



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232

Refer to NMFS No.:
WCR-2016-6048

January 9, 2018

Mark G. Eberlein
Regional Environmental Officer
FEMA Region X
130-228th Street, Southwest
Bothell, Washington 98021

Re: Endangered Species Act Section 7 Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Standard Local Operating Procedures for Endangered Species to fund actions under the Stafford Act Authorized or Carried Out by the Federal Emergency Management Agency in Oregon, Washington, and Idaho (FEMA Endangered Species Programmatic [FESP])

Dear Mr. Eberlein:

The enclosed document contains a programmatic biological opinion (opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of implementing a proposed set of standard local operating procedures used by the Federal Emergency Management Agency (FEMA) to fund actions under the Stafford Act to repair, rehabilitate or replace transportation related actions (road, culvert, bridge, stormwater facilities, utility lines, and streambank/channel stabilization), or restoration related actions (streambank, channel, and floodplain restoration), or in-water and over-water structure related actions (repair, rehabilitate, replace, or remove existing structures, pile driving and removal, and dredging) in Oregon, Washington, and Idaho (FEMA Endangered Species Programmatic). The proposed action is in accordance with FEMA's regulatory authority under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288) of 1974.

In this opinion, NMFS concluded that the actions authorized under the Stafford Act and other similar authorities are not likely to jeopardize the continued existence of the following 23 species, or result in the destruction or adverse modification of their proposed or designated critical habitats:



WCR-2016-6048

1. Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)
2. Upper Willamette River (UWR) Chinook salmon
3. Upper Columbia River (UCR) spring-run Chinook
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 summer-run chum salmon
9. LCR coho salmon (*O. kisutch*)
10. Oregon Coast (OC) coho salmon
11. Southern Oregon/Northern California Coast (SONCC) coho salmon
12. SR sockeye salmon (*O. nerka*)
13. Lake Ozette (LO) 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 Pacific eulachon (*Thaleichthys pacificus*)
21. Southern distinct population segment green sturgeon (*Acipenser medirostris*)
22. Georgia Basin (GB) bocaccio
23. GB yelloweye rockfish

The NMFS also concluded that the proposed action is not likely to adversely affect Southern Resident Killer Whale (*Orcinus orca*). The FEMA did not request consultation on the Mexico and Central America distinct population segments of humpback whale (*Megaptera novaeangliae*), Puget Sound/Georgia Basin distinct population segment of yelloweye rockfish (*Sebastes ruberrimus*), or the Puget Sound/Georgia Basin distinct population segment of bocaccio (*Sebastes paucispinis*) or their critical habitat. These species and their critical habitat are likely to overlap with the program action area. The proposed action is likely to adversely affect the Puget Sound/Georgia Basin distinct population segment of yelloweye rockfish and the Puget Sound/Georgia Basin distinct population segment of bocaccio and their critical habitats. However, our analysis shows, as further documented in this opinion that the proposed action is not likely to adversely affect the Mexico and Central American distinct population segment of humpback whale or Puget Sound/Georgia Basin distinct population segment of yelloweye rockfish critical habitat.

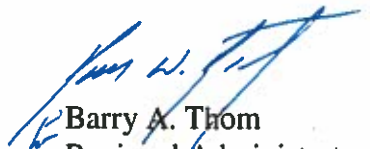
As required by section 7 of the ESA, NMFS is providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this program. The ITS also sets forth nondiscretionary 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.

This document also includes the results of our analysis of the program'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 recommendations, FEMA must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the program 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, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please direct questions regarding this opinion to Jennie Franks at 503.231.2344 of my staff in the Oregon Coast Branch of the Oregon Washington Coastal Area Office.

Sincerely,



Barry A. Thom
Regional Administrator

cc: Barry Gall
William Kerschke

Endangered Species Act – Section 7 Programmatic Biological Opinion, Letter of Concurrence and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

for the

Standard Local Operating Procedures for Endangered Species, to fund projects under the Stafford Act by the Federal Emergency Management Agency (Region X)
(FEMA Endangered Species Programmatic [FESP])

NMFS Consultation Number: WCR-2016-6048

Action Agency: Federal Emergency Management Agency Region X
Bothell, Washington

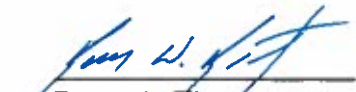
Affected Species and NMFS’ Determinations:

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 action likely to destroy or adversely modify critical habitat for this species?
Lower Columbia River Chinook salmon	T	Yes	No	No
Upper Willamette River 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
Lower Columbia River steelhead	T	Yes	No	No
Upper Willamette River 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
Green sturgeon	T	Yes	No	No
Eulachon	T	Yes	No	No
Southern resident killer whale	E	No	N/A	N/A
Mexico & Central America DPS humpback whale	E	No	No	N/A
Puget Sound/Georgia Basin DPS bocaccio	E	Yes	No	N/A
Puget Sound/Georgia Basin DPS yelloweye rockfish	T	Yes	No	N/A

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

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:



Barry A. Thom
Regional Administrator

Date: January 9, 2018

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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 biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, 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.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System [*WCR-2016-6048*]. A complete record of this consultation is on file at the Oregon Coast Branch of the Oregon Washington Coastal Area Office in Portland, Oregon.

The actions covered under this opinion may result from one or more grant programs under the Stafford Act or other Federal Emergency Management Agency (FEMA) authorities. The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1974 requires authorization from the U.S. Department of Homeland Security, acting through FEMA, to direct resources and coordinate government-efforts to enable communities to prepare for, protect against, respond to, and recover from presidentially declared emergencies and disasters. Funding provided through FEMA's programs (44 CFR Part 206) supports a wide range of disaster-related activities that have the potential to affect local environmental conditions.

The FEMA provides assistance for disaster relief, technical assistance, and mitigation to states, tribes, local governments, and certain private nonprofit organizations after a presidentially declared major disaster. Major disasters are defined as any natural catastrophe or fire, flood, or explosion, regardless of cause, which is of sufficient severity to warrant assistance under the Stafford Act to alleviate the damage, loss, or hardship caused by the event.

There are two main programs FEMA uses to provide assistance for disaster relief, the Public Assistance program (PA) and the Hazard Mitigation Grant Program (HMGP). The PA provides grants to state, local, and federally recognized tribal governments and certain private non-profit entities in assisting them with response and recovery from disasters. Specifically, the program provides assistance for the following project action categories: debris removal, emergency protective measures, roads and bridges, water control facilities, public buildings and contents, public utilities, and parks, recreational, and other facilities. Action categories such as streambank stabilization, dredging, pile removal, and water control structure removal might also be funded

under the PA. The PA will only fund pile removal and water control structure removal if it is part of a repair or a replacement of a damaged facility, or if it's needed to be done as an emergency protective measure to prevent flooding or otherwise protect lives or public health and safety.¹

The HMGP funds retrofits and upgrades of existing facilities, or in the case of stormwater management and minor flood control projects, HMGP will fund completely new facilities to address known hazards. The HMGP does not fund “repairs”, unless the repairs are done as part of an overall design-level-of-protection upgrade for a specific facility. Hazard mitigation is defined as any action taken to reduce or eliminate long term risk to people and property from natural hazards. The HMGP funds may be used to fund public or private property projects with public agency sponsorship, including but not limited to: road infrastructure retrofits and protection, stormwater management including green infrastructure; utility retrofits and protection, including undergrounding of hazard-exposed powerlines; riparian, floodplain, and stream restoration as part of a project to reduce flood hazard; and set-back existing berms, dikes, and levees.²

Other grant programs covered by this programmatic consultation which FEMA uses to provide assistance for disaster relief and non-disaster related projects include but are not limited to the following programs: the Individual Assistance (IA), the Pre-Disaster Mitigation (PDM) grant program, and the Flood Mitigation Assistance Grant Program (FMA). The proposed action for this programmatic consultation includes IA –funded access repairs which might include a driveway, culvert, or bridge. The PDM grant program may be used to fund pre-disaster natural hazard mitigation to reduce risk from future hazard events and reduce reliance on Federal funding in future disaster. PDM is a similar source of funding as the HMGP program and provides assistance to larger projects. The FMA grant program provides planning, project, or technical assistance grant funds to assist States and communities to implement measures to reduce or eliminate the long-term risk of flood damage to buildings and other structures insurable, which may include elevations and buyouts, under the National Flood Insurance Program.

1.2 Consultation History

The FEMA is in the process of or has completed consultations with NMFS on several actions receiving federal funds from FEMA through the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1974. In July of 2014, FEMA submitted a programmatic biological assessment for activities funded by the Public Assistance Program and Hazard Mitigation Assistance Program in Oregon. On August 23, 2016 NMFS and FEMA met to resume pre-consultation regarding completion of a programmatic consultation. Between August 23, 2016 and December 1, 2017 staff from FEMA and NMFS continued to meet to refine the proposed action and discuss the implementation of this programmatic biological opinion. We discussed strategies and approaches in developing a new programmatic biological opinion for actions commonly funded by FEMA under the Stafford Act. The FEMA Region X identified their area

¹ Per email communication with Anna Dagget (Dagget 2017), Public Assistance Specialist, FEMA. March 7, 2017.

² Per email communication with Steven Randolph (Randolph 2017), Senior Hazard Mitigation Specialist, FEMA. March 7, 2017.

of interest for these actions would encompass an action area that includes Oregon, Washington, and Idaho.

A final proposed action was agreed upon between the Federal Emergency Management Agency and the National Oceanic Atmospheric Administration (NOAA) Fisheries on December 1, 2017. The FEMA determined that the proposed program covered in this opinion and actions authorized under this program “may affect, but are not likely to adversely affect” southern resident (SR) killer whales (*Orcinus orca*). The FEMA concluded that the proposed actions funded by FEMA “may affect, and are likely to adversely affect” the following ESA-listed species and their designated critical habitats.

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

In Section 2.11 of this opinion, NMFS concurred with FEMA’s finding that the proposed action is not likely to adversely affect SR killer whales. The FEMA did not request consultation on the Mexico and Central America distinct population segments of humpback whale or their critical habitat. These distinct population segments of humpback whale and their critical habitat are likely to overlap with the program action area. However, our analysis shows, as further documented in this opinion, that the proposed action is not likely to adversely affect the Mexico and Central America distinct population segments of humpback whale.

1.3 Proposed Federal Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). For this consultation, FEMA will fund actions under the Stafford Act after a presidentially disaster has been declared and where work has not been initiated by the grantee. The proposed action does not include actions FEMA will reimburse where work has already occurred or has been completed prior to a federal disaster declaration. Use of the FEMA Endangered Species Programmatic (FESP) will ensure that FEMA’s regulatory oversight of these aquatic habitat actions will continue to meet requirements of the ESA and MSA with procedures that are simpler to use, more efficient, and more accountable for all parties.

Specifically, FEMA will propose to fund the following fourteen types of actions:

Transportation Related Actions

1. Road, culvert, and bridge repair, rehabilitation and replacement
2. Stormwater facilities
3. Utilities
4. Streambank and channel stabilization

Restoration Related Actions

5. Streambank restoration
6. Boulder placement
7. Large wood placement
8. Off- and side-channel habitat restoration
9. Set-back existing berms, dikes, and levees
10. Water control structure removal

In-Water Over-Water Structure Related Actions

11. In-water or over-water structures
12. Dredging to maintain vessel access
13. Dredging to maintain functionality of previously authorized channels, culverts, water intakes, or outfalls
14. Debris Removal

Transportation Related Actions

1. Road, culvert, and bridge repair, rehabilitation and replacement.

Repair, restore, or replace roads, culverts and bridges, and to withdraw temporary access roads constructed as part of a major disaster or emergency response from service in a way that promotes watershed restoration when their usefulness has ended. This includes actions necessary to complete geotechnical surveys, such as access road construction, drill pad preparation, mobilization and set up, drilling and sampling operations, demobilization, boring abandonment, and access road and drill pad reclamation. It also includes, excavation, grading, and filling necessary to maintain, rehabilitate, or replace existing roads, culverts, and bridges. This type of action does not include significant channel realignment, installation of fish passage (*e.g.*, fish ladders, juvenile fish bypasses, culvert baffles, roughened chutes, and step weirs), tidegate maintenance or replacements other than full removal, or any project which will result in or

contribute to land use changes that trigger effects, including indirect effects not considered in this opinion. The FEMA will provide funding assistance to repair, rehabilitate, and replace in-kind actions and will fund improvements or replacements that will need to comply with current standards.

2. Stormwater facilities. Repair, restore, or replace stormwater facilities, including new or upgraded stormwater outfalls. This may include surveys, access road construction, excavation, grading, and filling necessary to maintain, rehabilitate, or replace existing stormwater treatment or flow control best management practices (BMPs).

3. Utilities. Repair, restore, or replace pipes or pipelines, water intakes, or wastewater outfalls used to transport gas or liquids including new cables, lines, or wires used to transmit electricity or communication. Utility line actions involve excavation, temporary side casting of excavated material, backfilling of the trench, and restoration of the work site to preconstruction contours and vegetation. This type of action does not include construction or enlargement of any utility to support a new or expanded service area for which effects, including indirect effects from interrelated or interdependent activities, have not been analyzed in this opinion. This opinion also does not include construction of any utility line that transits the bed of an estuary or saltwater area at depths less than -10.0 feet (mean lower low water).

4. Streambank and channel stabilization. Repair, restore, or replace streambank or channel erosion controls for roads, culverts, bridges, or utility lines. Proposed streambank stabilization methods include alluvium placement, vegetated riprap with large wood (LW), log or roughened rock toe, woody plantings, herbaceous cover, deformable soil reinforcement, coir logs, bank reshaping and slope grading, floodplain flow spreaders, floodplain roughness, and engineered log jams (ELJs), alone or in combination. Any action that requires additional excavation or structural changes to a road, culvert, or bridge foundation is covered under road, culvert and bridge maintenance, rehabilitation, and replacement.

Restoration Related Actions

5. Streambank restoration. Repair, restore, or replace damaged shorelines or streambanks by (a) bank shaping and installation of coir logs or other soil reinforcements as necessary to support riparian or shoreline vegetation; (b) planting or installing large wood, trees, shrubs, and herbaceous cover and controlling invasive and non-invasive plant species as necessary to restore ecological function in riparian and floodplain habitats; or (c) a combination of the above methods.

6. Boulder placement. Rehabilitate or restore aquatic habitats by placing large boulders in stream beds where similar natural rock has been lost.

7. Large wood restoration. Rehabilitate or restore aquatic habitats by placing large wood in areas where natural wood accumulations have been lost or damaged.

8. Off-channel, side-channel, and floodplain habitat restoration. Rehabilitate or restore off-channel, side-channel, and floodplain habitats where they have been lost or damaged.

9. Set-back existing berms, dikes, and levees. Rehabilitate or restore connections between stream channels and floodplains by increasing the distance that existing berms, dikes or levees are set back from active streams or wetlands. Estuaries and tidal environments may continue to interact with existing berm, dike, or levee during high flow events.

In-Water Over-Water Structure Related Actions

10. In-water or overwater structures. Repair, restore, replace, or remove existing in-water or over-water structures.

11. Water control structure removal. Remove existing water control structures to restore aquatic habitats.

12. Dredging to maintain vessel access. Restore vessel access to a previously authorized docks, wharfs, mooring structures, or boat ramps by excavating an existing dredge prism, provided that any dredged materials and subsequent leave surface are suitable and verified for in-water disposal. If in-water disposal is not feasible due to contaminated sediments upland disposal shall be considered. The FEMA will fund dredging for one time dredge events. It does not include multiple maintenance dredging actions to ensure vessel access beyond the initial one time dredge event.

The proposed action does not include any modification that changes the character, scope, size, or location of the project area or previously authorized dredge prism, nor does it include any action that is part of the U.S. Army Corp of Engineers (Corps') navigation program to maintain Federal navigation channels.

13. Dredging to maintain functionality of previously authorized channels, culverts, water intakes, or outfalls. Restore lost function of a previously authorized channel, culvert, water intake, or outfall, including addition of a fish screen that meets NMFS criteria (2011a or most recent version) for any water intake or point of diversion.

14. Debris Removal. Restore lost function of infrastructure, such as utilities, drainage, and transportation systems, and the unimpeded use of navigational, recreational, and municipal services. Debris eligible for removal includes debris that could cause further damage to the structure or if the blockage could cause flood waters to inundate nearby facilities and immediately threaten lives, public health and safety, and immediate threats to significant damage to property.

1.3.1 Proposed Design Criteria (PDC)

The FEMA proposed to apply the following PDC, in relevant part, to every action authorized under this opinion. An outline of the following PDCs is provided and followed by a detailed description corresponding to the PDC number. Measures described under "Administration" apply to FEMA as it manages the FESP for actions funded by FEMA. The proposed design criteria is comprised of the 1) Program Administration, 2) Project Design Criteria-General Construction Measures, and 3) Project Design Criteria-Types of Actions. Measures described under "General Construction" apply, in relevant part, to each action that involves a construction

component and is organized by pre-construction, construction, and post-construction measures. Measures described under “Types of Action” apply, in relevant part, to each specific type of actions as described.

1.3.1.1 Program Administration

1. Initial Rollout
2. FEMA Review and Approval
3. NMFS Review and Verification
4. Electronic Notification
5. Full Implementation Required
6. Monitoring and reporting
7. Project Completion Report
8. Fish Salvage Report
9. Annual Program Report
10. Annual Coordination Meeting
11. Failure to Report May Trigger Reinitiation

1.3.1.2 Project Design Criteria - General Construction Measures

Pre-Construction Measures

12. Project Design
13. In-Water Work Timing
14. Fish Capture and Release
15. Work Area Isolation
16. Fish Screens
17. Site Layout and Flagging
18. Staging, Storage, and Stockpile Areas
19. Pollution and Erosion Control
20. Hazardous Material Safety
21. Temporary Access Roads and Paths
22. Temporary Stream Crossings
23. Drilling and Boring

Construction Measures

24. Equipment, Vehicles and Power Tools
25. Pile Installation
26. Pile Removal
27. Broken or Intractable Pile
28. Fish Passage
29. Surface Water Withdrawal
30. Dust Abatement
31. Construction Discharge Water
32. Pesticide and Preservative-Treated Wood For Uses Other Than Piles
33. Barge Use.
34. Invasive and Non-Native Plant Control

Post-Construction

- 35. Actions Requiring Post-Construction Stormwater Management
- 36. Site Restoration
- 37. Revegetation
- 38. Actions That Require Compensatory Mitigation

1.3.1.3 Project Design Criteria - Types of Actions

Transportation Related Actions

- 39. Road, culvert, and bridge repair, rehabilitation and replacement
- 40. Stormwater facilities
- 41. Utilities
- 42. Streambank and channel stabilization

Restoration Related Actions

- 43. Streambank restoration
- 44. Boulder placement for habitat restoration
- 45. Large wood placement
- 46. Off- and side-channel habitat restoration
- 47. Set-back existing berms, dikes, and levees
- 48. Water control structure removal

In-Water Over-Water Structure Related Actions

- 49. In-water or over-water structures
- 50. Dredging to maintain vessel access
- 51. Dredging to maintain functionality of previously authorized channels, culverts, water intakes, or outfalls
- 52. Debris Removal

1.3.1.1 Program Administration

This proposed action includes a process designed to ensure that only activities that properly fall under the completed programmatic get treated as such and also to provide a mechanism by which the agencies can track the number and nature of projects proceeding under the programmatic. In sum, the review and verification process involves early notification, the FEMA making a determination as to whether each project meets the criteria of the Programmatic Opinion, and then NMFS verifying that determination for certain activities. This process is not an ESA consultation and does not involve either agency making LAA/NLAA or jeopardy/no jeopardy decisions about a project; rather, it provides a protocol by which FEMA makes decisions about whether it is appropriate to treat projects as being already covered by this completed ESA programmatic consultation.

