatei* (Applegate's milk-vetch). Federal Register. 58, 143: 40547-40551.

USFWS (U.S. Fish and Wildlife Service). 1994. Determination of Endangered Status for *Lilium Occidentale* (Western Lily). Federal Register 59:42171-42176.

USFWS (U.S. Fish and Wildlife Service). 1994a. Recovery plan for woodland caribou in the Selkirk Mountains. Portland, OR. 63 pp.

USFWS (U.S. Fish and Wildlife Service). 1994b. Endangered and threatened wildlife and plants;The plant, Water Howellia (*Howellia aquatilis*), determined to be a threatened species. Fed. Reg. 59(134): 35860-35864. July 14, 1994.

USFWS (U.S. Fish and Wildlife Service). 1995. Ute ladies' tresses (*Spiranthes diluvialis*) draft recovery plan. U.S. Fish and wildlife Service, Denver, CO. 46 pp.

USFWS (U.S. Fish and Wildlife Service). 1996. Final rule to reclassify Mirabilis macfarlanei from endangered to threatened status. Federal Register 61 (52): 10693-10697.

USFWS (U.S. Fish and Wildlife Service). 1996b. Endangered and threatened wildlife and plants; Reclassification of *Mirabilis macfarlanei* (MacFarlane's Four-O'Clock) from endangered to threatened status. Fed. Reg. 61(52): 10693-10697. March 15, 1996.

USFWS (U.S. Fish and Wildlife Service). 1998. Applegate's milk-vetch (Astragalus applegatei) recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 41 pp. http://ecos.fws.gov/docs/recovery_plans/1998/980410d.pdf

USFWS (U.S. Fish and Wildlife Service). 1998a. Recovery Plan for the Threatened Nelson's Checker-mallow (*Sidaleea nelsoniana).* U.S. Fish and Wildlife Service. Portland, OR.

USFWS (U.S. Fish and Wildlife Service). 1998b. Recovery Plan for the Endangered Western lily (*Lilium occidentale*). Portland, Oregon. 82 pp.

USFWS (U.S. Fish and Wildlife Service). 1998c. Applegate's milk-vetch (*Astragalus applegatei*) recovery plan. Portland, Oregon: U.S. Fish & Wildlife Service, Pacific Region. p.41

USFWS (U.S. Fish and Wildlife Service). 1999b. Final Endangered Status for the Plant *Fritillaria gentneri* (Gentner's fritillary). Federal Register. 64, 237: 69195.

USFWS (U.S. Fish and Wildlife Service). 1999c. Endangered and threatened wildlife and plants;determination of endangered status for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-Mallow). U.S. Fish and Wildlife Service. Fed. Reg. 64(245):71680. December 22, 1999.

USFWS (U.S. Fish and Wildlife Service). 2000. Endangered and threatened wildlife and plants; Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Related Rule. U.S. Fish and Wildlife Service. Fed. Reg. 65: 16051-16086.

USFWS (U.S. Fish and Wildlife Service). 2000a. Revised recovery plan for Macfarlane's four-o'clock (Mirabilis macfarlanei). Region 1, U.S. Fish and Wildlife Service, Portland, OR. 46 pp.
USFWS (U.S. Fish and Wildlife Service). 2001. Endangered and threatened wildlife and plants; final rule to list Silene spaldingii (Spalding's catchfly) as threatened. Federal Register 66(196): 51598-51606.

USFWS (U.S. Fish and Wildlife Service). 2000b. Endangered Status for the Plant *Plagiobothrys hirtus* (Rough Popcornflower). Federal Register. 65, 16: 3866-3875.

USFWS (U.S. Fish and Wildlife Service). 2000c. Proposed Endangered Status for *Erigeron decumbens var. decumbens* (Willamette Daisy) and Fender's Blue Butterfly (*Icaricia icarioides fenderi*) and Threatened Status for *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine). Federal Register. 63, 17: 3863-3877

USFWS (U.S. Fish and Wildlife Service). 2000d. Recovery plan for the golden paintbrush (*Castilleja levisecta*). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2001a. Endangered and threatened wildlife and plants; Final designation of critical habitat for Nelson's checkermallow (*Sidalcea oregana var. calva).* Fed. Reg. 66(173): 46536-46548.

USFWS (U.S. Fish and Wildlife Service). 2001b. Endangered and threatened wildlife and plants; Final rule to list *Silene spaldingii* (Spalding's Catchfly) as threatened. Fed. Reg. 66(196): 51598-51606. October 10, 2001.

USFWS (U.S. Fish and Wildlife Service). 2002a. Recovery plan for Howell's spectacular thelypody (*Thelypodium howellii spectabilis*). Region 1, U.S. Fish and Wildlife Service, Portland, OR.

USFWS (U.S. Fish and Wildlife Service). 2002b. Determination of Endangered Status for *Lomatium cookii* (Cook's Lomatium) and *Limnanthes floccosa ssp. grandiflora (*Large-Flowered Woolly Meadowfoam) From Southern Oregon; Final Rule. Federal Register 67: 68004-68015.

USFWS (U.S. Fish and Wildlife Service). 2003a. Recovery Plan for the Rough Popcornflower (*Plagiobothrys hirtus*). Fish and Wildlife Service. Roseburg, OR.

USDI (U.S. Fish and Wildlife Service). 2003b. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon Vernal pool crustaceans and plants in California and Oregon. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2003c. Recovery plan for *Fritillaria gentneri* (Gentner's fritillary). U.S. Fish and Wildlife Service, Portland, Oregon.
viii + 89 pp.

