UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS Nos.:
NWP-2013-9664

April 25, 2013

Kent Connaughton, Regional Forester
Pacific Northwest Region 6
USDA Forest Service
333 SW First Avenue
Portland, Oregon 97204-3440

Jerome E. Perez, State Director
Oregon/Washington
USDI Bureau of Land Management
333 SW First Avenue
Portland, Oregon 97204

Stanley Speaks, Regional Director
Northwest Region
Bureau of Indian Affairs
911 NE 11th Avenue
Portland, Oregon 97232-4169

Re: 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).

Dear Mr. Connaughton, Mr. Perez, and Mr. Speaks:

This document contains a programmatic conference and biological opinion (opinion) on reinitiation of consultation on the effects of the U.S. Forest Service (Forest Service), Bureau of Land Management (BLM), and Bureau of Indian Affairs (BIA) (acting for the Coquille Indian Tribe) funding or carrying out aquatic restoration actions in the States of Oregon and Washington.[1] Actions covered in this opinion are modified from those analyzed in the biological opinion, issued on April 28, 2007, as summarized in the consultation history section of the opinion.

[1] 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, Wyden Amendment, 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).

During this consultation, NMFS concluded that the proposed action is not likely to adversely affect southern DPS green sturgeon *(Acipenser medirostris)* or Steller sea lion *(Eumetopias jubatus)*, or their designated critical habitat, or southern resident killer whales *(Orcinus orca)*, which does not have designated critical habitat within the action area. NMFS also concluded that proposed program is not likely to jeopardize the continued existence of the following fish species listed as threatened or endangered under the ESA, or result in the destruction or adverse modification of their proposed or designated critical habitats:

1. Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)
2. Upper Willamette River (UWR) spring-run Chinook salmon
3. Upper Columbia River (UCR) spring-run Chinook salmon
4. Snake River (SR) spring/summer-run Chinook salmon
5. SR fall-run Chinook salmon
6. Puget Sound (PS) Chinook salmon
7. Columbia River (CR) chum salmon (*O. keta*)
8. Hood Canal chum salmon
9. LCR coho salmon (*O. kisutch*)
10. Oregon Coast (OC) coho salmon
11. Southern Oregon/Northern California Coasts (SONCC) coho salmon
12. Lake Ozette sockeye salmon (*O. nerka*)
13. SR sockeye salmon
14. LCR steelhead (*O. mykiss*)
15. UWR steelhead,
16. Middle Columbia River (MCR) steelhead
17. UCR steelhead
18. Snake River Basin (SRB) steelhead
19. PS steelhead
20. Southern distinct population segment eulachon *(Thaleichthys pacificus*)

As required by section 7 of the ESA, NMFS is providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this program. The ITS also sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of the listed species considered in this opinion, except eulachon because NMFS has not yet promulgated an ESA section 4(d) rule prohibiting take of threatened eulachon. However, anticipating that such a rule is likely to be issued in the future, we have included terms and conditions to minimize take of eulachon. These terms and conditions are identical to the terms and conditions required to minimize take of listed salmon and steelhead. Therefore, we expect the action agencies would follow these terms and conditions regardless of whether take of eulachon is prohibited. The take exemption for eulachon will take effect on the effective date of any future 4(d) rule prohibiting take of eulachon.

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 a new diversion structure, or conveyance of water across Federal land. 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.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes three conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendation, the Forest Service, BLM, or BIA must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

If you have questions regarding this consultation, please contact Kenneth Phippen, OSHO Branch Chief, in the Roseburg Oregon State Habitat Office, at 541.957-3385.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

cc: Pauly Bridges, USFWS
Paul Henson, USFWS
Scott Lightcap, BLM
Scott Peets, Forest Service,
Michael Pond, BIA

Endangered Species Act – Section 7 Programmatic Consultation Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

for

Reinitiation of Aquatic Restoration Activities in States of Oregon and Washington (ARBO II)

NMFS Consultation Number: NWR-2013-9664

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?
Lower Columbia River Chinook salmon	T	Yes	No	No
Upper Willamette River spring-run Chinook salmon	T	Yes	No	No
Upper Columbia River spring-run Chinook salmon	E	Yes	No	No
Snake River spring/summer-run Chinook salmon	T	Yes	No	No
Snake River fall-run Chinook salmon	T	Yes	No	No
Puget Sound Chinook salmon	T	Yes	No	No
Columbia River chum salmon	T	Yes	No	No
Hood Canal summer-run chum salmon	T	Yes	No	No
Lower Columbia River coho salmon	T	Yes	No	No*
Oregon Coast coho salmon	T	Yes	No	No
Southern Oregon/Northern California Coasts coho salmon	T	Yes	No	No
Lake Ozette sockeye salmon	T	Yes	No	No
Snake River sockeye salmon	E	Yes	No	No
LCR steelhead	T	Yes	No	No
UWR steelhead	T	Yes	No	No
Middle Columbia River steelhead	T	Yes	No	No
Upper Columbia River steelhead	T	Yes	No	No
Snake River Basin steelhead	T	Yes	No	No
Puget Sound steelhead	T	Yes	No	No*
Southern green sturgeon	T	No	No	NA
Eulachon	T	Yes	No	No
Southern resident killer whale	T	No	No	NA
Steller sea lion	T	No	No	NA

*Critical habitat has been proposed for LCR coho salmon and PS steelhead.

Fishery Management Plan that Describes EFH in the Action Area	Would the action adversely affect EFH?	Are EFH conservation recommendations provided?
Coastal Pelagic Species	Yes	Yes
Pacific Coast Groundfish	Yes	Yes
Pacific Coast Salmon	Yes	Yes

Consultation
Conducted By: National Marine Fisheries Service
Northwest Region

Issued by:

William W. Stelle, Jr.
Regional Administrator

Date: April 25, 2013

TABLE OF CONTENTS

LIST OF ACRONYMS

A&P	abundance and productivity
ARBO	aquatic restoration biological opinion II
BA	aquatic restoration biological assessment II
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BRT	Biological Review Team
CFR	Code of Federal Regulations
CHART	Critical Habitat Analytical Review Team
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
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Hydropower System
FR	Federal Register
HC	Hood Canal
HUC	Hydraulic Unit Code
HWM	high water mark
IC	Interior Columbia
LCR	Lower Columbia River
LW	large wood
MPG	major population group
MCR	Middle Columbia River
MSA	Magnuson Stevens Act
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PCE	primary constituent element
PDC	project design criteria
POEA	polyethoxylated tallow amine
PS	Puget Sound
RHCA	riparian habitat conservation areas
RRT	regional review team
SR	Snake River
SRB	Snake River Basin
TRT	Technical Review Team
UCR	Upper Columbia River
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service

UWR	Upper Willamette River
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife
WLC	Willamette/Lower Columbia

1. 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

The National Marine Fisheries Service (NMFS) prepared the conference and biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq*.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq*.) and implementing regulations at 50 CFR 600.

The opinion, incidental take statement, and EFH conservation recommendations are each in compliance with Data Quality Act (44 U.S.C. 3504(d)(1) *et seq.*) and they underwent pre-dissemination review.

1.2 Consultation History

On June 27, 2007, NMFS issued the Aquatic Restoration Biological Opinion and EFH consultation (ARBO I) to the U.S. Forest Service (Forest Service), Bureau of Land Management (BLM), and Bureau of Indian Affairs (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 (NMFS 2008c). The Coquille Indian Tribe, which is the only Tribal signatory to the Northwest Forest Plan, is represented by the BIA under the 2007 and proposed programmatic consultations.

On January 28, 2013, the Action Agencies submitted a biological assessment (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 20 species listed under the ESA and their proposed or designated critical habitat (Table 1), and would adversely affect areas designated by the Pacific Fisheries Management Council as EFH for Pacific salmon (PFMC 1999) but is not likely to adversely affect southern distinct population segment (DPS) green sturgeon (*Acipenser medirostris)*, Steller sea lion *(Eumetopias jubatus)*, and southern resident killer whales *(Orcinus orca)* or their designated critical habitat.

Table 1. Listing status, status of critical habitat designations and protective regulations, 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; 'P' means proposed for listing or designation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River spring-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer-run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Puget Sound	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Chum salmon *(O. keta)*			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Hood Canal summer-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon *(O. kisutch)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	P 1/14/13; 78 FR 2726	6/28/05; 70 FR 37160
Oregon Coast	T 6/20/11; 76 FR 35755	2/11/08; 73 FR 7816	2/11/08; 73 FR 7816
Southern Oregon/Northern California Coasts	T 6/28/05; 70 FR 37160	5/5/99; 64 FR 24049	6/28/05; 70 FR 37160
Sockeye salmon *(O. nerka)*			
Lake Ozette	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Puget Sound	T 5/11/07; 72 FR 26722	P 1/14/13; 78 FR 2726	P 2/7/07; 72 FR 5648
Eulachon *(Thaleichthys pacificus)*			
Southern DPS	T 3/18/10; 75 FR 13012	10/20/11; 76 FR 65324	Not applicable

During consultation, NMFS also concluded that the action would adversely affect EFH designated for groundfish (PFMC 2005), and coastal pelagic species (PFMC 1998), including estuarine areas designated as Habitat Areas of Particular Concern.

For the period 2008-2011, the Action Agencies carried out 323 in-channel restoration projects (483 stream miles), 168 fish passage projects (242 stream miles of fish passage restored), three restoration projects in estuaries (112 wetland acres), 77 road treatment projects (500 road miles), and 69 vegetation treatments (20,048 acres) (Table 2 and 3).

Table 2. Aquatic restoration biological opinion (ARBO I) actions per year, 2008 to 2011.

Year	In-channel Projects[2]		Fish Passage Projects[3]		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

Table 3. ARBO I accomplishments by recovery domain for 2008 to 2011.[4]

Recovery Domain	In-channel Projects		Fish Passage Projects				Estuary Projects				Roads Treated		Vegetation Treated	
	# projects	miles treated	# projects	miles opened	fish handled[5]	fish mortality	# projects	acres treated	fish handled	fish mortality	# projects	miles treated	# projects	acres treated
PS	9	12	3	2	420	0	0	0	0	0	18	52	1	10
WLC	78	126	21	17	85	0	0	0	0	0	37	248	6	710
IC	38	33	46	73	467	1	0	0	0	0	15	19	13	18,300
OC	153	256	88	92	1,337	4	3	112	34	34	1	2	33	195
SONCC	45	56	10	15	0	0	0	0	0	0	4	178	16	433
Totals	323	483	168	184	2,309	5	3	112	34	34	75	499	69	19,648

[2] 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, streambank restoration, and in-channel nutrient enhancement.

[3] Fish Passage Projects include culvert and bridge replacements or removals.

[4] Accomplishment numbers for recovery domains are approximate.

[5] 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 Forest Service and BLM administrative lands in Oregon and Washington and the Coquille Indian Reservation in Oregon 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 (ARBO II). 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.
10. Piling and other Structure Removal.
11. In-channel Nutrient Enhancement.

[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).

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 force-account implementation plans.

2. **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[7] to ARBO.nwr@noaa.gov and the NMFS Level 1 Aquatics 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 (*e.g.*, Jones Creek, Tillamook Co., Oregon, 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.
    g. Project description – Brief narrative of the project and objectives
    h. Extent – Number of stream miles or acres to be treated
    i. Species affected – Listed Fish and or Wildlife species, Critical Habitat, and or EFH affected by project
    j. Date of submittal
    k. 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.
    l. For any action requiring NMFS fish passage and RRT reviews, attach a copy of the approval correspondence.

[7] The Action Agencies have developed a web-based reporting system to accumulate and manage data across the action area. The web-based system will generate notification, completion report, and fish salvage report forms with the information specified in this opinion.

m. 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.

n. SOD project notification requirements (see PDC 39h-i) as an attachment to notification form

3. **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. NMFS branch chiefs will authorize variances when there is a clear conservation benefit or there are no additional adverse effects (especially incidental take) 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.

4. **NMFS Fish Passage Review and Approve** – The NMFS Level 1 team member will coordinate NMFS fish passage review and approval for the following types of project:

   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 inches.
   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.

5. **Restoration Review Team (RRT)** – The following types of project require RRT review:

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

   The RRT will be comprised of highly skilled interagency (BLM, Forest Service, BIA, NMFS, USFWS) fisheries biologists, hydrologists, geomorphologists, soil scientists, or engineers to review and help select project designs. The RRT will have a four member core group—one individual from each of the following agencies: Forest Service, BLM, NMFS, and USFWS. The designated Forest Service 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 RRT reviews will help ensure that projects: (1) Meet the obligations set forth in the BA and subsequent ARBO II; (2) maximize ecological benefits of restoration and recovery projects; (3) maximize efficient and effective use of limited financial resources; 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, 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.[8]

The RRT will keep a record of each review, including any recommended clarifications, changes, or 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.

6. **Project Completion Report** – Level 1 teams will discuss and review aquatic restoration projects completed during a previous season. Each BLM, Forest Service, or BIA field office that completes a project will submit a Project Completion Report to ARBO.nwr@noaa.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. Date of submittal.
   f. Timing – Actual project start and end dates.
   g. Activity category – As listed above in section 1.3.
   h. Project description – Brief narrative of the completed project and objectives.
   i. Extent – Number of stream miles or acres treated.
   j. Species affected – Fish and or wildlife species, critical habitat, or EFH affected by the project.
   k. 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.

[8] NMFS 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 on our review of the 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.

l. State-specific Clean Water Act section 401 certification monitoring results. If protocol conditions were not met, describe effects and any remedial actions.
m. Post Project Assessment – Remedial actions taken, including any dates work ceased due to high flows.
n. SOD project completion requirements (see PDC 39h-ii; Table 6) as an attachment to project completion form.

7. **Annual Program Report –** The Action Agencies will provide an annual program report to NMFS and USFWS by February 15 of each year that describes projects funded or carried out 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 project carried out under ARBO II.
   c. A list of any projects that were funded or carried out by the Action Agencies using the ARBO II, including the name of the Action Agency designated as the lead agency for each project for ESA purposes.
   d. Data or analyses that the Action Agencies deem necessary or helpful to assess habitat trends as a result of actions carried out under the ARBO II.
   e. Totals for amount of incidental take and for each extent of take indicator by recovery domain.
   f. Requests for variance and their disposition and a description of RRT activity.
   g. SOD project annual report requirements (see PDC 39h-iii).

8. **Annual Coordination Meeting –** The BLM Oregon State Office, Forest Service 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.

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 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 5) who will then review the proposal and recommend to the Level 2 whether or not the project activity is

[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.

consistent with the effects and beneficial outcomes described under in this opinion. Further, the RRT can propose new actions to the Level 2 Team, accompanied by a consistency document, for inclusion into ARBO II. The consistency document shall include the following:

a. Project type, description.
b. Ecological process and disruption being addressed.
c. Benefits to ESA-listed species.
d. How the project is consistent with effects specified in ARBO II.
e. 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 opinion. 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.

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. [10] For National Forests in the state of Washington, the Forest Service 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 Forest Service (WDFW and USDA-Forest Service 2012).

[10] At NMFS, branch chiefs will have the authority to approve variances.

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.

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), 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 instream would result in less damage to the aquatic 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 Forest Service direction described in the Regional letter to Units, Use of Native and Nonnative 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 Action Agency 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, Forest Service, and BIA); Washington Department of Ecology (Washington BLM); and the Memorandum of Understanding between the Washington Department of Fish and Wildlife and Forest Service regarding Hydraulic Projects Conducted by Forest Service, Pacific Northwest Region (WDFW and USDA-Forest Service 2012); California, Idaho, or Nevada 401 Certification protocols (BLM and Forest Service).

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:
   - ii. Fish Passage Projects – Note any problems with channel scour or bedload deposition, substrate, discontinuous flow, vegetation establishment, or invasive plant infestation.
   - iii. Revegetation – For all plant treatment projects, including site restoration, monitor for and remove invasive plants until native plants become established.
   - iv. 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.

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. **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's electrofishing guidelines will be followed (NMFS 2000).[11]

   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 or are expected to rise above this temperature prior to concluding the fish capture.

[11] *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).

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.
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 above (PDC 20b). 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.

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.[12]

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 that meets

[12] 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* (2010).

criteria specified by NMFS (2011e) must be used on the intake to avoid juvenile fish entrainment. If ESA-listed salmon, steelhead, eulachon, or green sturgeon may be present, the Action Agencies will ensure that the fish screen design is reviewed and approved by NMFS for consistency with NMFS (2011e) criteria if the diversion (gravity or pump) is at a rate greater than 3 cfs. 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 inches) in the narrow dimension, or any other shape that is no larger than 1.75 mm (0.069 inches) 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 constructing or replacing fish screens for 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.

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 2008), 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):
   1. 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.
   2. 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 floodprone width. Floodprone width is the width measured at twice the maximum bankfull depth (Rosgen 1996).

ii. **Bridge Design**
   1. Bridges with vertical abutments, including concrete box culverts, which are constructed as bridges, shall have channel widths that are designed using the culvert criteria (PDC 21a-i above). This opinion does not cover bridges that require pile driving within a wetted stream channels.
   2. Primary structural elements must be concrete, metal, fiberglass, or untreated timber. Concrete must be sufficiently cured or dried[13] before coming into contact with stream flow.
   3. 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**
   1. Crossings shall be designed using an interdisciplinary design team consisting of an experienced Engineer, Fisheries Biologist, and Hydrologist/Geomorphologist.
   2. Forest Service crossing structures wider than 20 feet or with costs that exceed $100,000 shall be reviewed by the USDA-Forest

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

Service, Region 6, Aquatic Organism Passage Design Assistance Team.

3. 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 2008).
4. 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).

v. **Opportunity for individual consultation** – The 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 ARBO II are not new defaults to be used universally outside the programmatic arena.

vi. **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).

1. **Stabilize Headcuts**
    a. In streams with current or historic fish presence, 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 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.

vii. **Grade stabilization to promote fish passage associated with headcut stabilization**

1. **NMFS fish passage review and approve –** If a grade stabilization structure spans the channel and creates one or more discrete longitudinal drops > 6 inches, the Action Agencies 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).
2. 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 Large Wood, Boulder, and Gravel Placement (PDC 22) below.
3. 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.
4. 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.
5. If several structures will be used in series, space them at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate NMFS 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]).
6. Include gradated (cobble to fine) material in the rock structure material mix to help seal the structure/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient.
7. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

b. **Fish Ladders**

i. **NMFS fish passage review and approve –** The Action Agencies 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. Design preference is based on project type, level of maintenance, and required monitoring essential for reliable fish passage. Typical fishway designs include:

1. roughened channels/boulder step structures
2. channel spanning concrete sills
3. pool and chute, and
4. 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 staff prior to the conceptual design process of fishway projects to solicit NMFS's 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.

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

i. **NMFS fish passage review and approve** – The Action Agencies 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. 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 under their jurisdiction. This includes screens in temporary and permanent pump intakes.

---

[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.

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 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:
    1. Material more than 60% silt or clay will be disposed in uplands, outside of the active floodplain.
    2. Material with more than 40% gravel will be deposited within the active floodplain, but not in wetlands.
    3. Material with more than 50% gravel and less than 30% fines (silt or clay) may be deposited below the ordinary high water mark (HWM).

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 rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with rootwads should be a minimum of 1.5x bankfull channel width, while logs without rootwads should be a minimum of 2.0x bankfull 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]
    1. Use of adequate sized wood sufficient for stability
    2. Orient and place wood in such a way that movement is limited
    3. Ballast (gravel or rock) to increase the mass of the structure to resist movement
    4. Use of large boulders as anchor points for the LW
    5. 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)** 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 bankfull area, the Action Agencies will ensure that the action is

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

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 rootwads to provide functional refugia habitat for fish.

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

vi. The partial burial of LW 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 rootwad is left exposed to the flow, the bole placed into the streambank should be oriented downstream parallel to the flow direction so the pressure on the rootwad pushes the bole into the streambank and bed. 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 inches 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 2008) to determine gravel sizes appropriate for the stream.
iv. Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that 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 1994a) Riparian Reserve or PACFISH/INFISH (USDA-Forest Service 1995 ; USDA and USDI 1994b) 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.

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**

1. **NMFS fish passage review and approve –** The Action Agencies will ensure that the action is individually reviewed and approved by NMFS for consistency with criteria in NMFS (2011e).
2. **Restoration Review Team (RRT) –** The Action Agencies 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:

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

2. A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area (outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.
3. Sediment characterization to determine the proportion of coarse sediment (>2mm) in the reservoir area.
4. 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.
5. 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 Action Agencies will ensure that the action is individually reviewed and approved by the NMFS for consistency with criteria in NMFS (2011e).
   ii. Follow <u>Work Area Isolation, Surface Water Withdrawals, and Fish Capture and Release</u> (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.

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

e. If the structure being removed contains material (*e.g.*, LW, boulders) that is typically found within the stream or floodplain at that site, the material can be reused to implement habitat improvements described under the Large Wood, Boulder, and Gravel Placement activity category in this opinion.

f. 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.

g. 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.

h. 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.

i. 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.

j. 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**

1. **NMFS fish passage review and approve –** The Action Agencies will ensure that the action is individually reviewed and approved by NMFS for consistency with NMFS (2011e).
2. **Restoration Review Team (RRT) –** The Action Agencies will ensure that the action is individually reviewed by the RRT.

ii. **Design Guidance**

1. Construct geomorphically appropriate stream channels and floodplains within a watershed and reach context.
2. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
3. To the greatest degree possible, remove nonnative fill material from the channel and floodplain to an upland site.
4. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials,

which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives.

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

iii. **Project documentation** – Prior to the Design Review, the project contact will provide NMFS and the RRT with the following documentation:

1. Background and Problem Statement
    a. Site history.
    b. Environmental baseline.
    c. Problem Description.
    d. Cause of problem.
2. Project Description
    a. Goals/objectives.
    b. Project elements.
    c. Sequencing, implementation.
    d. Recovery trajectory –how does it develop and evolve?
3. Design Analysis
    a. Technical analyses.
    b. Computations relating design to analysis.
    c. References.
4. 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
    i. Were alternatives/options considered?
    ii. Are uncertainties and risk associated with selected alternative acceptable?
e. 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?
f. Implementation
    i. Are plans and specifications sufficient in scope and detail to execute the project?
    ii. Does plan address potential implementation impacts and risks?
g. Monitoring & Management
    i. Does monitoring plan address project compliance?
    ii. Does monitoring plan directly measure project effectiveness?
h. 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,[16] the Action Agencies will ensure that the action is reviewed by the RRT and reviewed and approved by NMFS for consistency with criteria in NMFS (2011e).

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 (≤ 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.