1. **Initial Rollout.** The FEMA will partner with NMFS to provide an initial rollout of this opinion for FEMA staff to ensure that the specifics of this programmatic are considered at the onset of each project, and incorporated into all phases of FEMA funded projects.
2. **FEMA Review and Approval.** For each project proposed to be carried-out under this programmatic, FEMA will review the project to determine whether it meets the following criteria and is therefore appropriately considered to be covered by the Programmatic

Opinion:

- a. Falls within the description of an activity in the proposed action.
 - b. Conforms with all the site-level BMPs that the FEMA decision-maker has determined to be appropriate and applicable, and conforms with general construction measures that apply to the applicable class of activity; and,
 - c. Conforms to all applicable Terms and Conditions in the Incidental Take Statement of the Programmatic Opinion.
 - d. The FEMA will review and approve each project to be covered under this opinion to ensure that it:
 - i. Is within the present or historical range of an ESA-listed salmon, steelhead, southern green sturgeon, southern resident killer whale, or eulachon, or designated critical habitat.
 - ii. Will not cause an effect to the listed species or critical habitat that was not considered in this opinion.
 - iii. Will not include actions that are specifically excluded from this opinion (but available for individual consultation) include the following actions, or result in the following conditions:
 1. Repair or replacement of a tide gate.
 2. Use of preservative or pesticide-treated wood (“treated wood”), except as described in PDC 25 & 32.
 3. Installation of a stream barb, non-porous partially spanning weir, or full-spanning weir.
 4. Exceeding the amount or extent of incidental take described in the incidental take statement issued with this opinion.
- 3. Formal Project Notification.** Once the FEMA makes a determination that a project satisfies 2 a, b, and c above, FEMA will submit an Action Implementation Worksheet at least 30 days prior to signing the Decision to NMFS using femaprogrammatic.wcr@noaa.gov email inbox. Early coordination is recommended prior to 30 days before the start of construction. The Action Implementation Worksheet (AIW) is located in Appendix A of this opinion.
- 4. NMFS Review and Verification.** Within 30 days of formal project notification, the NMFS Branch Chief will review all AIWs in order to verify whether NMFS agrees with FEMA’s determination that the project is covered by the Programmatic Opinion.
- a. Where NMFS agrees with FEMA’s determination, it will advise FEMA of that within the 30 day review period.
 - b. Where NMFS disagrees with FEMA’s determination, the NMFS Branch Chief would contact the FEMA officer for the respective project-informing them of that view within the 30 day review period.
 - c. The following minor project modifications are allowed under the proposed action on a case by case basis, when NMFS verifies the resulting environmental and biological effects of the modification fit within the biological opinion:
 - i. Work outside the in-water work window
 - ii. LW placement outside of the instream work window
 - iii. Alternate location for equipment, refueling, and staging
 - iv. Additional heavy equipment in constructing stream fords
 - v. Revegetating after the first growing season

- d. **Options for Projects that Don't Comply with Programmatic** – Where, informed by NMFS' input, FEMA revisits its earlier determination and decides that a project is not covered by the Programmatic Opinion, the FEMA has the option to: 1) Modify the project to ensure consistency with the Programmatic Opinion; 2) or Withdraw the project from consideration under the Programmatic Opinion, and proceed with an individual ESA consultation.
5. **Full Implementation Required.** Failure to comply with all applicable conditions for a specific project may invalidate protective coverage of ESA section 7(o)(2) regarding “take” of listed species, and may lead NMFS to a different conclusion regarding the effects of that project.
6. **Monitoring and reporting.** The FEMA will provide the following information to NMFS for each project to be completed under this opinion. All project notifications and reports are to be submitted electronically to NMFS at femaprogrammatic.wcr@noaa.gov, including:
 - a. Project notification within 30-days before start of construction (Part 1).
 - b. Project completion within 90-days of end of construction (Part 1 with Part 2 completed).
7. **Project Completion Report.** The FEMA will submit, the Action Implementation Worksheet (Appendix A, PDC 4) with the completion report portion completed (Parts 1 and 2) to the FEMA Programmatic mailbox within 90 days of the end of construction for any project authorized or carried out by FEMA.
8. **Fish Salvage Report.** The FEMA must require that each project completed under this opinion provide this notice in writing to the supervisor of each project completed under this opinion.
9. **Annual Program Report.** The FEMA will submit a monitoring report to the FEMA Programmatic mailbox by January 31 each year that describes FEMA's efforts to carry out this opinion, including an assessment of overall program activity, a map showing the location and type of each action authorized or carried out under this opinion, and any other data or analyses FEMA deems necessary or helpful to assess habitat trends as a result of actions authorized under this opinion.
10. **Annual Coordination Meeting.** The FEMA will attend an annual coordination meeting with NMFS by April 15 each year to discuss the annual report and any actions that can improve conservation under this opinion, or make the program more efficient or accountable.
11. **Failure to Report May Trigger Reinitiation.** The NMFS may recommend reinitiation of this consultation if FEMA, or the grantee if applicable, fails to provide all applicable notification, completion, site restoration/compensatory mitigation reports or annual program reports, or attend the annual coordination meeting.

1.3.1.2 Project Design Criteria - General Construction Measures

Pre-Construction Measures

12. **Project Design**
 - a. To the extent feasible, use site design to retain natural vegetation and permeable soils, limit compaction, and otherwise minimize the extent and duration of

- earthwork.
- b. Current regional climate change projections, such as changes in flow magnitude, duration, and sea level rise will be considered during project design for the life of the project.
 - c. Assess whether the project area is contaminated by chemical substances that may cause harm if released by the project. The assessment will be commensurate with site history and may include the following:
 - i. Review available records, *e.g.*, the history of existing structures and contamination events.
 - ii. If the project area was used for industrial processes, inspect to determine the environmental condition of the property.
 - iii. Interview people who are knowledgeable about the site, *e.g.*, site owners, operators, and occupants, neighbors, or local government officials.
 - iv. If contamination is found or suspected, consult with a suitably qualified and experienced contamination professional and NMFS before carrying out ground disturbing activities.

13. In-Water Work Timing

- a. Complete all work within the wetted channel during dates listed in the most recent version of in-water work guidelines corresponding to the following state under this programmatic:
 - i. Oregon - *Oregon In-water Work Guidelines* (ODFW 2008) (except that in-water work in the Willamette River below Willamette Falls is not allowed between December 1 and January 31).
 - ii. Washington - *Times When Spawning or Incubating Salmonids are Least Likely to be Present in Washington State Freshwaters* (WDFW 2015).
 - iii. Idaho - *Upper Salmon River Recommended Instream Work Windows and Fish Periodicity* (USBWP 2005). For all other anadromous streams in Idaho (Lower Salmon River, Lower Snake River, and Clearwater River Basins) refer to Table 1.

Table 1. Instream work windows for all other anadromous streams in Idaho (Lower Salmon River, Lower Snake River, and Clearwater River Basins).

Stream type	Instream work window
Perennial, no listed fish	Base the timing on the nearest listed fish found downstream from the project area
Perennial, listed steelhead only	Preferred window is August 1 through October 30; exceptions may be made on a project-specific basis to begin work as early as July 15.
Perennial, listed steelhead and unlisted salmon	August 1 through October 30 when Chinook and coho spawning habitats are not present in the action area; July 15 through August 15 when Chinook spawning habitat is present in action area; August 1 through September 15 when coho spawning habitat is present in the action area.
Perennial, listed steelhead as well as listed salmon or bull trout	July 15 through August 15
Intermittent	August 1 to October 30, or any time work can be completed while the stream is not flowing

14. Fish Capture and Release

- a. If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).
- b. Fish capture will be supervised by a qualified fisheries biologist, with experience in work area isolation and competent to ensure the safe handling of all fish.
- c. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.
- d. Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.
- e. Electrofishing will be used during the coolest time of day, only after other means of fish capture are determined to be not feasible or ineffective.
 - i. Do not electrofish when the water appears turbid, *e.g.*, when objects are not visible at depth of 12 inches.
 - ii. Do not intentionally contact fish with the anode.
 - iii. Follow NMFS (2000) electrofishing guidelines, including use of only direct current (DC) or pulsed direct current within the following ranges:³
 1. If conductivity is less than 100 microsecond (μ s), use 900 to 1100 volts.
 2. If conductivity is between 100 and 300 μ s, use 500 to 800 volts.
 3. If conductivity greater than 300 μ s, use less than 400 volts.
 - iv. Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.

³ National Marine Fisheries Service. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. Portland, Oregon and Santa Rosa, California.

- v. Immediately discontinue electrofishing if fish are killed or injured, *i.e.*, dark bands visible on the body, spinal deformations, significant de-scaling, torpid or inability to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.
- f. If buckets are used to transport fish:
 - i. Minimize the time fish are in a transport bucket.
 - ii. Keep buckets in shaded areas or, if no shade is available, covered by a canopy.
 - iii. Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.
 - iv. Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.
 - v. Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.
 - vi. Be careful to avoid mortality counting errors.
- g. Monitor and record fish presence, handling, and injury during all phases of fish capture and submit a fish salvage report (Appendix A, Part 1 with Part 3 completed) to FEMA and the mailbox (femaprogrammatic.wcr@noaa.gov) within 60 days.

15. Work Area Isolation

- a. Isolate any work area within the wetted channel from the active stream whenever ESA-listed fish are reasonably certain to be present, unless NMFS and FEMA agree in writing (email) that the work can be done with less potential risk to listed fish without isolating and dewatering the work area (e.g., placing large woody debris).
- b. Engineering design plans for work area isolation will include all isolation elements and fish release areas. Any temporary bypass channels will be reviewed and verified by a NMFS hydraulic engineer to ensure compliance with fish passage criteria (NMFS 2011a).
- c. Dewater the shortest linear extent of work area practicable, unless wetted in-stream work is deemed to be minimally harmful to fish, and is beneficial to other aquatic species.⁴
 - i. Use a coffer dam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch to divert flow around the dewatered area. Dissipate flow energy to prevent damage to riparian vegetation or stream channel and provide for safe downstream reentry of fish, preferably into pool habitat with cover.
 - ii. Where gravity feed is not possible, pump water from the work site to avoid rewatering and to sustain stream flow. Maintain a fish screen on the pump intake to avoid juvenile fish entrainment.
 - iii. Pump seepage water to a temporary storage and treatment site, or into upland areas, to allow water to percolate through soil or to filter through

⁴ For instructions on how to dewater areas occupied by lamprey, see *Best management practices to minimize adverse effects to Pacific lamprey (Entosphenus tridentatus)* (USFWS 2010).

- vegetation before reentering the stream channel with a treatment system comprised of either a hay bale basin or other sediment control device.
- iv. Monitor below the construction site to prevent stranding of aquatic organisms.
- v. When construction is complete, re-water the construction site slowly to prevent loss of surface flow downstream, and to prevent a sudden increase in stream turbidity.
- d. Whenever a pump is used to dewater the isolation area and ESA-listed fish may be present, a fish screen will be used that meets the most current version of NMFS's fish screen criteria (NMFS 2011a). The NMFS verification is required for pumping at a rate that exceeds 3 cfs.

16. Fish Screens

- a. Submit to NMFS for review and verification of fish screen designs for surface water diverted by gravity or by pumping at a rate that exceeds 3 cfs.
- b. Each fish screen will be installed, operated, and maintained according to NMFS's fish screen criteria.
 - i. Project fish screen criteria can be found in CH 11 of NMFS Anadromous Salmonid Fish Facility design manual (NMFS 2011a or subsequent version).

17. Site Layout and Flagging

- a. Before any significant ground disturbance or entry of mechanized equipment or vehicles into the construction area, clearly mark with flagging or survey marking paint the following areas:
 - i. Sensitive areas, *e.g.*, wetlands, water bodies, spawning areas will be flagged and identified by a qualified biologist.
 - ii. Equipment entry and exit points.
 - iii. Road and stream crossing alignments.
 - iv. Staging, storage, and stockpile areas.
- b. Before the use of herbicides, clearly flag no-application buffer zones. Herbicide buffer distances are described in PDC #34 Invasive and Non-Native Plant Control.

18. Staging, Storage, and Stockpile Areas

- a. Designate and use staging areas to store hazardous materials, or to store, fuel, or service heavy equipment, vehicles, and other power equipment with tanks larger than 5 gallons, that are at least 150 feet from any natural water body or wetland, or on an established paved area, such that sediment and other contaminants from the staging area cannot be deposited in the floodplain or stream.
- b. Natural materials that are displaced by construction and reserved for restoration, *e.g.*, LW, gravel, and boulders, may be stockpiled within the 100-year floodplain and covered to avoid runoff of sediment and natural materials due to precipitation.
- c. Dispose of any material not used in restoration and not native to the floodplain outside of the functional floodplain.⁵

⁵ **Functional floodplain** as defined in this document comprises the areas of the project delineated by the greatest of the following three boundaries: the floodplain for a 10-year flood event; 150 feet on each side of the active channel; or a site-potential tree height within the project area. Site-potential tree height is the average maximum height of the

- d. After construction is complete, obliterate all staging, storage, or stockpile areas, stabilize the soil, and revegetate the area.⁶ Areas where vegetation has been temporarily removed must be revegetated with trees, brush, and grasses native to the watershed. The long-term goal shall be to mimic the diversity and stocking levels of nearby undisturbed plant communities, while also incorporating those plants needed to minimize erosion in the near- and medium-term future. For instance, sterile non-native grasses may be used to help control surface erosion immediately after construction if native species are also planted which will later displace those non-native grasses. The stocking levels for planted trees and shrubs shall include consideration of possible future mortality rates. Revegetation efforts require monitoring that incorporates metrics that may trigger additional planting to achieve the desired future condition that is defined in the revegetation plan.

19. **Pollution and Erosion Control.**

- a. At a minimum, project designs and best management practices shall abide by those issued by the respective state department of ecology or department of environmental quality. Some (not all) pertinent state standards and guidance are available in the following documents (or any future documents that replace or supplement them):

Washington: Stormwater Management Manual for Western Washington; Volumes I thru V, Washington State Department of Ecology (as amended 2014) or Stormwater Management Manual for Eastern Washington; Washington State Department of Ecology Publication 04-10-076 (2004).

Oregon: Construction Stormwater Erosion and Sediment Control Manual, 1200-C PNPDES General Permit, State of Oregon Department of Environmental Quality (2013).

Idaho: Catalog of Stormwater Best Management Practices for Idaho Cities and Counties, Idaho Department of Environmental Quality (2005).

- b. Use site planning and site erosion control measures commensurate with the scope of the project to minimize damage to natural vegetation and permeable soils, and prevent erosion and sediment discharge from the project site.
- c. Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body. In tidal areas, plan work in dry areas as much as possible.

tallest dominant trees (200 years or older) for a given site class.

⁶ Road and path obliteration refers to the most comprehensive degree of decommissioning and involves decompacting the surface and ditch, pulling the fill material onto the running surface, and reshaping to match the original contour. In many cases tillage will be necessary to decompact soils and restore infiltration ability and soil productivity. A variety of implements/methods are available to decompact soils, including: winged subsoilers, rock ripper, excavators with brush rakes, mulching heads, or custom attachments such as the subsoiling grapple rake and subsoiling excavating bucket (egg. Ripping soils with an excavator bucket mounted with teeth). The depth of needed tillage can be estimated by referring to the rooting depth of nearby native vegetation. In areas of dispersed soil disturbance consider spot tillage.

- d. During construction:
 - i. Complete earthwork in wetlands, riparian areas, and stream channels as quickly as possible.
 - ii. Cease project operations when high flows may inundate the project area, except for efforts to avoid or minimize resource damage.
 - iii. If eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.
 - iv. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
 - v. Soil stabilization using wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil, if the materials are free of noxious weeds and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
 - vi. Inspect and monitor pollution and erosion control measures throughout the length of the project.
 - vii. Remove sediment from erosion controls if it reaches one-third of the exposed height of the control.
 - viii. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
 - ix. Stabilize all disturbed soils following any break in work unless construction will resume within four days.
- e. Remove temporary erosion controls after construction is complete and the site is fully stabilized.

20. Hazardous Material Safety

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

21. Temporary Access Roads and Paths

- a. Whenever reasonable, use existing access roads and paths preferentially.
- b. Minimize the number and length of temporary access roads and paths through riparian areas and floodplains.
- c. Minimize removal of riparian vegetation.
- d. When it is necessary to remove vegetation, cut at ground level (no grubbing).
- e. Do not build temporary access roads or paths where grade, soil, or other features suggest slope instability.

- f. Any road on a slope steeper than 30% will be designed by a civil engineer with experience in steep road design.
- g. After construction is complete, obliterate all temporary access roads and paths, stabilize the soil, and revegetate the area.
- h. Temporary roads and paths in wet areas or areas prone to flooding will be obliterated by the end of construction. Decompact road surfaces and drainage areas, pull fill material onto the running surface, and reshape to match the original contours.

22. Temporary Stream Crossings

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

23. Drilling and Boring

- a. If drilling or boring are used, isolate drilling operations in wetted stream channels using a steel casing or other appropriate isolation method to prevent drilling fluids from contacting water. If methods other than isolation are being considered, those proposed actions should be submitted to NMFS for review and verification prior to construction.
- b. If drilling through a bridge deck is necessary, use containment measures to prevent drilling debris from entering the channel.
- c. Sampling and directional drill recovery/recycling pits, and any associated waste or spoils will be completely isolated from surface waters, off-channel habitats and wetlands.
- d. All waste or spoils will be covered if precipitation is falling or imminent.
- e. All drilling fluids and waste will be recovered and recycled or disposed to prevent entry into flowing water.
- f. If a drill boring case breaks and drilling fluid or waste is visible in water or a wetland, make all possible efforts to contain the waste and contact NMFS within 48 hours.
- g. Waste containment

- i. All drilling equipment, drill recovery and recycling pits, and any waste or spoil produced, will be contained and then completely recovered and recycled or disposed of as necessary to prevent entry into any waterway. Use a tank to recycle drilling fluids.
- ii. When drilling is completed, remove as much of the remaining drilling fluid as possible from the casing (*e.g.*, by pumping) to reduce turbidity when the casing is removed.

Construction Measures

24. Equipment, Vehicles and Power Tools

- a. Select, operate and maintain all heavy equipment, vehicles, and power tools to minimize damage to natural vegetation and permeable soils, *e.g.*, low pressure tires, minimal hard-turn paths for track vehicles, use of temporary mats or plates to protect wet soils.
- b. Before entering wetlands or working within 150 feet of a water body:
 - i. Power wash all heavy equipment, vehicles and power tools, allow them to fully dry, and inspect them for fluid leaks, and to make certain no plants, soil, or other organic material are adhering to the surface.
 - ii. Ensure all equipment to be operated below ordinary high water is leak free or operating with biodegradable products.⁷ This does not apply to vehicles and equipment that are doing road work and/or passing through a project area (*e.g.*, dozers, graders, etc.).
- c. Repeat cleaning as often as necessary during operation to keep all equipment, vehicles, and power tools free of external fluids and grease, and to prevent a leak or spill from entering the water.
- d. Avoid use of heavy equipment, vehicles or power tools below OHW for riverine systems or below the HAT for marine systems unless project specialists determine such work is necessary, or if it is a temporary stream crossing or would result in less risk of sedimentation or other ecological damage than work above that elevation.
- e. Before entering the water, inspect any watercraft, waders, boots, or other gear/equipment to be used in or near water and remove any plants, soil, or other organic material adhering to the surface.
- f. Ensure that any generator, crane or other stationary heavy equipment that is operated, maintained, or stored within 150 feet of any water body is also protected as necessary to prevent any leak or spill from entering the water.

⁷ For additional information and suppliers of biodegradable hydraulic fluids, motor oil, lubricant, or grease, see, Environmentally Acceptable Lubricants by the U.S. EPA (2011a); *e.g.*, mineral oil, polyglycol, vegetable oil, synthetic ester; Mobil® biodegradable hydraulic oils, Total® hydraulic fluid, Terresolve Technologies Ltd.® bio-based biodegradable lubricants, Cougar Lubrication® 2XT Bio engine oil, Series 4300 Synthetic Bio-degradable Hydraulic Oil, 8060-2 Synthetic Bio-Degradable Grease No. 2, *etc.* The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and grantees 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.

- 25. Pile Installation.** Pile may be concrete, or steel round pile 24 inches in diameter or smaller, steel H-pile designated as HP24 or smaller, or wood that has not been treated with preservatives or pesticides except as described below. Pile wrappings⁸ may be used to wrap new inorganic arsenical pressure-treated wood piles (ammoniacal copper arsenate (ACA), and ammoniacal copper zinc arsenate (ACZA) in aquatic environments. Any proposal to use unwrapped treated wood pilings is not covered by this consultation and will require individual consultation.
- a. When practical, use a vibratory hammer for in-water pile installation. In the lower Columbia River only a vibratory hammer may be used in October.
 - b. Jetting may be used to install pile in areas with coarse, uncontaminated sediments that meet criteria for unconfined in-water disposal (USACE Northwest Division 2009).
 - c. When using an impact hammer to drive or proof a steel pile, one of the following sound attenuation methods will be used:
 - i. Completely isolate the pile from flowing water by dewatering the area around the pile.
 - ii. If water velocity is 1.6 feet per second or less, surround the pile being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100% of the pile perimeter for the full depth of the water column. See, *e.g.*, NMFS and USFWS (2006), CALTRANS Technical Report No. CTHWANP-RT-306.01.01 (2015), Wursig *et al.* (2000), and Longmuir and Lively (2001).
 - iii. If water velocity is greater than 1.6 feet per second, surround the pile being driven with a confined bubble curtain (*e.g.*, surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100% of the pile perimeter for the full depth of the water column.
 - iv. Provide NMFS information regarding the timing of in-water work, the number of impact hammer strikes per pile and the estimated time required to drive piles, hours per day pile driving will occur, depth of water, and type of substrate, hydroacoustic assumptions, and the pile type, diameter, and spacing of the piles.
 - v. Construction activities will shut down if marine mammals enter the zone of influence⁹. Construction activities will not resume until all marine mammals have been cleared from the zone of harm and are observed to be moving away from the construction site.
 1. If Southern Resident Killer whales (SRKW) have been documented more than four times during the proposed work window in the quadrant¹⁰ the project area is located in, a Marine

⁸ Pile wrapping as referenced in the American Wood Protection Association (AWPA) book of standards is described as a barrier protection system adhered or otherwise permanently affixed to the wooden member. This includes boots, sleeves, wraps, and spray on coatings that meet minimum thickness standards (AWPA 2016). The term “wrap” or “wrapping” refers to barrier protection systems designed and installed according to AWPA standards.

⁹ During vibratory pile driving, the zone of influence extends to the 120dB isopleth and extends to the 160dB isopleth during impact pile driving.

¹⁰ NOAA’s website identifies these quadrants
http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/evaluating_sound.html

Mammal Monitoring Plan (MMMP) must be prepared and submitted. The MMMP may be reviewed by a NMFS biologist. The goal of a MMMP is to stop or not start work if a marine mammal is in the area where it may be affected by pile driving noise.