USFWS (U.S. Fish and Wildlife Service). 2005a. Rangewide Status Review of Ute Ladies'-Tresses (Spiranthes diluvialis). Prepared for the USFWS and Central Utah Water Conservancy District. Prepared by Water Fertig, Rick Black, and Paige Wolken.

USFWS (U.S. Fish and Wildlife Service). 2005b. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Fender's Blue Butterfly (*Icaricia icarioides fenderi*), *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine), and *Erigeron decumbens var. decumbens* (Willamette Daisy); proposed rule. Federal Register 70: 66492-66599.

USFWS (U.S. Fish and Wildlife Service). 2007. Recovery Plan for Silene spaldingii (Spalding's Catchfly). U.S. Fish and Wildlife Service, Portland, Oregon. xiii+ 187 pages.
USFWS (U.S. Fish and Wildlife Service). 2008. Draft Status Review for Mirabilis macfarlanei (MacFarlane's four o'clock) (draft status review). Snake River Fish and Wildlife Office, Boise, Idaho. Dated September 10, 2008. 57 pages.

USFWS (U.S. Fish and Wildlife Service). 2009. Macfarlane's four-o'clock (Mirabilis macfarlanei) 5 year Review Summary and Evaluation. Snake River Fish and Wildlife Office, Boise, Idaho. June 2009, 26 pages.

USFWS (U.S. Fish and Wildlife Service). 2010b. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.
http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf

Verts, B.J. and l.N. Carraway. 1998. Land mammals of Oregon. University of California

Press. Berkley, California. 668 pp.

WDNR (Washington Department of Natural Resources). 1997. Final habitat conservation plan, September 1997. Washington Department of Natural Resources, Olympia, WA.

Wentworth, J.B. 1998. *Castilleja levisecta*, a threatened South Puget Sound prairie species. Pages 101-104 in P. Dunn and K. Ewing (eds.), Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy, Seattle, Washington.

Wentworth, J.B. 2000. The demography and population dynamics of Castilleja levisecta, a federally threatened perennial of Puget Sound grasslands. In: Reichard, S.H.; Dunwiddie, P.W.; Gamon, J.G.; Kruckeberg, A.R.; Salstrom, D.L., editors. Conservation of Washington's Rare Plants and Ecosystems. p 49-51.

Williams, J. E. & C.D. Williams. 1980. Feeding ecology of *Gila boraxobius* (*Osteichthyes: Cyprinidae*) endemic to a thermal lake in southeastern Oregon. Great Basin Naturalist. 40:101-114.

Williams, J.E. & C.A McDonald. 2003. A Review of the Conservation Status of the Borax Lake Chub, An Endangered Species. Final report to the US Fish and Wildlife Service, Portland, Or.

Young, S.P. and E.A. Goldman. 1944. The wolves of North America. Am. Wildlife. Inst., Washington, D.C. 385 pp.

Appendix B NMFS or USFWS Approval Templates

<u>RRT TEMPLATE RECOMMENDATION</u>

To: NMFS Branch Chief / USFWS Field Office Supervisor

Subject: RRT Project Recommendation: <PROJECT NAME>

The <PROGRAMMATIC> RRT has completed a technical and program review of <PROJECT NAME>, which is scheduled for implementation during the <YEAR> construction season.

Our review was based on the following documents:

- <Document 1>
- <Document 2>
- <Document 3>
- <Document 4>

The RRT fully supports this project and recommends covering the project under <PROGRAMMATIC>.

Sincerely,

<NAME>
<PROGRAMMATIC> Restoration Review Team Lead

NMFS or FWS TEMPLATE APPROVAL

Subject: <NMFS or FWS> Project Approval: <PROJECT NAME>

Thank you for submitting plans for the <PROJECT NAME>, which is scheduled for implementation during the <YEAR> construction season. Endangered Species Act compliance for <USFWS or NMFS> species will be provided through the <PROGRAMMATIC NAME> <DATE>.

This project was formally presented to the <PROGRAMMATIC> Restoration Review Team (RRT) on <DATE>, and received a thorough technical and program review. <ADD MORE HISTORY HERE, OR REVIEWER NAMES IF APPLICABLE>. Further, in order to address both implementation and effectiveness monitoring of this project, a detailed Monitoring and Adaptive Management Plan was developed, which was submitted to the full RRT for review on <DATE>. This Monitoring and Adaptive Management Plan is an additional requirement to the biological opinions.

Based on the project design plans and specifications, a summary of review comments and project modifications, and the thoroughness of the Monitoring and Adaptive Management Plan, the RRT fully supports this project and recommends covering the project under the biological opinion(s) referenced above.

Based on project design, Monitoring and Maintenance Plan, review comments, and that the project:

- Will take place where ESA-listed species occur and designated critical habitat occur,
- Was reviewed and approved by a NMFS fish passage engineer <NAME> on <DATE>,
- Was reviewed and approved by the <Programmatic> Restoration Review Team on <DATE>, and
- All other relevant project design criteria for construction practices will be used.

the <USFWS or NMFS> hereby approves inclusion of this project for coverage under the biological opinion(s) referenced above.

Sincerely,

<USFWS Field Office Supervisor>
<NMFS Branch Chief>

FISH PASSAGE TEMPLATE APPROVAL

Subject: NMFS Fish Passage Approval: <PROJECT NAME>

Upon review of the provided plans and other documentation for the <PROJECT NAME>, I find that the project meets NMFS fish passage criteria and is appropriate for the site. Please forward this approval as necessary for programmatic or individual biological opinion documentation.

NMFS appreciates the opportunity to review this project and to provide comments. If you have any questions or concerns, feel free to contact me at your convenience.

Sincerely,

<NMFS Fish Passage Engineer>