---

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

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 nonnative 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 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)(NMFS 2011e)(NMFS 2011e)(NMFS 2011e)(NMFS 2011e)(NMFS 2011e)(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.

a. **When removing an intact pile:**
   i. Install a floating surface boom to capture floating surface debris.
   ii. To the extent possible, keep all equipment (*e.g.*, bucket, steel cable, vibratory hammer) out of the water, grip piles above the waterline, and complete all work during low water and low current conditions.
   iii. Dislodge the piling with a vibratory hammer, whenever feasible. Never intentionally break a pile by twisting or bending.
   iv. Slowly lift piles from the sediment and through the water column.
   v. Place chemically-treated piles in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment. A containment basin for the removed piles and any adhering sediment may be constructed of durable plastic sheeting with sidewalls supported by hay bales or another support structure to contain all sediment.
   vi. Fill the holes left by each piling with clean, native sediments located from the project area.
   vii. Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.

b. **When removing a broken pile:**
   i. If a pile breaks above the surface of uncontaminated sediment, or less than 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* (Cramer 2012) 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 Forest Service and BLM/BIA-equivalent Travel and Access Management Plans will be subject to these PDC and may be addressed under this opinion. However, such "plans" for road management will require separate consultations. Such 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 road segments adjacent to a stream, use sediment control barriers between the road 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 the Action Agencies' 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 1994a) or RHCA under PACFISH/INFISH (USDA-Forest Service 1995 ; USDA and USDI 1994b) 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**

        1. 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.
        2. Carefully consider herbicide impacts to fish, wildlife, non-target native plants, and other resources when making herbicide choices.
        3. 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.
        4. Herbicide application rates will follow label direction, unless site-specific analysis determines a lower maximum rate is needed to reduce non-target impacts.
        5. 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.
        6. 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):[17]

---

[17] 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 Commerce or NMFS of any product or service to the exclusion of others that may be suitable.

1. aminopyralid (*e.g.*, *terrestrial*: Milestone VM)
2. chlorsulfuron (*e.g.*, *terrestrial*: Telar, Glean, Corsair)
3. clopyralid (*e.g.*, *terrestrial*: Transline)
4. dicamba (*e.g.*, *terrestrial*: Vanquish, Banvel)
5. diflufenzopyr + dicamba (*e.g.*, *terrestrial*: Overdrive)
6. glyphosate (*e.g.*, *aquatic*: Aquamaster, AquaPro, Rodeo, Accord)
7. imazapic (*e.g.*, *terrestrial*: Plateau)
8. imazapyr (*e.g.*, *aquatic*: Habitat; *terrestrial*: Arsenal, Chopper)
9. metsulfuron methyl (*e.g.*, *terrestrial*: Escort)
10. picloram (*e.g.*, *terrestrial*: Tordon, Outpost 22K)
11. sethoxydim (*e.g.*, *terrestrial*: Poast, Vantage)
12. sulfometuron methyl (*e.g.*, *terrestrial*: Oust, Oust XP)
13. triclopyr (*e.g.*, *aquatic*: Garlon 3A, Tahoe 3A, Renovate 3, Element 3A; *terrestrial*: Garlon 4A, Tahoe 4E, Pathfinder II)
14. 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:

1. Broadcast spraying using booms mounted on ground-based vehicles (this consultation does not include aerial applications).
2. 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.
3. Hand/selective through wicking and wiping, basal bark, frill ("hack and squirt"), stem injection, or cut-stump.
4. 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:

1. 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.
2. Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.
3. Keep boom or spray as low as possible to reduce wind effects.
4. Avoid or minimize drift by utilizing appropriate equipment and settings (*e.g.*, nozzle selection, adjusting pressure, drift reduction agents). 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]).
5. Follow herbicide label directions for maximum daytime temperature permitted (some types of herbicides volatilize in hot temperatures).
6. 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.
7. 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 Forest Service 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 mountains and in southwestern Oregon. Additionally, controlled burns may be implemented in localized lowland areas in western Oregon, *i.e.,* 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 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 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-feet 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 2005) 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.[18]

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 core areas that contain 100 or fewer adult bull trout.
   vi. Other removal methods, such as dip netting, spearing, and other means can be used.

38. **Beaver 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

[18] The protection measures specified in this PDC are designed to protect ESA-listed species under NMFS's jurisdiction. This opinion does not authorize incidental take for bull trout. The Action Agencies are advised to consult with the USFWS on bull trout.

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 – 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

1. Retain/protect non-host conifer LW and conifer and non-tanoak reserve trees.
2. 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.
3. Non-host brush or hardwood tree species may also be cut if resource specialists determine they pose the risk of fire spread.

4. 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.
5. 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.
6. Host leaf litter and other fine plant material in the eradication zones would also be raked into the piles.
7. 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.
8. 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.

1. 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.
2. Transport no more than a one day supply of fuel for chainsaws into riparian areas.
3. Fueling and refueling of chainsaws would not occur within 100 feet of surface waters to prevent direct delivery of contaminants into a water body.
4. 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.
5. Minimize ground disturbance by operating equipment on cut slash and piling it upon egress.
6. Only operate heavy mechanized equipment on slopes less than 35% and when soil moisture is not greater than 25%.
7. 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.
8. 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).

1. **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.
2. No broadcast spraying of herbicides.
3. Only daily quantities of aquatic-labeled glyphosate or aquatic-labeled imazapyr will be transported to the project site.
4. 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.
5. Equipment cleaning and storage and disposal containers would follow all applicable state and Federal laws.
6. 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

1. An experienced fuels technician, silviculturists and fisheries biologist shall be involved in designing prescribed burn treatments.
2. Prescriptions and burn plans will be prepared to implement safe and effective treatments.
3. 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.
4. Consume infested material to reduce or eliminate the pathogen on the site.
5. 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.
6. Avoid creating hydrophobic soils.
7. 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.
8. 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.

1. 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.
2. 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.

1. 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.
2. 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-inches 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
   1. No roads would be constructed or reconstructed for SOD treatments in riparian areas.
   2. Blading or rocking would not occur.
   3. No cutting of conifers greater than 16 inches DBH within the stream influence zone for access.
   4. See **Mechanical Treatment (Excavator and Feller/Buncher)** above for additional project design criteria.

ii. **Temporary Heavy Equipment Site Access**
   1. 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.
   2. 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.
   3. 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.
   4. Site access off of existing roads for heavy equipment would be minimal and for the purpose of limited machine access only.
   5. Stream channel crossing will be located as to minimize adverse effects to water quality, streambank stability, and riparian vegetation.
   6. Minimize or avoid locating within stream influence zones (1 site potential tree height for fish bearing or perennial stream or critical habitat).
   7. Do not locate on side slopes > 35 %.
   8. Do not access areas determined to have high erosion potential.
   9. Do not construct or use outside of dry conditions.
   10. 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.
   1. 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.

2. 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.
ii. 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.
iii. Planting will occur with Douglas-fir or other non-host species on sites when area is determined to be disease free.
iv. 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 SONC 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. **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.

iii. **Limitation #3:** Must stay at or below 3% of the Total Federal Perennial Stream miles per Watershed.

iv. Tracking and Check Points. To stay within the limitations #2 and #3, the action agencies will implement the following parameters.

   1. **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 2). For SOD treatment projects include the following items:

   1. Stream size (see Table 5)
   2. Acres treated within 1 Site Potential Tree Height of perennial streams
   3. Treatment on one or both sides of stream
   4. Proximity of treatment to edge of stream (bankfull width)
   5. 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 6). 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.

1. **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.
2. **Monitoring:** Report treatment unit data, including information items required for project completion listed above (see h.ii).
3. **Treatment tracking – Limitation #1:** Report total annual miles of treatment as they apply to Table 6.
4. **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).
5. **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 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[19], macro invertebrates,

[19] By non-lethal techniques, *i.e.,* snorkel, minnow trapping, not hooking or electrofishing.

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 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. Individual project-level action areas 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, where aquatic habitat conditions will be temporarily degraded until site restoration is complete. This estimate is based on an analysis of typical turbidity flux downstream 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.

All actions funded or carried out under this opinion will occur on Federal lands administered by the Forest Service, 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 within the States of Oregon[20] and Washington. Forest Service 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 7).

[20] The waters that form the Klamath River system in Oregon do not fall within the action area because the Klamath basin is not within the NMFS Northwest Region's area of responsibility and thus no ARBO projects will be authorized within that basin (nor will ARBO projects authorized in other areas have effects in that basin).

Table 7. 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 recovery domains in the same proportions as they were during the 2008-2011 period as described in Table 3.

Project sites includes the upland, riparian and aquatic area extending no more than 150 feet upstream and 300 feet downstream from the action footprint, where aquatic habitat conditions will be temporarily degraded until site restoration is complete. The estimated footprint downstream is based on an analysis of typical turbidity flux downstream from a nonpoint discharge in a stream with a wetted stream width 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 somewhat greater for project areas that are subject to tidal or coastal scour. For wetted stream widths no greater than 30 feet at the discharge point the turbidity point of compliance is only 50 feet downstream.

The overall action area is also designated by the Pacific Fishery Management Council (PFMC) as EFH for Pacific Coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Pacific Coast salmon (PFMC 1999), or is in an area where environmental effects of the proposed action is likely to adversely affect designated EFH for those species.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

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 U.S. Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service 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 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies to consult with NMFS 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. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

This opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[21]

We will use the following approach to determine whether the proposed action described in section 1.3 is likely to jeopardize listed species or destroy or adversely modify critical habitat:

[21] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

- *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. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" (VSP) paper (McElhany *et al.* 2000). The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the rangewide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. 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 in some designations) – 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 or, in the case of salmon and steelhead, their VSP parameters. We also evaluate the proposed action's effects on critical habitat features.
- *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 section 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.

In this opinion, NMFS concludes that the proposed action is not likely to adversely affect (NLAA) southern DPS green sturgeon and Steller sea lion or their designated critical habitat, or southern resident killer whales, which does not have designated critical habitat in the action area. See section 2.11 for details.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be 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 species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion 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.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and other relevant species NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany *et al.* 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany *et al.* 2000).

"Abundance" generally refers to the number of naturally-produced adults (*i.e.*, the progeny of naturally-spawning parents) in the natural environment (*e.g.*, on spawning grounds).

“Productivity,” as applied to viability factors, refers to the entire life cycle; *i.e*., the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany *et al*. (2000) use the terms “population growth rate” and “productivity” interchangeably when referring to production over the entire life cycle. They also refer to “trend in abundance,” which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species’ populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany *et al.* 2000).

The summaries that follow describe the status of the 20 ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of the species considered in this opinion, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early-spring will be less affected. Low-elevation areas are likely to be more affected.

During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas. Warming is likely to continue during the next century as average temperatures increase another 3 to 10°F. Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer months, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007; USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures will be warmer (ISAB 2007; USGCRP 2009).

Higher winter stream flows increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs. Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation. Lower stream flows and warmer water temperatures during summer will degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff *et al.* 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005; USGCRP 2009; Zabel *et al.* 2006). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel *et al.* 2006).

The status of species and critical habitat sections below are organized under four recovery domains (Table 8) to better integrate recovery planning information that NMFS is developing on the conservation status of the species and critical habitats considered in this consultation. Recovery domains are the geographically-based areas that NMFS is using to prepare multi-species recovery plans.

Table 8. Recovery planning domains identified by NMFS and their ESA-listed salmon and steelhead species.

Recovery Domain	Species
Puget Sound	PS Chinook salmon Hood Canal (HC)HC summer-run chum salmon Lake Ozette sockeye salmon PS steelhead
Willamette-Lower Columbia (WLC)	LCR Chinook salmon UWR Chinook salmon CR chum salmon LCR coho salmon LCR steelhead UWR steelhead
Interior Columbia (IC)	UCR spring-run Chinook salmon SR spring/summer-run Chinook salmon SR fall-run Chinook salmon SR sockeye salmon MCR steelhead UCR steelhead SRB steelhead
Oregon Coast (OC)	OC coho salmon
Southern Oregon/Northern California Coasts (SONCC)	SONCC coho salmon

For each recovery domain, a technical review team (TRT) appointed by NMFS has developed, or is developing, criteria necessary to identify independent populations within each species, recommended viability criteria for those species, and descriptions of factors that limit species survival. Viability criteria are prescriptions of the biological conditions for populations, biogeographic strata, and evolutionarily significant units (ESU) that, if met, would indicate that an ESU will have a negligible risk of extinction over a 100-year time frame.[22]

Although the TRTs operated from the common set of biological principals described in McElhany *et al.* (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria have qualitative as well as quantitative aspects. The diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations. For this and other reasons, viability criteria vary among species, mainly in the number and type of metrics and the scales at which the metrics apply (*i.e.*, population, major population group (MPG), or ESU) (Busch *et al.* 2008).

The abundance and productivity (A&P) score considers the TRT's estimate of a populations' minimum threshold population, natural spawning abundance and the productivity of the population. Productivity over the entire life cycle and factors that affect population growth rate provide information on how well a population is "performing" in the habitats it occupies during the life cycle. Estimates of population growth rate that indicate a population is consistently failing to replace itself are an indicator of increased extinction risk. The four metrics (abundance, productivity, spatial structure, and diversity) are not independent of one another and their relationship to sustainability depends on a variety of interdependent ecological processes (Wainwright *et al.* 2008).

Integrated spatial structure and diversity (SS/D) risk combines risk for likely, future environmental conditions, and diversity (Ford 2011; McElhany *et al.* 2007; McElhany *et al.* 2000). Diversity factors include:

- Life history traits: Distribution of major life history strategies within a population, variability of traits, mean value of traits, and loss of traits.
- Effective population size: One of the indirect measures of diversity is effective population size. A population at chronic low abundance or experiencing even a single episode of low abundance is at a higher extinction risk because of loss of genetic variability, inbreeding and the expression of inbreeding depression, or the effects of mutation accumulation.
- Impact of hatchery fish: Interbreeding of wild populations and hatchery origin fish are a significant risk factor to the diversity of wild populations if the proportion of hatchery fish in the spawning population is high and their genetic similarity to the wild population is low.
- Anthropogenic mortality: The susceptibility to mortality from harvest or habitat alterations will differ depending on size, age, run timing, disease resistance or other traits.

[22] For Pacific salmon, NMFS uses its 1991 ESU policy, that states that a population or group of populations will be considered a Distinct Population Segment if it is an Evolutionarily Significant Unit. An ESU represents a distinct population segment of Pacific salmon under the Endangered Species Act that 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species. The species *O. mykiss* is under the joint jurisdiction of NMFS and the Fish and Wildlife Service, so in making its listing January, 2006 determinations NMFS elected to use the 1996 joint FWS-NMFS DPS policy for this species.

- Habitat diversity: Habitat characteristics have clear selective effects on populations, and changes in habitat characteristics are likely to eventually lead to genetic changes through selection for locally adapted traits. In assessing risk associated with altered habitat diversity, historical diversity is used as a reference point.

Overall viability risk scores (high to low) and population persistence scores are based on combined ratings for the A&P and SS/D[23] metrics (Table 9) (McElhany *et al.* 2006). Persistence probabilities, which are provided here for Lower Columbia River salmon and steelhead, are the complement of a population's extinction risk (*i.e.*, persistence probability = 1 – extinction risk)(NMFS 2012c). The IC-TRT has provided viability criteria that are based on McElhany (2000) and McElhany (2006), as well as the results of previous applications in other TRTs and a review of specific information available relative to listed IC ESU populations (Ford 2011; IC-TRT 2007).

Table 9. Population persistence categories from McElhany *et al.* (2006). A low or negligible risk of extinction is considered "viable" (Ford 2011). Population persistence categories correspond to: 4 = very low (VL), 3 = low (L), 2 = moderate (M), 1 = high (H), and 0 = very high (VH) in Oregon populations, which corresponds to "extirpated or nearly so" (E) in Washington populations (Ford 2011).

Population Persistence Category	Probability of population persistence in 100 years	Probability of population extinction in 100 years	Description
0	0-40%	60-100%	Either extinct or "high" risk of extinction
1	40-75%	25-60%	Relatively "high" risk of extinction in 100 years
2	75-95%	5-25%	"Moderate" risk of extinction in 100 years
3	95-99%	1-5%	"Low" (negligible) risk of extinction in 100 years
4	>99%	<1%	"Very low" risk of extinction in 100 years

The boundaries of each population were defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups. To date, the TRTs have divided the 19 species of salmon and steelhead considered in this opinion into a total of 304 populations, although the population structure of Puget Sound (PS) steelhead has yet to be resolved. The overall viability of a species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before a full recovery plan is implemented (McElhany *et al.* 2000).

[23] The WLC-TRT provided ratings for diversity and spatial structure risks. The IC-TRT provided spatial structure and diversity ratings combined as an integrated SS/D risk.

The size and distribution of the populations considered in this opinion generally have declined over the last few decades due to natural phenomena and human activity, including climate change (as described in section 2.2), the operation of hydropower systems, over-harvest, effects of hatcheries, and habitat degradation. Enlarged populations of terns, seals, California sea lions, and other aquatic predators in the Pacific Northwest may be limiting the productivity of some Pacific salmon and steelhead populations (Ford 2011).

Viability status or probability or population persistence is described below for each of the populations considered in this opinion. Although eulachon are part of more than one recovery domain structure, they are presented below for convenience as part of the PS recovery domain.

Puget Sound Recovery Domain. Species considered in the PS recovery domain include PS Chinook salmon, Hood Canal (HC) summer-run chum salmon, Lake Ozette (LO) sockeye salmon, PS steelhead, and southern DPS eulachon. The PS TRT has identified 22 extant demographically-independent populations of Chinook salmon and two of summer-run chum salmon,[24] (Ford 2011)(Table 10). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. The PS steelhead TRT has not yet finalized its viability criteria for the PS steelhead DPS and is still conducting analyses to identify populations and MPGs within the DPS.

Table 10. Numbers of historical and extant populations for ESA-listed salmon and steelhead in the PS recovery domain (Ford 2011).

Species	Historical Populations	Extant Populations
PS Chinook salmon	31	22
HC summer-run chum salmon	18	2
LO sockeye salmon	1	1
PS steelhead	Not available	

Status of PS Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington, and progeny of 26 artificial propagation programs. The PS-TRT identified 22 historical populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 11). The NMFS adopted the Shared Strategy for Puget Sound's locally-developed listed species recovery plan for PS Chinook salmon in 2007 (Shared Strategy for Puget Sound 2007).

[24] One HC chum salmon population has four extant spawning aggregations and one has 10 extant spawning aggregations; some of these are recently reintroduced. Spawning aggregations are also referred to as subpopulations.

Table 11. Extant PS Chinook salmon populations in each geographic region (Ford 2011).

Geographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

Indices of spatial distribution and diversity have not been developed at the population level. Based on a Shannon Diversity Index at the ESU level, diversity is declining (due primarily to the increased abundance of returns to the Whidbey Basin region) for both distribution among populations and among regions (Ford 2011). Overall, the new information on abundance, productivity, spatial structure and diversity since the 2005 status review does not indicate a change in the biological risk category (Ford 2011).

Abundance and Productivity. No trend was notable for the total ESU escapements; while trends vary from decreasing to increasing among populations. Natural-origin pre-harvest recruit escapements remained fairly constant from 1985-2009. Returns (pre-harvest run size) from the natural spawners were highest in 1985, declined through 1994, remained low through 1999, increased in 2000 and again in 2001, and have declined through 2009, with 2009 having the lowest returns since 1997. Median recruits per spawner for the last 5-year period (brood years 2002-2006) is the lowest over any of the 5-year intervals. Many of the habitat and hatchery actions identified in the Puget Sound Chinook salmon recovery plan are likely to take years or decades to be implemented and to produce significant improvements in natural population attributes, and these trends are consistent with these expectations (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; Shared Strategy for Puget Sound 2007; SSPS 2007):

- Degraded nearshore and estuarine habitat: Residential and commercial development has reduced the amount of functioning nearshore and estuarine habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, and water quality have been degraded for adult spawning, embryo incubation, and rearing as a result of cumulative impacts of agriculture, forestry, and development.
- Anadromous salmonid hatchery programs: Salmon and steelhead released from Puget Sound hatcheries operated for harvest augmentation purposes pose ecological, genetic, and demographic risks to natural-origin Chinook salmon populations.
- Salmon harvest management: Total fishery exploitation rates have decreased 14 to 63% from rates in the 1980s, but weak natural-origin Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest in Chinook salmon-directed fisheries.

Status of HC Summer-run Chum Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries; populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington; and progeny of eight artificial propagation programs. The Strait of Juan de Fuca population spawns in rivers and streams entering the eastern Strait and Admiralty Inlet. The Hood Canal population includes all spawning aggregations within the Hood Canal area (Hood Canal Coordinating Council 2005; NMFS 2007a). The PS-TRT identified two independent populations of Hood Canal summer chum salmon (NMFS 2007b), which include 16 historical stocks or spawning aggregations (including eight that are extant), based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 12). The historical populations included at least those 16 spawning aggregation units and likely some additional undocumented and less-persistent aggregations (NMFS 2007b). Programs are underway to reintroduce summer-run chum salmon to several of the watersheds where stocks were lost.

Table 12. HC summer-run chum salmon populations (geographic regions), population aggregations, and their status (Ford 2011).

Geographic Region (Population)	Stock (Watershed)	Status
Strait of Juan de Fuca	Dungeness River	Unknown <5 adult returns annually recently
	Jimmycomelately Creek	Extant
	Salmon River	Extant
	Snow River	Extant
	Chimacum Creek	Extinct but reintroduced with natural spawning reported starting in 1999
Hood Canal	Big Quilcene River	Extant
	Little Quilcene River	Extant
	Dosewallips River	Extant
	Duckabush River	Extant
	Hamma Hamma River	Extant
	Lilliwaup Creek	Extant
	Big Beef Creek	Extinct but reintroduced with adult returns reported starting in 2001
	Anderson Creek	Extinct
	Dewatto Creek	Extinct, no returns mid 1990's, some natural recolonization apparent but numbers remain low (<70 annually)
	Tahuya River	Extinct but reintroduced with increased adult returns reported starting 2006
	Union River	Extant
	Skokomish River	Extinct; no spawning reported prior to 2001; very low numbers of adult returns (<40 annually) reported in recent years
	Finch Creek	Extinct

Diversity is increasing from the low values seen in the 1990s, due both to the reintroduction of spawning aggregates and the more uniform relative abundance between populations; this is a good sign for viability in terms of spatial structure and diversity. Spawning survey data shows that the spawning distribution within most streams has been extended farther upstream as abundance has increased (WDFW and Point No Point Treaty Tribes 2007). Estimates of population viability from three time periods (brood years 1971-2006, 1985-2006, and 1990-2006) all indicate that Hood Canal and Strait of Juan de Fuca populations of summer-run chum salmon are not currently viable (Ford 2011).

Abundance and Productivity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review in 2005 (Ford 2011). The spawning abundance of this species has clearly increased since the time of listing, although the recent abundance is down from the previous 5 years. However, productivity in the last 5-year period (2002-2006) has been very low, especially compared to the relatively high productivity in the 5-10 previous years (WDFW and Point No Point Treaty Tribes 2007). This is a concern for viability. Since abundance is increasing and productivity is decreasing, improvements in habitat and ecosystem function likely are needed.

Limiting factors include (Hood Canal Coordinating Council 2005; NMFS 2007a; NOAA Fisheries 2011):

- Nearshore and estuarine habitat throughout the range of the species has been altered by human activities. Nutrient loading has lowered dissolved oxygen concentrations, which can kill or stress marine organisms, including salmon. Residential and commercial development has reduced the amount of functioning habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development.

Status of LO Sockeye Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of sockeye salmon in Ozette Lake and streams and tributaries flowing into Ozette Lake, Washington, and progeny of two artificial propagation programs. The LO Technical Recovery Team concluded that five extant spawning aggregations in Ozette Lake are different subpopulations within a single population (Currens *et al.* 2009; NMFS 2009a). The subpopulations can be grouped according to whether they spawn in tributaries or near lake beaches (NMFS 2009a).