2. If in one or both of the previous two years there were four or more humpback whale sightings during the proposed work month, in the basin where pile driving will occur, a MMMP must be submitted.
- d. Alternatives to pesticide and preservative-treated wood piles:
- i. Pile wrappings may be used to wrap new inorganic arsenical treated wood piles (CCA and ACZA) in aquatic environments. Pile wraps cannot be used for new creosote, creosote solutions, or oil-borne preservatives under this biological opinion. The following criteria applies to the use of pile wrappings for pile maintenance and installation:
 - ii. Wraps can be pre-formed plastic such as polyvinyl chloride (PVC), fiber glass-reinforced plastic, or a high density polyethylene (HDPE) with an epoxy fill, petrolatum saturated tape (PST), or an inner wrap in the void between the wrapping and the pile.
 1. Exterior pilings, pilings that will come into direct contact with ocean and barge vessels, may only use high density polyethylene pile wrappings, steel-reinforced concrete, or steel-cased pilings.¹¹
 2. The material used for interior pilings must be durable enough to maintain the integrity for at least 10-years and a minimum of 1/10 of an inch thick with all joints sealed to prevent leakage.
 3. Sealing or capping the tops of the pilings shall prevent treated wood surface exposure within the water column and prevent dripping.
 - iii. Pile wrappings will extend above and below the portion of the piling in contact with the water. The wrapping shall extend down into the substrate at least 18 inches below the mudline to contain treatment chemicals. The wrapping may extend to either the top of the piling or to a minimum height above the OHW for riverine systems or the HAT line for marine systems to protect the treated wood from water contact.¹²
 - iv. All operations to prepare pile wrappings for placement cutting, drilling, and placement of epoxy fill will occur in a staging area away from the waterbody.
 - v. All pile wrappings will require an inspection and maintenance program. The program is designed to identify potential failures within the pile barrier system as soon as possible after a breach occurs. It is recommended that the maintenance of wrapped piles be performed by an experienced and licensed marine contractor. All submerged portions of the wrapped pilings will be inspected every 1-2 years beginning 3-5 years

¹¹ CCC (California Coastal Commission). 2005. Regular Coastal Development Permit Application number 3-04-072.

¹² CCC (California Coastal Commission). 2012. Nonpoint Source Program. Water Quality Fact Sheet: Pilings-Treated Wood and Alternatives.

after installation, particularly in active facilities where there is the potential for abrasion or boat collisions that can damage the barrier.

1. Freshwater Inspections. Freshwater inspections can occur using regular snorkeling gear. The inspector should concentrate on the upper portion of the wood nearer to the surface where activity is greatest and should look all around each pile to determine if any of the barrier has abraded or been torn away. Wood with evidence of barrier disruption should be marked so that repairs can be made.
 2. Saltwater Inspections. Saltwater inspection should concentrate on the tidal zone where the risk of impacts from floating debris or boats is greatest. Inspections should take place at low tide (i.e. a minus tide). The inspector should move around the pile examining the surface for evidence of tears or gaps in the barrier that might indicate damage. These zones should be more closely probed with a scraper that can remove any surface marine fouling organisms. Care should be taken to minimize damage to the barrier surface.
 3. When to Repair. Small gaps or tears in the barrier will have little effect on potential migration of preservative. Damage to 25 % or more of the barrier surface on an individual pile should result in action to repair the surface by adding additional coating or barrier material to mitigate any future preservative loss. Missing or damaged wraps should be replaced as soon as possible.
 4. The inspection and maintenance program will be reviewed and verified by NMFS.
- vi. Polyurea barrier systems may be used to coat new inorganic arsenical pressure-treated wood piles in aquatic environments. The coating must be an impact-resistant, biologically inert coating that lasts or is maintained for a specified amount of time (NMFS 2009a). All polyurea coated treated wood piles will require an inspection and maintenance program (refer to PDC #25(d)(v) for inspection and maintenance requirements).
1. The polyurea coating should be specified by the manufacturer for in-water use to avoid degradation of the coating and over water spills. Prefabrication will be used whenever possible to minimize cutting, drilling and field preservative treatment.
 2. Polyurea products must be coated on dry piles, free of loose wood, splinters, or sawdust and mechanical damage.
 3. Only products treated in accordance with the WWPI and best management practices will be accepted for coating.
 4. The polyurea coating must be ultraviolet light resistant and a minimum of 250 mil thick in the area that is submerged (Morrell 2017).
- 26. Pile Removal.** The following steps will be used to minimize creosote release, sediment disturbance and total suspended solids:
- a. Install a floating surface boom to capture floating surface debris.

- b. Keep all equipment (*e.g.*, bucket, steel cable, vibratory hammer) out of the water, grip piles above the waterline, and complete all work during low water and low current conditions.
 - c. Dislodge the pile with a vibratory hammer, when possible; never intentionally break a pile by twisting or bending.
 - d. Slowly lift the pile from the sediment and through the water column.
 - e. Place the pile in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment. A containment basin for the removed piles and any adhering sediment may be constructed of durable plastic sheeting with sidewalls supported by hay bales or another support structure to contain all sediment and return flow which may otherwise be directed back to the waterway.
 - f. Fill the hole left by each pile with clean, native sediments immediately after removal.
 - g. Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.
- 27. Broken or Intractable Pile**
- a. If a pile breaks above the surface of uncontaminated sediment, or less than 2 feet below the surface, make every attempt short of excavation to remove it entirely. If the pile cannot be removed without excavation, drive the pile deeper if possible.
 - b. If a pile in contaminated sediment is intractable or breaks above the surface, cut the pile or stump off at the sediment line.
 - c. 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.
 - d. If dredging is likely where broken piles are buried, use a global positioning system (GPS) device to note the location of all broken piles for future use in site debris characterization.
- 28. Fish Passage**
- a. Provide fish passage for any adult or juvenile ESA-listed fish likely to be present in the action area during construction, unless passage did not exist before construction or the stream is naturally impassable at the time of construction.
 - b. After construction, provide fish passage for any adult or juvenile ESA-listed fish that meets NMFS's fish passage criteria (NMFS 2011a or subsequent version) for the life of the fish passage structure.
- 29. Surface Water Withdrawal for Construction Needs**
- a. Surface water may be diverted to meet construction needs, including dust abatement, only if water from developed sources (*e.g.*, municipal supplies, small ponds, reservoirs, or tank trucks) are unavailable or inadequate; and
 - b. Diversions may not exceed 10 percent of the available flow and will have a juvenile fish exclusion device that is consistent with NMFS's criteria (NMFS 2011a).¹³
- 30. Dust Abatement**
- a. If needed, use dust abatement measures commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures.

¹³ National Marine Fisheries Service. 2011. Anadromous salmonid passage facility design. Northwest Region.

- b. Sequence and schedule work to reduce the exposure of bare soil to wind erosion.
- c. Maintain spill containment supplies on-site whenever dust abatement chemicals are applied.
- d. Do not use petroleum-based products.
- e. Do not apply dust-abatement chemicals, *e.g.*, magnesium chloride, calcium chloride salts, ligninsulfonate, within 25 feet of a water body, or in other areas where they may runoff into a wetland or water body.
- f. Do not apply ligninsulfonate at rates exceeding 0.5 gallons per square yard of road surface, assuming a 50:50 solution of ligninsulfonate to water.

31. Construction Discharge Water.

- a. Treat all discharge water using best management practices to remove debris, sediment, petroleum products, and any other pollutants likely to be present (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours, drilling fluids), to avoid or minimize pollutants discharged to any perennial or intermittent water body.
- b. 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. Treat water used to cure concrete until pH stabilizes to background levels.

32. Pesticide and Preservative-Treated Wood For Uses Other Than Piles¹⁴

- a. Types of Uses.
 - i. The following criteria pertains to the repair or maintenance of pre-existing bridges, boardwalks, docks, footbridges, piers, stringers, and structures in or near waterways and wetlands.
 - ii. Pesticide and preservative-treated wood can only be used for substructures that are not in direct exposure to leaching by precipitation, overtopping waves, or submersion. This excludes the use of treated wood for the application of decking.
- b. Installation of treated wood.
 - iii. Treated wood shipped to the project area will be stored out of contact with standing water and wet soil, and protected from precipitation.
 - iv. Each load and piece of treated wood will be visually inspected and rejected for use in or above aquatic environments if visible residue, bleeding of preservative, preservative-saturated sawdust, contaminated soil, or other matter is present.
 - v. Prefabrication will be used whenever possible to minimize cutting, drilling and field preservative treatment.
 - vi. When field fabrication is necessary, all cutting, drilling, and field preservative treatment of exposed treated wood will be done above OHW for riverine systems or HAT for marine systems to minimize discharge of sawdust, drill shavings, excess preservative and other debris.

¹⁴Creosote, pentachlorophenol, and copper naphthenate and oil-type wood preservatives are not proposed for use under this consultation are.

- vii. Tarps, plastic tubs or similar devices will be used to contain the bulk of any fabrication debris, and any excess field preservative will be removed from the treated wood by wiping and proper disposal.
 - c. Removal of treated wood.
 - viii. Evaluate all wood construction debris removed during a project to ensure proper disposal of treated wood.
 - ix. Ensure that no treated wood debris falls into the water or, if debris does fall into the water, remove it immediately.
 - x. After removal, place treated wood debris in an appropriate dry storage site protected from precipitation until it can be removed from the project area.
 - xi. Do not leave any treated wood debris in the water or stacked on the streambank at or below OHW or HAT.
- 33. Barge Use.** Any barge used as a work platform to support construction will be:
- a. Large enough to remain stable under foreseeable loads and adverse conditions.
 - b. Inspected before arrival to ensure vessel and ballast are free of invasive species.
 - c. Secured, stabilized and maintained as necessary to ensure no loss of balance, stability, anchorage, or other condition that can result in the release of contaminants or construction debris.
- 34. Invasive and Non-Native Plant Control**
- Non-herbicide methods.*** Limit vegetation removal and soil disturbance within the riparian zone by limiting the number of workers there to the minimum necessary to complete manual, mechanical, or hydro-mechanical plant control (*e.g.*, hand pulling, bending,¹⁵ clipping, stabbing, digging, brush-cutting, mulching, radiant heat, portable flame burner, super-heated steam, pressurized hot water, or hot foam (Arsenault *et al.* 2008; Donohoe *et al.* 2010).¹⁶ Do not allow cut, mowed, or pulled vegetation to enter waterways.
- a. ***Herbicide Label.*** Herbicide applicators will comply with all label instructions.
 - b. ***Power equipment.*** Refuel gas-powered equipment with tanks larger than 5 gallons in a vehicle staging area placed 150 feet or more from any natural water body, or in an isolated hazard zone such as a paved parking lot.
 - c. ***Maximum herbicide treatment area.*** Do not exceed treating 1.0% of the acres of riparian habitat within a 6th-field Hydrologic Unit Code (HUC) with herbicides per year.
 - d. ***Herbicide applicator qualifications.*** Herbicides may only be applied by an appropriately licensed applicator using an herbicide specifically targeted for a particular plant species that will cause the least impact. The applicator will be responsible for preparing and carrying out the herbicide transportation and safety plan, as follows.
 - e. ***Herbicide transportation and safety plan.*** The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or

¹⁵ Knotweed treatment pre-treatment; See Nickelson (2013).

¹⁶ See University of California-Davis, Advanced Highway Maintenance & Construction Technology Research Center Toolbox for Vegetation Control.

misapplication, to take remedial actions in the event of spills, and to fully report the event.

- f. **Herbicides.** The only herbicides proposed for use under this opinion are (some common trade names are shown in parentheses):¹⁷
- i. aquatic imazapyr (*e.g.*, Habitat)
 - ii. aquatic glyphosate (*e.g.*, AquaMaster, AquaPro, Rodeo)
 - iii. aquatic triclopyr-TEA (*e.g.*, Renovate 3)
 - iv. chlorsulfuron (*e.g.*, Telar, Glean, Corsair)
 - v. clopyralid (*e.g.*, Transline)
 - vi. imazapic (*e.g.*, Plateau)
 - vii. imazapyr (*e.g.*, Arsenal, Chopper)
 - viii. metsulfuron-methyl (*e.g.*, Escort)
 - ix. picloram (*e.g.*, Tordon)
 - x. sethoxydim (*e.g.*, Poast, Vantage)
 - xi. sulfometuron-methyl (*e.g.*, Oust, Oust XP)
- g. **Herbicide adjuvants.** When recommended by the label, an aquatic surfactant or drift retardant can be used to improve herbicidal activity or application characteristics. Adjuvants that contain alky amine ethoxylates, *i.e.*, polyethoxylated tallow amine, alkylphenol ethoxylates (including alkyl phenol ethoxylate phosphate esters), or herbicides that contain these compounds are **not** covered by this opinion. The following product names are covered by this opinion:

- | | |
|-----------------------|-----------------|
| 1. Agri-Dex | 2. AquaSurf |
| 3. Bond | 4. Bronc Max |
| 5. Bronc Plus Dry-EDT | 6. Class Act NG |
| 7. Competitor | 8. Cut Rate |
| 9. Cygnet Plus | 10. Destiny HC |
| 11. Exciter | 12. Fraction |
| 13. InterLock | 14. Kinetic |
| 15. Level 7 | 16. Liberate |
| 17. Magnify | 18. One-AP XL |
| 19. Pro AMS Plus | 20. Spray-Rite |
| 21. Superb HC | 22. Tactic |
| 23. Tronic | |

- h. **Herbicide carriers.** Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil. Use of diesel oil as an herbicide carrier is not covered by this opinion.
- i. **Dyes.** Use a non-hazardous indicator dye (*e.g.*, Hi-Light or Dynamark™) with herbicides within 100 feet of water. The presence of dye makes it easier to see where the herbicide has been applied and where or whether it has dripped, spilled,

¹⁷ The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and grantees 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.

or leaked. Dye also makes it easier to detect missed spots, avoid spraying a plant or area more than once, and minimize over-spraying (SERA 1997).

- j. **Herbicide mixing.** Mix herbicides and adjuvants, carriers, and/or dyes more than 150 feet from any perennial or intermittent water body to minimize the risk of an accidental discharge.
- k. **Tank Mixtures.** The potential interactive relationships that exist among most active ingredient combinations have not been defined and are uncertain. Therefore, combinations of herbicides in a tank mix are not covered by this opinion.
- l. **Spill Cleanup Kit.** Provide a spill cleanup kit whenever herbicides are used, transported, or stored. At a minimum, cleanup kits will include material safety data sheets, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain spills.
- m. **Herbicide application rates.** Apply herbicides at the lowest effective label rates.
- n. **Herbicide application methods.** Apply liquid or granular forms of herbicides as follows:
 - i. Hand/selective – wicking and wiping, basal bark, fill (“hack and squirt”), stem injection, cut-stump.
 - ii. Spot spraying – hand held nozzles attached to back pack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants.
 - iii. Broadcast spraying – hand held nozzles attached to back pack tanks or vehicles, or by using vehicle mounted booms.
 - 1. Triclopyr – will not be applied by broadcast spraying.
 - iv. Keep the spray nozzle within four feet of the ground when applying herbicide. If spot or patch spraying tall vegetation more than 15 feet away from the high water mark, keep the spray nozzle within 6 feet of the ground.
 - v. Apply spray in swaths parallel towards the project area, away from the waterbody and desirable vegetation, *i.e.*, the person applying the spray will generally have their back to the creek or other sensitive resource.
 - vi. Avoid unnecessary run off during cut surface, basal bark, and hack-squirt/injection applications.
- o. **Washing spray tanks.** Wash spray tanks 300 feet or more away from any surface water.
- p. **Minimization of herbicide drift and leaching.** Minimize herbicide drift and leaching as follows:
 - i. Do not spray when wind speeds exceed 10 miles per hour, or are less than 2 miles per hour.
 - ii. Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.
 - iii. Keep boom or spray as low as possible to reduce wind effects.
 - iv. Increase spray droplet size whenever possible by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.

- v. Do not apply herbicides during temperature inversions, or when air temperature exceeds 80 degrees Fahrenheit.
- vi. Wind and other weather data will be monitored and reported for all broadcast applications.
- q. **Rain.** Do not apply herbicides when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon bearing waters from the treated area is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides may follow label instructions. Do not conduct hack-squirt/injection applications during periods of heavy rainfall.
- r. **Herbicide buffer distances.** Observe the following no-application buffer-widths, measured in feet, as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Widths are based on herbicide formula, stream type, and application method, during herbicide applications (Table 2). Before herbicide application begins, flag or mark the upland boundary of each applicable herbicide buffer to ensure that all buffers are in place and functional during treatment.

Table 2. Herbicide buffer distances by herbicide formula, stream type, and application method.

Herbicide	No Application Buffer Width (feet)					
	Streams and Roadside Ditches with flowing or standing water present and Wetlands			Dry Streams, Roadside Ditches, and Wetlands		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
Aquatic Glyphosate	100	waterline	waterline	50	None	none
Aquatic Imazapyr	100	15	waterline	50	None	none
Aquatic Triclopyr-TEA	Not Allowed	15	waterline	Not Allowed	None	none
Low Risk to Aquatic Organisms						
Imazapic	100	15	bankfull elevation	50	None	none
Clopyralid	100	15	bankfull elevation	50	None	none
Metsulfuron-methyl	100	15	bankfull elevation	50	None	none
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	bankfull elevation	50	15	bankfull elevation
Sulfometuron-methyl	100	50	5	50	15	bankfull elevation
Chlorsulfuron	100	50	bankfull elevation	50	15	bankfull elevation
High Risk to Aquatic Organisms						
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50

*waterline is defined as the ordinary high water.

*bankfull elevation is defined as the elevation point at a given location along a river which is intended to represent the maximum water level that will not overflow the river banks or cause any significant damages from flooding.

Post-Construction

35. Actions Requiring Post-Construction Stormwater Management (PCSM).

- a. Provide PCSM for any action that will:
 - i. Increase the impervious area within the project area, including roads, driveways, parking lots, sidewalks, roofs, and other waterproof structures.
 1. Gravel road surfaces are considered impervious and stormwater treatment and management is required identical to an asphalt or concrete roadway. When modeling stormwater runoff from gravel roads, refer to your state department of transportation's guidance for determining the runoff coefficient C for gravel roads¹⁸.
 - ii. Construct new pavement that increases capacity or widens the road prism.
 - iii. Reconstruct pavement down to subgrade.
 - iv. Rehabilitate or restore a stream crossing or bridge to repair structural or functional deficiencies that are too complicated to be corrected through normal maintenance, except for seismic retrofits that make a bridge more resistant to earthquake damage (e.g., external post-tensioning, supplementary dampening) but do not affect the bridge deck or drainage.¹⁹
 - v. Change stormwater conveyance.
- b. PCSM is not required for actions that replace or make minor repairs to existing impervious areas, not including ones covered with coal tar or galvanized material unless that material has been sealed or otherwise confined so that it will not leach into runoff. The repairs may include chip seal, grind/inlay, overlay and resurfacing (i.e., nonstructural pavement preservation, a single lift or inlay).
- c. To provide PCSM, prepare and carry out a plan that is commensurate with the scope of the action and includes site sketches, drawings, specifications, and other data as needed to explain how post-construction runoff from all impervious area within the project area will be treated with stormwater control measures (SCMs) for water quality (pollution reduction) and quantity (detention or retention) as follows:
 - i. For water quality, first reduce by treating post-construction runoff using on-site infiltration to the maximum extent feasible. Any runoff not infiltrated on-site must be treated at least 50% of the cumulative rainfall from the 2-year, 24-hour storm before being discharged off-site. If stormwater treatment is unattainable for gravel road surfaces, provide justification for why the site cannot treat stormwater and provide stormwater management that includes but is not limited to the use of

¹⁸ Refer to Appendix F-Rational Method from the Oregon Department of Transportation Hydraulics Manual (2011), Appendix D from the Catalog of Stormwater Best Management Practices for Idaho Cities and Counties (2005), and Department of Ecology Eastern and Western Washington stormwater manuals (20012 & 2014) to determine the runoff coefficient.

¹⁹ Stormwater management recommendations for road-stream crossings include but are not limited to berms, curbs, routing surface runoff into existing vegetation, riparian plantings, planters, and water bars when appropriate. Maintenance is defined to maintain or rehabilitate existing pavement in good condition and before the onset of serious damage, including routing and preventative maintenance and minor rehabilitation to extend pavement life by treatments at or near the surface, but without making structural improvements or changes to road capacity or geometry.

waterbars, ditches lined with native vegetation or rock if the slope is >5%, diversion ditches, diversion berms, vegetated turnouts, velocity controls and energy dissipaters.

1. All water quality SCMs must be provided with adequate pretreatment as necessary to prevent overloading, primarily by sediment, and to dissipate energy or provide additional storage.
 2. SCMs with no subdrains designed for on-site infiltration through vegetation and soil media specifically engineered for water quality treatment (soil composition and depth, water residence time) include but are not limited to the following examples:
 - a. Bio-retention area
 - b. Constructed wetland
 - c. Drywell
 - d. Green roof
 - e. Infiltration trench
 - f. Impervious area removal
 - g. Porous pavement
 - h. Rain garden
 - i. Tree canopy
 - j. Upland dispersal (appropriate sites only)
 - k. Vegetated area
 - l. Wet pond
 3. SCMs for off-site discharge include but are not limited to the following examples:
 - a. Any practice listed above that is also equipped with an impermeable liner or sub-drain.
 - b. Dry pond
 - c. Proprietary technology demonstrated to be as effective as vegetated stormwater practices.
- ii. For water quantity, ensure that any discharge of post-construction runoff either directly, or indirectly through a conveyance system, into a fresh waterbody, including wetlands, does not exceed the range of discharge rated for the pre-developed site condition²⁰ from 50% of the 2-year peak flow up to the 10-year peak flow.
1. This requirement does not apply to stormwater discharges into streams that are in basins with greater than 100 square miles.
 2. SCMs for flow control:
 - a. Catch basins or manholes with outflow controls
 - b. Detention ponds, roofs, parking lots, tanks, or vaults
 - c. Infiltration facilities
- iii. When conveyance is necessary to discharge treated stormwater into a fresh waterbody, including a wetland, the following requirements apply:
1. Maintain natural drainage patterns.

²⁰ Pre-developed site condition means pre-settlement forest cover, unless historical information indicates otherwise or the immediate area and all subsequent downstream basins have at least 40% impervious cover. In that case, pre-developed condition will mean the existing land cover conditions.

2. Ensure that treatment for post-construction runoff from the site is completed before it is allowed to commingle with any offsite runoff in the conveyance.
3. Prevent erosion of the flow path from the site to the receiving water and, if necessary, provide a discharge facility made entirely of manufactured elements (*e.g.*, pipes, ditches, discharge facility protection) that extends at least to ordinary high water.
- iv. Include a maintenance plan and schedule for each SCM, including the name and contact information for the entity responsible for that maintenance.
- v. Include the name and contact information for the person responsible for preparing the PCSM plan.
- d. A PCSM plan prepared for an action covered under this opinion will need to be reviewed and verified by NMFS.²¹

36. Site Restoration

- a. Restore any significant disturbance of riparian vegetation, soils, stream banks or stream channel.
- b. Remove all project related waste; *e.g.*, pick up trash, sweep roadways in the project area to avoid runoff-containing sediment, *etc.*
- c. Obliterate all temporary access roads, crossings, and staging areas.
- d. Loosen compacted areas of soil when necessary for revegetation or infiltration. In many cases tillage will be necessary to decompact soils and restore infiltration ability and soil productivity. A variety of implements/methods are available to decompact soils, including: winged subsoilers, rock ripper, excavators with brush rakes, mulching heads, or custom attachments such as the subsoiling grapple rake and subsoiling excavating bucket (*egg.* Ripping soils with an excavator bucket mounted with teeth). The depth of needed tillage can be estimated by referring to the rooting depth of nearby native vegetation. In areas of dispersed soil disturbance consider spot tillage.
- e. Although no single criterion is sufficient to measure restoration success, the intent is that the following features should be present in the upland parts of the project area, within reasonable limits of natural and management variation:
 - i. Human and livestock disturbance, if any, are confined to small areas necessary for access or other special management situations.
 - ii. Areas with signs of significant past erosion are completely stabilized and healed, bare soil spaces are small and well-dispersed.
 - iii. Soil movement, such as active rills and soil deposition around plants or in small basins, is absent or slight and local.

²¹ The most efficient way for a grantee or FEMA to prepare and submit a PCSM for NMFS' review in Oregon, Washington, or Idaho is to attach a completed *Post-Construction Stormwater Management Plan Checklist* (ODEQ updated 2016, or the most recent version), with the electronic notification when it is sent to the **FEMA Programmatic mailbox**. For actions in Washington State, follow the most recent Department of Ecology stormwater manual or an equivalent manual approved by the Department of Ecology. For actions in Idaho State, a Stormwater Pollution Prevention Plan (SWPPP) is required for construction and industrial related activities under EPA's jurisdiction.

- iv. Native woody and herbaceous vegetation, and germination microsites, are present and well distributed across the site; invasive plants are absent.
- v. Plants have normal, vigorous growth form, and a high probability of remaining vigorous, healthy and dominant over undesired competing vegetation.
- vi. Plant litter is well distributed and effective in protecting the soil with little or no litter accumulated against vegetation as a result of active sheet erosion (“litter dams”).
- vii. A continuous corridor of shrubs and trees appropriate to the site are present to provide shade and other habitat functions for the entire streambank.

37. Revegetation

- a. Plant and seed disturbed areas before or at the beginning of the first growing season after construction.
- b. 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.* When feasible, use vegetation salvaged from local areas scheduled for clearing due to development.
- c. For long-term revegetation use only species native to the project area or region that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site.
- d. Short-term stabilization measures may include use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.
- e. Do not apply surface fertilizer within 50 feet of any wetland or water body.
- f. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
- g. Do not use invasive or non-native species for site restoration.
- h. Conduct post-construction monitoring and treatment to remove or control invasive plants until native plant species are well-established.

38. Actions That Require Compensatory Mitigation

- a. The FEMA will rely on 44 CFR 9.11 when considering appropriate mitigation to restore aquatic or floodplain values. Grantees will follow the mitigation sequence that lists options in descending order of preferred methods. The preferred for a grantee is to provide in-kind, on-site compensatory actions within the project action area. The second option is to provide in-kind, off-site compensation within the same 5th field HUC watershed that the project is located in, as close to the project area as possible, and preferably within the same 6th field sub-watershed. If in-kind mitigation is not feasible the third option is to provide on-site, out-of-kind mitigation. The last and least preferred option is either to: a) purchase credits from an appropriate mitigation bank or purchase credits from an approved in-lieu-fee sponsor; or b) conduct off-site, out-of-kind mitigation. In all cases the grantee will need to document how they considered each option, and why any of the generally more preferred methods were not practicable and/or more effective for the proposed action. In some cases banking or other generally less preferred

approaches may be the only ones practical due to site conditions and/or the scale of the proposed project and its associated funding request.

- b. The NMFS will verify compensatory mitigation plans.
- c. The following actions in this programmatic will require compensatory mitigation:
 - i. Any stormwater management facility that requires a new or enlarged structure within the riparian zone; or that has insufficient capacity to infiltrate and retain the volume of stormwater called for by this opinion.
 - ii. Any riprap revetment that extends rock above the streambank toe, extends the use of riprap laterally into an area that was not previously revetted, or revetment that does not include adequate vegetation and LW (PDC #42f &g).
 - iii. Any action that displaces riparian or aquatic habitats or otherwise prevents development of properly functioning condition of natural habitat processes, unless the grantee can demonstrate that all the impacts are short-term. This includes but is not limited to construction of enlarged boat ramp or float, the addition of scour protection to a boat ramp, or construction of new impervious surfaces without adequate stormwater treatment.
- d. Include the name, address, and telephone number of a person responsible for designing this part of the action that NMFS may contact if additional information is necessary to complete the effects analysis.
- e. Describe practices that will be used to ensure:
 - i. No net loss of habitat function
 - ii. Completion before, or concurrent with, construction whenever possible
 - iii. Achieve a mitigation ratio that is greater than one-to-one and larger (*e.g.*, 1.5 to 1.0) when necessary to compensate for any time lags between the loss of conservation value in the project area and replacement of conservation value in the mitigation area, uncertainty of conservation value replacement in the mitigation area, or when the affected area has demonstrably higher conservation value than the mitigation area.²²
 - iv. When practicable and environmentally sound, mitigation should be near the project impact site, or within the same 6th field HUC sub-watershed and stream(s) occupied by the affected population(s) and age classes. Mitigation should be completed prior to or concurrent with the adverse impacts, or have an increased ratio as noted above.
 - v. To minimize delays and objections during the review process, grantees are encouraged to seek the advice of NMFS during the planning and design of mitigation plans. For complex mitigation projects, such consultation may improve the likelihood of mitigation success and reduce permit-processing time.
- f. For riprap:
 - i. The primary habitat functions of concern are related to floodplain connectivity, forage, natural cover, and free passage.

²² For additional information on compensatory mitigation, see Floodplain Habitat Assessment and Mitigation, Regional Guidance for the Puget Sound Basin More information is available from FEMA Region 10, Bothell, Washington.

- ii. Acceptable mitigation for those losses include removal of existing riprap; retrofit existing riprap with vegetated riprap and LW, or one or more other streambank stabilization methods described in this opinion, and restoration of shallow water or off-channel habitats.
- g. For a bridge replacement and additional rock armoring:
 - i. The primary habitat functions of concern are floodplain connectivity, forage, natural cover, and free passage.
 - ii. Acceptable mitigation is removing fill from elsewhere in the floodplain – native channel material, soil and vegetation may not be counted as fill.
- h. For displaced riparian and aquatic habitat:
 - i. The primary habitat functions of concern are related to the physical and biological features essential to the long-term conservation of listed species. Those are water quality, water quantity, channel substrate, floodplain connectivity, forage, natural cover, space, and free passage.
 - ii. Examples of acceptable mitigation for riparian losses includes planting trees or other woody vegetation in the riparian area at a stocking rate that will compensate for loss functions due the age, size, numbers, and diversity of lost vegetation; removal of existing overwater structures or restoration of shallow-water, off-channel, or beach habitat by adding features such as submerged or overhanging large wood, aquatic vegetation, large rocks and boulders, side channels and undercut banks.
 - iii. For new impervious surfaces with inadequate stormwater treatment, the primary habitat functions of concern are water quality and water quantity. Examples of acceptable mitigation for inadequate stormwater management includes providing adequate stormwater treatment at an alternate site where it did not exist before or retrofitting an existing but substandard stormwater facility to provide capacity necessary to infiltrate and retain the proper volume of stormwater.
 - iv. As part of NMFS’s review, NMFS will determine if the proposed compensatory mitigation adequately offsets permanent displacement of riparian or aquatic habitats and/or impacts that prevent development of properly functioning processes.
- i. Mitigation actions will meet general construction criteria and other appropriate minimization measures (dependent on the type of proposed mitigation).

1.3.1.3 Project Design Criteria - Types of Actions

39. Road, culvert, and bridge repair, rehabilitation and replacement

- a. Project fish passage criteria is found in the most recent version of NMFS *Anadromous Salmonid Fish Facility* design manual (NMFS 2011a or subsequent version).
 - i. Project structures affecting fish passage shall adhere to industry engineering and construction methods and standards found in the most recent version of one of the following:
 - 1. *Water Crossings Design Guidelines* (Barnard *et al.* 2013).

2. *Part XII, Fish Passage Design and Implementation, Salmonid Stream Habitat Restoration Manual* (California Department of Fish and Game 2009).
 3. *Rock Weir Design Guidance* (USBR 2016).
 4. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream* (USDA-Forest Service 2008).
 5. Or other design references verified by NMFS.
- b. Routine road surface, culvert and bridge maintenance activity will be completed in accordance with Oregon, Washington, and Idaho state specific transportation manuals:²³
- i. Any conflict between the state specific manuals and this opinion (*e.g.*, stormwater management for maintenance yards, erosion repair related to use of riprap, dust abatement, and use of pesticides) will be resolved in favor of PDC in this opinion.
 - ii. Grade stabilization. Grade control materials may include both rock and LW. Material shall not in any part consist of gabion baskets, sheet piles, concrete, articulated concrete blocks, or cable anchors.
 - iii. Grade control shall be provided using morphologically-appropriate drop structures including; constructed riffles for riffle-pool morphologies, rough constructed riffles/ramps for plane bed morphologies, wood/debris jams, rock bands, and boulder weirs for step-pool morphologies, and roughened channels for cascade morphologies.
 - iv. LW placements and ELJs may be used to control grade individually or together with other grade control methods by simulating natural log jams and debris accumulation that traps sediment and creates forced, riffle-pool, step-pool, or cascade-pool morphologies.
 - v. Stream banks and bed shall be designed to be immobile at the design event to reduce undermining and flanking.
 - vi. The crest of channel spanning structures will be slightly sloped on either side, with the low point in the center, to direct flows to the middle of channel and away from streambanks. Install these structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.0- to 1.5-year flow event).
 - vii. Key all structures into the streambed at a depth which minimizes structure undermining due to scour, at least 2.5 times their exposure height, or the Lower Vertical Adjustment Potential (LVAP) line with an offset of 2 times D_{90} , whichever is deeper.

²³ ODOT Routine Road Maintenance: Water Quality and Habitat Guide Best Management Practices (ODOT 2014); WSDOT Highway Runoff Manual (HRM) (WSDOT 2014) or Washington Department of Ecology Stormwater Management and Design Manuals for Eastern and Western Washington (Dept. of Ecology 2004, 2014), and Endangered Species Act Biological Opinion and Magnuson Stevens Act Essential Fish Habitat Response for Funding or Permitting of Routine Maintenance Activities on State Highways; Salmon River Basin; Clearwater River Basin, and Lower Snake Asotin Subbasins; 170602, 170603, 1706103; Idaho. (Refer to: 2010/01122 & 2010/06828) (May 17, 2012) or the most recent version verified by NMFS, unless maintenance activities and practices in those manual conflicts with the PDCs in this opinion.

1. LVAP, and 2 times D_{90} offset, as calculated in *Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings* (USDA-Forest Service 2008).
- viii. Structures should be keyed into both banks—if feasible greater than 8 feet.
- ix. If several drop structures will be used in series, space them at the appropriate distances to promote fish passage of target species and life histories. Incorporate NMFS (2011a) fish passage criteria (jump height, pool depth, *etc.*) in the design of drop structures.
- x. Spacing for boulder weirs should be no closer than the net drop divided by the channel slope (for example, a one-foot high step structure designed with a project slope of two-percent gradient will have a minimum spacing of 50-feet [1/0.02]). Maximum project slope for boulder weir designs is 5%.
- xi. A series of short steep rough ramps/chutes, cascades, or roughened channel type structures, broken up by energy dissipating pools, are required where project slope is greater than 5%.
- c. Road-stream crossing replacement
 - i. General road-stream crossing criteria
 1. Span
 - a. Span is determined by the crossing width at the proposed streambed grade.
 - b. Single span structures will maintain a clear, unobstructed opening above the general scour elevation that is at least as wide as 1.5 times the active channel width.²⁴
 - c. Multi-span structures will maintain clear, unobstructed openings above the general scour elevation (except for piers or interior bents) that are at least as wide as 2.2 times the active channel width.
 - d. Entrenched streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the crossing width will accommodate the flood prone width. Flood prone width is the channel width measured at twice the maximum bankfull depth (Rosgen 1996).
 - e. Minimum structure span in perennial streams is 6 feet.
 2. Bed Material
 - a. Install clean alluvium with similar angularity as the natural bed material, no crushed rock.
 - b. Bed material shall be designed based on the native particle size distribution of the adjacent channel or reference reach, as quantified by a pebble count.

²⁴ Active channel width means the stream width measured perpendicular to stream flow between the OHW lines, or at the channel bankfull elevation if the OHW lines are indeterminate. This width includes the cumulative active channel width of all individual side- and off-channel components of channels with braided and meandering forms, and measure outside the area influence of any existing stream crossing, *e.g.*, five to seven channel widths upstream and downstream. The 1.5 times bankfull width requirement is the standard for current programmatic biological opinions including SLOPES Stormwater, Transportation, & Utilities (WCR-2013-10411), BPA Transmission WCR-2014-1600), USFWS PROJECTS (WCR-2013-10221), BPA HIP (WCR-2013-9724), SLOPES Restoration (WCR-2013-9717), and FAHP in the State of Oregon (WCR-2011-02095)

- c. Rock band designs as detailed in *Water Crossings Design Guidelines* (Barnard *et al.* 2013) are authorized.
 - d. Bed material in systems where stream gradient exceeds 3% may be conservatively sized to resist movement.
3. Scour Prism
- a. Designs shall maintain the general scour prism, as a clear, unobstructed opening (*i.e.*, free of any fill, embankment, scour countermeasure, or structural material to include abutments, footings, and culvert inverts). No scour or stream stability countermeasure may be applied above the general scour elevation.²⁵
 - a. The lateral delineation of the scour prism is defined by the criteria span.
 - b. The vertical delineation of the scour prism is defined by the LVAP with an additional offset of 2 times D_{90} , as calculated in *Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings* (USDA-Forest Service 2008).
 - b. When bridge abutments or culvert footings are set back beyond the applicable criteria span they are outside the scour prism.
4. Embedment
- a. All abutments, footings, and inverts shall be placed below the thalweg a depth of 3 feet, or the LVAP line with an offset of 2 times D_{90} , whichever is deeper.
 - a. LVAP, and 2 times D_{90} offset, as calculated in *Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings* (USDA-Forest Service 2008).
 - b. In addition to embedment depth, embedment of closed bottom culverts shall be between 30% and 50% of the culvert rise.
 - c. In specific cases, embedment may not be feasible due to site constraints, such as bedrock, sewer pipes, buried utilities, etc. If this occurs, provide justification to the NMFS staff biologist on why embedment cannot occur at the project site and verify that the proposed design meets fish passage requirements with a NMFS engineer.
5. Bridges
- a. Primary bridge structural elements will be concrete, metal, fiberglass, or untreated timber. The use of treated wood for bridge construction or replacement is not part of this proposed action. The use of treated wood for maintenance

²⁵ For guidance on how to complete bridge scour and stream stability analysis, see Lagasse *et al.* (2012) (HEC-20), Lagasse *et al.* (2001) (HEC-23), Richardson and Davis (2001) (HEC-18), ODOT (2011), and AASHTO (2013).

- and repair of existing wooden bridges is part of the proposed action if in conformance with project design criterion 29.
- b. All concrete will be poured in the dry, or within confined waters not connected to surface waters, and will be allowed to cure a minimum of 7 days before contact with surface water as recommended by Washington State Department of Transportation (WSDOT 2010).
 - c. Riprap may only be placed below bankfull height of the stream when necessary for protection of abutments and pilings. The placement of riprap will not constrict the bankfull width.
 - d. Temporary work bridges will also meet the latest version of NMFS (2011a) criteria.
- d. The electronic notification for each permanent stream crossing replacement will contain the following:
- i. Site sketches, drawings, aerial photographs, or other supporting specifications, calculations, or information that is commensurate with the scope of the action, that show the bankfull width, the 100-year floodplain, any artificial fill within the project area, the existing crossing to be replaced, and the proposed crossing.
 - ii. A completed scour and stream stability analysis for any crossing that includes scour or stream stability countermeasures within the crossing opening that shows the general scour elevation and the local scour elevation for any pier or interior bent.
 - iii. The name, address, and telephone number of a person responsible for designing this part of the action that NMFS may contact if additional information is necessary to complete the effects analysis.
- e. Rock Structures
- i. Rock structures will be constructed out of a mix of well-graded boulder, cobble, and gravel, including the appropriate level of fines, to allow for compaction and sealing to ensure minimal loss of surface flow through the newly placed material.
 - ii. Rock sizing depends on the size of the stream, maximum depth of flow, plan form, entrenchment, and ice and debris loading.
 - iii. Large structural rock should be present throughout the bed and banks of the project reach, not only consolidated, or present, at drop structures.
 - iv. The project designer or an inspector experienced in these structures should be present during installation.
 - v. To ensure that the structure is adequately sealed, no sub-surface flow will be present before equipment leaves the site.
 - vi. Rock shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used.
 - vii. Where feasible, channel spanning structures should be coupled with LW to improve habitat complexity of riparian areas.

- f. Structure Stabilization
 - i. When a footing, facing, head wall, or other protection will be constructed with rock to prevent scouring or down-cutting of, or fill slope erosion or failure at, an existing culvert or bridge, the amount of rock used is limited to the minimum necessary to protect the integrity of the structure. Include soil, vegetation, and wood throughout the structure to the level possible.
 - g. **NMFS fish passage review and verification.** The FEMA will await NMFS review of any installment, replacement, or improvement of a structure and upon verification, condition the grant funding per 2 CRF Part 200. Fish passage and verification must be consistent with NMFS's fish passage criteria (NMFS 2011a).
- 40. Stormwater facilities and outfalls**
- a. Any action involving stormwater facilities and/or stormwater outfalls will meet the stormwater management criteria found in PDC 35, Actions Requiring PCSM.
 - b. **NMFS Verification.** The NMFS will review proposed stormwater treatment and new or upgraded stormwater outfalls plans.
- 41. Utilities**
- a. Design utility line stream crossings in the following priority:
 - i. Aerial lines, including lines hung from existing bridges.
 - ii. Directional drilling, boring and jacking that spans the channel migration zone and any associated wetland.
 - iii. Trenching – this method is restricted to intermittent streams and may only be used when the stream is naturally dry, all trenches will be backfilled below the OHW for riverine systems or the HAT line for marine systems with native material and capped with clean gravel suitable for fish use in the project area.
 - iv. Align each crossing as perpendicular to the watercourse as possible.
 - v. Ensure that the drilled, bored or jacked crossings are below the total scour prism.
 - vi. Any large wood displaced by trenching or plowing will be returned as nearly as possible to its original position, or otherwise arranged to restore habitat functions.
 - b. In preventing and minimizing the effects of an inadvertent return of drilling fluids to the surface (frac-out release) from HDD operations, the following conservation measures shall be taken:
 - i. The grantee will have all necessary equipment and supplies on-site to contain an unintended release of drilling mud.
 - ii. The entry and exit locations on all directionally drilled crossings shall have dry (upland) land segments where a frac-out can be easily detected, contained, and remediated.
 - iii. On-site visual monitoring by a knowledgeable HDD inspector must occur during construction operations and of the construction area including coverage upstream and downstream from the crossing for inadvertent returns.
 - iv. If a frac-out has been detected due to visual signs of surface seepage or loss of circulation/pressure of the drilling fluid, drilling operations will be

stopped immediately and will not continue until the response/containment process has been initiated and under control.

1. The grantee must notify all agencies immediately if an unintended release of drilling mud occurs.
- v. A frac-out contingency plan must be in place to handle potential problems that could arise during the HDD and the plan must have NMFS review and verification. The plan should include the following site specific information:
 1. Geotechnical information including soil type, elevation, and depth of the HDD;
 2. A containment, response, and notification plan;
 3. Clean-up measures; and
 4. Restoration and post-construction monitoring plan.