Abundance and Productivity. LO sockeye salmon population sizes remain very small compared to historical sizes. Additionally, population estimates remain highly variable and uncertain, making it impossible to detect changes in abundance trends or in productivity in recent years. The most recent brood years (1999-2003) have had the lowest average recruits per spawner. Spatial structure and diversity are also difficult to appraise; there is currently no successfully quantitative program to monitor beach spawning or spawning at other tributaries. Assessment methods must improve to evaluate the status of this species and its responses to recovery actions. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting factors include (NMFS 2009a; NOAA Fisheries 2011; USDC 2009b):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, lake beach spawning habitat, and stream substrate have been degraded as a result of cumulative impacts of forest practices, agriculture, and development.
- Predation: Harbor seals and river otters, and predaceous non-native and native fish species, are reducing the abundance of adult fish that successfully spawn, and the abundance of sockeye smolts escaping seaward from the watershed each year.

Status of PS Steelhead

Spatial Structure and Diversity. Steelhead populations can be divided into two basic reproductive ecotypes, based on the state of sexual maturity at the time of river entry (summer or winter) and duration of spawning migration (Burgner *et al.* 1992)(Table 13). The PS DPS includes all naturally spawned anadromous winter-run and summer-run steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard *et al.* 2007; USDC 2007).

Table 13. PS steelhead populations and risk of extinction (Ford 2011).

Geographic Region (MPGs)	Population (Watershed)	Extinction Risk (probability of decline to 10% of its current estimated abundance)
Northern Cascades	Samish River (winter)	High—about 80% within 25 years
	Skagit River (winter)	High—about 80% within 75 years.
	Snohomish River (winter)	Moderately High—about 50% within 100 years
	Stillaguamish River (winter)	High—about 90% within 60 years
	Tolt River summer	High—nearly 80% within 100 years
	Nooksack River (winter)	Unable to calculate
South Puget Sound	Lake Washington (winter)	High—~ 90% within 40 years
	Green River (winter)r	High—about 90% within 80 years
	Nisqually River (winter)	High—about 80% within 40 years
	Puyallup River (winter)	High—about 90% within 25-30 years
	White River (winter)	High—about 90% within 50 years
	South Sound Tributaries (winter)	Unable to calculate
Olympic	Elwha River (winter)	Fairly High— ~ 90% within 40 years
	Dungeness River (winter)	High—within 100 years (population too low to calculate %)
	Port Angeles (winter)	High—nearly 80% within 100 years
	West Hood Canal (winter)	Low—near zero within 100 years
	East Hood Canal (winter)	Low—about 30% within 100 years
	Skokomish River (winter)	High—about 80% within 80 years

The Puget Sound Steelhead TRT has completed a set of simple population viability analyses (PVAs) for these draft populations and MPGs within the DPS. No new estimates of productivity, spatial structure and diversity of PS steelhead have been made available since the 2007 review, when the BRT concluded that low and declining abundance and low and declining productivity were substantial risk factors for the species (USDC 2007). Loss of diversity and spatial structure were judged to be “moderate” risk factors. Since the listing of this species, this threat has not changed appreciably (Ford 2011).

Abundance and Productivity. The BRT considered the major risk factors facing Puget Sound steelhead to be: widespread declines in abundance and productivity for most natural steelhead populations in the ESU, including those in Skagit and Snohomish rivers (previously considered to be strongholds); the low abundance of several summer-run populations; and the sharply diminishing abundance of some steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca (Hard *et al.* 2007). For all but a few putative PS steelhead populations, estimates of mean population growth rates obtained from observed spawner or redd counts are declining—typically 3 to 10% annually—and extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for draft populations in the putative South Sound and Olympic MPGs. Most populations within the DPS continue downward trends in estimated abundance, a few sharply so. Extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for populations in the South Sound and Olympic MPGs.

Limiting factors include (NOAA Fisheries 2011):

- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years.
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with wild stock diversity throughout the DPS.
- Declining diversity in the DPS, including the uncertain but weak status of summer-run fish in the DPS.
- A reduction in spatial structure for steelhead in the DPS.
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of LW.
- Increased flood frequency and peak flows during storms, reduced groundwater-driven summer flows in the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, has resulted in gravel scour, bank erosion, and sediment deposition.
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, have increased the likelihood of gravel scour and dislocation of rearing juveniles.

Status of Southern DPS Eulachon

Spatial Structure and Diversity. The southern distinct population segment of eulachon occur in four salmon recovery domains: Puget Sound, the Willamette and Lower Columbia, Oregon Coast, and Southern Oregon/Northern California Coasts. The ESA-listed population of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly known although the amount of eulachon bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean.

Abundance and Productivity. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River with no evidence of returning to their former population levels since then (Drake *et al.* 2008). Persistent low returns and landings of eulachon in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that provides for restricted harvest management when parental run strength, juvenile production, and ocean productivity forecast a poor return (WDFW and ODFW 2001). Despite a brief period of improved returns in 2001–2003, the returns and associated commercial landings have again declined to the very low levels observed in the mid-1990s (Joint Columbia River Management Staff 2009), and since 2005, the fishery has operated at the most conservative level allowed in the management plan (Joint Columbia River Management Staff 2009). Large commercial and recreational fisheries have occurred in the Sandy River in the past. The most recent commercial harvest in the Sandy River was in 2003. No commercial harvest has been recorded for the Grays River from 1990 to the present, but larval sampling has confirmed successful spawning in recent years (USDC 2011).

Limiting Factors include (Gustafson *et al.* 2011; Gustafson *et al.* 2010; NOAA Fisheries 2011):

- Changes in ocean conditions due to climate change, particularly in the southern portion of its range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Climate-induced change to freshwater habitats, dams and water diversions (particularly in the Columbia and Klamath Rivers where hydropower generation and flood control are major activities)
- Bycatch of eulachon in commercial fisheries
- Adverse effects related to dams and water diversions
- Artificial fish passage barriers
- Increased water temperatures, insufficient streamflow
- Altered sediment balances
- Water pollution
- Over-harvest
- Predation

Willamette-Lower Columbia Recovery Domain. Species considered in the Willamette-Lower Columbia (WLC) Recovery Domain include LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, and southern DPS eulachon. The WLC-TRT has identified 107 demographically independent populations of Pacific salmon and steelhead (Table 14). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. All 107 populations use parts of the mainstem of the Columbia River and the Columbia River estuary for migration, rearing, and smoltification.

Table 14. Populations in the WLC recovery domain. Combined extinction risks for salmon and steelhead based on an analysis of Oregon populations.

Species	Populations
LCR Chinook salmon	32
UWR Chinook salmon	7
CR chum salmon	17
LCR coho salmon	24
LCR steelhead	23
UWR steelhead	4

Status of LCR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River; the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River; and progeny of seventeen artificial propagation programs.[25] LCR Chinook populations exhibit three different life history types base on return timing and other features: fall-run (a.k.a. "tules"), late-fall-run (a.k.a. "brights"), and spring-run. The WLC-TRT identified 32 historical populations of LCR Chinook salmon— seven in the coastal subregion, six in the Columbia Gorge, and 19 in the Cascade Range (Table 15). Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers and other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (Lower Columbia Fish Recovery Board 2010; ODFW 2010). Out of the 32 populations that make up this ESU, only the two late-fall runs, the North Fork Lewis and Sandy, are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so) (Ford 2011; Lower Columbia Fish Recovery Board 2010; ODFW 2010). Five of the six strata fall significantly short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2012c).

[25] In 2009, the Elochoman tule fall Chinook salmon program was discontinued and four new fall Chinook salmon programs have been initiated. In 2011, NMFS recommended removing the Elochoman program from the ESU and adding the new programs to the ESU (NMFS 2011a).

Table 15. LCR Chinook salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2012b). Persistence probability of the population (NMFS 2012c). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Spawning Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	Run Timing					
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL
		Lewis River (WA)	VL	H	H	VL
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL
		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	H
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Young Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

Abundance and Productivity. A&P ratings for LCR Chinook salmon populations are currently “low” to “very low” for most populations, except for spring Chinook salmon in the Sandy River, which are “moderate” and late-fall Chinook salmon in North Fork Lewis River and Sandy River, which are “very high” (NMFS 2012c). Low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners. Particularly for tule fall Chinook salmon populations, poor data quality prevents precise quantification of population abundance and productivity; data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (Ford 2011).

Limiting Factors include (NMFS 2012c; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects
- Hatchery-related effects
- Harvest-related effects on fall Chinook salmon
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of UWR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River; in the Willamette River and its tributaries above Willamette Falls, Oregon; and progeny of seven artificial propagation programs. All seven historical populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 16). The McKenzie River population currently characterized as at a “low” risk of extinction and the Clackamas population has a “moderate” risk. (Ford 2011). Consideration of data collected since the last status review in 2005 has confirmed the high fraction of hatchery origin fish in all of the populations of this species (even the Clackamas and McKenzie rivers have hatchery fractions above WLC-TRT viability thresholds). All of the UWR Chinook salmon populations have “moderate” or “high” risk ratings for diversity. Clackamas River Chinook salmon have a “low” risk rating for spatial structure (Ford 2011).

Table 16. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Clackamas River	M	M	L	M
Molalla River	VH	H	H	VH
North Santiam River	VH	H	H	VH
South Santiam River	VH	M	M	VH
Calapooia River	VH	H	VH	VH
McKenzie River	VL	M	M	L
Middle Fork Willamette River	VH	H	H	VH

Abundance and Productivity. The Clackamas and McKenzie river populations currently have the best risk ratings for A&P, spatial structure, and diversity. Data collected since the BRT status update in 2005 highlighted the substantial risks associated with pre-spawning mortality. Although recovery plans are targeting key limiting factors for future actions, there have been no significant on-the-ground-actions since the last status review to resolve the lack of access to historical habitat above dams nor have there been substantial actions removing hatchery fish from the spawning grounds. Overall, the new information does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Significantly reduced access to spawning and rearing habitat because of tributary dams
- Degraded freshwater habitat, especially floodplain connectivity and function, channel structure and complexity, and riparian areas and LW recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Hatchery-related effects
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation on, and competition with, native UWR Chinook salmon
- Ocean harvest rates of approximately 30%

Status of CR Chum Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, and progeny of three artificial propagation programs. The WLC-TRT identified 17 historical populations of CR chum salmon and aggregated these into four strata (Myers *et al.* 2006)(Table 17). CR chum salmon spawning aggregations identified in the mainstem Columbia River were included in the population associated with the nearest river basin.

Table 17. CR chum salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012c). Persistence probability ratings are very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum: Ecological Subregion	Stratum: Run Timing	Spawning Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Persistence Probability
Coast Range	Fall	Young's Bay (OR)	*	*	*	VL
		Grays/Chinook rivers (WA)	VH	M	H	M
		Big Creek (OR)	*	*	*	VL
		Elochoman/Skamakowa rivers (WA)	VL	H	L	VL
		Clatskanie River (OR)	*	*	*	VL
		Mill, Abernathy and Germany creeks (WA)	VL	H	L	VL
		Scappoose Creek (OR)	*	*	*	VL
Cascade Range	Summer	Cowlitz River (WA)	VL	L	L	VL
	Fall	Cowlitz River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		Lewis River (WA)	VL	H	L	VL
		Salmon Creek (WA)	VL	L	L	VL
		Clackamas River (OR)	*	*	*	VL
		Sandy River (OR)	*	*	*	
		Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Fall	Lower Gorge (WA & OR)	VH	H	VH	H
		Upper Gorge (WA & OR)	VL	L	L	VL

* No data are available to make a quantitative assessment.

The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. Although, hatchery production of chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and the low abundance in the remaining populations (fewer than 100 spawners per year for most populations)(Lower Columbia Fish Recovery Board 2010; NMFS 2012c). The Lower Gorge population meets abundance and productivity criteria for very high levels of viability, but the distribution of spawning habitat (*i.e.*, spatial structure) for the population has been significantly reduced (Lower Columbia Fish Recovery Board 2010); spatial structure may need to be improved, at least in part, through better performance from the Oregon portion of the population (NMFS 2012c).

<u>Abundance and Productivity</u>. Of the 17 populations that historically made up this ESU, 15 of them (six in Oregon and nine in Washington) are so depleted that either their baseline probability of persistence is very low or they are extirpated or nearly so (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2012c; ODFW 2010). All three strata in the ESU fall significantly short of the WLC-TRT criteria for viability. Currently almost all natural production occurs in just two populations: the Grays/Chinook and the Lower Gorge. The

Grays/Chinook population has a moderate persistence probability, and the Lower Gorge population has a high probability of persistence (Lower Columbia Fish Recovery Board 2010; NMFS 2012c).

Limiting factors include (NMFS 2012c; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat, in particular of floodplain connectivity and function, channel structure and complexity, stream substrate, and riparian areas and LW recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded stream flow as a result of hydropower and water supply operations
- Loss of access and loss of some habitat types as a result of passage barriers such as roads and railroads
- Reduced water quality
- Current or potential predation from hatchery-origin salmonids, including coho salmon
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of LCR Coho Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers; in the Willamette River to Willamette Falls, Oregon; and progeny of 25 artificial propagation programs.[26] Spatial diversity is rated "moderate" to "very high" for all the populations, except the North Fork Lewis River, which has a "low" rating for spatial structure.

Three status evaluations of LCR coho salmon status, all based on WLC-TRT criteria, have been conducted since the last NMFS status review in 2005 (McElhany *et al.* 2007; NMFS 2012c). Out of the 24 populations that make up this ESU (Table 18), 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2012c; ODFW 2010).

[26] The Elochoman Hatchery Type-S and Type-N coho salmon programs were eliminated in 2008. The last adults from these two programs returned to the Elochoman in 2010. NMFS has recommended that these two programs be removed from the ESU (NMFS 2011a).

Table 18. LCR coho salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012c). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Ecological Subregions	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Coast Range	Young's Bay (OR)	VL	VH	VL	VL
	Grays/Chinook rivers (WA)	VL	H	VL	VL
	Big Creek (OR)	VL	H	L	VL
	Elochoman/Skamokawa creeks (WA)	VL	H	VL	VL
	Clatskanie River (OR)	L	VH	M	L
	Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
	Scappoose River (OR)	M	H	M	M
Cascade Range	Lower Cowlitz River (WA)	VL	M	M	VL
	Upper Cowlitz River (WA)	VL	M	L	VL
	Cispus River (WA)	VL	M	L	VL
	Tilton River (WA)	VL	M	L	VL
	South Fork Toutle River (WA)	VL	H	M	VL
	North Fork Toutle River (WA)	VL	M	L	VL
	Coweeman River (WA)	VL	H	M	VL
	Kalama River (WA)	VL	H	L	VL
	North Fork Lewis River (WA)	VL	L	L	VL
	East Fork Lewis River (WA)	VL	H	M	VL
	Salmon Creek (WA)	VL	M	VL	VL
	Clackamas River (OR)	M	VH	H	M
	Sandy River (OR)	VL	H	M	VL
	Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Lower Gorge Tributaries (WA & OR)	VL	M	VL	VL
	Upper Gorge/White Salmon (WA)	VL	M	VL	VL
	Upper Gorge Tributaries/Hood (OR)	VL	VH	L	VL

Abundance and Productivity. In Oregon, the Clatskanie Creek and Clackamas River populations have "low" and "moderate" persistence probability ratings for A&P, while the rest are rated "very low." All of the Washington populations have "very low" A&P ratings. The persistence probability for diversity is "high" in the Clackamas population, "moderate" in the Clatskanie, Scappoose, Lower Cowlitz, South Fork Toutle, Coweeman, East Fork Lewis, and Sandy populations, and "low" to "very low" in the rest (NMFS 2012c). Uncertainty is high because of a lack of adult spawner surveys. Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011; NMFS 2011a; NMFS 2012c).

Limiting Factors include (NMFS 2012c; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Fish passage barriers that limit access to spawning and rearing habitats
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Hatchery-related effects
- Harvest-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of LCR Steelhead

Spatial Structure and Diversity. Four strata and 23 historical populations of LCR steelhead occur within the DPS: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecological subregions (Table 19).[27] The DPS also includes the progeny of ten artificial propagation programs.[28] Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates.

[27] The White Salmon and Little White Salmon steelhead populations are part of the Middle Columbia steelhead DPS and are addressed in a separate species-level recovery plan, the Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009b).

[28] In 2007, the release of Cowlitz Hatchery winter steelhead into the Tilton River was discontinued; in 2009, the Hood River winter steelhead program was discontinued; and in 2010, the release of hatchery winter steelhead into the Upper Cowlitz and Cispus rivers was discontinued. In 2011, NMFS recommended removing these programs from the DPS. A Lewis River winter steelhead program was initiated in 2009, and in 2011, NMFS proposed that it be included in the DPS (NMFS 2011a).

Table 6. LCR steelhead strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012c). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	**Run Timing**					
Cascade Range	Summer	Kalama River (WA)	H	VH	M	M
		North Fork Lewis River (WA)	VL	VL	VL	VL
		East Fork Lewis River (WA)	VL	VH	M	VL
		Washougal River (WA)	M	VH	M	M
	Winter	Lower Cowlitz River (WA)	L	M	M	L
		Upper Cowlitz River (WA)	VL	M	M	VL
		Cispus River (WA)	VL	M	M	VL
		Tilton river (WA)	VL	M	M	VL
		South Fork Toutle River (WA)	M	VH	H	M
		North Fork Toutle River (WA)	VL	H	H	VL
		Coweeman River (WA)	L	VH	VH	L
		Kalama River (WA)	L	VH	H	L
		North Fork Lewis River (WA)	VL	M	M	VL
		East Fork Lewis River (WA)	M	VH	M	M
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	M	VH	M	M
		Sandy River (OR)	L	M	M	L
		Washougal River (WA)	L	VH	M	L
Columbia Gorge	Summer	Wind River (WA)	VH	VH	H	H
		Hood River (OR)	VL	VH	L	VL
	Winter	Lower Gorge (WA & OR)	L	VH	M	L
		Upper Gorge (OR & WA)	L	M	M	L
		Hood River (OR)	M	VH	M	M

It is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Spatial structure remains relatively high for most populations Out of the 23 populations, 16 are considered to have a “low” or “very low” probability of persisting over the next 100 years, and six populations have a “moderate” probability of persistence (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2012c; ODFW 2010). All four strata in the DPS fall short of the WLC-TRT criteria for viability (NMFS 2012c).

Baseline persistence probabilities were estimated to be “low” or “very low” for three out of the six summer steelhead populations that are part of the LCR DPS, moderate for two, and high for one—the Wind, which is considered viable (Lower Columbia Fish Recovery Board 2010; NMFS 2012c; ODFW 2010). Thirteen of the 17 LCR winter steelhead populations have “low” or “very low” baseline probabilities of persistence, and the remaining four are at “moderate” probability of persistence (Table 19) (Lower Columbia Fish Recovery Board 2010; NMFS 2012c; ODFW 2010).

Abundance and Productivity. The "low" to "very low" baseline persistence probabilities of most Lower Columbia River steelhead populations reflects low abundance and productivity (NMFS 2012c). All of the populations increased in abundance during the early 2000s, generally peaking in 2004. Most populations have since declined back to levels within one standard deviation of the long term mean. Exceptions are the Washougal summer-run and North Fork Toutle winter-run, which are still higher than the long term average, and the Sandy, which is lower. In general, the populations do not show any sustained dramatic changes in abundance or fraction of hatchery origin spawners since the 2005 status review (Ford 2011). Although current LCR steelhead populations are depressed compared to historical levels and long-term trends show declines, many populations are substantially healthier than their salmon counterparts, typically because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010; NMFS 2012c).

Limiting Factors include (NMFS 2012c; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and recruitment of LW, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects and lowland development
- Avian and marine mammal predation in the lower mainstem Columbia River and estuary
- Hatchery-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of UWR Steelhead.

Spatial Structure and Diversity. This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River. One stratum and four extant populations of UWR steelhead occur within the DPS (Table 20). Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance. Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, not part of the DPS. Additionally, stocked summer steelhead that have become established in the McKenzie River were not considered in the identification of historical populations (ODFW and NMFS 2011).

Table 20. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR steelhead (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Molalla River	VL	M	M	L
North Santiam River	VL	M	H	L
South Santiam River	VL	M	M	L
Calapooia River	M	M	VH	M

Abundance and Productivity. Since the last status review in 2005, UWR steelhead initially increased in abundance but subsequently declines and current abundance is at the levels observed in the mid-1990s when the DPS was first listed. The DPS appears to be at lower risk than the UWR Chinook salmon ESU, but continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Reduced access to spawning and rearing habitats mainly as a result of artificial barriers in spawning tributaries
- Hatchery-related effects: impacts from the non-native summer steelhead hatchery program
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation and competition on native UWR steelhead

Interior Columbia Recovery Domain. Species in the Interior Columbia (IC) recovery domain include UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, UCR steelhead, Mid-Columbia River (MCR) steelhead, and SRB steelhead. The IC-TRT identified 82 populations of those species based on genetic, geographic (hydrographic), and habitat characteristics (Table 21). In some cases, the IC-TRT further aggregated populations into “major groupings” based on dispersal distance and rate, and drainage structure, primarily the location and distribution of large tributaries (IC-TRT 2003). All 82 populations identified use the lower mainstem of the Snake River, the mainstem of the Columbia River, and the Columbia River estuary, or part thereof, for migration, rearing, and smoltification.

Table 21. Populations of ESA-listed salmon and steelhead in the IC recovery domain.

Species	Populations
UCR spring-run Chinook salmon	3
SR spring/summer-run Chinook salmon	28
SR fall-run Chinook salmon	1
SR sockeye salmon	1
MCR steelhead	17
UCR steelhead	4
SRB steelhead	24

The IC-TRT also recommended viability criteria that follow the VSP framework (McElhany *et al.* 2006) and described biological or physical performance conditions that, when met, indicate a population or species has a 5% or less risk of extinction over a 100-year period (IC-TRT 2007; see also NRC 1995).

Status of UCR Spring-run Chinook Salmon

Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River), the Columbia River upstream to Chief Joseph Dam, and progeny of six artificial propagation programs. The IC-TRT identified four independent populations of UCR spring-run Chinook salmon in the upriver tributaries of Wenatchee, Entiat, Methow, and Okanogan (extirpated), but no major groups due to the relatively small geographic area affected (Ford 2011; IC-TRT 2003)(Table 22).

Table 22. Scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for spring-run UCR Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Population	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River				E

The composite SS/D risks for all three of the extant populations in this MPG are at "high" risk. The spatial processes component of the SS/D risk is "low" for the Wenatchee River and Methow River populations and "moderate" for the Entiat River (loss of production in lower section increases effective distance to other populations). All three of the extant populations in this MPG are at "high" risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners in natural spawning areas and lack of genetic diversity among the natural-origin spawners (Ford 2011).

Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low. Overall, the viability of Upper Columbia Spring Chinook salmon ESU has likely improved somewhat since the last status review, but the ESU is still clearly at "moderate-to-high" risk of extinction (Ford 2011).