42. **Streambank and channel stabilization**

- a. The streambank and channel stabilization action category is to ensure that roads, culverts, bridges and utility lines do not become hazardous due to the long-term effects of toe erosion, scour, subsurface entrainment, or mass failure.
- b. The following streambank stabilization methods (as further described below) may be used individually or in combination:
 - i. Alluvium placement
 - ii. Large wood placement
 - iii. Vegetated riprap with large wood
 - iv. Roughened toe
 - v. Woody plantings
 - vi. Herbaceous cover, in areas where the native vegetation does not include trees or shrubs
 - vii. Bank reshaping and slope grading
 - viii. Coir logs
 - ix. Deformable soil reinforcement
 - x. ELJs
 - xi. Floodplain flow spreaders
 - xii. Floodplain roughness
- c. For more information on the above methods see Federal Emergency Management Agency (FEMA 2009) Engineering with Nature, Natural Resources Conservation Service (NRCS 2016) Natural Channel and Floodplain Restoration, Applied Fluvial Geomorphology, or Cramer *et al.* (2003) Washington State Aquatic Habitat Guidelines Program: Integrated Streambank Protection Guidelines. Other than those methods relying solely upon woody and herbaceous plantings, streambank stabilization projects must be designed by a qualified engineer that is appropriately registered in the state where the work is performed.
- d. Stream barbs and full-spanning weirs are not allowed for stream bank stabilization under this opinion.
- e. **Alluvium placement** can be used as a method for providing bank stabilization using imported gravel/cobble/boulder-sized material of the same composition and size as that in the channel bed and banks, to halt or attenuate streambank erosion, and stabilize riffles. This method is predominantly for use in small to moderately

sized channels and is not appropriate for application in mainstem systems. Alluvium placement is a method designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.

- i. **NMFS fish passage verification.** The NMFS will review alluvium placement projects that would occupy more than 25% of the channel bed or more than 25% of the bankfull cross sectional area.
- ii. This design method is only verified in those areas where the natural sediment supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate or simulate sediment accumulations in conjunction with other structures, such as LW placements and ELJs.
- iii. When a hole in the channel bed caused by local scour will be filled with rock to prevent damage to a culvert, road, or bridge foundation, the amount of rock will be limited to the minimum necessary to protect the integrity of the structure.
- iv. When a footing, facing, head wall, or other protection will be constructed with rock to prevent scouring or down-cutting of, or fill slope erosion or failure at, an existing culvert or bridge, the amount of rock used will be limited to the minimum necessary to protect the integrity of the structure. Whenever feasible, include soil and woody vegetation as a covering and throughout the structure.
- v. Material used to construct the toe should be placed in a manner that mimics attached longitudinal bars or point bars.
- vi. Size distribution of toe material will be diverse and predominately comprised of D_{84} to D_{max} size class material.
- vii. Spawning gravels will constitute at least one-third of the total alluvial material used in the design.
- viii. Spawning gravels are to be placed at or below an elevation consistent with the water surface elevation of a bankfull event.
- ix. Spawning size gravel can be used to fill the voids within toe and bank material and placed directly onto stream banks in a manner that mimics natural debris flows and erosion.
- x. All material will be clean alluvium with similar angularity as the natural bed material. When possible use material of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.
- xi. Material can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.
- xii. Crushed rock is not permitted.
- xiii. After placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.

- xiv. Do not place material directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.
 - xv. Imported material will be free of invasive species and non-native seeds. If necessary, wash prior to placement.
- f. **Large Wood Placements** are defined as structures composed of LW that do not use mechanical methods as the means of providing structure stability (*i.e.*, large rock, rebar, rope, cable, *etc.*). The use of native soil, alluvium with similar angularity as the natural bed material, large wood, or buttressing with adjacent trees as methods for providing structure stability are authorized. This method is predominantly for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.
- i. **NMFS fish passage review and verification.** NMFS will review LW placement projects that would occupy greater than 25% of the bankfull cross section area.
 - ii. The grantee will procure logs from an upland area to use as large wood. However, with NMFS review and verification, riparian trees may be dislodged or felled for constructing instream habitat in areas where the project will not significantly impact stream shading or streambank stability, sufficient natural recruitment of native woody vegetation is expected, the threat of invasive vegetation filling created gaps is minimal and replanting with native woody species is planned, and the trees to be felled are not providing suitable habitat for ESA-listed terrestrial species.
 - iii. Structure shall simulate disturbance events to the greatest degree possible and include, but not be limited to, log jams, debris flows, wind-throw, and tree breakage.
 - iv. Structures may partially or completely span stream channels or be positioned along stream banks.
 - v. Where structures partially or completely span the stream channel, LW should be comprised of whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates.
 - vi. Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, *etc.*
 - vii. For individual logs that are completely exposed, or embedded less than half their length, logs with rootwads should be a minimum of 1.5 times bankfull channel width, while logs without rootwads should be a minimum of 2.0 times bankfull width.
 - viii. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.
- g. **Vegetated riprap with large wood (LW)**
- i. NMFS will review and verify bank stabilization projects that use vegetated riprap with LW.

- ii. When this method is necessary, limit installation to the areas identified as most highly erodible, with highest shear stress, or at greatest risk of mass-failure, and provide compensatory mitigation. The greatest risk of mass-failure will usually be at the toe of the slope and will not extend above OHW (riverine) or HAT (marine) elevation except in incised streams.
- iii. Do not use invasive or non-native species for site restoration.
- iv. Remove or control invasive plants until native plant species are well-established.
- v. Do not apply surface fertilizer within 50-feet of any stream channel.
- vi. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
- vii. Vegetated riprap with LW will be installed as follows:
 1. When present, use natural hard points, such as large, stable trees or rock outcrops, to begin or end the toe of the revetment.
 2. Develop rock size gradations for elevation zones on the bank, especially if the rock will extend above OHW (riverine) or the HAT (marine) – the largest rock should be placed at the toe of the slope, while small rock can be used higher in the bank where the shear stress is generally lower. Most upper bank areas will not require the use of any rock but can depend on the vegetation for erosion protection.
 3. For bank areas above OHW or the HAT where rock is still deemed necessary, mix rock with soil to provide a better growing medium for plants.
 4. Minimum amount of wood incorporated into the treated area, for mitigation of riprap, is equal to the number of whole trees whose cumulative summation of rootwad diameters is equal to 80% of linear-feet of treated streambank or 20% of the treated area (square feet) of streambank, whichever is greater.
 5. Where whole trees are not used (*i.e.*, snags, logs, and partial trees) designers are required to estimate the dimensions of parent material based on rootwad diameter, and calculating a cumulative equivalency of whole trees.
 6. LW should be distributed throughout the structure (not just concentrated at the toe) to engage flows up to the bankfull flow. LW placed above the toe may be in the form of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, *etc.* Maximize the exposure of wood to water by placing and orienting wood to project into the water column up to the bankfull elevation.
 7. Develop an irregular toe and bank line to increase roughness and habitat value.
 8. Use LW and irregular rock to create large interstitial spaces and small alcoves to create planting spaces and habitat to mitigate for flood-refuge impacts – do not use geotextile fabrics as filter behind

the riprap whenever possible, if a filter is necessary to prevent sapping, use a graduated gravel filter.

9. Structure toe will incorporate LW with intact rootwads. Minimum spacing between rootwads placed at the toe will be no greater than an average rootwad diameter.
 10. Minimum rootwad diameter for LW placed at the toe of the structure shall be 1.0 times the bankfull depth, unless LW availability constrains the project to a smaller rootwad size. Where rootwad size is constrained due to availability, the largest diameter rootwads available should be used.
 11. LW placed at the toe will be sturdy material, intact, hard, and undecayed and should be sized or embedded sufficiently to withstand the design flood.
 12. Space between root wads may be filled with large boulders, trimmed or untrimmed, whole trees, logs, snags, slash, *etc.* When used, diameter of boulders placed between toe logs with rootwads should be 1.5 to 2.0 times log diameter at breast height (dbh) of adjacent toe logs. A reasonable maximum rock size is 5-6 feet in diameter.
 13. Plant woody vegetation in the joints between the rocks to enhance streambank vegetation.
 14. Where possible, use terracing, or other bank shaping, to increase habitat diversity.
 15. When possible, create or enhance a vegetated riparian buffer.
- viii. Monitor vegetated riprap each year following installation by visual inspection during low flows to examine transitions between undisturbed and treated banks to ensure that native soils above and behind the riprap are not collapsing, sinking, or showing other evidence of piping loss or movement of rock materials; and the overall integrity of the riprap treatment, including:
1. Loss of rock materials
 2. Survival rate of vegetation
 3. Anchoring success of LW placed in the treatment.
 4. Any channel changes since construction.

h. Roughened toe

- i. Where designs use any of the approved streambank stabilization methods outlined in this section, in lieu of lining the bank with riprap above the toe, the design of any rock-filled toe will adhere to project criteria outlined in (c)(viii) Vegetated riprap with large wood (7-15, from above).
 - ii. Minimum amount of wood incorporated into the treated area, for mitigation of riprap, is equal to the number of whole trees whose cumulative summation of rootwad diameters is equal to 80% of linear-feet of treated streambank.
- i. Engineered Logjams (ELJs) are structures designed to redirect flow and change

scour and deposition patterns.²⁶ While providing valuable fish and wildlife habitat, they are also designed to redirect flow and can provide stability to a streambank or downstream gravel bar. To the extent practical, ELJs are designed to simulate stable natural log jams and can be either naturally stable due to LW size and/or stream width or anchored in place using rebar, rock, or piles (driven into a dewatered area or the streambank, but not in water). They are also designed to create a hydraulic shadow, a low-velocity zone downstream that allows sediment to settle out and scour holes adjacent to the structure.

- i. **NMFS fish passage review and verification.** NMFS will review proposed ELJ projects.
- 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. Large wood must be intact, hard, and undecayed to partly decaying, and should have untrimmed root wads to provide functional refugia habitat for fish. Use of decayed or fragmented wood found lying on the ground or partially sunken in the ground is not acceptable. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream.
- 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 streambank or channel.
- vii. Angle and offset – The LW portions of ELJ structures should be oriented such that the force of water upon the LW increases stability. If a rootwad is left exposed to the flow, the bole placed into the streambank should be oriented downstream parallel to the flow direction so the pressure on the rootwad pushes the bole into the streambank and bed.
- viii. Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow.
- ix. If LW mechanical anchoring is required, a variety of methods may be used. These include large angular rock, buttressing the wood between adjacent trees, the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections, may be used. Rock may be used for ballast but is limited to what is needed to anchor the LW. Use of cable or chain is not covered by this opinion.

²⁶ Engineered Logjams are composted of large wood with at least three key members and incorporating the use of any mechanical anchoring system (i.e., rebar, rope, angular, or large rock, etc.). Native soil, simulated streambed and bank materials, wood, or buttressing with adjacent trees, are not mechanical anchoring systems.

43. Streambank restoration.²⁷

- a. The streambank restoration action category includes projects focused on restoring eroded streambanks not due to a road crossing, culvert, bridge, or utility line.
- b. Without changing the location of the bank toe, restore damaged streambanks to a natural slope, pattern, and profile suitable for establishment of permanent woody vegetation.
- c. Complete all soil reinforcement earthwork and excavation in the dry. Use soil layers or lifts that are strengthened with biodegradable fabrics and penetrable by plant roots.
- d. Include large wood in each streambank restoration action to the maximum extent feasible. Large wood must be intact, hard, and undecayed to partly decaying, and should have untrimmed root wads to provide functional refugia habitat for fish. Use of decayed or fragmented wood found lying on the ground or partially sunken in the ground is not acceptable. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream.
- e. Rock may not be used for streambank restoration, except as ballast to stabilize large wood.
- f. Revegetate the streambank and follow the project design criteria for revegetation (PDC # 37).

44. Boulder placement for habitat restoration.²⁸

- a. Boulder placement is limited to stream reaches with an intact, well-vegetated riparian area, including trees and shrubs where those species would naturally occur, or that are part of riparian area restoration action; and a stream bed that consists predominantly of coarse gravel or larger sediments.
- b. Install boulders as follows:
 - i. The cross-sectional area of boulders may not exceed 25% of the cross-sectional area of the low flow channel, or be installed to shift the stream flow to a single flow pattern in the middle or to the side of the stream.
 - ii. Boulders will be machine-placed (no end dumping allowed).
 - iii. Permanent anchoring, including rebar and cables, may not be used.

45. Large wood placement.²⁹

- a. Place large wood in areas where it would naturally occur and in a manner that closely mimic natural accumulations for that particular stream type.
- b. Stabilizing or key pieces of large wood that will be relied on to provide streambank stability or redirect flows must be intact, hard, and undecayed to partly decaying, and should have untrimmed root wads to provide functional refugia habitat for fish.
- c. Use of decayed or fragmented wood found lying on the ground or partially sunken in the ground is not acceptable.

²⁷ For additional information on methods and design for bank shaping; installation of coir logs and soil reinforcements; anchoring and placement of large wood; woody plantings; and herbaceous cover, see Cramer *et al.* (2003), and “riparian restoration and management” in Cramer (2012).

²⁸ For additional information on design and methods for boulder placement, see “boulder clusters” in Cramer (2012).

²⁹ For additional information on selection of large wood for restoration actions, see stream slope and width dimensions and minimum large wood piece diameters described in Figure 1 in the most recent version of ODF and ODFW (1995), WDFW stream habitat restoration guidelines (2012), and for anchoring and placement, see Cramer *et al.* (2003).

- d. Anchoring alternatives may be used in preferential order: 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 and/or rock) to increase the mass of the structure to resist movement; 4) use large boulders as anchor points for the large wood.

46. Off- or side-channel habitat restoration.³⁰

- a. Reconnection of off- and side-channels habitats that have been blocked includes the removal of plugs, which impede water movement through off- and side-channels, and excavation within historical channels that does not exceed the thalweg depth in the main channel. The purpose of the additional sediment removal is to provide unimpeded flow through the side-channel to minimize fish entrapment.
- b. 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.
- c. Data requirements and analysis that must be submitted to NMFS with a request for verification of off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information and sediment contamination potential (PDC 11).
- d. The FEMA will not fund off- or side channel habitat restoration until the action has been reviewed and verified by NMFS.

47. Set-back existing berm, dike, or levee.³¹

- a. To the greatest degree possible, non-native fill material, originating from outside the floodplain of the action area will be removed from the floodplain to an upland site.
- b. 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.
 - i. Breaches shall be equal to or greater than the active channel width.
 - ii. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project and/or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel, thus minimizing fish entrapment.
 - iii. When necessary, loosen compacted soils once overburden material is removed.
- c. 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 does not impede floodplain function.

48. Water control structure removal.

- a. This includes removal of small dams that are less than 10 meters (16.4 feet) high, do not impound contaminated sediments, and are not likely to initiate head-

³⁰ For additional information on methods and design considerations for off- and side-channel habitat restoration, see “side channel/off-channel habitat restoration” in Cramer (2012).

³¹ For additional information on methods and design considerations for levee removal? and modification, see “levee removal and modification” in Cramer (2012).

cutting; channel-spanning structures; subsurface drainage features; tide gates; or instream flow redirection structures. FEMA will fund this type of action if the action can be shown to mitigate future risk by a cost-benefit analysis.

- i. Data requirements and analysis for structure removal include:
 1. A longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream 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.
- ii. A survey of any downstream spawning areas that may be affected by sediment released by removal of the water control structure. 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.

49. In-water or Over-water Structures

- a. Boat ramps. All boat ramps must consist of pre-cast concrete slabs below ordinary high water, and may be cast-in-place above ordinary high water if completed in the dry. Rock may be used to prevent scouring, down-cutting, or failure at the boat ramp, provided that the rock is no larger than necessary and does not extend further than 4-feet from the edge of the ramp in any direction.
- b. Educational signs. To educate the public about pollution from boating activities and its prevention, the FEMA shall require the grantee to include the following information or its equivalent to be posted on a permanent sign that will be maintained at each permitted facility that is used by the public (*e.g.*, a public boat ramp or marina):
 - i. A description of the ESA-listed species which are or may be present in the project area.
 - ii. Notice that adults and juveniles of these species are protected by the ESA and other laws so that they can successfully migrate, spawn, rear, and complete other behaviors necessary for their recovery.
 - iii. Therefore, all users of the facility are encouraged or required to: (i) Follow procedures and rules governing use of sewage pump-out facilities; (ii) minimize the fuel and oil released into surface waters during fueling, and from bilges and gas tanks; (iii) avoid cleaning boat hulls in the water to prevent the release of cleaner, paint and solvent; (iv) practice sound fish cleaning and waste management, including proper disposal of fish waste;

- and (v) dispose of all solid and liquid waste produced while boating in a proper facility away from surface waters.
- c. Flotation material. All synthetic flotation material must be permanently encapsulated to prevent breakup into small pieces and dispersal in water.
 - d. Replacement floats. Any replacement float must be placed at least 50 feet from the shoreline (100-feet from the shoreline in the Columbia River) as measured at ordinary low water or mean lower low water and may not be placed in an estuarine area with submerged aquatic vegetation. Any float wider than 6-feet must also include (a) an open area of grating that is at least 50% of the total surface area,; or (b) be placed where current velocity is at least 0.7 feet per second year-round.
 - i. Replacement, repairs, and maintenance on existing boat docks must have been previously permitted in order to qualify for coverage under this programmatic opinion.
 - ii. Recreational boat docks will need to be verified by the respective NMFS supervisor for the appropriate geographic area and basin.
 - e. Piscivorous birds. All float pilings, mooring buoys, and navigational aids must be fitted with devices to prevent perching by piscivorous birds.
 - f. Relocation of existing structures in a marina. Any existing structure that is relocated in a marina must remain within the existing overall footprint, but no closer than 50 feet of the shoreline (100 feet in the Columbia River) as measured at ordinary low water or mean lower low water. A submerged aquatic vegetation (SAV) survey will need to be conducted for the relocation of existing structures in a marina.
 - g. Repair or replacement of wall and roof components for a covered moorage or boat house. Any replacement for a roof, wall, or garage door of a covered moorage or boat house must be made of translucent materials or incorporate skylights to allow light penetration.
 - h. Bulkhead Repair and Removal. When repairing or removing bulkheads for coastal marine waters³², existing marinas and existing parks in Oregon and Washington (excluding Puget Sound and other inland marine waters of Washington State).
 - i. All bulkhead repairs and removals must meet the following criteria:
 - 1. Work will occur during low tide in the approved in-water work window and in phases to coordinate with tidal exposure and allowing for curing time before tidal inundation
 - 2. Prior to high tide, block nets should be set to prevent fish from accessing the area behind the new sheet pile section
 - 3. A barge or land-based equipment will be used to deliver materials and to avoid grounding at any time.
 - 4. Bulkhead removals must include a riparian vegetation plan.

³² Marine waters consist of the open ocean overlying the continental shelf and its associated high-energy coastline. Shallow coastal indentations or bays without appreciable freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the marine environment. Marine waters extends from the outer edge of the continental shelf shoreward to one of three lines: (1) the landward limit of tidal inundation (extreme high water of spring tides), including the splash zone from breaking waves; (2) the seaward limit of wetland emergent, trees, or shrubs; or (3) the seaward limit of estuarine waters (Cowardin *et. al.* 1979 & Dethier 1990).

5. Bulkhead repairs cannot extend further along the shoreline or further waterward of the OHW (riverine) or the HAT (marine) mark.
6. New bulkheads, bulkhead extensions or enlargements are not proposed as part of this programmatic consultation.

50. Dredging to maintain vessel access

- a. When dredging to maintain access to previously authorized docks, wharfs, mooring structures, and boat ramps, the following conditions apply:
 - i. All dredged materials and subsequent leave surface must be suitable and verified for in-water disposal using newly acquired or historical data based on criteria in the Sediment Evaluation Framework (USACE Northwest Division 2009). If in-water disposal is not feasible due to contaminated sediments upland disposal shall be considered. Upland disposal will also be considered if dredging occurs in the estuary.
 - ii. Upstream of the lower estuary, all dredged sediment and debris must be side cast or returned to the channel within the ordinary high-water line downstream from the dredging site where it will be recruited by the next annual high flow and continue to provide aquatic habitat functions.
 - iii. The dredging must not alter the character, scope, size, or location of the project area or previously authorized dredge prism.

51. Dredging to maintain functionality of previously authorized channels, culverts, water intakes, or outfalls

- a. When discharging or excavating to maintain the functionality of a channel, culvert, intake, or outfall, the following conditions apply:
 - i. Either the discharge or excavation will be limited to the greatest extent possible. Where a water intake or point of diversion occur a fish screen must be installed, operated and maintained according to NMFS fish screen criteria and meet NMFS fish passage criteria.
 - ii. All dredged materials and subsequent leave surface must be suitable and verified for in-water disposal using newly acquired or historical data based on criteria in the Sediment Evaluation Framework.
 - iii. All dredged sediment and debris must be side cast or returned within the annual high flow channel downstream from the dredging site where it will continue to provide aquatic habitat functions.
 - iv. The dredging must not alter the character, scope, size, or location of the project area.

52. Debris Removal

- a. When removing fallen trees, organic, mineral, and anthropogenic debris, the following conditions apply:
 - i. Fallen Trees. Large wood should be made available for habitat restoration projects above and below the project area. Large wood that can be relied on to provide streambank stability or redirect flows must be intact, hard, and undecayed to partly decaying, and should have untrimmed root wads to provide functional refugia habitat for fish. The use of decayed or fragmented wood found lying on the ground or partially sunken in the ground is not acceptable.

- ii. Organic Debris. Organic debris consists of twigs, leaves, bushes, tree trunks, rootwads, and branches that are removed from culverts, bridges, road/trailside ditches, levee systems, boat ramps, constructed and maintained channels, or other eligible facilities. Plant and organic debris material will be removed and placed, to the extent practicable, above mean higher high water (MHHW), downstream of the in-water structure or stockpiled for use as a habitat-forming feature for a future project
- iii. Mineral Debris. Mineral debris includes the excavation and disposal of substrate³³ to prevent flooding, erosion, and habitat degradation by returning the facility to its design configuration and function. Removal of mineral debris only applies to material accumulated as a result of the disaster event. Removal of additional pre-existing substrate or material (other than minor inadvertent over-excavation or digging a temporary material pit at the downstream end of the structure) is not included as part of this proposed action. Mineral debris may be removed during or after the disaster event including in high velocity and turbid conditions to prevent further flooding or damage to surrounding structures.
 - 1. During mineral debris removal, the grantee should determine if dewatering the work area or water diversion is appropriate, install erosion/sediment control best management practices, remove the material from the affected area, and haul the material to a facility for sorting and disposal.
- iv. Anthropogenic Debris. Anthropogenic debris includes material created by humans (cars, garbage, and construction material), or animals (waste and carcasses) that collect in culverts, road/trail surfaces, road/trailside ditches, levee systems, boat ramps, constructed and maintained sediment collection basins and channels, and/or other facilities. Anthropogenic debris will be separated, hauled, and disposed of at an appropriate facility based on debris classification. Work will occur during or following the disaster event when turbidity levels are still high. Occasionally road maintenance or solid waste units are tasked with removing animal carcasses from rivers and floodplains and hauling to acceptable disposal facilities.