Abundance and Productivity. UCR spring-run Chinook salmon is not currently meeting the viability criteria (adapted from the IC-TRT) in the Upper Columbia Recovery Plan. A&P remains at "high" risk for each of the three extant populations in this MPG/ESU (Table 21). The 10-year geometric mean abundance of adult natural origin spawners has increased for each population relative to the levels for the 1981-2003 series, but the estimates remain below the corresponding IC-TRT thresholds. Estimated productivity (spawner to spawner return rate at low to moderate escapements) was on average lower over the years 1987-2009 than for the previous period. The combinations of current abundance and productivity for each population result in a "high" risk rating.

Limiting Factors include (NOAA Fisheries 2011; Upper Columbia Salmon Recovery Board 2007):

- Mainstem Columbia River hydropower–related adverse effects: upstream and downstream fish passage, ecosystem structure and function, flows, and water quality
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded estuarine and nearshore marine habitat
- Hatchery related effects: including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species
- Harvest in Columbia River fisheries

Status of SR Spring/summer-run Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins; and progeny of fifteen artificial propagation programs. The IC-TRT currently believes there are 27 extant and 4 extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into major population groups (Ford 2011; IC-TRT 2007). Each of these populations faces a "high" risk of extinction (Ford 2011) (Table 23).

Table 23. SR spring/summer-run Chinook salmon ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Ecological Subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Lower Snake River	Tucannon River	H	M	M	H
	Asotin River				E
Grande Ronde and Imnaha rivers	Wenaha River	H	M	M	H
	Lostine/Wallowa River	H	M	M	H
	Minam River	H	M	M	H
	Catherine Creek	H	M	M	H
	Upper Grande Ronde R.	H	M	H	H
	Imnaha River	H	M	M	H
	Big Sheep Creek				E
	Lookingglass Creek				E
South Fork Salmon River	Little Salmon River	*	*	*	H
	South Fork mainstem	H	M	M	H
	Secesh River	H	L	L	H
	EF/Johnson Creek	H	L	L	H
Middle Fork Salmon River	Chamberlin Creek	H	L	L	H
	Big Creek	H	M	M	H
	Lower MF Salmon	H	M	M	H
	Camas Creek	H	M	M	H
	Loon Creek	H	M	M	H
	Upper MF Salmon	H	M	M	H
	Sulphur Creek	H	M	M	H
	Bear Valley Creek	H	L	L	H
	Marsh Creek	H	L	L	H
Upper Mainstem Salmon	N. Fork Salmon River	H	L	L	H
	Lemhi River	H	H	H	H
	Pahsimeroi River	H	H	H	H
	Upper Salmon-lower mainstem	H	L	L	H
	East Fork Salmon River	H	H	H	H
	Yankee Fork	H	H	H	H
	Valley Creek	H	M	M	H
	Upper Salmon main	H	M	M	H
	Panther Creek				E

* Insufficient data.

Abundance and Productivity. Population level status ratings remain at "high" risk across all MPGs within the ESU, although recent natural spawning abundance estimates have increased, all populations remain below minimum natural origin abundance thresholds (Table 23). Spawning escapements in the most recent years in each series are generally well below the peak returns but above the extreme low levels in the mid-1990s. Relatively low natural production rates and spawning levels below minimum abundance thresholds remain a major concern across the ESU.

The ability of SR spring/summer-run Chinook salmon populations to be self-sustaining through normal periods of relatively low ocean survival remains uncertain. Factors cited by Good (2005) remain as concerns or key uncertainties for several populations. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, elevated water temperature, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Mainstem Columbia River and Snake River hydropower impacts
- Harvest-related effects
- Predation

Status of SR Fall-run Chinook Salmon

Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River, and progeny of four artificial propagation programs. The IC-TRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of Snake River fall-run Chinook salmon is the only remaining population from an historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (Ford 2011; IC-TRT 2003). The population is at moderate risk for diversity and spatial structure. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Abundance and Productivity. The recent increases in natural origin abundance are encouraging. However, hatchery origin spawner proportions have increased dramatically in recent years – on average, 78% of the estimated adult spawners have been hatchery origin over the most recent brood cycle. The apparent leveling off of natural returns in spite of the increases in total brood year spawners may indicate that density dependent habitat effects are influencing production or that high hatchery proportions may be influencing natural production rates. The A&P risk rating for the population is "moderate." Given the combination of current A&P and SS/D ratings summarized above, the overall viability rating for Lower SR fall Chinook salmon would be rated as "maintained."[29]

[29] "Maintained" population status is for populations that do not meet the criteria for a viable population but do support ecological functions and preserve options for ESU/DPS recovery.

Limiting Factors include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, and channel structure and complexity have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Harvest-related effects
- Loss of access to historic habitat above Hells Canyon and other Snake River dams
- Mainstem Columbia River and Snake River hydropower impacts
- Hatchery-related effects
- Degraded estuarine and nearshore habitat

Status of SR Sockeye Salmon

Spatial Structure and Diversity**.** This species includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake captive propagation program. The IC-TRT identified historical sockeye salmon production in at least five Stanley Basin and Sawtooth Valley lakes and in lake systems associated with Snake River tributaries currently cut off to anadromous access (*e.g.,* Wallowa and Payette Lakes), although current returns of SR sockeye salmon are extremely low and limited to Redfish Lake (IC-TRT 2007).

Abundance and Productivity. This species is still at extremely high risk across all four basic risk measures (abundance, productivity, spatial structure and diversity. Although the captive brood program has been successful in providing substantial numbers of hatchery produced *O. nerka* for use in supplementation efforts, substantial increases in survival rates across life history stages must occur to re-establish sustainable natural production (Hebdon *et al.* 2004; Keefer *et al.* 2008). Overall, although the risk status of the Snake River sockeye salmon ESU appears to be on an improving trend, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors. The key factor limiting recovery of SR sockeye salmon ESU is survival outside of the Stanley Basin. Portions of the migration corridor in the Salmon River are impeded by water quality and temperature (Idaho Department of Environmental Quality 2011). Increased temperatures likely reduce the survival of adult sockeye returning to the Stanley Basin. The natural hydrological regime in the upper mainstem Salmon River Basin has been altered by water withdrawals. In most years, sockeye adult returns to Lower Granite suffer catastrophic losses (Reed *et al.* 2003) (*e.g.*, > 50% mortality in one year) before reaching the Stanley Basin, although the factors causing these losses have not been identified. In the Columbia and lower Snake River migration corridor, predation rates on juvenile sockeye salmon are unknown, but terns and cormorants consume 12% of all salmon smolts reaching the estuary, and piscivorous fish consume an estimated 8% of migrating juvenile salmon (NOAA Fisheries 2011).

Status of MCR Steelhead

Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the

Yakima River, Washington, excluding steelhead from the Snake River basin; and progeny of seven artificial propagation programs. The IC-TRT identified 17 extant populations in this DPS (IC-TRT 2003). The populations fall into four major population groups: the Yakima River Basin (four extant populations), the Umatilla/Walla-Walla drainages (three extant and one extirpated populations); the John Day River drainage (five extant populations) and the Eastern Cascades group (five extant and two extirpated populations) (Table 24) (Ford 2011; NMFS 2009b).

Table 24. Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for MCR steelhead (Ford 2011; NMFS 2009b). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological Subregions	Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	L	L	L	Viable
	Klickitat River	M	M	M	MT?
	Eastside Deschutes River	L	M	M	Viable
	Westside Deschutes River	H	M	M	H*
	Rock Creek	H	M	M	H?
	White Salmon				E*
	Crooked River				E*
John Day River	Upper Mainstem	M	M	M	MT
	North Fork	VL	L	L	Highly Viable
	Middle Fork	M	M	M	MT
	South Fork	M	M	M	MT
	Lower Mainstem	M	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	MT
	Touchet River	M	M	M	H
	Walla Walla River	M	M	M	MT
Yakima River	Satus Creek	M	M	M	Viable (MT)
	Toppenish Creek	M	M	M	Viable (MT)
	Naches River	H	M	M	H
	Upper Yakima	H	H	H	H

* Re-introduction efforts underway (NMFS 2009).

Straying frequencies into at least the Lower John Day River population are high. Out-of-basin hatchery stray proportions, although reduced, remain very high in the Deschutes River basin.

Abundance and Productivity. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the MCR steelhead DPS is not currently meeting the viability criteria (adopted from the IC-TRT) in the MCR steelhead recovery plan (NMFS 2009b). In addition, several of the factors cited by Good (2005) remain as concerns or key uncertainties. Natural origin spawning estimates of populations have been highly variable with respect to meeting minimum abundance thresholds. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NMFS 2009b; NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, fish passage, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, tributary hydro system activities, and development
- Mainstem Columbia River hydropower–related impacts
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Harvest-related effects
- Effects of predation, competition, and disease

Status of UCR Steelhead

Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border, and progeny of six artificial propagation programs. Four independent populations of UCR steelhead were identified by the IC-TRT in the same upriver tributaries as for UC spring-run Chinook salmon (*i.e.*, Wenatchee, Entiat, Methow, and Okanogan; Table 25) and, similarly, no major population groupings were identified due to the relatively small geographic area involved (Ford 2011; IC-TRT 2003). All extant populations are considered to be at high risk of extinction (Table 25)(Ford 2011). With the exception of the Okanogan population, the Upper Columbia populations rated as "low" risk for spatial structure. The "high" risk ratings for SS/D are largely driven by chronic high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations. The proportions of hatchery origin returns in natural spawning areas remain extremely high across the DPS, especially in the Methow and Okanogan River populations. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Table 25. Summary of the key elements (A&P, diversity, and SS/D) and scores used to determine current overall viability risk for UCR steelhead populations (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River	H	H	H	H

Abundance and Productivity. Upper Columbia steelhead populations have increased in natural origin abundance in recent years, but productivity levels remain low. The modest improvements in natural returns in recent years are probably primarily the result of several years of relatively good natural survival in the ocean and tributary habitats.

Limiting Factors include (NOAA Fisheries 2011; Upper Columbia Salmon Recovery Board 2007):

- Mainstem Columbia River hydropower–related adverse effects
- Impaired tributary fish passage
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Effects of predation, competition, and disease mortality: Fish management, including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species.
- Hatchery-related effects
- Harvest-related effects

Status of SRB Steelhead

Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, and progeny of six artificial propagation programs. The IC-TRT identified 24 populations in five major groups (Table 26) (Ford 2011; IC-TRT 2010). The IC-TRT has not assessed the viability of this species. The relative proportion of hatchery fish in natural spawning areas near major hatchery release sites is highly uncertain. There is little evidence for substantial change in ESU viability relative to the previous BRT and IC-TRT reviews. Overall, therefore, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Table 26. Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SRB steelhead (Ford 2011; NMFS 2011b). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	**	M	M	H
	Asotin Creek	**	M	M	MT
Grande Ronde River	Lower Grande Ronde	**	M	M	Not rated
	Joseph Creek	VL	L	L	Highly viable
	Upper Grande Ronde	M	M	M	MT
	Wallowa River	**	L	L	H
Clearwater River	Lower Clearwater	M	L	L	MT
	South Fork Clearwater	H	M	M	H
	Lolo Creek	H	M	M	H
	Selway River	H	L	L	H
	Lochsa River	H	L	L	H
Salmon River	Little Salmon River	**	M	M	MT
	South Fork Salmon	**	L	L	H
	Secesh River	**	L	L	H
	Chamberlain Creek	**	L	L	H
	Lower MF Salmon	**	L	L	H
	Upper MF Salmon	**	L	L	H
	Panther Creek	**	M	H	H
	North Fork Salmon	**	M	M	MT
	Lemhi River	**	M	M	MT
	Pahsimeroi River	**	M	M	MT
	East Fork Salmon	**	M	M	MT
	Upper Main Salmon	**	M	M	MT
Imnaha	Imnaha River	M		M	MT

* There is uncertainty in these ratings due to a lack of population-specific data.
** Insufficient data.

Abundance and Productivity. The level of natural production in the two populations with full data series and the Asotin Creek index reaches is encouraging, but the status of most populations in this DPS remains highly uncertain. Population-level natural origin abundance and productivity inferred from aggregate data and juvenile indices indicate that many populations are likely below the minimum combinations defined by the IC-TRT viability criteria.

Limiting Factors include (IC-TRT 2010; NMFS 2011b):

- Mainstem Columbia River hydropower–related adverse effects
- Impaired tributary fish passage

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Impaired water quality and increased water temperature
- Related harvest effects, particularly for B-run steelhead
- Predation
- Genetic diversity effects from out-of-population hatchery releases

Oregon Coast Recovery Domain. The OC recovery domain includes OC coho salmon and southern DPS eulachon, on the Oregon coast and streams south of the Columbia River and north of Cape Blanco. Streams and rivers in this area drain west into the Pacific Ocean, and vary in length from less than a mile to more than 210 miles in length.

Status of OC Coho Salmon

Spatial Structure and Diversity**.** This species includes populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco. The Cow Creek stock (South Umpqua population) is included as part of the ESU because the original brood stock was founded from the local, natural origin population and natural origin coho salmon have been incorporated into the brood stock on a regular basis.

The OC-TRT identified 56 populations; 21 independent and 35 dependent. The dependent populations were dependent on strays from other populations to maintain them over long time periods. The TRT also identified 5 biogeographic strata (Table 27)(Lawson *et al.* 2007).

Table 27. OC coho salmon populations. Dependent populations (D) are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI) (Lawson *et al.* 2007; McElhany *et al.* 2000).

Stratum	Population	Type	Stratum	Population	Type
North Coast	Necanicum River	PI	Mid-Coast (cont.)	Alsea River	FI
	Ecola Creek	D		Big Creek (Alsea)	D
	Arch Cape Creek	D		Vingie Creek	D
	Short Sands Creek	D		Yachats River	D
	Nehalem River	FI		Cummins Creek	D
	Spring Creek	D		Bob Creek	D
	Watseco Creek	D		Tenmile Creek	D
	Tillamook Bay	FI		Rock Creek	D
	Netarts Bay	D		Big Creek (Siuslaw)	D
	Rover Creek	D		China Creek	D
	Sand Creek	D		Cape Creek	D
	Nestucca River	FI		Berry Creek	D
	Neskowin Creek	D		Sutton Creek	D
Mid-Coast	Salmon River	PI	Lakes	Siuslaw River	FI
	Devils Lake	D		Siltcoos Lake	PI
	Siletz River	FI		Tahkenitch Lake	PI
	Schoolhouse Creek	D		Tenmile Lakes	PI
	Fogarty Creek	D	Umpqua	Lower Umpqua River	FI
	Depoe Bay	D		Middle Umpqua River	FI
	Rocky Creek	D		North Umpqua River	FI
	Spencer Creek	D		South Umpqua River	FI
	Wade Creek	D	Mid-South Coast	Threemile Creek	D
	Coal Creek	D		Coos River	FI
	Moolack Creek	D		Coquille River	FI
	Big Creek (Yaquina)	D		Johnson Creek	D
	Yaquina River	FI		Twomile Creek	D
	Theil Creek	D		Floras Creek	PI
	Beaver Creek	PI		Sixes River	PI

A 2010 BRT noted significant improvements in hatchery and harvest practices have been made (Stout *et al.* 2011). However, harvest and hatchery reductions have changed the population dynamics of the ESU. Current concerns for spatial structure focus on the Umpqua River. Of the four populations in the Umpqua stratum, the North Umpqua and South Umpqua, were of particular concern. The North Umpqua is controlled by Winchester Dam and has historically been dominated by hatchery fish. Hatchery influence has recently been reduced, but the natural productivity of this population remains to be demonstrated. The South Umpqua is a large, warm system with degraded habitat. Spawner distribution appears to be seriously restricted in this population, and it is probably the most vulnerable of any population in this ESU to increased temperatures.

Current status of diversity shows improvement through the waning effects of hatchery fish on populations of OC coho salmon. In addition, recent efforts in several coastal estuaries to restore lost wetlands should be beneficial. However, diversity is lower than it was historically because of the loss of both freshwater and tidal habitat loss coupled with the restriction of diversity from very low returns over the past 20 years.

Abundance and Productivity. It has not been demonstrated that productivity during periods of poor marine survival is now adequate to sustain the ESU. Recent increases in adult escapement do not provide strong evidence that the century-long downward trend has changed. The ability of the OC coho salmon ESU to survive another prolonged period of poor marine survival remains in question. Wainwright (2008) determined that the weakest strata of OC coho salmon were in the North Coast and Mid-Coast of Oregon, which had only "low" certainty of being persistent. The strongest strata were the Lakes and Mid-South Coast, which had "high" certainty of being persistent. To increase certainty that the ESU as a whole is persistent, they recommended that restoration work should focus on those populations with low persistence, particularly those in the North Coast, Mid-Coast, and Umpqua strata.

Limiting Factors include (NOAA Fisheries 2011; Stout *et al.* 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, instream mining, dams, road crossings, dikes, levees, *etc.*
- Fish passage barriers that limit access to spawning and rearing habitats
- Adverse climate, altered past ocean/marine productivity, and current ocean ecosystem conditions have favored competitors and predators and reduced salmon survival rates in freshwater rivers and lakes, estuaries, and marine environments

Southern Oregon and Northern California Coasts Recovery Domain. The SONCC recovery domain includes coho salmon and southern DPS eulachon. The SONCC recovery domain extends from Cape Blanco, Oregon, to Punta Gorda, California. This area includes many small-to-moderate-sized coastal basins, where high quality habitat occurs in the lower reaches of each basin, and three large basins (Rogue, Klamath and Eel) where high quality habitat is in the lower reaches, little habitat is provided by the middle reaches, and the largest amount of habitat is in the upper reaches.

Status of SONCC Coho Salmon

Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of coho salmon in coastal streams from the Elk River near Cape Blanco, Oregon, through and including the Mattole River near Punta Gorda, California, and progeny of three artificial propagation programs (NMFS 2012d). Williams *et al.* (2006) designated 45 populations of coho salmon in the SONCC coho salmon ESU. These populations were further grouped into seven diversity strata based on the geographical arrangement of the populations and basin-scale genetic, environmental, and ecological characteristics (Table 28).

Table 28. SONCC coho salmon populations in Oregon. Williams *et al.* (2006) classified populations as dependent or independent based on their historic population size. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI). Core population types are independent populations judged most likely to become viable most quickly. Non-core 1 population types are independent populations judged to have lesser potential for rapid recovery than the core populations. Dependent populations (D) are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Two ephemeral populations (E) are defined as populations both small enough and isolated enough that they are only intermittently present (McElhany *et al.* 2000; NMFS 2012d; Williams *et al.* 2006).

Stratum	Population	Population Type
Northern Coastal	Elk River	FI Core
	Hubbard Creek	E
	Brush Creek	D
	Mussel Creek	D
	Euchre Creek	E
	Lower Rogue River	PI Non-Core 1
	Hunter Creek	D
	Pistol River	D
	Chetco River	FI Core
	Winchuck River*	PI Non-Core 1
Interior Rogue	Upper Rogue River	FI Core
	Middle Rogue/Applegate*	FI Non-Core 1
	Illinois River*	FI Core
Interior Klamath	Upper Klamath River*	FI Core
Central Coastal	Smith River*	FI core

* Populations that also occur partly in California.

NMFS considered the role each population is expected to play in a recovered ESU to determine population abundance and juvenile occupancy targets for all the populations in the SONCC coho salmon ESU. Independent populations are evaluated using a modified Bradbury (1995) framework. This model uses three groupings of criteria for ranking watersheds for Pacific salmon restoration prioritization: 1) biological and ecological resources (Biological Importance); 2) watershed integrity and salmonid extinction risk (Integrity and Risk); and 3) potential for restoration (Optimism and Potential). Scores for Biological Importance are based on the concept of VSPs (McElhany *et al.* 2000), and are used to describe the current status of the population – population size, productivity, spatial structure, and diversity. "Core" populations were designated based on current condition, geographic location in the ESU, low risk threshold compared to the number of spawners needed for the entire stratum, and other factors. "Non-core 1" populations are in the moderate risk threshold, which is the depensation threshold[30] multiplied by four.

[30] Williams (2008) defines the depensation threshold as one spawner per km of stream with estimated rearing potential or Intrinsic Potential.

NMFS chooses this target if the population is likely to ultimately produce considerably more than the depensation threshold, but less than the low risk threshold.

The draft recovery plan establishes the following criteria at the ESU, diversity strata, and population scales to measure whether the recovery objectives are met (NMFS 2012d).

VSP Parameter	Population Type	Recovery Objective	Recovery Criteria
Abundance	Core	Low risk of extinction.	The geometric mean of wild spawners over 12 years at least meets the "low risk threshold" of spawners for each core population
	Non-Core 1	Moderate or low risk of extinction.	The annual number of wild spawners meets or exceeds the moderate risk threshold for each non-core population
Productivity	Core and Non-Core 1	Population growth rate is not negative.	Slope of regression of the geometric mean of wild spawners over the time series ≥ zero
Spatial Structure	Core and Non-Core 1	Ensure populations are widely distributed.	Annual within-population distribution ≥ 80% of habitat (outside of a temperature mask)
	Non-Core 2 and Dependent	Achieve inter- and intra-stratum connectivity.	20% of accessible habitat is occupied in years following spawning of cohorts that experienced good marine survival
Diversity	Core and Non-Core 1	Achieve low or moderate hatchery impacts on wild fish.	Proportion of hatchery-origin spawners (pHOS) ≤ 0.10
	Core and Non-Core 1	Achieve life history diversity.	Variation is present in migration timing, age structure, size and behavior. Variation in these parameters is retained.

Abundance and Productivity. Although long-term data on abundance of SONCC coho salmon are scarce, available evidence from shorter-term research and monitoring efforts indicate that conditions have worsened for populations since the last formal status review was published (Good *et al.* 2005; NMFS 2012d). Because the extinction risk of an ESU depends upon the extinction risk of its constituent independent populations and the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable (NMFS 2012d).

Limiting Factors. Threats from natural or man-made factors have worsened in the past 5 years, primarily due to four factors: small population dynamics, climate change, multi-year drought, and poor ocean survival conditions (NMFS 2012d; NOAA Fisheries 2011). Limiting factors include:

- Lack of floodplain and channel structure
- Impaired water quality
- Altered hydrologic function (timing of volume of water flow)
- Impaired estuary/mainstem function
- Degraded riparian forest conditions
- Altered sediment supply
- Increased disease/predation/competition
- Barriers to migration

- Adverse fishery-related effects
- Adverse hatchery-related effects

2.2.2 Status of the Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated areas. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support spawning, rearing, migration and foraging).

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[31] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (*e.g.*, one of a very few spawning areas), a unique contribution of the population it served (*e.g.*, a population at the extreme end of geographic distribution), or the fact that it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

The physical or biological features of freshwater spawning and incubation sites, include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 29-30). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

[31] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

Table 29. PCEs of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, and SONCC coho salmon), and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine areas	Forage Water quality	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Table 30. PCEs of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon, and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

CHART Salmon and Steelhead Critical Habitat Assessments. The CHART for each recovery domain assessed biological information pertaining to areas under consideration for designation as critical habitat to identify the areas occupied by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for:

- Factor 1. Quantity,
- Factor 2. Quality – Current Condition,
- Factor 3. Quality – Potential Condition,
- Factor 4. Support of Rarity Importance,
- Factor 5. Support of Abundant Populations, and
- Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality - current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Southern DPS Eulachon. Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). All of these areas are designated as migration and spawning habitat for this species. In Oregon, 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek have been designated. The mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles is also designated as critical habitat. Table 31 delineates the designated physical or biological features for eulachon.

Table 31. Physical or biological features of critical habitats designated for eulachon and corresponding species life history events.

Physical or biological features		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning and incubation	Flow Water quality Water temperature Substrate	Adult spawning Incubation
Freshwater migration	Flow Water quality Water temperature Food	Adult and larval mobility Larval feeding

The range of eulachon in the Pacific Northwest completely overlaps with the range of several ESA-listed stocks of salmon and steelhead. Although the habitat requirements of these fishes differ somewhat from eulachon, efforts to protect habitat generally focus on the maintenance of watershed processes that would be expected to benefit eulachon. The BRT identified dams and water diversions as moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath systems, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods (Gustafson *et al.* 2010). Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown (Gustafson *et al.* 2010). The BRT identified dredging as a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.

The lower Columbia River mainstem provides spawning and incubation sites, and a large migratory corridor to spawning areas in the tributaries. Prior to the construction of Bonneville Dam, eulachon ascended the Columbia River as far as Hood River, Oregon. Major tributaries that support spawning runs include the Grays, Skamokawa, Elochoman, Kalama, Lewis and Sandy rivers.

The number of eulachon returning to the Umpqua River seems to have declined in the 1980s, and does not appear to have rebounded to previous levels. Additionally, eulachon are regularly caught in salmonid smolt traps operated in the lower reaches of Tenmile Creek by the Oregon Department of Fish and Wildlife (ODFW).

Puget Sound Recovery Domain. Critical habitat has been designated in Puget Sound for PS Chinook salmon, HC summer-run chum salmon, LO sockeye salmon, and southern DPS eulachon, and proposed for PS steelhead. Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and LW recruitment (Shared Strategy for Puget Sound 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and LW. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Shared Strategy for Puget Sound 2007; Spence *et al.* 1996).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of suspended sediment, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (Shared Strategy for Puget Sound 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (Shared Strategy for Puget Sound 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist *et al.* 2011).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (*e.g*., Elwha River dams block anadromous fish access to 70 miles of potential habitat) changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and LW to downstream areas (Shared Strategy for Puget Sound 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (Shared Strategy for Puget Sound 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound’s tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (Shared Strategy for Puget Sound 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (Hood Canal Coordinating Council 2005; Shared Strategy for Puget Sound 2007).

In summary, critical habitat throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of LW, intense urbanization, agriculture, alteration of floodplain and stream morphology (*i.e*., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat.

The PS recovery domain CHART determined that only a few watersheds with PCEs for Chinook salmon in the Whidbey Basin (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good to excellent condition with no potential for improvement. Most HUC_5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 32).

Table 32. **Puget Sound Recovery Domain:** Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and chum salmon (CM) (NOAA Fisheries 2005).[32] Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = reduced, with high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Potential Quality
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1

[32] On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and PS steelhead (USDC 2013). A draft biological report, which includes a CHART assessment for PS salmon, was also completed (NMFS 2012a). Habitat quality assessments for PS steelhead are out for review; therefore, they are not included on this table.

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = reduced, with high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Potential Quality
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

Willamette-Lower Columbia Recovery Domain. Critical habitat was designated in the WLC recovery domain for UWR spring-run Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, southern DPS eulachon, and proposed for LCR coho salmon. In addition to the Willamette and Columbia River mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

Land management activities have severely degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the WLC domain.

The mainstem Willamette River has been channelized and stripped of LW. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). Gregory (2002a) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the ACOE. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of LW in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, organic inputs from litter fall, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Gregory *et al.* (2002c) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash tree openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion has reduced river shading and the potential for recruitment of wood to the river, reducing channel complexity and the quality of rearing, migration and spawning habitats.

Hyporheic flow in the Willamette River has been examined through discharge measurements and found to be significant in some areas, particularly those with gravel deposits (Fernald *et al.* 2001; Wentz *et al.* 1998). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001).

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2012c). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia River and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2012c). Since 1878, 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River have been dredged as a navigation channel by the ACOE. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial facilities.

The most extensive urban development in the Lower Columbia River subbasin has occurred in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2012c). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary's capacity to support juvenile salmon (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2012c). Diking and filling activities have reduced the tidal prism and eliminate emergent and forested wetlands and floodplain habitats. These changes have likely reduced the estuary's salmon-rearing capacity. Moreover, water and sediment in the Lower Columbia River and its tributaries have toxic contaminants that are harmful to aquatic resources (Lower Columbia River Estuary Partnership 2007).

Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns have likely begun to enhance the estuary's productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats.

The WLC recovery domain CHART determined that most HUC_5 watersheds with PCEs for salmon or steelhead are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement (Table 33).

Table 33. Willamette-Lower Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005).[33] Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Columbia Gorge #1707010xxx			
Wind River (511)	CK/ST	2/2	2/2
East Fork Hood (506), & Upper (404) & Lower Cispus (405) rivers	CK/ST	2/2	2/2
Plympton Creek (306)	CK	2	2
Little White Salmon River (510)	CK	2	0
Grays Creek (512) & Eagle Creek (513)	CK/CM/ST	2/1/2	1/1/2
White Salmon River (509)	CK/CM	2/1	1/2
West Fork Hood River (507)	CK/ST	1/2	2/2
Hood River (508)	CK/ST	1/1	2/2
Unoccupied habitat: Wind River (511)	Chum conservation value "Possibly High"		
Cascade and Coast Range #1708000xxx			
Lower Gorge Tributaries (107)	CK/CM/ST	2/2/2	2/3/2
Lower Lewis (206) & North Fork Toutle (504) rivers	CK/CM/ST	1/3/1	2/1/2
Salmon (101), Zigzag (102), & Upper Sandy (103) rivers	CK/ST	2/2	2/2
Big Creek (602)	CK/CM	2/2	2/2
Coweeman River (508)	CK/CM/ST	2/2/1	2/1/2
Kalama River (301)	CK/CM/ST	1/2/2	2/1/2
Cowlitz Headwaters (401)	CK/ST	2/2	1/1
Skamokawa/Elochoman (305)	CK/CM	2/1	2
Salmon Creek (109)	CK/CM/ST	1/2/1	2/3/2
Green (505) & South Fork Toutle (506) rivers	CK/CM/ST	1/1/2	2/1/2
Jackson Prairie (503) & East Willapa (507)	CK/CM/ST	1/2/1	1/1/2
Grays Bay (603)	CK/CM	1/2	2/3
Upper Middle Fork Willamette River (101)	CK	2	1
Germany/Abernathy creeks (304)	CK/CM	1/2	2
Mid-Sandy (104), Bull Run (105), & Lower Sandy (108) rivers	CK/ST	1/1	2/2
Washougal (106) & East Fork Lewis (205) rivers	CK/CM/ST	1/1/1	2/1/2
Upper Cowlitz (402) & Tilton rivers (501) & Cowlitz Valley Frontal (403)	CK/ST	1/1	2/1
Clatskanie (303) & Young rivers (601)	CK	1	2

[33] On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and PS steelhead (USDC 2013). A draft biological report, which includes a CHART assessment for PS steelhead, was also completed (NMFS 2012a). Habitat quality assessments for LCR coho salmon are out for review; therefore, they are not included on this table.

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Rifle Reservoir (502)	CK/ST	1	1
Beaver Creek (302)	CK	0	1
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
Willamette River #1709000xxx			
Upper (401) & South Fork (403) McKenzie rivers; Horse Creek (402); & McKenzie River/Quartz Creek (405)	CK	3	3
Lower McKenzie River (407)	CK	2	3
South Santiam River (606)	CK/ST	2/2	1/3
South Santiam River/Foster Reservoir (607)	CK/ST	2/2	1/2
North Fork of Middle Fork Willamette (106) & Blue (404) rivers	CK	2	1
Upper South Yamhill River (801)	ST	2	1
Little North Santiam River (505)	CK/ST	1/2	3/3
Upper Molalla River (905)	CK/ST	1/2	1/1
Abernethy Creek (704)	CK/ST	1/1	1/2
Luckiamute River (306) & Yamhill (807) Lower Molalla (906) rivers; Middle (504) & Lower (506) North Santiam rivers; Hamilton Creek/South Santiam River (601); Wiley Creek (608); Mill Creek/Willamette River (701); & Willamette River/Chehalem Creek (703); Lower South (804) & North (806) Yamhill rivers; & Salt Creek/South Yamhill River (805)	CK/ST	1	1
Hills (102) & Salmon (104) creeks; Salt Creek/Willamette River (103), Hills Creek Reservoir (105), Middle Fork Willamette/Lookout Point (107); Little Fall (108) & Fall (109) creeks; Lower Middle Fork of Willamette (110), Long Tom (301), Marys (305) & Mohawk (406) rivers	CK	1	1
Willamina Creek (802) & Mill Creek/South Yamhill River (803)	ST	1	1
Calapooia River (303); Oak (304) Crabtree (602), Thomas (603) & Rickreall (702) creeks; Abiqua (901), Butte (902) & Rock (903) creeks/Pudding River; & Senecal Creek/Mill Creek (904)	CK/ST	1/1	0/1
Row River (201), Mosby (202) & Muddy (302) creeks, Upper (203) & Lower (205) Coast Fork Willamette River	CK	1	0
Unoccupied habitat in North Santiam (501) & North Fork Breitenbush (502) rivers; Quartzville Creek (604) and Middle Santiam River (605)	CK & ST Conservation Value "Possibly High"		
Unoccupied habitat in Detroit Reservoir/Blowout Divide Creek (503)	Conservation Value: CK "Possibly Medium"; ST Possibly High"		
Lower Willamette #1709001xxx			
Collawash (101), Upper Clackamas (102), & Oak Grove Fork (103) Clackamas rivers	CK/ST	2/2	3/2
Middle Clackamas River (104)	CK/ST	2/1	3/2

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Eagle Creek (105)	CK/ST	2/2	1/2
Gales Creek (002)	ST	2	1
Lower Clackamas River (106) & Scappoose Creek (202)	CK/ST	1	2
Dairy (001) & Scoggins (003) creeks; Rock Creek/Tualatin River (004); & Tualatin River (005)	ST	1	1
Johnson Creek (201)	CK/ST	0/1	2/2
Lower Willamette/Columbia Slough (203)	CK/ST	0	2

Interior Columbia Recovery Domain. Critical habitat has been designated in the IC recovery domain, which includes the Snake River Basin, for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead.

Habitat quality in tributary streams in the IC recovery domain varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (NMFS 2009b; Wissmar *et al.* 1994). Critical habitat throughout much of the IC recovery domain has been degraded by intense agriculture, alteration of stream morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately owned dams in the Snake and Upper Columbia river basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho, including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good *et al.* 2005), and Grand Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River.

Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles. A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population (IC-TRT 2003). Similarly, operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have significantly reduced flows and degraded water quality and physical habitat in this domain.

Many stream reaches designated as critical habitat in the IC recovery domain are over-allocated under state water law, with more allocated water rights than existing streamflow. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence *et al.* 1996). Reduced tributary stream flow has been identified as a major limiting factor for all listed salmon and steelhead species in this recovery domain except SR fall-run Chinook salmon and SR sockeye salmon (NMFS 2007c; NOAA Fisheries 2011).

Many stream reaches designated as critical habitat are listed on the state of Oregon's Clean Water Act section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

The IC recovery domain is a very large and diverse area. The CHART determined that few watersheds with PCEs for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most IC recovery domain watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement. In Washington, the Upper Methow, Lost, White, and Chiwawa watersheds are in good-to-excellent condition with no potential for improvement. In Oregon, only the Lower Deschutes, Minam, Wenaha, and Upper and Lower Imnaha Rivers HUC_5 watersheds are in good-to-excellent condition with no potential for improvement. In Idaho, a number of watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, Middle Fork Salmon, Little Salmon, Selway, and Lochsa rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River HUC_5watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (Table 34).

Table 34. Interior Columbia Recovery Domain: Current and potential quality of Oregon and Washington HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Upper Columbia # 1702000xxx			
White (101), Chiwawa (102), Lost (801) & Upper Methow (802) rivers	CK/ST	3	3
Upper Chewuch (803) & Twisp rivers (805)	CK/ST	3	2
Lower Chewuch River (804); Middle (806) & Lower (807) Methow rivers	CK/ST	2	2
Salmon Creek (603) & Okanogan River/Omak Creek (604)	ST	2	2
Upper Columbia/Swamp Creek (505)	CK/ST	2	1
Foster Creek (503) & Jordan/Tumwater (504)	CK/ST	1	1
Upper (601) & Lower (602) Okanogan River; Okanogan River/Bonaparte Creek (605); Lower Similkameen River (704); & Lower Lake Chelan (903)	ST	1	1
Unoccupied habitat in Sinlahekin Creek (703)	ST Conservation Value "Possibly High"		
Upper Columbia #1702001xxx			
Entiat River (001); Nason/Tumwater (103); & Lower Wenatchee River (105)	CK/ST	2	2
Lake Entiat (002)	CK/ST	2	1
Columbia River/Lynch Coulee (003); Sand Hollow (004); Yakima/Hansen Creek (604), Middle Columbia/Priest Rapids (605), & Columbia River/Zintel Canyon (606)	ST	2	1
Icicle/Chumstick (104)	CK/ST	1	2
Lower Crab Creek (509)	ST	1	2
Rattlesnake Creek (204)	ST	0	1
Yakima #1703000xxx			
Upper (101) & Middle (102) Yakima rivers; Teanaway (103) & Little Naches (201) rivers; Naches River/Rattlesnake Creek (202); & Ahtanum (301) & Upper Toppenish (303) & Satus (305) creeks	ST	2	2
Umtanum/Wenas (104); Naches River/Tieton River (203); Upper Lower Yakima River (302); & Lower Toppenish Creek (304)	ST	1	2
Yakima River/Spring Creek (306)	ST	1	1
Lower Snake River #1706010xxx			
Snake River/Granite (101), Getta (102), & Divide (104) creeks; Upper (201) & Lower (205) Imnaha River; Snake River/Rogersburg (301); Minam (505) & Wenaha (603) rivers	ST	3	3

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Grande Ronde River/Rondowa (601)	ST	3	2
Big (203) & Little (204) Sheep creeks; Asotin River (302); Catherine Creek (405); Lostine River (502); Bear Creek (504); & Upper (706) & Lower (707) Tucannon River	ST	2	3
Middle Imnaha River (202); Snake River/Captain John Creek (303); Upper Grande Ronde River (401); Meadow (402); Beaver (403); Indian (409), Lookingglass (410) & Cabin (411) creeks; Lower Wallowa River (506); Mud (602), Chesnimnus (604) & Upper Joseph (605) creeks	ST	2	2
Ladd Creek (406); Phillips/Willow Creek (408); Upper (501) & Middle (503) Wallowa rivers; & Lower Grande Ronde River/Menatche Creek (607)	ST	1	3
Five Points (404); Lower Joseph (606) & Deadman (703) creeks	ST	1	2
Tucannon/Alpowa Creek (701)	ST	1	1
Mill Creek (407)	ST	0	3
Pataha Creek (705)	ST	0	2
Snake River/Steptoe Canyon (702) & Penawawa Creek (708)	ST	0	1
Flat Creek (704) & Lower Palouse River (808)	ST	0	0
Mid-Columbia #1707010xxx			
Wood Gulch (112); Rock Creek (113); Upper Walla Walla (201), Upper Touchet (203), & Upper Umatilla (301) rivers; Meacham (302) & Birch (306) creeks; Upper (601) & Middle (602) Klickitat River	ST	2	2
Glade (105) & Mill (202) creeks; Lower Klickitat River (604); Mosier Creek (505); White Salmon River (509); Middle Columbia/Grays Creek (512)	ST	2	1
Little White Salmon River (510)	ST	2	0
Middle Touchet River (204); McKay Creek (305); Little Klickitat River (603);Fifteenmile (502) & Fivemile (503) creeks	ST	1	2
Alder (110) & Pine (111) creeks; Lower Touchet River (207), Cottonwood (208), Pine (209) & Dry (210) creeks; Lower Walla Walla River (211); Umatilla River/Mission Creek (303) Wildhorse Creek (304); Umatilla River/Alkali Canyon (307); Lower Butter Creek (310); Upper Middle Columbia/Hood (501); Middle Columbia/Mill Creek (504)	ST	1	1
Stage Gulch (308) & Lower Umatilla River (313)	ST	0	1
John Day #170702xxx			
Middle (103) & Lower (105) South Fork John Day rivers; Murderers (104) & Canyon (107) creeks; Upper John Day (106) & Upper North Fork John Day (201) rivers; & Desolation Creek (204)	ST	2	2
North Fork John Day/Big Creek (203); Cottonwood Creek (209) &	ST	2	1

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Lower NF John Day River (210)			
Strawberry (108), Beech (109), Laycock (110), Fields (111), Mountain (113) & Rock (114) creeks; Upper Middle John Day River (112); Granite (202) & Wall (208) creeks; Upper (205) & Lower (206) Camas creeks; North Fork John Day/Potamus Creek (207); Upper Middle Fork John Day River (301) & Camp (302), Big (303) & Long (304) creeks; Bridge (403) & Upper Rock (411) creeks; & Pine Hollow (407)	ST	1	2
John Day/Johnson Creek (115); Lower Middle Fork John Day River (305); Lower John Day River/Kahler Creek (401), Service (402) & Muddy (404) creeks; Lower John Day River/Clarno (405); Butte (406), Thirtymile (408) & Lower Rock (412) creeks; Lower John Day River/Ferry (409) & Scott (410) canyons; & Lower John Day River/McDonald Ferry (414)	ST	1	1
Deschutes #1707030xxx			
Lower Deschutes River (612)	ST	3	3
Middle Deschutes River (607)	ST	3	2
Upper Deschutes River (603)	ST	2	1
Mill Creek (605) & Warm Springs River (606)	ST	2	1
Bakeoven (608) & Buck Hollow (611) creeks; Upper (701) & Lower (705) Trout Creek	ST	1	2
Beaver (605) & Antelope (702) creeks	ST	1	1
White River (610) & Mud Springs Creek (704)	ST	1	0
Unoccupied habitat in Deschutes River/McKenzie Canyon (107) & Haystack (311); Squaw Creek (108); Lower Metolius River (110), Headwaters Deschutes River (601)	ST Conservation Value “Possibly High”		

<u>Oregon Coast Recovery Domain</u>. In this recovery domain, critical habitat has been designated for OC coho salmon, and southern DPS eulachon. Many large and small rivers supporting significant populations of coho salmon flow through this domain, including the Nehalem, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, and Coquille.

The historical disturbance regime in the central Oregon Coast Range was dominated by a mixture of high and low-severity fires, with a natural rotation of approximately 271 years. Old-growth forest coverage in the Oregon Coast Range varied from 25 to 75% during the past 3,000 years, with a mean of 47%, and never fell below 5% (Wimberly *et al.* 2000). Currently, the Coast Range has approximately 5% old-growth, almost all of it on Federal lands. The dominant disturbance now is logging on a cycle of approximately 30 to 100 years, with fires suppressed.

Oregon's assessment of OC coho salmon (Nicholas *et al.* 2005) mapped how streams with high intrinsic potential for rearing are distributed by land ownership categories. Agricultural lands and private industrial forests have by far the highest percentage of land ownership in high intrinsic potential areas and along all coho salmon stream miles. Federal lands have only about 20% of coho salmon stream miles and 10% of high intrinsic potential stream reaches. Because of this distribution, activities in lowland agricultural areas are particularly important to the conservation of OC coho salmon.

The OC coho salmon assessment concluded that at the scale of the entire domain, pools are generally abundant, although slow-water and off-channel habitat (which are important refugia for coho salmon during high winter flows) are limited in the majority of streams when compared to reference streams in minimally-disturbed areas. Amounts of LW in streams are low in all four ODFW monitoring areas and land-use types relative to reference conditions. Amounts of fine sediment are high in three of the four monitoring areas, and were comparable to reference conditions only on public lands. Approximately 62 to 91% of tidal wetland acres (depending on estimation procedures) have been lost for functionally and potentially independent populations of coho salmon.

As part of the coastal coho salmon assessment, the Oregon Department of Environmental Quality analyzed the status and trends of water quality in the range of OC coho salmon using the Oregon water quality index, which is based on a combination of temperature, dissolved oxygen, biological oxygen demand, pH, total solids, nitrogen, total phosphates, and bacteria. Using the index at the species scale, 42% of monitored sites had excellent to good water quality, and 29% show poor to very poor water quality. Within the four monitoring areas, the North Coast had the best overall conditions (six sites in excellent or good condition out of nine sites), and the Mid-South coast had the poorest conditions (no excellent condition sites, and only two out of eight sites in good condition). For the 10-year period monitored between 1992 and 2002, no sites showed a declining trend in water quality. The area with the most improving trends was the North Coast, where 66% of the sites (six out of nine) had a significant improvement in index scores. The Umpqua River basin, with one out of nine sites (11%) showing an improving trend, had the lowest number of improving sites.

Southern Oregon/Northern California Coasts Recovery Domain. In this recovery domain critical habitat has been designated for SONCC coho salmon. Many large and small rivers supporting significant populations of coho salmon flow through this area, including the Elk, Rogue, Chetco, Smith and Klamath. The following summary of critical habitat information in the Elk, Rogue, and Chetco rivers is also applicable to habitat characteristics and limiting factors in other basins in this area.

The Elk River flows through Curry County, and drains approximately 92 square miles (or 58,678 acres)(Maguire 2001). Historical logging, mining, and road building have degraded stream and riparian habitats in the Elk River basin. Limiting factors identified for salmon and steelhead production in this basin include sparse riparian cover, especially in the lower reaches, excessive fine sediment, high water temperatures, and noxious weed invasions (Maguire 2001).

The Rogue River drains approximately 5,160 square miles within Curry, Jackson and Josephine counties in southwest Oregon. The mainstem is about 200 miles long and traverses the coastal mountain range into the Cascades. The Rogue River estuary has been modified from its historical condition. Jetties were built by the ACOE in 1960, which stabilized and deepened the mouth of the river. A dike that extends from the south shore near Highway 101 to the south jetty was completed in 1973. This dike created a backwater for the large shallow area that existed here, which has been developed into a boat basin and marina, eliminating most of the tidal marsh.

The quantity of estuary habitat is naturally limited in the Rogue River. The Rogue River has a drainage area of 5,160 square miles, but the estuary at 1,880 acres is one of the smallest in Oregon. Between 1960 and 1972, approximately 13 acres of intertidal and 14 acres of subtidal land were filled in to build the boat basin dike, the marina, north shore riprap and the other north shore developments (Hicks 2005). Jetties constructed in 1960 to stabilize the mouth of the river and prevent shoaling have altered the Rogue River, which historically formed a sill during summer months (Hicks 2005).

The Lower Rogue Watershed Council's watershed analysis (Hicks 2005). lists factors limiting fish production in tributaries to Lower Rogue River watershed. The list includes water temperatures, low stream flows, riparian forest conditions, fish passage and over-wintering habitat. Limiting factors identified for the Upper Rogue River basin include fish passage barriers, high water temperatures, insufficient water quantity, lack of LW, low habitat complexity, and excessive fine sediment (Rogue Basin Coordinating Council 2006).