The NMFS relied on the foregoing description of the proposed action, including all PDCs, to complete this consultation.

“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 (50 CFR 402.02). No interdependent or interrelated activities are associated with the proposed action.

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). The action area consists of

³³ Mineral debris removal includes all substrate sizes (boulder, cobble, gravel, sand, and silt).

all the areas where the environmental effects of actions authorized by FEMA under this program may occur in Oregon, Washington, and Idaho. This includes all upland, riparian, and aquatic areas affected by implementation of the proposed action and its PDC. The action area also includes estuaries and coastal waters where water quality effects of the action may occur (small quantities of herbicides, stormwater runoff, or other contaminants move downstream of where they enter the water, eventually reaching the estuaries and coastal waters). There is overlap between the areas impacted by the proposed FEMA projects and the range of ESA-listed salmon, steelhead, green sturgeon, eulachon, or designated critical habitat. Twenty-four ESA-listed species and designated critical habitats were considered in this opinion. This includes the following recovery domains within Oregon, Washington and Idaho: Puget Sound, Willamette River-Lower Columbia, Interior Columbia, Oregon Coast, and Southern Oregon/Northern California Coast.

The action area is also designated as EFH for Pacific Coast salmon (PFMC 2014), Pacific groundfish, and coastal pelagics or is in an area where environmental effects of the proposed action may 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 upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must 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. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

The proposed action is not likely to adversely affect SR killer whales, their critical habitat, and the Mexico and Central America DPSs of humpback whale. The analyses for these species is found in the "Not Likely to Adversely Affect" Determinations Section 2.11.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "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). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This opinion relies on the definition of “destruction or adverse modification”, which “means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features” (81 FR 7214).

The designation of critical habitat uses the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the range wide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species’ likelihood of both survival and recovery. The species status section also 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 PBFs 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. Climate change is likely to play an increasingly important role in determining the abundance and distribution 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. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote et al. 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et

al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7°C by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick 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, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future

2.2.1 Status of the Species

Table 3, below, provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. These documents are available on the NMFS West Coast Region website (<http://www.westcoast.fisheries.noaa.gov/>).

Table 3. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013a	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk. Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	<ul style="list-style-type: none"> • Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	<ul style="list-style-type: none"> • Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2016a (draft)	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All except one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	<ul style="list-style-type: none"> • Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation
Upper Willamette River Chinook salmon	Threatened 6/28/05	NMFS 2011b	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the	<ul style="list-style-type: none"> • Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				ESU since the last review, so the ESU remains at moderate risk.	
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2015a (draft)	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	<ul style="list-style-type: none"> • Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Puget Sound Chinook salmon	Threatened 6/28/05	Shared Strategy for Puget Sound 2007 NMFS 2006	NWFSC 2015	This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the TRT planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.	<ul style="list-style-type: none"> • Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013a	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • 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 wake strandings • Contaminants
Hood Canal summer-run chum	Threatened 6/28/05	Hood Canal Coordinating Council 2005 NMFS 2007	NWFSC 2015	This ESU is made up of two independent populations in one major population group. Natural-origin spawner abundance has increased since ESA-listing and spawning abundance targets in both populations have been met in some years. Productivity was quite low at the time of the last review, though rates have increased in the last five years, and have been greater than replacement rates in the past two years for both populations. However, productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters for each population have increased and nearly meet the viability criteria. Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time.	<ul style="list-style-type: none"> • Reduced floodplain connectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013a	NWFSC 2015	<p>Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners. Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years</p>	<ul style="list-style-type: none"> • Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • 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 wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Oregon Coast coho salmon	Threatened 6/20/11	NMFS 2016b	NWFSC 2015	This ESU comprises 56 populations including 21 independent and 35 dependent populations. The last status review indicated a moderate risk of extinction. Significant improvements in hatchery and harvest practices have been made for this ESU. Most recently, spatial structure conditions have improved in terms of spawner and juvenile distribution in watersheds; none of the geographic area or strata within the ESU appear to have considerably lower abundance or productivity. The ability of the ESU to survive another prolonged period of poor marine survival remains in question.	<ul style="list-style-type: none"> • Reduced amount and complexity of habitat including connected floodplain habitat • Degraded water quality • Blocked/impaired fish passage • Inadequate long-term habitat protection • Changes in ocean conditions
Southern Oregon/Northern California Coast coho salmon	Threatened 6/28/05	NMFS 2014	NMFS 2016c	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because 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	<ul style="list-style-type: none"> • Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function • Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015b	NWFSC 2015	This single population ESU is at very high risk due to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production. In terms of natural production, the Snake River Sockeye ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	<ul style="list-style-type: none"> • Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lake Ozette sockeye salmon	Threatened 6/28/05	NMFS 2009b	NWFSC 2015	This single population ESU's size 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. 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. Abundance of this ESU has not changed substantially from the last status review. The quality of data continues to hamper efforts to assess more recent trends and spatial structure and diversity although this situation is improving.	<ul style="list-style-type: none"> • Predation by harbor seals, river otters, and predaceous non-native and native species of fish • Reduced quality and quantity of beach spawning habitat in Lake Ozette • Increased competition for beach spawning sites due to reduced habitat availability • Stream channel simplification and increased sediment in tributary spawning areas
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	<ul style="list-style-type: none"> • Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013a	NWFSC 2015	<p>This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.</p>	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • 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 wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 1/5/06	NMFS 2011b	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. 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 and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	<ul style="list-style-type: none"> • Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009c	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. 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 DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	<ul style="list-style-type: none"> • Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 1/5/06	NMFS 2016a (draft)	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain. A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	<ul style="list-style-type: none"> • Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases
Puget Sound steelhead	Threatened 5/11/07	In development	NWFSC 2015	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.	<ul style="list-style-type: none"> • Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern DPS of green sturgeon	Threatened 4/7/06	In development	NMFS 2015c	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	<ul style="list-style-type: none"> • Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching
Southern DPS of eulachon	Threatened 3/18/10	NMFS 2017	Gustafson et al. 2016	The Southern DPS 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. Sub populations for this species include the Fraser River, Columbia River, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years.	<ul style="list-style-type: none"> • Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries • Adverse effects related to dams and water diversions • Water quality, • Shoreline construction • Over harvest • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound/ Georgia Basin DPS of yelloweye Rockfish	Threatened 04/28/10	NMFS 2016d (draft)	NMFS 2016f	Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range.	<ul style="list-style-type: none"> • Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics
Puget Sound/ Georgia Basin DPS of Bocaccio	Endangered 04/28/10	NMFS 2016e (draft)	NMFS 2016f	Though bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.	<ul style="list-style-type: none"> • Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics

2.2.2 Status of the Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-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 most salmon and steelhead, NMFS' critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, 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. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

For southern DPS green sturgeon, a team similar to the CHARTs — a critical habitat review team (CHRT) — identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas necessary to ensure the conservation of the species (USDC 2009). The CHRT did not identify those particular areas using HUC nomenclature, but did provide geographic place names for those areas, including the names of freshwater rivers, the bypasses, the Sacramento-San Joaquin Delta, coastal bays and estuaries, and coastal marine areas (within 110 m depth) extending from the California/Mexico border north to Monterey Bay, California, and from the Alaska/Canada border northwest to the Bering Strait; and certain coastal bays and estuaries in California, Oregon, and Washington.

For southern DPS eulachon, critical habitat includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). We designated all of these areas as migration and spawning habitat for this species.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 4, below.

Table 4. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Willamette River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Puget Sound Chinook salmon	9/02/05 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Hood Canal summer-run chum	9/02/05 70 FR 52630	Critical habitat for Hood Canal summer-run chum includes 79 miles and 377 miles of nearshore marine habitat in HC. Primary constituent elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Oregon Coast coho salmon	2/11/08 73 FR 7816	Critical habitat encompasses 13 subbasins in Oregon. The long-term decline in Oregon Coast coho salmon productivity reflects deteriorating conditions in freshwater habitat as well as extensive loss of access to habitats in estuaries and tidal freshwater. Many of the habitat changes resulting from land use practices over the last 150 years that contributed to the ESA-listing of Oregon Coast coho salmon continue to hinder recovery of the populations; changes in the watersheds due to land use practices have weakened natural watershed processes and functions, including loss of connectivity to historical floodplains, wetlands and side channels; reduced riparian area functions (stream temperature regulation, wood recruitment, sediment and nutrient retention); and altered flow and sediment regimes (NMFS 2016b). Several historical and ongoing land uses have reduced stream capacity and complexity in Oregon coastal streams and lakes through disturbance, road building, splash damming, stream cleaning, and other activities. Beaver removal, combined with loss of large wood in streams, has also led to degraded stream habitat conditions for coho salmon (Stout et al. 2012)
Southern Oregon/Northern California Coast coho salmon	5/5/99 64 FR 24049	Critical habitat includes all areas accessible to any life-stage up to long-standing, natural barriers and adjacent riparian zones. SONCC coho salmon critical habitat within this geographic area has been degraded from historical conditions by ongoing land management activities. Habitat impairments recognized as factors leading to decline of the species that were included in the original listing notice for SONCC coho salmon include: 1) Channel morphology changes; 2) substrate changes; 3) loss of in-stream roughness; 4) loss of estuarine habitat; 5) loss of wetlands; 6) loss/degradation of riparian areas; 7) declines in water quality; 8) altered stream flows; 9) fish passage impediments; and 10) elimination of habitat
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lake Ozette sockeye salmon	9/02/05 70 FR 52630	Critical habitat is comprised of a single subbasin containing a single watershed, Ozette Lake Subbasin located in Clallam County, Washington. It encompasses approximately 101 mi ² and approximately 317 miles of streams; Ozette Lake, the dominant feature of the watershed, is entirely located within the Olympic National Park. The known beach spawning areas, and three tributaries used by sockeye salmon for spawning, incubation, and migration, are encompassed as part of critical habitat for the listed species. Beach spawning is degraded by historical sediment loading, disrupted hydrology, and encroachment of riparian vegetation. Streams supporting spawning, rearing, and migration are impaired by lack of large wood, excessive fine sediment levels (Big River), and mammalian predation.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Upper Willamette River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Puget Sound steelhead	2/24/16 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Southern DPS of green sturgeon	10/09/09 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays, as listed in Table 1 in USDC (2009). The CHRT identified several activities that threaten the PBFs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the bays and estuaries, as well as the growth and reproductive health of Southern DPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom (but result in beneficial or adverse effects on prey resources for green sturgeon).
Southern DPS of eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are 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 river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Puget Sound/Georgia Basin DPS of yelloweye rockfish	11/13/2014 79 FR 68042	Critical habitat for yelloweye rockfish includes 414.1 square miles of deepwater marine habitat in Puget Sound, all of which overlaps with areas designated for canary rockfish and bocaccio. No nearshore component was included in the CH listing for juvenile yelloweye rockfish as they, different from bocaccio and canary rockfish, typically are not found in intertidal waters (Love et al., 1991). Yelloweye rockfish are most frequently observed in waters deeper than 30 meters (98 ft) near the upper depth range of adults (Yamanaka et al., 2006). Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound/Georgia Basin DPS of bocaccio	11/13/2014 79 FR68042	Critical habitat for bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for all three species, critical habitat was not designated in that area. Based on the natural history of bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: 1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.

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).

As described above in the Status of the Species and Critical Habitat sections, factors that limit the recovery of species considered in this opinion vary with the overall condition of aquatic habitats on surrounding lands. Within the action area, many stream and riparian areas have been degraded by the effects of land and water use, including road construction, forest management, agriculture, mining, transportation, urbanization, and water development. Each of these economic activities has contributed to the myriad factors for the decline of species in the action area. 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, direct take, and loss of habitat refugia. 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.

West of the Cascade Mountains in Oregon and Washington, stream habitats and riparian areas have been degraded by road construction, timber harvest, splash damming, urbanization, agricultural activities, mining, flood control, filling of estuaries, and construction of dams. East of the Cascade Mountains, aquatic habitats have been degraded by road building, timber harvest, splash damming, livestock grazing, water withdrawal, agricultural activities, mining, urbanization, and construction of reservoirs and dams (FEMAT 1993; Lee *et al.* 1997; McIntosh *et al.* 1994; Wissmar *et al.* 1994). FEMA’s program actions that are the subject of this programmatic opinion are typically carried out in developed areas degraded by one or more human activity or natural events.

The Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large woody debris, intense urbanization, agriculture, alteration of floodplain and stream morphology, riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, timber harvest, and mining. These activities have resulted in loss of available habitat, reduced habitat quality, altered forage species communities, reduced stream complexity, and altered stream flow and sediment load. Water quality in the Puget Sound basin has also been degraded from stormwater, municipal and industrial discharges, and agriculture and non-point source conveyances associated with the aforementioned activities. The negative impacts of these activities to aquatic habitat in the Puget Sound basin have contributed to the decline in abundance, productivity, diversity, and distribution and are limiting the recovery of PS steelhead, PS Chinook salmon, HC summer-run chum salmon, Puget Sound/Georgia Basin yelloweye rockfish and bocaccio in the basin.

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.

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 large wood in mainstem rivers 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).

Johnson *et al.* (2013) found polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT) in juvenile salmon and salmon diet samples from the lower Columbia River and estuary at concentrations above estimated thresholds for effects on growth and survival. The Columbia River between Portland, Oregon, and Longview, Washington, appears to be an important source of contaminants for juvenile salmon and a region in which salmon were exposed to toxicants associated with urban development and industrial activity. Highest concentrations of PCBs were found in fall Chinook salmon stocks with subyearling life histories, including populations from the upper Columbia and Snake rivers, which feed and rear in the tidal freshwater and estuarine portions of the river for extended periods. Spring Chinook salmon stocks with yearling life histories that migrate more rapidly through the estuary generally had low PCB concentrations, but high concentrations of DDTs. Pesticides can be toxic to primary producers and macroinvertebrates, thereby limiting salmon population recovery through adverse, bottom-up impacts on aquatic food webs (Macneale *et al.* 2010).

Listed fish species 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. 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. Delay in project reservoirs, particularly immediately upstream from the dams, increases smolt exposure to avian predators, and juvenile bypass systems concentrate smolts, creating potential feeding stations for birds. Dredge spoil islands, associated with maintaining the Columbia River navigation channel, provide habitat for nesting Caspian terns and other piscivorous birds. Caspian terns, double-crested cormorants, glaucous-winged/western gull hybrids, California gulls, and ring-billed gulls are the principal avian predators in the basin. As with piscivorous predators, predation by birds has and continues to decrease population abundance and productivity.

Water quality throughout most of the program action area is degraded to various degrees because of contaminants that are harmful to species considered in this consultation. Aerial deposition, discharges of treated effluents, and stormwater runoff from residential, commercial, industrial, agricultural, recreational, and transportation land uses are all source of these contaminants. For example, 4.7 million pounds of toxic chemicals were discharged into surface waters of the Columbia River Basin (a 39% decrease from 2003) and another 91.7 million pounds were discharged in the air and on land in 2011 (USEPA 2011). This reduction can be attributed, in part, to significant state, local and private efforts to modernize and strengthen tools available to treat and manage stormwater runoff (USEPA 2009; USEPA 2011).

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 within 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. Fifty-seven 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) (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).

The role of stormwater runoff in degrading water quality has been known for years but reducing that role has been notoriously difficult because the runoff is produced everywhere in the developed landscape, the production and delivery of runoff are episodic and difficult to attenuate, and runoff accumulates and transports much of the collective waste of the developed environment (NRC 2009). In most rivers in Oregon, the full spatial distribution and load of contaminants is not well understood. Hydrologically low-energy areas, where fine-grained sediment and associated contaminants settle, are more likely to have high water temperatures, concentrations of nitrogen and phosphorus that may promote algal blooms, and concentrations of aluminum, iron, copper, and lead that exceed ambient water quality criteria for chronic toxicity to aquatic life (Fuhrer *et al.* 1996). Even at extremely low levels, contaminants still make their way into salmon tissues at levels that are likely to have sublethal and synergistic effects on individual Pacific salmon, such as immune toxicity, reproductive toxicity, and growth inhibition (Baldwin *et al.* 2011; Carls and Meador 2009; Hicken *et al.* 2011; Johnson *et al.* 2013), that may be sufficient to reduce their survival and therefore the abundance and productivity of some populations (Baldwin *et al.* 2009; Spromberg and Meador 2006). The adverse effect of contaminants on aquatic life often increases with temperature because elevated temperatures accelerate metabolic processes and thus the penetration and harmful action of toxicants.

The full presence of contaminants throughout the program action area is poorly understood, but the concentration of many increase in downstream reaches (Fuhrer *et al.* 1996; Johnson *et al.* 2013; Johnson *et al.* 2005; Morace 2012). The fate and transport of contaminants varies by type, but are all determined by similar biogeochemical processes (Alpers *et al.* 2000b; Alpers *et al.* 2000a; Bricker 1999; Chadwick *et al.* 2004; Johnson *et al.* 2005). After deposition, each contaminant typically processes between aqueous and solid phases, sorption and deposition into active or deep sediments, diffusion through interstitial pore space, and re-suspension into the water column. Uptake by benthic organisms, plankton, fish, or other species may occur at any stage except deep sediment, although contaminants in deep sediments become available for biotic uptake when re-suspended by dredging or other disturbances.

Whenever a contaminant is in an aqueous phase or associated with suspended sediments, it is subject to the processes of advection and dispersion toward the Pacific Ocean. However, once soluble metal releases are reduced or terminated, the solute half-time in Columbia River water is months versus about 20 years for adsorbed metals on surficial (or resuspended) bed sediments. The much slower rate of decline for sediment, as compared to the solute phase, is attributed to resuspension, transport and redeposition of irreversibly bound metals from upstream sedimentary deposits. This implies downstream exposure of benthic or particle-ingesting biota can continue for years following source remediation and/or termination of soluble metal releases (Johnson *et al.* 2005). Adsorbed contaminants are highest in clay and silt, which can only be deposited in areas of reduced water velocity, such as behind dams and the backwater or off-channel areas preferred as rearing habitat by juveniles of some Pacific salmon (Johnson *et al.* 2005; ODEQ 2012). Similar estimates for the residence time of contaminants in the freshwater plume are unavailable, although the plume itself has been tracked as a distinct coastal water mass that may extend up to 50 miles beyond the mouth of the Columbia River, where the dynamic interaction

of tides, river discharge, and winds can cause significant variability in the plume's location at the interannual, seasonal scale, and even at the event scale of hours (Burla *et al.* 2010; Kilcher *et al.* 2012; Thomas and Weatherbee 2006).

The existing highway system contributes to a poor environmental baseline condition in several significant ways. Many miles of highway that parallel streams have degraded stream bank conditions by armoring the banks with rip rap, degraded floodplain connectivity by adding fill to floodplains, and discharge untreated or marginally treated highway runoff to streams. Culvert and bridge stream crossings have similar effects, and create additional problems for fish when they act as physical or hydraulic barriers that prevent fish access to spawning or rearing habitat, or contribute to adverse stream morphological changes upstream and downstream of the crossing itself.

The environmental baseline includes the anticipated impacts of all Federal actions in the action area that have already undergone formal consultation. The Corps, Bonneville Power Administration (BPA), and Bureau of Reclamation have consulted on large water management actions, such as operation of the Federal Columbia River Power System, the Umatilla Basin Project, and the Deschutes Project. The U.S. Bureau of Indian Affairs (BIA), U.S. Bureau of Land Management (BLM), and the U.S. Forest Service (USFS) have consulted on Federal land management throughout Oregon, including restoration actions, forest management, livestock grazing, and special use permits. The BPA, NOAA Restoration Center, and U.S. Fish and Wildlife Service have also consulted on large restoration programs that consist of actions designed to address species limiting factors or make contributions that would aid in species recovery. 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. After going through consultation, many ongoing actions, such as stormwater facilities, roads, culverts, bridges and utility lines, have less impact on listed salmon and steelhead.

As noted above, it is likely that the proposed action will take place at sites where habitat conditions have been previously disturbed. Specifically, NMFS made the following assumptions regarding the environmental baseline conditions in specific areas where projects will be carried out fit within the proposed action:

1. Projects will occur at sites where the biological requirements of individual fish of ESA-listed species are not being fully met due, in part, to the presence of impaired fish passage, floodplain fill, streambank degradation, or degraded channel or riparian conditions.
2. Projects will occur at sites where the biological requirements of individual fish of ESA-listed species are not being met 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.

2.4 Effects of the Action on Species and Designated Critical Habitat

Under the ESA, "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 effects of the proposed action are those caused by activities completed under the FEMA Endangered Species Programmatic. Therefore, to frame the analysis of the effects of the action, we first deconstruct the program in the following subsection to identify the individual types of actions and examine the general environmental impacts of each of those actions. In the subsequent two sections, we then analyze those effects for their combined impact on species and designated critical habitats.

2.4.1 Analysis of the Environmental Effects of Program Action Types

Programmatic consultation is a tool enabling the review of many; similar actions and works best when the outcomes of those actions can be readily anticipated and prescriptively addressed to ensure those outcomes meet the requirements of ESA section 7(a). Therefore, when implementing the proposed program, FEMA will ensure that: (a) The PDC and the descriptions of actions in the proposed action are applied to the action throughout the action area; (b) the effects of the action are within the range considered in the Opinion; and (c) the action can be carried out under the proposed program level monitoring and reporting requirements. These procedures are a central part of the programmatic opinion and function to ensure that individual projects covered by this opinion remain within the scope of effects considered here, and to ensure that the aggregate or program-level effects of those individual projects are also accounted for. Activities that fall within the proposed action, and otherwise comply with this opinion and ITS do not require further consultation. Activities that do not meet these criteria, including those that are expressly identified as exclusions, are not covered by this opinion, but can be the subject of individual consultations.

The discussion of the direct physical and chemical effects of this part of the action on the environment will vary depending on the type of action being performed, but will be based on a common set of effects related to construction. Actions as described in this opinion and involving transportation, restoration, and in-water and over-water structures related actions are likely to have all the following effects. Actions that only involve placement of boulders, gravel, or wood will only have a subset of those effects, or will express those effects to a lesser degree.

Construction will have direct physical and chemical effects on the environment that commonly begin with pre-construction activity, such as surveying, minor vegetation clearing, and placement of stakes and flagging guides. This requires movement of personnel and sometimes machines over the action area. The next stage, site preparation, may require development of access roads, 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 may be removed, deeper soil layers exposed, and operations extended into the active channel. The final stage of construction is site restoration. This stage consists of any action necessary to undo disturbance caused by the action, may include replacement of large wood, native vegetation, topsoil, and native channel material displaced by construction, and otherwise restoring ecosystem processes that form and maintain productive fish habitats.

The physical, chemical, and biotic effects of each individual project the FEMA funds under the Stafford Act will vary according to the number and type of elements present, although each

action will share a common set of effects related to pre-construction and construction (Darnell 1976; Spence *et al.* 1996), site restoration (Cramer *et al.* 2003; Cramer 2012), and operation and maintenance. The NMFS assumes that every individual project will result in some of the effects described here in proportion to the project's complexity, footprint, and proximity to species and critical habitat, but that no action will have effects that are greater than the full range of effects described here, because every action is based on the same set of underlying construction activities or elements, and each element is limited by the same PDC. The duration of construction required to complete most projects will normally be less than one year, although significant fish passage projects may require additional in-water work or upland work to complete. Projects requiring an EIS pursuant to NEPA that evaluate alternatives affecting listed species are ineligible for coverage under this consultation due to the potentially large and unpredictable effects caused by projects of this scale.

2.4.1.1. General Effects

Program Administration

FEMA will ensure the appropriate design criteria are incorporated into all phases of design for each authorized project, and that any unique project or site constraint related to site suitability, right-of-way, special maintenance needs, compensatory mitigation, or cost is resolved as the project is being designed. Additionally, FEMA will obtain verification from NMFS for temporary bypass channels, alluvium placement, blasting, compensatory mitigation, engineered log jams, fish screens for diversion of greater than 3 cfs, grade stabilization, large wood placement, stormwater outfalls and facilities, off and side channel habitat restoration, pile installation, road-stream crossing replacements, set-back of an existing berm, dike, or levee, utility line crossing that includes directional drilling that spans the channel migration zone or any associated wetland, vegetated riprap with large wood, water control structure removal, access maintenance, streambank and channel stabilization, and any minor project modifications (see Action Notification Sheet Instructions at the end of this Opinion). Furthermore, FEMA will notify NMFS before each project begins construction. NMFS will respond with verifications or denials within 30 days of receiving the FEMA Project Action Notification Sheet. Shortly (within 60 days) after all in-water work for a project is completed, FEMA will submit the completion report portion of the implementation sheet, along with any pertinent information needed, to ensure that a completed project matches its proposed design.

As an additional program-level check on the continuing effects of the action, FEMA and NMFS will meet at least annually to review implementation of this opinion and opportunities to improve conservation, or make the program overall more effective or efficient. Application of consistent PDC and engineering improvements to the maximum extent feasible in each recovery domain is likely to gradually reduce the total adverse impacts, improve ecosystem resilience, and contribute to management actions necessary for the recovery of ESA-listed species and critical habitats in Washington, Oregon, and Idaho.

Pre-construction Activities

Pre-construction activities for transportation, restoration, and in-water and over-water structure related projects typically include work area isolation, surveying, mapping, placement of stakes and flagging guides, erosion and pollution control, creating temporary access roads, material staging areas, exploratory drilling, and boring. Project footprints that extend far into the active channel, such as the replacement of culverts and bridges, may require activities like work area isolation, fish capture, and relocation. Pre-construction activities are likely to have short-term adverse effects due to vegetation removal and the compaction of soil reducing permeability and infiltration due to site preparation for construction activities to occur in aquatic or riparian habitats. Short-term effects are minimized with the use of best management practices described within the PDCs including the use of erosion and pollution control measures.

Work Area Isolation. If work area isolation is necessary, any juvenile salmon or steelhead present in the work isolation area will be captured and released. It is unlikely that any adult fish, including salmon, steelhead, green sturgeon, or eulachon will be affected by this procedure because it will occur when adults are unlikely to be present and, if any are present, their size allows them to easily escape from the containment area. Capturing and handling fish causes them stress though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived (NMFS 2002).

Grantees will use cofferdams to isolate the work areas in any flowing streams during the construction. This will include replacing fish passage culverts, construction of bridges, replacement culverts, and any new culverts. Dewatering of the isolated work areas will dry out the substrate in that area, reducing the risk of exposure of streams to sediment and chemical contaminants resulting from construction of culverts and a bridge. However, macro-invertebrates residing in the isolated work areas will die as the area dries out. Work isolations will also temporarily decrease spatial availability within the river, and reduce available aquatic habitats. Isolation will occur during the summer approved in-water work period, which lasts approximately 10-14 weeks.

The primary contributing factors to stress and death from handling are differences in water temperature between the river where the fish are captured and wherever the fish are held, dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on fish increases rapidly from handling if the water temperature exceeds 64°F or dissolved oxygen is below saturation. FEMA's conservation measures regarding fish capture and release, use of pump-intake screens during the de-watering phase, and fish passage around the isolation area are based on standard NMFS guidance to reduce the adverse effects of these activities (NMFS 2011a). If it is determined that carrying out the project had any unanticipated role in the death of an ESA-listed fish, that information will be reviewed by FEMA and NMFS at the annual meeting to decide whether it is necessary to modify the project or if reinitiation of the consultation is required.

Surveying, mapping, and the placement of stakes and flagging entail minor movements of machines and personnel over the action area with minimal direct effects but important indirect effects by establishing geographic boundaries that will limit the environmental impact of

subsequent activities. FEMA will ensure that work area limits are marked to preserve vegetation and reduce soil disturbance as a fundamental and effective management practice that will avoid and reduce the impact of all subsequent construction actions.

Erosion and pollution control measures will be applied to any project that involves soil disturbance. Those measures will constrain the use and disposal of all hazardous products, the disposal of construction debris, and secure the site against erosion and inundation during high flow events. During and after wet weather, increased runoff resulting from soil and vegetation disturbance at a construction site during both preconstruction and construction phases is likely to suspend and transport more sediment to receiving waters as long as construction continues so that multi-year projects are likely to cause more sedimentation. This increases total suspended solids 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 flow increases stream energy that scours stream bottoms and transports greater sediment loads farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, increase water temperature, and modify water chemistry. Redeposited sediments partly or completely fill pools, increase the width to depth ratio of streams, and change the distribution of pools, riffles, and glides. Increased fine sediments in substrate also reduce survival of eggs and fry, reducing spawning success of salmon, steelhead, and eulachon.

During dry weather, the physical effects of increased runoff appear as reduced ground water storage, lowered stream flows, and lowered wetland water levels. The combination of erosion and mineral loss reduce soil quality and site fertility in upland and riparian areas. Concurrent in-water work compacts or dislodges channel sediments, thus increasing total suspended solids and allowing currents to transport sediment downstream where it is eventually re-deposited. Continued operations when the construction site is inundated significantly increase the likelihood of severe erosion and contamination. However, FEMA proposes to cease work when high flows may inundate the project area, except for efforts to avoid or minimize resource damage, so significant erosion and contamination is unlikely.

Temporary access roads, any new roads, and staging areas requires disturbance of vegetation and soils that support floodplain and riparian function, such as delivery of large wood and particulate organic matter, shade, 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 size of areas likely to be adversely affected by actions proposed to be authorized or carried out under this opinion are small, and those effects are likely to be short-term (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 flow in the immediate area may be temporarily reduced. Loose soil will temporarily accumulate in the construction area. In dry weather, part of this soil is dispersed as dust and in wet weather; part is transported to streams by erosion and runoff, particularly in steep areas. Erosion and runoff increase the supply of sediment to lowland drainage areas and eventually to aquatic habitats, where they increase total suspended solids and sedimentation.

Whenever possible, temporary access roads will not be built on steep slopes, where grade, soil, or other features suggest a likelihood of excessive erosion or failure; will use existing ways whenever possible; and will minimize soil disturbance and compaction within 150 feet of a stream, water body, or wetland. All temporary access roads will be obliterated when the action is completed, the soil will be stabilized and the site will be revegetated. Temporary roads in wet or flooded areas will be restored by the end of the applicable in-water work period.

Drilling operations as a means of soil testing may themselves cause erosion, sedimentation from drilling mud, or other temporary site disturbances. Similarly, untreated drilling fluids sometimes travel along a subsurface soil layer and exit in a stream or wetland and degrade water quality. Air rotary drilling produces dust, flying sand-sized rock particles, foaming additives, and fine water spray that will be collected to prevent deposition in a stream or wetland. The distances that cuttings and liquids (*e.g.*, water, foaming additives) are ejected out of the boring depend on the size of the drilling equipment. Unrestrained, larger equipment will disperse particles up to 6.1 meters, while smaller equipment will typically expel particles up to 3 meters. As with any heavy equipment, drilling rigs are subject to accidental spills of fuel, bentonite, lubricants, hydraulic fluid and other contaminants that, if unconfined, may harm the riparian zone or aquatic habitats.

Applicants will use staging areas to store hazardous materials, or to store, fuel, or service heavy equipment, vehicles, and other power equipment with tanks larger than 5 gallons, that are at least 150 feet from any natural water body or wetland, or on an established paved area, such that sediment and other contaminants from the staging area cannot be deposited in the floodplain or stream. FEMA will also require applicants to isolate drilling operations in wetted stream channels to prevent drilling fluids from contacting any water. Furthermore, if the action involves HDD drilling operations, the applicant must 1) have all necessary equipment and supplies on-site to contain an unintended release of drilling mud, 2) the entry and exit locations shall be located upland where a frac-out can be easily detected, 3) on-site visual monitoring by a knowledgeable HDD inspector must occur during construction operations, 4) drilling operations will stop if visual signs of surface seepage or loss of circulation/pressure of the drilling fluid is detected, and 5) the applicant will have a frac-out contingency plan in preventing and minimizing the effects of an inadvertent return of drilling fluids to the surface (frac-out release). These conservation measures will reduce the risk and scale of accidental spills by requiring the applicant to provide staging areas for heavy equipment, to isolate drilling operations from wetted stream channels, and to be prepared if a frac-out release occurs.

When borings are abandoned near streams or wetlands, excess grout will be contained to prevent pollution, especially during rainy periods. In some cases, boring abandonment may not occur for months or even years after the drilling has been completed. Then, soils and vegetation are subjected to additional disturbance when workers re-enter the site. Sometimes, instruments will be drilled out. When this occurs, effects are similar to those described above for drilling.

Construction

Construction activities for transportation, restoration, and in-water and over-water structure related projects typically include the use of heavy equipment, pile driving and removal, water withdrawal, installation of rock and other hard structures, the use of treated wood, and non-

native and invasive plant control. Each construction footprint that extends into a riparian or instream area is likely to have short-term adverse effects due to the physical and chemical consequences of altering those environments, and to have long-term adverse effects due to the impact of the built environment's encroachment on aquatic habitats. Conversely, under the action as proposed, some projects are also likely to have long-term positive effects through application of PDCs that reduce pre-existing impacts by, for example, improving floodplain connectivity, streambank function, water quality, or fish passage.

Use of heavy equipment for vegetation removal and earthwork compact the soil, thus reducing permeability and infiltration. Use of heavy equipment, including stationary equipment like generators and cranes, also creates a risk that accidental spills of fuel, lubricants, hydraulic fluid, coolants, and other contaminants may occur. Petroleum-based contaminants (such as fuel, oil, and some hydraulic fluids) contain polycyclic aromatic hydrocarbons (PAHs), which are acutely toxic to listed fish species and other aquatic organisms at high levels of exposure and cause sublethal adverse effects on aquatic organisms at lower concentrations (Heintz *et al.* 2000; Heintz *et al.* 1999; Incardona *et al.* 2005; Incardona *et al.* 2004; Incardona *et al.* 2006). It is likely that petroleum-based contaminants have similar effects on eulachon. To minimize the risk of contamination from accidental spills that result from leaks and ruptured hydraulic hoses, equipment, vehicles, and power tools, operators will replace petroleum-based hydraulic fluids with biodegradable products when working within wetlands or within 150 feet of a water body.

FEMA will also require that heavy-duty equipment and vehicles for each project be selected with care and attention to features that minimize adverse environmental effects (*e.g.*, minimal size, temporary mats or plates within wet areas or sensitive soils), use of staging areas at least 150 feet from surface waters, and regular inspection and cleaning before operation to ensure that vehicles remain free of external oil, grease, mud, and other visible contaminants. Also, as noted above, to reduce the likelihood that sediment or pollutants will be carried away from project construction sites, the FEMA will ensure that clearing areas are limited and that a suite of erosion and pollution control measures will be applied to any project that involves the likelihood of soil and vegetation disturbance that can increase runoff and erosion, including securing the site against erosion, inundation, or contamination by hazardous or toxic materials.

Work involving the presence of equipment or vehicles in the active channel when ESA-listed fish are present is likely to result in injury or death of some individuals. FEMA will avoid or reduce that risk by limiting the timing of that work to avoid vulnerable life stages of ESA-listed fish, including migration, spawning and rearing. Further, when work in the active channel involves substantial excavation, backfilling, embankment construction, or similar work below OHW (riverine) or the HAT (marine) where adult or juvenile fish are reasonably certain to be present, or 300 feet or less upstream from spawning habitats, FEMA will require that the work area be effectively isolated from the active channel to reduce the likelihood of direct, mechanical interactions with fish, or indirect interactions through environmental effects. Regardless of whether a work area is isolated or not, and with few exceptions, FEMA will require that passage for adult and juvenile fish that meets NMFS's (2011a) criteria, or most recent version, will be provided around the project area during and after construction.

Pile driving and removal with a vibratory or impact hammer are likely to result in adverse effects to ESA listed salmon and steelhead by temporarily increasing suspended sediment, and increasing underwater sound, and sound pressures.

Suspended sediment generated from pile driving or removal is temporary and confined to the area close to the operation. NMFS expects that some individual ESA listed salmon and steelhead may be harassed by turbidity plumes resulting from pile driving or removal. Indirect lethal take can occur if individual juvenile fish are preyed on when leaving the work area to avoid temporary turbidity plumes. The proposed requirements for completing the work during the preferred in-water work window will minimize the effects of suspended sediment on listed species.

In the short term, removal of creosote or other piles treated with oil-based preservatives can release toxic preservatives into the surrounding water, resulting in a temporary degradation of water quality (Weston Solutions 2006). In the long term, removal of creosote piles will reduce water quality degradation.

Benthic invertebrates in shallow-water habitats are key food sources for salmonids. New pilings may reduce the substrate available to benthic aquatic invertebrates and therefore the food available for salmonids within the project area. NMFS believes that some effect on salmon and steelhead productivity may occur due to suppression of benthic prey species. Most existing commercial dock structures have a high density of existing piles and are not likely to provide significant habitat for listed salmonids. Further, listed salmonids must migrate by such structures. This likely takes place in an area of diminished light intensity and deeper water along the outer margin of the structure, where they may have higher predation.

Piles will be removed using a vibratory hammer, direct pull, clam shell grab, or cutting/breaking the pile below the mudline. Vibratory pile removal causes sediments to slough off at the mudline, resulting in some suspension of sediments and, possibly, contaminants. Old and brittle piles may break under the vibrations and require use of another method. The direct pull method involves placing a choker around the pile and pulling upward with a crane or other equipment. When the piling is pulled from the substrate, sediments clinging to the piling slough off as it is raised through the water column, producing a plume of turbidity, contaminants, or both. The use of a clamshell may suspend additional sediment if it penetrates the substrate while grabbing the pile. If a piling breaks the stub is often removed with a clam shell and crane. Sometimes pilings are cut, broken, or driven below the mudline, and the buried section left in place. This may suspend small amounts of sediment, providing the stub is left in place and little digging is required to reach the pile. Direct pull or use of a clamshell to remove broken piles is likely to suspend more sediment and contaminants.

FEMA will require the use of a vibratory hammer to remove any pilings and for placement of steel piles. An impact hammer may be required should hard substrate be encountered during vibratory driving. Most often pile driving will occur in the dry above the ordinary high water line or in a dewatered isolation area primarily for use of construction of abutments for bridges. If an impact hammer is required for in-water work, FEMA will require deployment of a bubble curtain for sound attenuation during the impact hammer driving.

Pile driving often generates intense sound pressure waves that can injure or kill fish (Reyff 2003, Abbott and Bing-Sawyer 2002, Caltrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001). The type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer all influence the sounds produced during pile driving. Fishes with swim bladders (including salmon and steelhead) are sensitive to underwater impulsive sounds, *i.e.*, sounds with a sharp sound pressure peak occurring in a short interval of time, (Caltrans 2001). As the pressure wave passes through a fish, the swim bladder is rapidly squeezed due to the high pressure, and then rapidly expanded as the under pressure component of the wave passes through the fish. The pneumatic pounding may rupture capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues (Caltrans 2001). The injuries caused by such pressure waves are known as barotraumas, and include hemorrhage and rupture of internal organs, as described above, and damage to the auditory system. Death can be instantaneous, can occur within minutes after exposure, or can occur several days later.

Fish respond differently to sounds produced by impact hammers than to sounds produced by vibratory hammers. Fish consistently avoid sounds like those of a vibratory hammer (Enger *et al.* 1993; Dolat 1997; Knudsen *et al.* 1997; Sand *et al.* 2000) and appear not to habituate to these sounds, even after repeated exposure (Dolat, 1997; Knudsen *et al.* 1997). On the other hand, fish may respond to the first few strikes of an impact hammer with a startle response, but then the startle response wanes and some fish remain within the potentially harmful area (Dolat 1997). Compared to impact hammers, vibratory hammers make sounds that have a longer duration (minutes vs. milliseconds) and have more energy in the lower frequencies (15-26 Hz vs. 100-800 Hz) (Würsig, *et al.* 2000).

A multi-agency work group identified criteria to define sound pressure levels where effects to fish are likely to occur from pile driving activities (Hydroacoustic Working Group, 2008). Keep in mind these thresholds represent the initial onset of injury, and not the levels at which fish will be severely injured or killed. The most harmful level of effects is where a single strike generates peak noise levels greater than 206 dB_{peak}³⁴ where direct injury or death of fish can occur. Besides peak levels, sound exposure levels (SEL) (the amount of energy dose the fish receive) can also injure fish. These criteria are either 187 dB_{SEL}³⁵ for fish larger than 2 grams or 183 dB_{SEL} for fish smaller than 2 grams for cumulative strikes (Hydroacoustic Working Group, 2008). In addition, any salmonid within a certain distance of the source (*i.e.* the radius where the root mean square (RMS) sound pressure level will exceed 150 dB_{RMS}³⁶) will be exposed to levels that change the fish's behavior or cause physical injury (*i.e.* harm). The result of exposure could be a temporary threshold shift in hearing due to fatigue of the auditory system, which can increase the risk of predation and reduce foraging or spawning success (Stadler and Woodbury, 2009). When these effects take place, they are likely to reduce the survival, growth, and reproduction of the affected fish.

³⁴ dB_{peak} is referenced to 1 micropascal (re: 1μPa or one millionth of a pascal) throughout the rest of this document. A pascal is equal to 1 newton of force per square meter).

³⁵ dB_{SEL} is referenced to 1 micropascal-squared-seconds (re: 1μPa²·sec) throughout the rest of this document

³⁶ dB_{RMS} is referenced to 1 micropascal (re: 1μPa) throughout the rest of this document

In water, vibratory hammers are known to produce lower sound levels than impact hammers; generally 10 to 20 dB lower. The general assumption here is that pile driving in the dry or in a dewatered isolation area would result in even lower sound levels than in the water. Root mean square (RMS) sound levels below 150 dB could cause fish to avoid the area, thus hindering their free passage, but unlikely to injure the fish. Caltrans (2015) suggested that vibratory hammer use on a 12-inch steel pile produced sound values of 171 dB (peak) and 155 for both RMS and sound exposure level (SEL). Using the practical spreading model for transmission loss and sound attenuation, we determined that during in-water vibratory pile driving RMS sound levels greater than 150 dB would extend to a distance of 72 feet laterally in all directions from the pile. However, this distance is likely less because transmission loss through soil or sediment is likely greater than through water resulting in higher level of sound attenuation. This impact is limited to within fish salvage and dewatering operations of a bridge structure. Impacts during vibratory driving will be short-term (up to 2.5 hours per day) and localized within the 200 feet of a bridge.