The Chetco River estuary has been significantly modified from its historical condition. Jetties were erected by the ACOE in 1957, which stabilized and deepened the mouth of the river. These jetties have greatly altered the mouth of the Chetco River and how the estuary functions as habitat for salmon migrating to the ocean. A boat basin and marina were built in the late 1950s and eliminated most of the functional tidal marsh. The structures eliminated shallow water habitats and vegetation in favor of banks stabilized with riprap. Since then, nearly all remaining bank habitat in the estuary has been stabilized with riprap. The factors limiting fish production in the Chetco River appear to be high water temperature caused by lack of shade, especially in tributaries, high rates of sedimentation due to roads, poor over-wintering habitat due to a lack of LW in tributaries and the mainstem, and poor quality estuary habitat (Maguire 2001).

2.3 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).

Because the action area for this programmatic consultation includes combined action areas 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 the action area, 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 analysis in this consultation, NMFS made the following assumptions regarding the environmental baseline in each area that will eventually be chosen 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 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 salmon and steelhead 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 salmon and steelhead vary with the overall condition of aquatic habitats, which vary from excellent to poor (Tables 32-34). 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 salmon and steelhead. 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.

Anadromous salmonids have been affected by the development and operation of dams. Dams, without adequate fish passage systems, have extirpated anadromous 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).

Marine fish considered in this opinion are exposed to high rates of predation during all life stages. Fish, birds, and marine mammals, including harbor seals, sea lions, and killer whales all prey on juvenile and adult salmon and eulachon. The Columbia River Basin has a diverse assemblage of native and introduced fish species, some of which prey on salmon, steelhead, and eulachon. The primary resident fish predators of salmonids in many areas of the State of Oregon inhabited by anadromous salmon 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). Increased predation by non-native predators has and continues to decrease population abundance and productivity.

Avian predation is another factor limiting salmonid 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 smolts. Smolt migration is delayed in project reservoirs, particularly immediately upstream from dams, where the juvenile bypass systems concentrate smolts, increasing their exposure to avian predators. 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. 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. For Federal lands in Oregon and Washington, all activities are subject to the provisions of the Northwest Forest Plan (USDA and USDI 1994a) or PACFISH (USDA and USDI 1994b).[34] In response to the ESA listing of the northern spotted 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 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 anadromous fish habitat.

The protections afforded anadromous fish and their habitat by the Northwest Forest Plan and PACFISH 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 listed salmon and steelhead. 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 2008 ARBO and other programmatic agreements, such as a 2011 programmatic opinion with the same land managers (Forest Service, BLM and the Coquille Indian Tribe) for management activities in western Oregon. NMFS consulted on Federal land management throughout Oregon, including restoration actions, timber harvest, livestock grazing, and special use permits. However, with programmatic consultations operational, the number of individual formal consultations has dropped. From 2008 to 2011, NMFS conducted 12 formal consultation with the Forest Service in Oregon, and eight formal consultations in Washington. With the BLM, NMFS conducted nine formal consultations in Oregon and none in Washington. Each of these actions was designed to avoid or minimize effects on listed salmon, steelhead, and their habitats. None of these consultations reached a jeopardy or adverse modification of critical habitat conclusion.

Of the consultations completed with the Forest Service in Oregon, one was a restoration project, 5 were natural resources management projects (timber harvest, grazing, road maintenance, mining, special use permit, herbicide application, *etc.*), and 3 were projects that involved both restoration actions and natural resource management. In Washington, consultations completed with the Forest Service include 3 restoration projects, and five were natural resource management projects. For the BLM in Oregon, 9 consultations were conducted on restoration projects. Impacts to the environmental baseline from these previous projects vary from short-term adverse effects to long-term beneficial effects.

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

Under the current environmental baseline, the biological needs of salmon and steelhead are being met on some Federal lands in Oregon and Washington and not being met in others. Since a typical action area of a restoration project will be already degraded in one form or another, at least some biological requirements of salmon and steelhead 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 action areas for 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 salmon and steelhead populations. After going through consultation, many ongoing actions, such as water management, have less impact on listed salmon and steelhead. 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.

2.4 Effects of the Action on the Species and its Designated Critical Habitat

"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 restoration actions addressed by this programmatic opinion will all have long-term beneficial effects to salmon, steelhead, and eulachon, and their habitat. These beneficial effects will improve three salmon and steelhead VSP parameters: abundance, productivity, 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 Oregon and Washington 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 will create little or no disturbance instream. The effects of these actions will be less severe due to the buffering effect of a zone of undisturbed vegetation and soils between the action's footprint and natural water bodies. Those actions will include upland plant control, chemical plant control, upland juniper removal, construction and maintenance of livestock water facilities, 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 salmon, steelhead, or eulachon, 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 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 salmonids are likely to receive 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 listed salmonids 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.

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 and, in some cases, stream fertility. 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.

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 salmonid 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.

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.

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. Microclimate 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.

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 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 adult salmonids are present.

Activity Category-Specific Effects

1. ***Fish Passage Restoration.*** For 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 activities. 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. Salmon are particularly vulnerable during the fall and winter, when adult salmon are migrating and spawning, and 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. However, because of the seasonal restrictions imposed by in-water work windows, these effects will be avoided.

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 PAHs, that leach from pesticide-treated wood used to construct a road, culvert or bridge are likely to adversely affect salmon, steelhead, and eulachon 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 (NOAA Fisheries – Southwest Region 2009).

Fish passage impediments are common throughout Oregon and Washington 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 will 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 construction of 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 salmon, steelhead, 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 diversion, and no additional water withdrawals points will be established and no greater rates of water withdrawal will be authorized.

The primary long-term beneficial effect of properly screening diversions is decreased salmonid mortality. Although it is well accepted that screens prevent fish from dying, NMFS cannot predict exactly how many fish would be saved by installing screens on Federal lands in Oregon and Washington. 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, NMFS recognizes the value of screening and supports the Action Agencies' precautionary approach to screen diversions that may affect listed salmon and steelhead. The removal of unneeded diversion structures improves fish passage and restores natural bedload movement.

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 Oregon and Washington. 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 in Oregon and Washington, we expect an increase in habitat functions, improvements to VSP 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 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 salmonid 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 listed salmon, steelhead, 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 Large Wood Projects. Installation of wood and boulder instream structures is likely to require entry of personnel into the riparian area and channel 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 Oregon and Washington, we expect an increase in habitat functions, improvements to VSP 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). LW 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 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 Oregon and Washington (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 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 salmon 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 critical 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 proposed. 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.

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 restored, 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 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 NMFS can 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, NMFS 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 juvenile 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. 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 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, especially for coho and chum salmon that actively seek these areas, and have high value as summer and winter rearing habitat for coho salmon (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. However, because of the seasonal restrictions imposed by in-water work windows, these effects will be avoided.

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 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 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 allochthonous nutrient inputs that drive the food base that juvenile salmonids consume when rearing and migrating to the ocean. 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 exclude livestock or humans 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 created by salmon or steelhead 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 Forest Service and BLM invasive plant control programs (NMFS 2010; NMFS 2012e). 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 35).

Table35. Potential pathways of effects of invasive and non-native plan control.

Treatment Methods	Pathways of Effects							
	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 and 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. NMFS 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 salmon and steelhead, 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.

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 proposed, 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 ensuing 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 this invasive plant programmatic activity were selected due to their low to moderate aquatic toxicity to listed salmonids. The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is mitigated in this programmatic activity by reducing stream delivery potential by restricting application methods. 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 salmon, steelhead and trout. 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 Forest Service; *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 2011c), glyphosate (SERA 2011b), and triclopyr (SERA 2011a). 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 listed fish. In the case of sulfometuron-methyl, threshold values for fathead minnow were lower than salmonid values, so threshold values for minnow were used to evaluate effects to listed fish.

Data on toxicity to wild fish under natural conditions are limited and most studies are conducted on lab specimens. Adverse effects could be observed in stressed populations of fish, and it is less likely that effects 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 are fully described by NMFS in other recent opinions with the U.S. Environmental Protection Agency (EPA) and Forest Service (NMFS 2010; NMFS 2011d; NMFS 2011f; NMFS 2012e) and in SERA reports. For the 2008 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 2008 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, then 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 listed fish species.

Aminopyralid

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.

Chlorsulfuron

No chlorsulfuron HQ exceedences 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 exceedence 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.

Clopyralid

Application of clopyralid under the modeled scenario did not result in any HQ exceedences for any of the species groups. Clopyralid applications are not likely to adversely affect listed 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 Pacific salmon and steelhead 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 2005). 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 exceedence 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 exceedence 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 2011d).

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 exceedence 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 exceedence 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 2011a). 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 Forest Service 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 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 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 salmon, steelhead, and trout. Those findings do not necessarily extend to other life stages or other physiological processes (*e.g.*, smoltification, disease susceptibility, behavior).

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

14. 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.

15. 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).[35] 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.

---

[35] 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.

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 (Reiman *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, 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 recent 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 did result 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 lower 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.

16. 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.

17. 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 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 salmon and steelhead species, but this capture method allows the capture and release of juvenile salmon and steelhead 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 nonnative 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). Thus far, no bull trout have resided for a significant amount of time in areas where migrating juvenile salmon and steelhead are artificially concentrated and vulnerable to predation (*i.e.*, Clackamas River hydroelectric facilities). In both years, reintroduced bull trout were observed spawning in a headwater tributaries (Allen and Koski 2013). 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 is required.

Although this category has the potential to harass, kill, or injure listed salmon and steelhead, 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 listed salmon and steelhead would be insignificant.

18. 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 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 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.

19. 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.

Herbicide treatment. Aquatic-labeled glyphosate and aquatic-labeled imazapyr would be used in accordance with 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 salmon 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 with 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 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 would 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.

20. 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 salmon and steelhead 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.

2.4.1 Effects on ESA-Listed Salmon and Steelhead

The most intense adverse effects of the proposed action result from in- or-near-water construction, *e.g.*, stream crossing replacement projects, channel reconstruction/relocation. 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 unlikely that individual adult or embryonic salmon or steelhead will be adversely affected by the proposed action because all in-water construction will be deferred until after spawning season has passed and fry have emerged from gravel. However, in some locations, where adult salmon or steelhead may be present during part of the in-water work, and juvenile steelhead may still be emerging from the gravel. Therefore, a judgment call will need to be made by NMFS to determine the best timing. 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 adult and embryonic fish that will likely be absent during implementation of projects, juvenile salmonids will be present at many of most of the restoration sites. At in- or-near-water construction projects (*e.g.*, stream crossing replacement projects, channel reconstruction/relocation*)*, some direct effects of the proposed actions are likely 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 juvenile fish present within the work isolation area and to release them at a safe location, although some juvenile fish 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. Stress from handling increases rapidly if water temperature exceeds 18ºC (64ºF), 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. Downstream 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). As explained more fully below in the *Amount or Extent of Take* section, approximately 602 juveniles are likely to be injured or killed during in-water work area isolation.

In addition to the short-term adverse effects of construction on listed species 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 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.

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 juvenile-to-adult survival rate for salmon and steelhead is generally very low, the effects of a proposed action would have to kill hundreds or even thousands of juvenile fish in a single 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 population over a full life cycle. Moreover, because the geographic area that will be affected by the proposed programmatic action is so large, juvenile fish that are likely to be killed are from more than 300 independent populations. The adverse effects of each proposed individual action will be too infrequent, short-term, and limited to kill more than a small number of juvenile fish at a particular site or even across the range of a single population, much less when that number is even partly distributed among all 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 to the primary VSP attributes of abundance or population growth rate for any single population. This is also true for very small populations of endangered species considered in this opinion, *i.e.*, UCR spring-run Chinook salmon and SR sockeye salmon, for which a combination of low abundance, river-type ecology, and a distribution within the action area that is restricted to the mainstem of the Columbia River make it unlikely that individuals from those species will be injured or killed by the proposed action.

The remaining VSP 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 VSP characteristics of any salmon or steelhead population, the proposed actions also will not have any a measurable effect on species-level abundance, productivity, or ability to recover.

The effects of proposed action, as a whole, on the 21 species considered in this opinion will be the combined effects of all of the individual actions that are funded or carried out under this opinion. Combining the effects of many actions does not change the nature of the effects caused by individual actions, but does require an analysis of the additive effects of multiple occurrences of the same type of effects at the individual fish, population, and species scales. If the adverse effects of one action are added to the effects of one or more additional actions in the same place and time, individual fish will likely experience a more significant adverse effect than if only one action was present. This would occur when the 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 2008 ARBO, the Action Agencies completed an average of 124 restoration actions (in-channel, fish passage and estuary) per year, with far fewer being completed in any single recovery domain. 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." Numbers of projects will likely 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.

2.4.2 Effects on ESA-Listed Eulachon

Eulachon are limited to a relatively few subtidal and intertidal areas, but they return to those areas with a presumed fidelity that indicates close association between a particular stock and its spawning environment (Gustafson *et al.* 2011; Gustafson *et al.* 2010). In the Columbia, major spawning runs occur in the mainstem lower Columbia and Cowlitz rivers with periodic runs appearing in the Grays, Skamokawa, Elochoman, Kalama, Lewis, and Sandy rivers. Washington rivers outside the Columbia Basin where eulachon have been known to spawn include the Bear, Naselle, Nemah, Wynoochee, Quinault, Queets, and Nooksack rivers. Oregon waterbodies include the Winchuck, Chetco, Pistol, Rogue, Elk, Sixes, Coquille, Coos, Siuslaw, Umpqua, and Yaquina rivers; and Hunter, and Euchre rivers, Tenmile Creek (draining Tenmile Lake), and Tenmile Creek (near Yachats, Oregon) (Gustafson *et al.* 2010). Spawning occurs between December and June with the majority of the run occurring over a 20-day period, eggs hatch in 3 to 8 weeks depending on temperature, and larvae are transported rapidly by spring freshets to estuaries. Normal timing of migration coincides with the rainy season when few activities would occur and exposure to suspended sediment and other polluted runoff would be diluted (Gustafson *et al.* 2011; Gustafson *et al.* 2010). Of the numerous potential threats throughout every stage of their life cycle that eulachon face, shoreline construction effects and water quality would be ranked low compared to other factors.

Effects to eulachon would primarily result from instream and streambank work on the few streams where they occur. Impacts would be similar to those described for salmon and steelhead that are listed above. Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the VSP characteristics of any eulachon population, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover.

2.4.3 Effects of the Action on Designated Critical Habitat

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 actions because of differences in the scope of construction at each, and in the current condition of PCEs and the factors responsible for those conditions. This assumption is based all of the actions being based on the same set of underlying construction actions, and the PCEs and conservation needs identified for each species are also essentially the same. In general, ephemeral effects are likely to last for hours or days, short-term effects are likely to last for weeks, 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.

Because the area affected for individual projects is small, the intensity and severity of the effects described is relatively low, and 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, critical habitat conditions that existed before the action. Moreover, projects completed under the proposed program are also 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 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 to 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.

Summary of the effects of the action by critical habitat PCE:

1. <u>Freshwater spawning sites</u>
    a. Water quantity – Brief reduction in flow due to short-term construction needs, reduced riparian permeability, increased riparian runoff, and reduced late season flows; slight longer-term increase based on improved riparian function and floodplain connectivity.
    b. Water quality – Short-term increase in total suspended solids, dissolved oxygen demand, and temperature due to riparian and channel disturbance; longer-term improvement due to improved riparian function and floodplain connectivity.

c. Substrate – Short-term reduction in quality due to increased compaction and sedimentation; long-term increase in quality due to gravel placement, and increased sediment storage from boulders and LW.

2. Freshwater rearing sites
    a. Water quantity – as above.
    b. Floodplain connectivity – Short-term decrease due to increased compaction and riparian disturbance; long-term improvement due to off- and side channel habitat restoration, set-back of existing berms, dikes, and levees, and removal of water control structures.
    c. Water quality – as above.
    d. Forage – Short-term decrease due to riparian and channel disturbance, and water quality impairments; long-term improvement due to improved habitat diversity and complexity, and improved riparian function and floodplain connectivity, and increased litter retention.
    e. Natural cover – Short-term decrease due to riparian and channel disturbance; long-term increase due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and off- and side channel habitat restoration.
3. Freshwater migration corridors
    a. Free passage – Short-term decrease due to decreased water quality and in-water work isolation; long-term increase due to improved water quantity and quality, habitat diversity and complexity, forage to support juvenile migration, and natural cover.
    b. Water quantity – as above.
    c. Water quality – as above.
    d. Natural cover – as above.
4. Estuarine areas
    a. Free passage – as above.
    b. Water quality – as above.
    c. Water quantity – as above.
    d. Salinity – no effect.
    e. Natural cover – as above.
    f. Forage – as above.

Effects on Eulachon Critical Habitat. Critical habitat for eulachon includes: (1) Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles; (2) freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted; and, (3) nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. The Oregon and Washington coast and Lower Columbia River tributaries would likely be subject to few restoration actions under this opinion. Between 2008 to 2011, there were only three ARBO projects in estuaries. The essential features for eulachon critical habitat are as follows:

1. Freshwater spawning sites and incubation
    a. Flow – Ephemeral reduction due to short-term construction needs, reduced riparian permeability, and increased riparian runoff; slight longer-term increase based on improved riparian function and floodplain connectivity.
    b. Water quality – Short-term releases of suspended sediment, increased dissolved oxygen demand, and increased temperature due to riparian and channel disturbance.
    c. Substrate – Short-term reduction due to increased compaction and sedimentation and removal. Long term benefit from the restoration of natural sediment transport.
2. Freshwater and estuarine migration corridors
    a. Free passage – Short-term decrease due to decreased water quality and in-water work isolation.
    b. Flow – as above.
    c. Water quality – as above.
    d. Temperature – no effect.
    e. Food – no effect.
3. Nearshore and offshore marine foraging areas
    a. Food – no effect.
    b. Water quality – no effect.

Summary of effects to critical habitat. 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).

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 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 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 recovery domain using the prior version of this opinion in a single year has varied greatly. During the period 2008-2011, the majority of the restoration projects (284, 48%) occurred in the Oregon Coast recovery domain. 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 recovery domains. 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 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 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 harmed 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 reduce 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 for juvenile fish to proceed downstream and reach the ocean. Without those features, the species cannot successfully spawn and produce offspring. As noted above, however, the declining level of resource-based industrial activity and rapidly rising industry standards for resource protection 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, 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. The NMFS 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 salmon and steelhead 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 also occurs on Federal lands but has not until recently been subject to regulation by the action agencies. This mining causes releases of suspended sediment, riparian disturbance, and harassment of salmon and steelhead. We expect that recreational mining on Federal lands will be the subject of a future consultation.

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 salmon and steelhead within the action area from angling is unknown, but is expected to remain at current levels.

When considered together, these cumulative effects are likely to have a small negative effect on salmon and steelhead 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.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step of NMFS's assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (section 2.4) to the environmental baseline (section 2.3) and the cumulative effects (section 2.5) 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 or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (section 2.2).

2.6.1 Species at the Population Scale

The status of each species addressed by this consultation varies considerably from very high risk (SR sockeye salmon) to moderate risk (*e.g.,* OC coho salmon, MCR steelhead). Similarly, the hundreds 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 these species share is degradation of freshwater and estuarine habitat. 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.

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 such that the proposed activities will cause only short-term, localized, and minor effects. Also, actions are likely to be widely distributed across all recovery domains in Oregon and Washington, 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 salmon or steelhead population, will be affected by the adverse effects of any single action permitted under the proposed action. Because the VSP 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 2.2, individuals of many ESA-listed salmon and steelhead species and eulachon use the program action area to fully complete the migration, spawning and rearing parts of their life cycle; some salmon, steelhead, and eulachon migrate and rear in the program action area; and some species only migrate through, once as out-migrating juveniles and then again as adult fish on upstream spawning migration. Southern DPS eulachon population abundance has declined significantly since the early 1990s and there is no evidence to date of their returning to former population levels. Although NMFS considers variation in ocean productivity to be the most important natural phenomenon affecting the productivity of these species, NMFS identified many other factors associated with the freshwater phase of their life cycle that are also limiting the recovery of these 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 described in section 2.5 are likely to have a small negative effect on salmon and steelhead 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.

2.6.2 Critical Habitat at the Watershed Scale

Many streams in the action area are designated as critical habitat for ESA-listed salmon, steelhead, or eulachon. CHART teams determined that most designated critical habitat for ESA-listed salmon and steelhead has a high conservation value, based largely on its restoration potential. Baseline conditions for these PCEs vary widely, from poor to excellent. The effects analysis demonstrated that the adverse effects of the proposed action on critical habitat PCEs will be short-lived (lasting days to weeks), widely dispersed among watersheds, and limited to the scale of the site or stream reach and mild, while the long-term effects (lasting weeks to years) are likely to contribute to lessening of the factors limiting the recovery of these species during the freshwater phase of their life cycle. Because of this, critical habitat will remain functional, or retain the ability for its PCEs to become functionally established and serve the intended conservation role for the species. The features of eulachon critical habitat that are likely to be affected by projects completed under the proposed program are freshwater spawning and incubation habitat, and freshwater migration. By contributing to improved habitat conditions this proposed action will, over the long term, improve PCE site conditions that support various life history events, a critical step toward recovery of these species as whole.

Climate change and human development have and continue to adversely impact critical habitat creating limiting factors and threats to the recovery of the ESA listed species. Climate change will likely result in a generally negative trend for stream flow and temperature.

Information in section 2.3 described the environmental baseline in the action area as widely variable but NMFS assumes that the environmental baseline is also not meeting the biological requirements of individual fish of ESA-listed species at sites where restoration projects will occur due to one or more impaired aquatic habitat functions related to any of the habitat factors limiting the recovery of the species in that area, but the quality of critical habitat at those sites is likely to be raised due to completion of the restoration projects.

As described in section 2.5, the cumulative effects are likely to have a small negative effect on salmon and steelhead 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. Federal efforts to improve aquatic habitat conditions may moderate any adverse cumulative effects, and add to any beneficial ones, so that the action area may be guided toward improved habitat conditions overall.

Thus, the proposed program is not likely to 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 reduce the value of designated or proposed critical habitat for the conservation of the species.

2.7 Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UWR spring-run Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, PS Chinook salmon, CR chum salmon, Hood Canal summer-run chum salmon, LCR coho salmon, OC coho salmon, SONCC coho salmon, SR sockeye salmon, LO sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, PS steelhead, or southern DPS eulachon, or result in the destruction or adverse modification of critical habitat that has been designated for these species.

We also conclude that the proposed action will not adversely modify critical habitat proposed for LCR coho salmon and PS steelhead. You may ask NMFS to adopt the conference opinion as a biological opinion when critical habitat for LCR coho salmon and PS steelhead is designated. The request must be in writing. If we review the proposed action and find there have been no significant changes to the action that would alter the contents of the opinion and no significant new information has been developed (including during the rulemaking process), we may adopt the conference opinion as the biological opinion on the proposed action and no further consultation will be necessary.

2.8. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation 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. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For purposes of this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[36] Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, if that action is performed in compliance with the terms and conditions of this incidental take statement.

NMFS has not yet promulgated an ESA section 4(d) rule prohibiting take of threatened eulachon. Anticipating that such a rule may be issued in the future, we have included a prospective incidental take exemption for eulachon. The elements of this ITS that relate to eulachon would take effect on the effective date of any future 4(d) rule prohibiting take of eulachon.

2.8.1 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 opinion will take place beside and within aquatic habitats that are reasonably certain to be occupied by individuals of the 20 ESA-listed species considered in this opinion. As described below, each type of restoration action is likely to cause incidental take of one or more of those species. Juvenile life stages are most likely to be affected, although adults will sometimes also be present when the actions occur in coastal areas or the Willamette Valley, and when actions do not involve work within the active channel and therefore may not be constrained by application of an in-water work window.

Juvenile 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 to 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 injury or death of some individual fish.

Similarly, 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

[36] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, *etc.*" The U.S. Fish and Wildlife Service defines "harass" in its regulations as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering," 50 CFR 17.3. The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the U.S. Fish and Wildlife Service interpretation of the term.

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; SOD treatments; and 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.

Capture of Juvenile Fish During In-water Work Area Isolation

Under the 2008 ARBO (2008-2011), the Action Agencies completed 640 projects (323 in-channel, 168 fish passage, 3 estuary, 77 road treatment, and 69 vegetation treatment); with an average of 160 projects per year. Because there are additional activity categories in ARBO II, NMFS assumes that a somewhat greater average number of projects will be completed annually under this opinion than the 160 projects per year under the 2008 opinion. We assume that 50% more actions per year would be funded or carried out in the WLC, IC, OC and SONCC recovery domains. We are doubling the estimate of projects in the PS recovery domain. During the 2008 ARBO period, there were only about 8 projects per year (2008-2011), which the Forest Service indicates was due to staff turnover on the Olympic and Mt. Baker/Snoqualmie national forests. With increased interest in aquatic restoration in the region, the number of projects will likely double on the during the 2008 ARBO period in the PS recovery domain. Thus, under ARBO II, about 243 projects could be completed across the region. We assume that 60% of those projects (*i.e.*, 146 actions per year) will require inwater work with fish capture.

Projects under ARBO II, such as channel reconstruction, will have a larger footprint than projects under the 2008 ARBO. 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. 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.

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. Of the ESA-listed salmonids to be captured and handled, 98% or more are expected to survive with no long-term effects. Thus, NMFS anticipates that up to 19,256 juvenile individuals of the salmon and steelhead species considered in the consultation will be captured, per year, and up to 385 juvenile individuals will be injured or killed, per year, (*i.e.*, 60% of 243 x

132 = 19,256; and 2% of 19,256 = 385) as a result of fish capture necessary to isolate in-water construction areas. Nonetheless, a more expansive estimate of 5% average annual lethal take (*i.e.,* 5% of 19,256 = 963) will be used here to allow for variations in experience and work conditions. Because these fish are from different species that are similar to each other in appearance and life history, and to unlisted species that occupy the same area, it is not possible to assign this take to individual species. NMFS will, however, allocate this take proportionally across recovery domain areas, as it is more practical to predict which fish will be present in these defined areas. Consultation must be reinitiated if the amount or extent of take is exceeded for any domain.

An estimate of the maximum effect that capture and release operations for projects authorized or completed under this opinion will have on the abundance of adult salmon and steelhead in each recovery domain was obtained as follows: A = n(pct), where:

A = number of adult equivalents "killed" each year
n = number of projects likely to occur in a recovery domain each year
p = 132, *i.e.*, number of captured juveniles per project requiring capture and isolation[37]
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).[38]
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.

Thus, the effects of work area isolation on the abundance of juvenile or adult salmon or steelhead in any recovery domain or population is likely to small (Table 36).

[37] From 2010 to 2012, the USFWS and NOAA-Restoration Center completed 35 aquatic restoration projects that required isolation and fish capture. Mean capture of ESA-listed salmon and steelhead across the region was 132 fish per project.
[38] 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.

Table 36. Estimate of the amount of take by direct capture (*i.e.,* culvert replacements), per year, for projects authorized or carried out under the ARBO II opinion, by NMFS recovery domain. "PS" means Puget Sound; "WLC" means Willamette/ Lower Columbia; "IC" means Interior Columbia; "OC" means Oregon Coast; "SONCC" means Southern Oregon California Coasts; "n" means the estimated number of projects per year that will require work area isolation.

Type of take	Recovery Domain				
	PS n=9	WLC n=32	IC n=25	OC n=63	SONCC n=17
Juvenile fish captured	1,228	4,218	3,327	8,257	2,228
Juvenile fish killed or injured	62	211	167	413	112
"Adult equivalents" killed or injured	1.2	4.2	3.3	8.3	2.2

NMFS does not anticipate that any adult salmon or steelhead or southern DPS eulachon will be captured as a result of work necessary to isolate in-water construction areas. SR sockeye salmon are only present in the mainstem Snake and Columbia rivers in Oregon and Washington. No members of this species will be captured while migrating through these large rivers. No incidental take is anticipated or exempted for this species.

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 NMFS 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, NMFS 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.

Suspended sediment and contaminants. Near and instream construction activities required for many activities will result in an increase in suspended sediment and contaminants that will cause juvenile fish to move away from the action area. Salmonids 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. Salmonids 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 a minor increase in fine sediment levels in downstream substrates, temporarily reducing the value of that habitat for spawning and rearing.

For projects involving near- and in-water construction, the extent of take due to suspended sediment and contaminants is best identified as the maximum extent of the turbidity plume generated by construction activities. The distance that take (turbidity) will extend downstream will be proportional to the size of the stream. 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 upstream 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.

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 from 2008-2011 under the 2008 ARBO ($\bar{X}$ = 483/4=121 miles per year). With additional activity categories, and a factor of increase (50%) in activity per year in the WLC, IC, OC and SONCC recovery domains and a factor of two in PS recovery domain over the 2008-2011 period, we expect no more than 183 miles of work in stream channels in the action area. Therefore, the extent of take on this group of actions (in-channel projects) per year is 183 linear stream miles, or 964,260 linear feet. This region-wide take is allocated per recovery domain in Table 37.

Construction-related disturbance of upland, wetland, and estuarine 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 rearing habitat due to activities in upland or wetland areas, or by road and estuary 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 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 recovery domain (Table 3) with a factor of increase (50%) in activity per year in WLC, IC, OC and SONCC recovery domain and a factor of two in PS recovery domain over the 2008-2011 period. Based these factors, the extent of take is 194 miles per year, or 1,022,340 linear feet, and 7,411 acres of road and vegetation and estuary treatment per year, respectively.

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 listed salmonids. 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 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 with a Riparian Reserve or RHCA within a 6^{th-}field HUC/year.

The amount and extent of authorized incidental take differs by the six "extent of take" indicators and the five recovery domains 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 recovery domain. In summary, the best available indicators for the extent of take for these proposed actions are as follows (Table 37):

- ***Capture of juvenile fish during in-water work area isolation –*** the amount of take is 19,256 ESA-listed fish, per year.
- ***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 183 linear stream miles, or 964,260 linear stream feet, of streambank or channel alteration per year.
- ***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 194 miles of road treatment per year, and
    b. No more than 7,411 acres of upland vegetation treatment per year.
- ***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

NMFS assumes that the proposed actions will continue to be distributed among the recovery domains in the same proportion as in the past (Table 3) and has assigned take indicators for isolation/capture, near/instream construction, and harassment/harm to individual recovery domains (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 recovery domain in a given calendar year than are listed in Table 37.

Table 37. Extent of take indicators for projects authorized or carried out under the ARBO II opinion, by NMFS recovery domain, per calendar year. "PS" means Puget Sound; "WLC" means Willamette/ Lower Columbia; "IC" means Interior Columbia; "OC" means Oregon Coast; "SONCC" means Southern Oregon California Coasts; "n" means the estimated number of projects per year (all categories).

Extent of Take Indicator	Recovery Domains				
	PS n=16	WLC n=53	IC n=42	OC n=104	SONCC n=28
ESA-listed fish captured (number salvaged)	1,228	4,218	3,327	8,257	2,228
Visible suspended sediment (turbidity)	10% increase in natural stream turbidity				
Streambank/channel alteration (x1000 feet)	31.7	249.5	65.3	506.9	110.9
Road/trail treatment/decommissioning (x1000 feet)	137.3	491.0	37.6	4.0	352.4
Upland vegetation treatment (acres)	5	266	6,863	115	162
Invasive/non-native plant control (acres/HUC_6)	10% of a Riparian Reserve or RHCA				

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 a new diversion structure, or conveyance of water across Federal land. 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.

2.8.2 Effect of the Take

In the accompanying opinion, NMFS determined that this level of incidental take is not likely to result in jeopardy to the listed species.

2.8.3 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 NMFS 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.

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 NMFS 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 NMFS 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.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

The following conservation recommendation is a discretionary measure that NMFS believes is consistent with this obligation and therefore should be carried out by the Federal action agency:

1. The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the Action Agencies use species recovery plans to help ensure that their actions will address the underlying processes that limit fish recovery. Most of these plans are currently available in final or draft form at: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Draft-Plans.cfm.

2. Encourage special use permit holders for irrigation or water delivery/management actions to work with appropriate agencies to identify and protect minimum instream flows in streams where flow is identified as a factor limiting the recovery of species considered in this biological opinion.

3. Ensure that any irrigation or water management action under this program that is associated with a special use permit, such as for water conveyance ditch or pipeline that traverses Federal land, is conditioned as necessary to ensure instream flows as necessary to support the recovery of ESA-listed species.

4. NMFS also recommends that the Action Agencies evaluate whether the regulatory streamlining provided by this opinion influences the design of restoration actions, or acts as an incentive that increases the likelihood that restoration actions will be completed.

Please notify NMFS if these recommendations are implemented so that we will be kept informed of actions that are intended to improve the conservation of listed species and their designated critical habitats.

2.10 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.

Failure to provide timely reporting would constitute a modification of the programmatic consultation that has an effect to listed species or critical habitat not considered in the biological opinion and thus is likely to require reinitiation of this consultation. To reinitiate consultation, contact the Oregon State Habitat Office of NMFS and refer to the NMFS Number assigned to this consultation.

2.11 "Not Likely to Adversely Affect" Determinations

In this biological opinion, NMFS concludes that the proposed action is not likely to adversely affect southern green sturgeon, eastern Steller sea lion, or southern resident killer whales, or their designated critical habitat. These conclusions are based on the following considerations.

Southern DPS Green Sturgeon Determination. Two DPSs have been defined for green sturgeon: a northern DPS (spawning populations in the Klamath and Rogue rivers) and a southern DPS (spawners in the Sacramento River). The southern DPS of green sturgeon were listed as threatened in 2006, and includes all naturally-spawned populations of green sturgeon that occur south of the Eel River in Humboldt County, California. When not spawning, this anadromous species is broadly distributed in nearshore marine areas from Mexico to the Bering Sea. Although it is commonly observed in bays, estuaries, and sometimes the deep riverine mainstem in lower elevation reaches of non-natal rivers along the west coast of North America, the distribution and timing of estuarine use are poorly understood.

The principal factor for the decline of southern green sturgeon is the reduction of its spawning area to a single known population limited to a small portion of the Sacramento River. It is currently at risk of extinction primarily because of human-induced ‘‘takes’’ involving elimination of freshwater spawning habitat, degradation of freshwater and estuarine habitat quality, water diversions, fishing, and other causes (USDC 2010). Adequate water flow and temperature are issues of concern. Water diversions pose an unknown but potentially serious threat within the Sacramento and Feather Rivers and the Sacramento River Delta. Poaching also poses an unknown but potentially serious threat because of high demand for sturgeon caviar. The effects of contaminants and nonnative species are also unknown but potentially serious threats. Retention of green sturgeon in both recreational and commercial fisheries is now prohibited within the western states, but the effect of capture/release in these fisheries is unknown. There is evidence of fish being retained illegally, although the magnitude of this activity likely is small (NOAA Fisheries 2011). Climate change, as described in Section 2.2, is likely to reduce the conservation value of designated critical habitats in the Pacific Northwest.

Critical habitat was designated in 2009, and the designation includes coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington. Within the action area, this includes Lower Columbia River estuary and certain coastal bays and estuaries in Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor)(USDC 2009a). Table 38 delineates PCEs for southern DPS green sturgeon.

Table 38. PCEs of critical habitat for southern green sturgeon and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site Type	**Site Attribute**	
Freshwater riverine system	Food resources Migratory corridor Sediment quality Substrate type or size Water depth Water flow Water quality	Adult spawning Embryo incubation, growth and development Larval emergence, growth and development Juvenile metamorphosis, growth and development
Estuarine areas	Food resources Migratory corridor Sediment quality Water flow Water depth Water quality	Juvenile growth, development, seaward migration Subadult growth, development, seasonal holding, and movement between estuarine and marine areas Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

Large estuaries are clearly important habitats for green sturgeon (Lindley *et al.* 2011). Southern green sturgeon subadult and adults may enter the action area for non-breeding, non-rearing purposes. Tagged adults and subadults in the San Francisco Bay Estuary occupied shallow depths during directional movements but stayed close to the bottom during non-directional movements, presumably because they were foraging in depths as shallow as 1.7 m (Kelly *et al.* 2007). However, information from fisheries-dependent sampling suggests that green sturgeon only occupy large estuaries during the summer and early fall, and would not be present during the in-water work period (Moser and Lindley 2007), which is generally late-fall to spring in Oregon estuaries (ODFW 2008).

NMFS does not expect green sturgeon to be present in the vicinity of most of the actions. Impacts from construction to green sturgeon are the same as those described above for salmonids. From 2008 to 2011, the Action Agencies only conducted three projects in estuaries (Tables 2 and 3). Most restoration projects authorized or carried out under this opinion will occur in the upper reaches and tributaries of the larger rivers, or in riparian and wetland areas along the water's edge for estuarine and coastal areas; green sturgeon congregate in deeper mid-channel areas. Potential projects in estuaries might include fish passage projects, such as tidegate removals, or the removal or setback of existing berms, dikes, and levees, and the removal of pilings. While these projects may release a small amount of suspended sediment temporarily, the long-term effects on water quality are beneficial.

Because of their age, location, and life history, these individuals are relatively distant from, and insensitive to, the effects of the actions described above, and those effects are unrelated to the principal factor for the decline of this species, *i.e.*, the reduction of its spawning area in the Sacramento River. Adult and subadult green sturgeon are likely to be far less sensitive to suspended sediment and deposition than salmonids, and will not be present in the tributaries where the vast majority of the activities will occur. The NMFS is also reasonably certain elevated suspended sediment concentrations will result in insignificant behavioral and physical response due to the higher tolerance of green sturgeon, which usually inhabit much more turbid environments than do salmonids.

It is unlikely that green sturgeon will be encountered during work area isolation and fish salvage for implementation of these projects based on: 1) monitoring information from previous fish salvage operations associated with similar projects; 2) the large size of subadult and adult southern green sturgeon; and 3) the type and location of projects typically funded.

Effects to green sturgeon will primarily result from impacts associated with general disturbance related to in-water construction. Green sturgeon are unlikely to occur in the vicinity of any projects implemented under this opinion, and are accustomed to the level of background activity associated with the proposed action. NMFS does not expect impacts to accrue from the other activities considered in this opinion.

Based on this analysis, NMFS finds that the effects of the proposed action are expected to be insignificant and/or discountable, and thus are not likely to adversely affect the southern DPS of green sturgeon or their critical habitat.

Steller Sea Lion Determination. The eastern Steller sea lion ranges from southeast Alaska to southern California. The best available information indicates the eastern DPS has increased from an estimated 18,040 animals in 1979 (90% CI: 14,076-24,761) to an estimated 63,488 animals in 2009 (90% CI: 53,082 - 80,497); thus an estimate of an overall rate of increase for the eastern DPS of 4.3% per year (90% confidence bounds of 1.99% – 7.33%) (NMFS 2012b). The greatest increases have occurred in southeast Alaska and British Columbia (together accounting for 82 percent of pup production), but performance has remained poor in California at the southern extent of their range. In Southeast Alaska, British Columbia and Oregon, the number of Steller sea lions has more than doubled since the 1970s. There are no substantial threats to the species, and the population continues to increase at approximately 3 percent per year. The final Steller sea lion recovery plan identifies the need to initiate a status review for the eastern DPS and consider removing it from the federal List of Endangered Wildlife and Plants (NMFS 2008a). The eastern Steller sea lions breeds on rookeries located in southeast Alaska, British Columbia, Oregon, and California; there are no rookeries located in Washington. Haulouts are located throughout the eastern Steller sea lion range (NMFS 2008a).

Steller sea lions are generalist predators, able to respond to changes in prey abundance. Their primary prey includes a variety of fishes and cephalopods. Some prey species are eaten seasonally when locally available or abundant, and other species are available and eaten year-round (NMFS 2008a). Pacific hake appears to be the primary prey item across the eastern Steller sea lion range (NMFS 2008a). Other prey items include Pacific cod, walleye Pollock, salmon, and herring, among other species.

Steller sea lions occur in Oregon waters throughout the year, and use breeding rookeries at Rogue Reef and Orford Reef and haulout locations along the Oregon coast. Four haulout sites are used by Steller sea lions in the Columbia River, including the tip of the South Jetty, where greater than 500 Steller sea lions commonly occur, and three locations proximate to and at the Bonneville Dam tailrace area where Steller sea lions occasionally occur.

Over the last nine years, the number of Steller sea lions seasonally present at the Bonneville Dam has increased from zero individuals in 2002 to a minimum estimate of 53 subadult and adult male Steller sea lions in 2010, which although an increase is still a relatively small number of individuals (NMFS 2008a; Stansell and Gibbons 2010; Stansell *et al.* 2008; Stansell *et al.* 2009). The few Steller sea lions that travel up the Columbia River to the tailrace area of Bonneville Dam travel there to forage on anadromous fishes. Some individual Steller sea lions occur at the tailrace area as early as fall; their numbers peak in winter to early spring and they depart by late spring (Stansell and Gibbons 2010; Stansell *et al.* 2008; Stansell *et al.* 2009). Individuals are likely to transit through the river up to the tailrace area within 1-2 days based on the transit times of California sea lions. Median downriver and upriver speeds were 6.7 km/hr and 3.7 km/hr, respectively (Brown *et al.* 2011).

Steller sea lions may be present in the Lower Columbia River or near the mouths of other coastal rivers during the proposed in-water work window. It is unlikely that Steller sea lions exposed to sound levels above disturbance thresholds will temporarily avoid traveling through the affected area. For example, Steller sea lions en route to the Bonneville tailrace area are highly motivated to travel through the action area in pursuit of foraging opportunities upriver (NMFS 2008a). Steller sea lions have shown increasing habituation in recent years to various hazing techniques used to deter the animals from foraging on sturgeon and salmon in the Bonneville tailrace area, including acoustic deterrent devices, boat chasing, and above-water pyrotechnics (Stansell *et al.* 2009). Many of the individuals that travel to the tailrace area return in subsequent years (NMFS 2008a).

The amount of disturbance that may occur before a Steller sea lion is detected is unlikely to significantly change Steller sea lions' behavior, or the amount of time they would otherwise spend in the foraging areas. Even in the event that either change was significant and animals were displaced from foraging areas in the Columbia River, there are alternative foraging areas available to the affected individuals. All other effects of actions completed under the proposed program are at most expected to have a discountable or insignificant effect on Steller sea lions, including an insignificant reduction in the quantity and quality of prey otherwise available to Steller sea lions where they would intercept the affected species (*i.e.,* salmonids and green sturgeon as described in the respective sections above).

NMFS finds that any affect the proposed program is may have on Steller sea lions, including any indirect effects on their prey, is likely to be discountable, insignificant or beneficial. Sea lions are unlikely to be close enough to any project site to experience the adverse effects of the proposed action.

Southern Resident Killer Whale Determination. Southern Resident killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and typically move south into Puget Sound in early autumn (NMFS 2008b). Pods make frequent trips to the outer coast during this season. In the winter and early spring, Southern Resident killer whales move into the coastal waters along the outer coast from the Queen Charlotte Islands south to central California, including coastal Oregon and off the Columbia River although they do not have critical habitat designated in Oregon (NMFS 2008b).

No documented sightings exist of Southern Resident killer whales in coastal bays, and there is no documented pattern of predictable Southern Resident occurrence along the outer coast and any potential occurrence would be infrequent and transitory. Southern Residents primarily eat salmon and prefer Chinook salmon (Hanson *et al.* 2010; NMFS 2008b).

As stated above for Steller sea lions, the proposed program may affect the quantity of their preferred prey, Chinook salmon. Any salmonid take including Chinook salmon up to the aforementioned amount and extent of take would result in an insignificant reduction in adult equivalent prey resources for Southern Resident killer whales that may intercept these species within their range.

NMFS finds that any affect the proposed program may have on Southern Resident killer whales, including indirect effects on their prey, is likely to be discountable, insignificant or beneficial. Therefore, NMFS finds that the proposed program may affect, but is not likely to adversely affect Southern Resident killer whales.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Federal action agency and descriptions of EFH contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce for Pacific Coast salmon (PFMC 1999).

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of Chinook and coho salmon; groundfish; and coastal pelagic species.

3.2 Adverse Effects on Essential Fish Habitat

Based on information provided in the BA (USDA-Forest Service *et al.* 2013) and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed action will have the following adverse effects to EFH designated for those species:

1. Freshwater EFH quantity will be reduced due to short-term construction effects, including reduced riparian permeability and increased riparian runoff, and will increase slightly over the long-term due to improved riparian function and floodplain connectivity.
2. Freshwater EFH quality will be reduced due to a short-term release of suspended sediment, increased dissolved oxygen demand, and increased water temperature due to riparian and channel disturbance. These conditions will improve over the long term due to improved riparian function and floodplain connectivity.
3. The quality of tributary substrate will be reduced in the short term due to increased compaction and sedimentation, and will increase over the long term due to gravel placement, increased sediment storage from boulders and LW.
4. Floodplain connectivity will decrease in the short-term due to increased compaction and riparian disturbance during construction, and a will improve over the long term due to off- and side channel habitat restoration, set-back of existing berms, dikes, and levees, and removal of water control structures.
5. Forage availability will decrease in the short term due to riparian and channel disturbance, and improve over the long term due to improved habitat diversity and complexity, and improved riparian function and floodplain connectivity.
6. Natural cover will decrease in the short term due to riparian and channel disturbance, and increase in the long term due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and off- and side channel habitat restoration.
7. Fish passage will be impaired in the short term due to decreased water quality and in-water work isolation, and improved over the long-term due to improved water quantity and quality, habitat diversity and complexity, forage, and natural cover.
8. Estuarine EFH will be temporarily reduced due to short-term releases of suspended sediment, benthic disturbance, and damage to submerged aquatic vegetation.

3.3 Essential Fish Habitat Conservation Recommendations

The following three conservation recommendations are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH.

1. The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the Action Agencies use species recovery plans to help ensure that their actions will address the underlying processes that limit fish recovery.
2. NMFS also recommends that the Action Agencies evaluate whether the regulatory streamlining provided by this opinion influences the design of restoration actions, or acts as an incentive that increases the likelihood that restoration actions will be completed.

3. As appropriate to each action issued a regulatory permit under this opinion, NMFS recommends that the Action Agencies include the PDC for administration, construction, and types of actions as enforceable permit conditions.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal action agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS's EFH Conservation Recommendations, unless NMFS and the Federal action agency have agreed to use alternative time frames for the Federal action agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS Conservation Recommendations, the Federal action agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects, 50 CFR 600.920(k)(1).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Federal action agencies (Forest Service, BLM, BIA) must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS's EFH conservation recommendations, 50 CFR 600.920(l).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these Data Quality Act (DQA) components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users are the Federal action agencies (Forest Service, BLM and BIA). An individual copy was provided to the Action Agencies. This consultation will be posted on the NMFS Northwest Region website (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

***Information Product Category*:** Natural Resource Plan.

***Standards*:** This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01, *et seq*., and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

***Best Available Information*:** This consultation and supporting documents use the best available information, as referenced in the Literature Cited section. The analyses in this opinion/EFH consultation contain more background on information sources and quality.

***Referencing*:** All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

***Review Process*:** This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

5. LITERATURE CITED

Allen, C., and M. Koski. 2013. Clackamas River bull trout reintroduction, placing bull trout on the path towards recovery. U.S. Fish and Wildlife Service. http://www.fws.gov/endangered/news/episodes/bu-01-2013/story1/index.html.

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.

Barnard, B. 2011. Deer Lagoon Alternatives Analysis. Washington Department of Fish and Wildlife. http://wildfishconservancy.org/projects/deer-lagoon-restoration-assessment/DeerLagoonalternativeanalysis_website.pdf.

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.

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.

Bilby, R.E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82:609-613.

Bindoff, N.L., J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley, and A. Unnikrishnan. 2007. Observations: Oceanic climate change and sea level*In:* Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (editors). Cambridge University Press. Cambridge, United Kingdom and New York.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-68. 246 p.

Bradbury, B., W. Nehlsen, T.E. Nickelson, K.M.S. Moore, R.M. Hughes, D. Heller, J. Nicholas, D.L. Bottom, W.E. Weaver, and R.L. Beschta. 1995. Handbook for prioritizing watershed protection and restoration to aid recovery of native salmon: Ad hoc working group sponsored by Oregon State Senator Bill Bradbury, Pacific Rivers Council. 56 p.

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.

Brown, R., S. Jeffries, D. Hatch, B. Wright, and S. Jonker. 2011. Field Report: 2011 Pinniped management activities at and below Bonneville Dam. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and Columbia River Inter-Tribal Fish Commission. Report. October 4. http://www.mediate.com/DSConsulting/docs/Bonneville%202011%20Field%20Report.pdf.

Burgner, R.L., J.T. Light, L. Margolis, T.L. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific. International North Pacific Fisheries Commission Bulletin 51:1-92.

Busch, S., P. McElhany, and M. Ruckelshaus. 2008. A comparison of the viability criteria developed for management of ESA listed Pacific salmon and steelhead. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle. http://www.nwfsc.noaa.gov/trt/trt_documents/viability_criteria_comparison_essay_oct_10.pdf.

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.

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.

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.

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.

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.

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.

Currens, K.P., R.R. Fuerstenberg, W.H. Graeber, K. Rawson, M.H. Ruckelshaus, N.J. Sands, and J.B. Scott. 2009. Identification of an independent population of sockeye salmon in Lake Ozette, Washington. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-96, 18 p.

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.

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.

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.

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.

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.

Drake, J., R. Emmett, K. Fresh, R. Gustafson, M. Rowse, D. Teel, M. Wilson, P. Adams, E.A.K. Spangler, and R. Spangler. 2008. Summary of scientific conclusions of the review of the status of eulachon (*Thaleichthys pacificus*) in Washington, Oregon and California. Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle.

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.

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.

Feist, B.E., E.R. Buhle, P. Arnold, J.W. Davis, and N.L. Scholz. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. Plos One 6(8):e23424.

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.D.o. Commerce. NOAA Technical Memorandum NMFS-NWFSC-64. 160 p.

Fernald, A.G., P.J. Wigington, and D.H. Landers. 2001. Transient storage and hyporheic flow along the Willamette River, Oregon: Field measurements and model estimates. Water Resources Research 37(6):1681-1694.

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.

Ford, M.J., (editor). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-113. 281 p.

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.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: An evaluation of the effects of selected factors on salmonid population viability. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-69. 105 p.

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.

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.

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.

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.

Good, T.P., R.S. Waples, and P. Adams, (editors). 2005. Updated status of federally listed ESUs of west coast salmon and steelhead. West Coast Salmon Biological Review Team. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-66. 598 p.

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.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, and K. Wildman. 2002a. Historical Willamette River channel change. Pages 18-26. *In:* Willamette River Basin planning atlas: Trajectories of environmental and ecological change. D. Hulse, S. Gregory, and J. Baker (editors). Oregon State University Press. Corvallis, Oregon.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, R. Wildman, P. Minear, S. Jett, and K. Wildman. 2002b. Revetments. Pages 32-33. *In:* Willamette River Basin planning atlas: Trajectories of environmental and ecological change. D. Hulse, S. Gregory, and J. Baker (editors). Oregon State University Press. Corvallis, Oregon.

Gregory, S., L. Ashkenas, P. Haggerty, D. Oetter, K. Wildman, D. Hulse, A. Branscomb, and J. Van Sickle. 2002c. Riparian vegetation. Pages 40-43. *In:* Willamette River Basin planning atlas: Trajectories of environmental and ecological change. D. Hulse, S. Gregory, and J. Baker (editors). Oregon State University Press. Corvallis, Oregon.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

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.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-105. 360 p.

Gustafson, R.G., M.J. Ford, P.B. Adams, J.S. Drake, R.L. Emmett, K.L. Fresh, M. Rowse, E.A.K. Spangler, R.E. Spangler, D.J. Teel, and M.T. Wilson. 2011. Conservation status of eulachon in the California Current. Fish and Fisheries.

Hanson, M.B., R.W. Baird, J.K.B. Ford, J. Hempelmann-Halos, D.M. Van Doornik, J.R. Candy, C.K. Emmons, G.S. Schorr, B. Gisborne, K.L. Ayers, S.K. Wasser, K.C. Balcomb, K. Balcomb-Bartok, J.G. Sneva, and M.J. Ford. 2010. Species and stock identification of prey selected by endangered "southern resident" killer whales in their summer range. Endangered Species Research 11:69-82.

Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-81, 117 p.

Hebdon, J.L., P. Kline, D. Taki, and T.A. Flagg. 2004. Evaluating reintroduction strategies for Redfish Lake sockeye salmon captive brood progeny. American Fisheries Society Symposium 44:401-413.

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.

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.

Hicks, D. 2005. Lower Rogue watershed assessment. South Coast Watershed Council. Gold Beach, Oregon. Report. https://nrimp.dfw.state.or.us/web%20stores/data%20libraries/files/OWEB/OWEB_966_2_LowerRogue_WatershedAssessment_August2005.pdf.

Hood Canal Coordinating Council. 2005. Hood Canal & Eastern Strait of Juan de Fuca summer chum salmon recovery plan. November 15.

Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries. Technical Report No. 119. Olympia, Washington.

IC-TRT. 2003. Working draft. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River domain. July. U.S. Department of Commerce, NOAA Fisheries.

IC-TRT. 2007. Viability criteria for application to Interior Columbia Basin salmonid ESUs. Interior Columbia Tecnical Recovery Team, review draft (March). Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle.

IC-TRT. 2010. Draft recovery plan for Idaho Snake River spring/summer Chinook and steelhead populations in the Snake River spring/summer Chinook salmon evolutionarily significant unit and Snake River steelhead distinct population segment. National Marine Fisheries Service, Northwest Region, Protected Resources Division. Boise, Idaho. November 18.

Idaho Department of Environmental Quality. 2011. Idaho Department of Environmental Quality final 2010 integrated report. Boise, Idaho.

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 (editor). 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.

Joint Columbia River Management Staff. 2009. 2010 joint staff report concerning stock status and fisheries for sturgeon and smelt. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. http://wdfw.wa.gov/publications/00886/wdfw00886.pdf.

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.

Keefer, M.L., C.A. Peery, and M.J. Henrich. 2008. Temperature mediated en route migration mortality and travel rates of endangered Snake River sockeye salmon. Ecology of Freshwater Fish 17:136-145.

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, J.T., A.P. Klimley, and C.E. Crocker. 2007. Movements of green sturgeon, *Acipenser medirostris*, in the San Francisco Bay estuary, California. Environmental Biology of Fishes 79:281-295.

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.

Knox, J.C. 2006. Floodplain sedimentation in the Upper Mississippi Valley: Natural versus human accelerated. Geomorphology 79:286-310.

Kondolf, G.M. 1997. Hungry water: Effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

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.

Lawson, P.W., E.P. Bjorkstedt, M.W. Chilcote, C.W. Huntington, J.S. Mills, K.M. Moores, T.E. Nickelson, G.H. Reeves, H.A. Stout, T.C. Wainwright, and L.A. Weitkamp. 2007. Identification of historical populations of coho salmon (*Onchorynchus kisutch*) in the Oregon Coast evolutionarily significant unit. NMFS-NWFSC-79. U.S. Department of Commerce, NOAA Technical Memorandum. 129 p.

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.

Lindley, S.T., D.L. Erickson, M.L. Moser, G. Williams, O.P. Langness, B.W. McCovey Jr., M. Belchik, D. Vogel, W. Pinnix, J.T. Kelly, J.C. Heublein, and A.P. Klimley. 2011. Electronic tagging of green sturgeon reveals population structure and movement among estuaries. Transactions of the American Fisheries Society 140:108-122.

Lower Columbia Fish Recovery Board. 2010. Washington lower Columbia salmon recovery & fish and wildlife subbasin plan. Olympia, Washington. May 28. http://www.lcfrb.gen.wa.us/Recovery%20Plans/RP%20Frontpage.htm.

Lower Columbia River Estuary Partnership. 2007. Lower Columbia River and estuary ecosystem monitoring: Water quality and salmon sampling report. Portland, Oregon. Report. http://www.estuarypartnership.org/sites/default/files/resource_files/WaterSalmonReport.pdf.

Madej, M.A. 2001. Erosion and sediment delivery following removal of forest roads. Earth Surface Processes and Landforms 26:175-190.

Maguire, M. 2001. Chetco River watershed assessment. South Coast Watershed Council. Gold Beach, Oregon. Report.

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.

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.

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.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel, and C. Willis. 2006. Revised viability criteria for salmon and steelhead in the Willamette and Lower Columbia basins. Review Draft.

Willamette/Lower Columbia Technical Recovery Team and Oregon Department of Fish and Wildlife.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and Lower Columbia Basins. Prepared for Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Portland, Oregon.

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.

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.

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.

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.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.

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.

Moser, M.L., and S.T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes 79:281-295.

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.

Myers, J.M., C. Busack, D. Rawding, A.R. Marshall, D.J. Teel, D.M. Van Doornik, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-73. 311 p. http://www.nwfsc.noaa.gov/assets/25/6490_04042006_153011_PopIdTM73Final.pdf.

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.

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.

Nicholas, J., B. McIntosh, E. Bowles, Oregon Watershed Enhancement Board, and Oregon Department of Fish and Wildlife. 2005. Coho assessment, Part 1: Synthesis Final Report. Salem, Oregon. May 6.

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. 2007a. Recovery plan for the Hood Canal and eastern Strait of Juan de Fuca summer chum salmon (*Oncorhynchus keta*). National Marine Fisheries Service, Northwest Region. Portland, Oregon.

NMFS. 2007b. Draft. Dawgz 'n the hood: The Hood Canal summer chum salmon ESU. Puget Sound Technical Recovery Team, Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle. February 28.

NMFS. 2007c. 2007 Report to Congress: Pacific Coastal Salmon Recovery Fund, FY 2000-2006. U.S. Department of Commerce, NOAA, National Marine Fisheries Service. Washington, D.C.

NMFS. 2008a. Steller Sea Lion Recovery Plan, Eastern and Western Distinct Population Segments (*Eumetopias jubatus*) (Revision, Original Version: December 1992) (March 2008). National Marine Fisheries Service, Office of Protected Resources. Silver Springs, Maryland.

NMFS. 2008b. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Regional Office. http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_killer.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. 2009a. Recovery plan for Lake Ozette sockeye salmon (*Oncorhynchus nerka*). National Marine Fisheries Service, Salmon Recovery Division. Portland, Oregon. 394 pp.

NMFS. 2009b. Middle Columbia River steelhead distinct population segment ESA recovery plan. November 30. http://www.nwr.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/middle_columbia/mid-c-plan.pdf.

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. 2011a. 5-year review: summary and evaluation of Lower Columbia River Chinook, Columbia River chum, Lower Columbia River coho, and Lower Columbia River steelhead. National Marine Fisheries Service. Portland, Oregon.

NMFS. 2011b. 5-year review: summary and evaluation of Snake River sockeye, Snake River spring-summer Chinook, Snake River fall-run Chinook, Snake River Basin steelhead. National Marine Fisheries Service, Portland, Oregon.

NMFS. 2011c. Columbia River estuary ESA recovery plan module for salmon and steelhead. Prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc. (subcontractor). National Marine Fisheries Service, Northwest Region. Portland, Oregon. January. http://www.nwr.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/willamette_lowercol/lower_columbia/estuary-mod.pdf.

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. 2012a. Designation of critical habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead, DRAFT Biological Report. NMFS, Protected Resources Division. Portland, Oregon. November. http://www.nwr.noaa.gov/publications/protected_species/salmon_steelhead/critical_habitat/draft4_b__2__pssteelhead_lcrcoho.pdf.

NMFS. 2012b. (Draft) Status review of the eastern distinct population segment of Steller sea lion (*Eumetopias jubatus*). Protected Resources Division, Alaska Region, National Marine Fisheries Service. Juneau, Alaska. 106 pp. + Appendices. http://www.fakr.noaa.gov/protectedresources/stellers/edps/draftedps0412.pdf.

NMFS. 2012c. Proposed ESA recovery plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. National Marine Fisheries Service, Northwest Region. April. http://www.nwr.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/lower_columbia_river/proposed_lower_columbia_river_recovery_plan_for_salmon_steelhead.html.

NMFS. 2012d. Public draft recovery plan for southern Oregon/northern California coast coho salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service. Arcata, California.

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).

NOAA Fisheries. 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Oceanic and Atmospheric Administration, NMFS-Protected Resources Division. Portland, Oregon.

NOAA Fisheries. 2011. Biennial report to Congress on the recovery program for threatened and endangered species October 1, 2008 – September 30, 2010. NOAA-National Marine Fisheries Service. Washington, D.C.

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.

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.

ODFW. 2010. Lower Columbia River conservation and recovery plan for Oregon populations of salmon and steelhead. Oregon Department of Fish and Wildlife. Salem, Oregon.

ODFW, and NMFS. 2011. Upper Willamette River conservation and recovery plan for Chinook salmon and steelhead. Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Northwest Region. August 5.

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.

PFMC. 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council. Portland, Oregon. December. http://www.pcouncil.org/wp-content/uploads/a8apdxd.pdf.

PFMC. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Appendix A to Amendment 14 to the Pacific Coast Salmon Plan. Pacific Fishery Management Council. Portland, Oregon. http://www.pcouncil.org/salmon/fishery-management-plan/adoptedapproved-amendments/amendment-14-to-the-pacific-coast-salmon-plan-1997/.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council. Portland, Oregon. November. http://www.pcouncil.org/groundfish/fishery-management-plan/fmp-amendment-19/.

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.

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.

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.

Reed, D.H., J.J. O'Grady, J.D. Ballou, and R. Frankham. 2003. The frequency and severity of catastrophic die-offs in vertebrates. Animal Conservation 6:109-114.

Reeves, G.H., J.D. Hall, T.D. Roelfs, T.L. Hickman, and C.O. Baker. 1991. Rehabilitating and modifying stream habitats. Pages 519-557. *In:* Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan (editor). American Fisheries Society. Bethesda, Maryland.

Reiman, B., D. Lee, D. Burns, R. Gresswell, M. Young, R. Stowell, J. Rinne, and P. Howell. 2003. Status of native fish in the western Untied States and issues for fire and fuels management. Forest Ecology and Management 178:197-211.

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 Untied States. North American Journal of Fisheries Management 16:653-658.

Rogue Basin Coordinating Council. 2006. Watershed health factors assessment: Rogue River Basin. Rogue Basin Coordinating Council. Talent, Oregon. Report.

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, 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.

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.

Roper, B.B., J.J. Dose, and J.E. Williams. 1997. Stream restoration: Is fisheries biology enough? Fisheries 22(5):6-11.

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.

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.

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.

Sedell, J.R., and J.L. Froggatt. 1984. Importance of streamside forests to large rivers: The isolation of the Willamette River, Oregon, USA from its floodplain by snagging and streamside forest removal. Internationale Vereinigung für Theoretische und angewandte Limnologie Verhandlungen 22:1828-1834.

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.

Shared Strategy for Puget Sound. 2007. Puget Sound salmon recovery plan. Volume 1, recovery plan. Shared Strategy for Puget Sound. Seattle.

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25(1-4):299-352.

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, 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.

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.

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, 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.

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.

SSPS. 2007. Puget Sound salmon recovery plan. Volume 1, recovery plan. Shared Strategy for Puget Sound. Seattle, Washington.

Stansell, R., S. Tackley, and K. Gibbons. 2008. Status Report – Pinniped Predation and Hazing at Bonneville Dam in 2008. U.S. Army Corps of Engineers. Cascade Locks, Oregon. Report. April 8. 6 p. http://www.nwd-wc.usace.army.mil/tmt/documents/fish/2008/update20080408.pdf.

Stansell, R., S. Tackley, and K. Gibbons. 2009. Status Report – Pinniped predation and deterrent activities at Bonneville Dam, 2009. U.S. Army Corps of Engineers. Bonneville Dam, Cascade Locks, Oregon. Report. May 22. 11 p. http://www.nwd-wc.usace.army.mil/tmt/documents/fish/2009/update20090522.pdf.

Stansell, R., and K. Gibbons. 2010. Status Report – Pinniped Predation and Deterrent Activities at Bonneville Dam, 2010. Cascade Locks, Oregon. Report. May 26. 9 p. http://www.nwd-wc.usace.army.mil/tmt/documents/fish/2010/update20100326.pdf.

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.

Stout, H.A., P.W. Lawson, D. Bottom, T. Cooney, M. Ford, C. Jordan, R. Kope, L. Kruzic, G. Pess, G. Reeves, M. Scheuerell, T. Wainwright, R. Waples, L. Weitkamp, J. Williams, and T. Williams. 2011. Scientific conclusions of the status review for Oregon Coast coho salmon (*Oncorhynchus kisutch*). Draft revised report of the Oregon Coast Coho Salmon Biological Review Team. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle.

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 Sociey. Bethesda, Maryland.

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.

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.

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.

Upper Columbia Salmon Recovery Board. 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. http://www.nwr.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/upper_columbia/upper_columbia_spring_chinook_steelhead_recovery_plan.html.

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. 2008. 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, 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, and USDI. 1994b. Environmental Assessment for the Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). U.S. Department of Agriculture and U.S. Department of Interior. March.

USDC. 2007. Endangered and threatened species: Final listing determination for Puget Sound steelhead. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 72(91):26722-26735.

USDC. 2009a. Endangered and threatened wildlife and plants: Final rulemaking to designate critical habitat for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(195):52300-52351.

USDC. 2009b. Endangered and threatened species; recovery plans for Lake Ozette sockeye salmon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(102):25706-25710.

USDC. 2010. Endangered and threatened wildlife and plants, final rulemaking to establish take prohibitions for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 75(105):30714-30728.

USDC. 2011. Endangered and threatened species: Designation of critical habitat for the southern distinct population segment of eulachon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 76(203):65324-65352.

USDC. 2013. Endangered and threatened species; Designation of critical habitat for Lower Columbia River Coho salmon and Puget Sound steelhead; Proposed Rule. Federal Register 78(9):2726. January 14, 2013.

USDI-BLM. 2005. Diflufenzopyr Ecological Risk Assessment, Final Report. USDI-Bureau of Land Management. ENSR Document Number 09090-020-650. Reno, Nevada.

USDI-Bureau of Land Management. 2005. 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. 2010. Best management practices to minimize adverse effects to Pacific lamprey (*Entosphenus tridentatus*). U.S. Fish and Wildlife Service, Pacific Region, Fisheries Resources. Portland, Oregon.

USGCRP. 2009. Global climate change impacts in the United States. U.S. Global Change Research Program. Washington, D.C. 188 p. http://waterwebster.org/documents/climate-impacts-report.pdf.

Wainwright, T.C., M.W. Chilcote, P.W. Lawson, T.E. Nickelson, C.W. Huntington, J.S. Mills, K.M.S. Moore, G.H. Reeves, H.A. Stout, and L.A. Weitkamp. 2008. Biological recovery criteria for the Oregon Coast coho salmon evolutionarily significant unit. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-NWFSC-91. Seattle. http://docs.lib.noaa.gov/noaa_documents/NMFS/NWFSC/TM_NMFS_NWFSC/TM_NMFS_NWFSC_91.pdf

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, 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 Office of Financial Management. 2010. Forecast of the State Population, November 2010 Forecast. http://www.ofm.wa.gov/pop/stfc/stfc2010/stfc_2010.pdf.

Washington State Department of Agriculture. 2003. Imazapyr Fact Sheet. Report. http://www.spartina.org/referencemtrl/ImazapyrFactSheet.pdf.

WDFW, and ODFW. 2001. Joint state eulachon management plan. Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife.

WDFW, and Point No Point Treaty Tribes. 2007. Five-year review of the summer chum salmon conservation initiative: Supplemental report no. 7, summer chum salmon conservation initiative – an implementation plan to recover summer chum in the Hood Canal and Strait of Juan de Fuca Region. Washington Department of Fish and Wildlife. Olympia, Washington.

WDFW. 2009. Fish passage and surface water diversion screening assessment and prioritization manual. Washington Department of Fish and Wildlife. Olympia, Washington.

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.

Wentz, D.A., B.A. Bonn, K.D. Carpenter, S.R. Hinkle, M.L. Janet, F.A. Rinella, M.A. Uhrich, I.R. Waite, A. Laenen, and K.E. Bencala. 1998. Water quality in the Willamette Basin, 1991-1995. U.S. Geological Survey Circular 1161. May 20.

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.

Williams, T.H., E.P. Bjorkstedt, W.G. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, M. Rode, R.G. Szerlong, R.S. Schick, M.N. Goslin, and A. Agrawal. 2006. Historical population structure of coho salmon in the Southern Oregon/Northern California coasts evolutionarily significant unit. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-390, 71 p.

Williams, T.H., B.C. Spence, W. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, T.E. Nickelson, E. Mora, and T. Pearson. 2008. Framework for assessing viability of threatened coho salmon in the Southern Oregon/Northern California coast evolutionarily significant unit. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-432. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center. La Jolla, California. 96 p. http://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-432.pdf.

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.

Wimberly, M.C., T.A. Spies, C.J. Long, and C. Whitlock. 2000. Simulating historical variability in the amount of old forests in the Oregon Coast Range. Conservation Biology 14(1):167-180.

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, 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.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.

Zedler, J.B. 1996. Ecological issues in wetland mitigation: An introduction to the forum. Ecological Applications 6(1):33-37.