During in-water impact driving, FEMA will require a bubble curtain for sound attenuation. The level of attenuation provided by a bubble curtain varies from project to project. Surrounding the pile with a bubble curtain can attenuate the peak SPLs by approximately 28 dB and is equivalent to a 97% reduction in sound energy. Whether confined inside a sleeve made of metal or fabric or unconfined, these systems have been shown to reduce underwater sound pressure (Würsig *et al.* 2000; Longmuir and Lively 2001; Christopherson and Wilson 2002; Reyff and Donovan 2003). However, the sound attenuation achieved by bubble curtains varies greatly depending on design and location. Observed ranges have been between 0 and 30 dB (Caltrans 2015). Thus, a bubble curtain may not bring the peak and RMS SPLs below the established thresholds, and take may still occur. Studies on pile driving and underwater explosions suggest that, besides attenuating peak pressure, bubble curtains also reduce the impulse energy and, therefore, the likelihood of injury (Keevin 1998). Because sound pressure attenuates more rapidly in shallow water (Rogers and Cox 1988), it may have fewer deleterious effects there.

Unconfined bubble curtains lower sound pressure by as much as 17 dB (85%) (Würsig *et al.* 2000, Longmuir and Lively 2001), while bubble curtains contained between two layers of fabric reduce sound pressure up to 22 dB (93%) (Christopherson and Wilson 2002). However, an unconfined bubble curtain can be disrupted and rendered ineffective by currents greater than 1.15 miles per hour (Christopherson and Wilson 2002). When using an unconfined air bubble system in areas of strong currents, it is essential that the pile be fully contained within the bubble curtain, and that the curtain have adequate air flow, and horizontal and vertical ring spacing around the pile.

NMFS has developed a spreadsheet to assess the potential effect to fishes exposed to elevated levels of underwater sound (peak and RMS pressure as well as sound exposure level (SEL)) resulting from pile driving. The distance to the thresholds of behavioral impacts and onset of physical injury can be calculated with the following information described in Appendix A: Pile Installation Worksheet.

ESA-listed salmonids occur year-round in waters covered by this opinion. However, the likelihood of injury or death resulting from pile driving and removal will be minimized by completing the work during preferred in-water work windows, using a vibratory hammer where

possible, using sound attenuators where an impact hammer is necessary, and limiting the number of strikes per day. Impact pile driving will result in sound increases greater than 150 dB that will degrade the fish passage within line of sight measured through water of the pile. Sound pressure levels generated from impact driving with a bubble curtain are expected to be below the instantaneous injury threshold of 206 dB_{peak}, thus there is little potential for an instantaneous injury from single strike peak pressure to juvenile or adult salmonids. Cumulative injury to salmonids is possible above 187 dB_{SEL} for salmonids weighing greater than 2 grams, and above 183 dB_{SEL} for salmonids weighing 2 grams or less.

Over a five year period, FEMA has funded 10 piling projects averaging 2 piling projects per year (Gall, 2017) mostly within the Puget Sound and lower Columbia recovery domains. We expect varying levels of behavioral responses from no change, to mild awareness, or a startle response (Hastings and Popper, 2005), but we do not believe that this response will alter the fitness of any adults. However, a small number of juvenile salmonids and rockfish may exhibit a behavioral response from pile driving that can lead to changes in feeding behavior or movement to a location where they are predated on, which will produce an effect that may kill or injure a listed juvenile salmonid.

Water withdrawal is limited to minor amounts used in construction projects (dust abatement, isolation procedures, bedload compaction, concrete washout, drilling fluids, etc.). Any temporary water withdrawal will have a fish screen installed, operated, and maintained as described in NMFS (2011a). Diversions may not exceed 10 percent of the available flow, and are short in duration as they are expected to last for only as long as it takes to fill a desired tank. FEMA will require that all discharge water created by concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids, or other construction work will be treated using the BMPs applicable to site conditions for removal of debris, heat, nutrients, sediment, petroleum products, metals and any other pollutants likely to be present (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours) to ensure that no pollutants are discharged from the construction site.

Rock and other hard structures. Many actions authorized or carried out under this opinion will seek to install rock or other hard structures within a functional floodplain to stabilize a streambank or channel and reduce erosion of the approach to, or foundation of, a road, culvert, or bridge. In addition to the construction impacts described above, the adverse impacts of hardening the interactive floodplain include direct habitat loss, reduced water quality, upstream and downstream channel impacts, reduced ecological connectivity, and the risk of structural failure (Barnard *et al.* 2013; Cramer 2012; Fischenich 2003; NMFS 2011a; Schmetterling *et al.* 2001). The habitat features of concern include water velocity, depth, substrate size, gradient, accessibility and space that are suitable for salmon and steelhead rearing. In spawning areas, rock and other hard structures are often used to replace spawning gravels, and realign channels to eliminate natural meanders, bends, spawning riffles and other habitat elements. Riffles and gravel bars downstream are scoured when flow velocity is increased. For eulachon, the important habitat features are flow, water quality, and substrate conditions. For sturgeon, the habitat features of concern include bays, estuaries, and sometimes the deep riverine mainstem in lower elevations where sturgeons congregate.

FEMA proposes to avoid or minimize the adverse impacts of installing rock or other hard structures by ensuring that existing rock or hard structures will be maintained in a way that reduces their on-going adverse effects (*e.g.*, requirements to move existing structures and structural fill out of the interactive floodplain whenever possible, and for erosion protection measures to incorporate vegetation, planting terraces, large wood, irregular faces, toe roughness), or else avoids or minimizes the adverse effects of altering the interactive floodplain through compensatory mitigation (*e.g.*, remove or retrofit existing riprap, hard structures, or other fill elsewhere in the interactive floodplain).

Treated wood. Projects that fall within the proposed action and use treated wood in or near water are wrapped piles and the repair or maintenance of pre-existing substructures on bridges, boardwalks, docks, footbridges, piers, and stringers. If FEMA or a grantee would like to use treated wood for other purposes, then individual consultation would be required.

Examples of pesticide-treated wood preservatives include water-based wood preservatives, such as ammoniacal copper zinc arsenate (ACZA), alkaline copper quaternary (ACQ-B and ACQ-D), ammoniacal copper citrate (CC), copper azoles (CBA-A and CA-B), copper dimethyldithiocarbamate (CDDC), borate preservatives, and oil-type wood preservatives, such as creosote, pentachlorophenol, and copper naphthenate (FPL 2000).³⁷ Acid copper chromate (ACC) and copper HDO (CX-A) are more recent compounds not yet in wide use (Lebow 2004). Withdrawal of CCA from most residential applications has increased interest in arsenic-free preservative systems that all rely on copper as their primary active ingredient (FPL 2004; Lebow 2004) with the proportion of preservative component ranging from 17% copper oxide in some CDDC formulations, to 96% copper oxide in CA-B (Lebow 2004).

A pesticide-treated wood structure placed in or over flowing water will leach copper and a variety of other toxic compounds directly into the stream (Hingston *et al.* 2001; Kelly and Bliven 2003; Poston 2001; Weis and Weis 1996). Although the likelihood of leaching pesticides, including copper, from wood used above or over the water is different than splash zone or in-water applications (Western Wood Preservers Institute *et al.* 2011), these accumulated materials add to the background loads of receiving streams. Movement of leached preservative components is generally limited in soil but is greater in soils with high permeability and low organic content. Mass flow with a water front is probably most responsible for moving metals appreciable distances in soil, especially in permeable, porous soils. Preservatives leached into water are more likely to migrate downstream compared with preservatives leached into soil, with much of the mobility occurring in the form of suspended sediment. If shavings, sawdust, or smaller particles of pesticide-treated wood generated during construction, use, or maintenance of a structure are allowed to enter soil or water below, they make a disproportionately large contribution to environmental contamination because the rate of leaching from smaller particles is 30 to 100 times greater than from solid wood (FPL 2001; Lebow 2004; Lebow and Tippie 2001).

Copper and other toxic chemicals, such as zinc, arsenic, chromium, and PAHs, that leach from pesticide-treated wood used to construct roads, culverts or bridges are likely to adversely affect salmon, steelhead, green sturgeon, and eulachon that spawn, rear, or migrate by those structures,

³⁷ The proposed action does not include the use of oil based treated wood such as creosote and pentachlorophenol.

and when they ingest contaminated prey (Poston 2001). Early efforts by NMFS to analyze the science applicable to treated wood impacts on anadromous fish (NMFS 1998, cited in NOAA Fisheries 2009) assumed that certain thresholds for exposure were protective of fish, including juvenile salmon, for example a water column concentration of 7 ppb for copper as a threshold for behavioral avoidance by salmon and 0.018 toxic units for PAH as adequately protective against toxic effects or bioaccumulation. NMFS relied on the 1998 document when developing the 2004 SLOPES biological opinion (NMFS 2004).

More recently, copper has been shown to impair the olfactory nervous system and olfactory-mediated behaviors in salmon and steelhead at levels as low as 0.6 ppb, with a range from 0.3 to 3.2 ppb (Baldwin *et al.* 2003; Baldwin and Scholz 2005; Hecht *et al.* 2007; Linbo *et al.* 2006; McIntyre *et al.* 2008; Feist *et al.* 2011, Scholz *et al.* 2011, Spromberg and Scholz 2011).

Moreover, we now have more sophisticated understandings of the synergistic impacts of copper and PAH when combined with other contaminant and stressors, as well as a greater appreciation for the repeated exposures of anadromous fish during the life cycle. Specifically, all life history stages of salmon are typically exposed to complex environmental mixtures of other toxic compounds (e.g., other metals, pesticides, weathered PAHs) in conjunction with other stressors (e.g., elevated temperatures, low dissolved oxygen) through a variety of exposure routes other than the water column, including consumption of contaminated prey items (dietary) or direct contact with contaminated sediments (Sandahl *et al.* 2007, Macneale *et al.* 2010, Scholz *et al.* 2011, Feist *et al.* 2011, Laetz *et al.* 2014). No stand-alone thresholds take into account these multiple routes of exposure or the potential impacts of complex mixtures of contaminants on olfaction or other physiological functions. Interactions among multiple stressors, including contaminant mixtures, were far beyond the scope of the NMFS 1998 guidelines, or any other current guidelines, and warrant careful consideration in site-specific assessments.

The proposed action significantly limits exposure of fish to the adverse effects of treated wood by minimizing the use of treated wood to only be used to maintain or repair pre-existing over water structures that are not in direct exposure to leaching by precipitation, overtopping waves, or submersion. Any chemicals that enter the water column will likely be very small due to the minute amount of treated wood that is in indirect contact with the aquatic environment, unexposed to precipitation, and at low risk of abrasion. In addition, for overwater structure maintenance and repair, treated wood is subject to strict conditions. Those limits include requirements that any treated wood will first be inspected to ensure that no visible residue, bleeding of preservative, preservative-saturated sawdust, contaminated soil, or other matter is present, then stored out of contact with standing water and wet soil and protected from precipitation. The use of prefabrication is required whenever possible to ensure that cutting, drilling and field preservative treatments are minimized. When field fabrication is necessary, all cutting and drilling of pesticide-treated wood, and field preservative treatment of wood exposed by cutting and drilling, will occur above OHW (riverine) or above the HAT (marine) to minimize discharge of sawdust, drill shavings, excess preservative and other debris in riparian or aquatic habitats. Tarps, plastic tubs or similar devices will be used to contain the bulk of any fabrication debris, and any excess field preservative will be wiped off.

Additionally, any project that requires removal of pesticide-treated wood will ensure that, to the extent possible, no wood debris falls into the water. If wood debris does fall into the water, it will be removed immediately. After treated wood is removed, it will be placed in an appropriate dry storage site until it can be removed from the project area. When these measures are considered collectively, they will significantly limit the amount of toxic preservatives reaching water bodies occupied by ESA-listed fish.

Because of these limitations and conditions, the actual area where we expect juvenile fish to experience sublethal effects, such as reduced foraging success and reduced growth, is so small relative to the total area occupied by juvenile fish, and the total area of designated critical habitat, we do not expect the impacts of treated wood use to alter population growth rate, abundance, or any other demographic characteristic.

Alternatives to treated wood that are used could also have some adverse effects. Materials such as wood that is not treated with pesticides (e.g., redwood, cedar, cypress, or exotic hardwoods) or less toxic preservatives (e.g., sodium silicate), galvanized steel, concrete, recycled plastic lumber, rubber, or composite materials are increasingly being used in aquatic construction projects due to expected longevity, increased strength, and minimal leaching characteristics (USEPA 2014, Hutton and Samis 2000, Stratus 2006a, USFS 2014). Those materials are all likely to contain little, if any, copper or PAH, but may include other metal or synthetic materials that cannot be considered entirely non-toxic (USEPA 2014, Hutton and Samis 2000, Stratus 2006a, USFS 2014).

The proposed action allows for the use of treated wood piles with pile wraps and polyurea coatings. Pile wraps and polyurea coating are described as barrier protection systems adhered or otherwise permanently affixed to the treated wood that includes boots, sleeves, wraps, and spray on coatings that meet minimum thickness standards (American Wood Protection Association 2016). Pile wraps and polyurea coatings are effective at minimizing the rate of leaching from pressure-treated wood piles and are widely used (Brown, B. 2011, CCC 2012, Husain et al. 2004, Konkler & Morrell 2017, NMFS 2009a, Pendleton 1990, Poston 2001, Schottle & Prickett 2010, Stratus 2006a). A 2010 study concluded that the use of four different pile wraps were effective in minimizing short-term (≤ 1 month) metal leaching rates from ACZA pressure-treated pilings (ranging from 0.12 ± 0.02 to 61.1 ± 9.4 mg/cm²/day) compared to unwrapped treated piles that did not exceed $.01 \mu\text{g}/\text{cm}^2/\text{day}$ (Schottle & Prickett 2010). The Naval Civil Engineering Laboratory participated in two long-term studies determining the effectiveness of plastic barrier systems for treated wood piles (Pendleton 1990). They concluded that there was no visible marine borer damage, no polyurethane adhesion loss, and the wraps remained intact after five years of marine aquatic exposure (Pendleton 1990). Wraps can be prefabricated using outer plastic wraps such as PVC, HDPE, or fiber-glass reinforced (RFP) plastic products with an epoxy fill, petrolatum saturated tape (PST) or an inner wrap of polyethylene in the void between the wrapping and pile to seal the preservative treated wood pile.

If the pile wrap becomes damaged, there is potential for a breach to occur, however unlikely, in-between the pile and the wrapping which would result in a sudden release of contaminants into the immediate environment (Schottle & Prickett 2010; Stratus 2006a, b). If a breach occurs, metals will leach at a higher rate than an unwrapped treated pile. However, the contaminants are

expected to be localized and proportional to the area of the exposed wood, and anticipated to reduce to “minute levels” within a short time period (days to weeks) (Poston 2001). Pile wraps can also result in a sudden release of contaminants due to failed points along seams and fasteners from wood expansion and contraction over time (Brown, B. 2011). After being in-water for one month, Schottle & Prickett (2010) intentionally cut a small square from both the inner and outer wraps to determine the rate of leaching from ACZA-treated wood. Significant leaching occurred from the breach, especially a high short-increase in copper. Any failure points that are likely to occur is likely to be small and proximal to the area and will likely decrease over time. By installing wraps prior to installation and following an inspection and maintenance program that is reviewed and verified by NMFS, the likelihood of a breach occurring is minimal and we do not expect adverse effects to occur. Inspections will occur every 1-2 years beginning 3-5 years after installation and repairs will be made if damage has occurred to 25% or more to the barrier surface on an individual pile. Repairs consist of adding additional coating or barrier material to mitigate for any future preservative loss.

Polyurea coatings have been used in numerous projects and are currently required in some California ports (Konkler & Morrell 2017). Seamed and sealed coatings are effective as long as they are “an impact-resistant, biologically inert coating that lasts or is maintained” (NMFS 2009a). Konkler & Morrell (2017) found metal levels within the water column, containing coated ACZA-treated wood, were below detection limits (0.05 mg/kg for each element) and remained low (<4 mg/kg of metal concentration) within the sediment in a synthetic salt water, non-circulating environment.

NMFS expects the use of pile wraps and polyurea coating to minimize the rate of leaching from pressure-treated wood piles and an inspection and maintenance program will reduce the likelihood of a breach occurring and no more than minimal leaching of preservatives occur from the use of wrapped piles.

Non-native and Invasive Plant Control. Manual, mechanical, biological and herbicidal treatments of invasive and non-native plants are often conducted as part of an action to restore native riparian vegetation on streambank stabilization, culvert, and bridge projects. NMFS has recently analyzed the effects of these activities using the similar active ingredients and PDC for proposed USDA Forest Service and USDI Bureau of Land Management invasive plant control programs (NMFS 2010; NMFS 2012). The types of plant control actions analyzed here are a conservative (*i.e.*, less aggressive) subset of the types of actions considered in those analyses, and the effects presented here are summarized from those analyses. Each type of treatment is likely to affect fish and aquatic macrophytes through a combination of pathways, including disturbance, chemical toxicity, dissolve oxygen and nutrients, water temperature, sediment, instream habitat structure, forage, and riparian and emergent vegetation (Table 5).

Table 5. 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 will be replaced by planted native 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. The short-term shade reduction that is likely to occur due to removal of riparian weeds could slightly affect stream temperatures or dissolved oxygen levels, which could cause short-term stress to fish adults, juveniles and eggs. Effects pathways are described in detail below.

Manual and mechanical treatments are likely to result in mild 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 cases, 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; root systems will restore soil and streambank stability and vegetation will provide shade. Therefore, any adverse effects due to biological treatments, by themselves, are likely to be very mild. 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. Stream margins often provide shallow, low-flow conditions, have a slow mixing rate with mainstem waters, and are the site at which runoff and subsurface flows are 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. 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.

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 (DiTomaso *et al.* 2006). Triclopyr, which is 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 2011c).

Several proposed PDC reduce the risk of herbicide drift. Ground equipment reduces the risk of drift, and hand equipment nearly eliminates it. Relatively calm conditions, preferably when humidity is high and temperatures are relatively low, and low sprayer nozzle height will reduce the distance that herbicide droplets will fall before reaching 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 speeds. The higher that an application is made above the ground, the more likely it is to be carried by faster wind speeds, result in long distance drift.

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.

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 (DiTomaso1997). 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 2011c). Proposed PDC minimize these concerns by ensuing proper calibration, mixing, and cleaning of equipment. Non-point source groundwater contamination of herbicides 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. Near wet stream channels, only aquatic labeled herbicides are to be applied. Aquatic glyphosate, aquatic imazapyr, and aquatic triclopyr-TEA can be applied up to the waterline, but only using hand selective techniques. A 15-foot buffer is required to use aquatic imazapyr and aquatic triclopyr-TEA by spot spraying. On dry streams, ditches, and wetlands, no buffers are required when using the aquatic herbicides for spot spraying or hand

selective application. The associated application methods were selected for their low risk of contaminating soils and subsequently introducing herbicides to streams. However, direct and indirect exposure and toxicity risks are inherent in some application scenarios.

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

The 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 the OHW mark) application along streams, lakes and ponds, (2) runoff from treated ditches and dry intermittent streams, and (3) application within perennial streams (dry areas within channel and emergent plants). The potential for herbicide movement from broadcast drift was also evaluated. Risks associated with exposure and associated effects were also evaluated for terrestrial species.

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

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

Data on toxicity to wild fish under natural conditions are limited and most studies are conducted on lab specimens. Adverse effects could be observed in stressed populations of fish, and it is less likely that effects will be noted in otherwise healthy populations of fish. Chronic studies or even

long-term studies on fish egg-and-fry are seldom conducted. Risk characterizations for both terrestrial and aquatic species are limited by the relatively few animal and plant species on which data are available, compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments. Additionally, in laboratory studies, test animals are exposed to only a single chemical. In the environment, humans and wildlife may be exposed to multiple toxicants simultaneously, which can lead to additive or synergistic effects.

The effects of herbicides on salmonids are fully described by NMFS in other recent opinions with the EPA, USFS, BPA, and USACE (NMFS 2010; NMFS 2011c; NMFS 2011d; NMFS 2012; NMFS 2013b; NMFS 2013c; NMFS 2013d) and in SERA reports. For the 2008 Aquatic Restoration Biological Opinion (ARBO) the USFS, BLM, and BIA evaluated the risk of adverse effects to listed salmonids and their habitat in terms of hazard quotient (HQ) values (NMFS 2008b).

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

For *imazapic*, *picloram*, and *triclopyr*, we referred to NMFS’s opinions, SERA reports, various other literature sources, and the 2013 BA for ARBO II (USDA-Forest Service *et al.* 2013) to characterize risk to listed fish species.

Chlorsulfuron. No chlorsulfuron HQ exceedences occur for fish or aquatic invertebrates. HQ exceedences occur for algae at rainfall rates of 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 to 5.0, and HQ exceedences 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.

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

Imazapyr. No HQ exceedences occurred for imazapyr for fish or aquatic invertebrates. HQ exceedences 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 for typical applications. In the event of an accidental spill, substantial mortality will be likely in both sensitive species of fish and sensitive species of algae (SERA 2011b).

Sethoxydim. No HQ exceedences occurred for sethoxydim for aquatic invertebrates, algae, or aquatic macrophytes. The HQ exceedences for fish occurred at rainfall rates of 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). PDC sharply reduce the risk of naphtha solvent presence in percolation runoff reaching streams. When PDC to reduce naphtha solvent exposure are employed, application of sethoxydim adjacent to stream channels will not adversely affect listed salmonids or their habitat.

Sulfometuron-methyl. No HQ exceedences occurred for sulfometuron-methyl for fish, aquatic invertebrates, or algae. The HQ exceedence for aquatic macrophytes occurred at a rainfall rate of 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 non-target species (including humans) associated with the contamination of surface water are low, relative to risks associated with contaminated vegetation. Stehr *et al.* (2009) observed no developmental effects at nominal concentrations of 10 mg/L or less for purified triclopyr alone or for the TEA formulations Garlon 3A and Renovate.

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

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

Several of these compounds were not proposed in this consultation because they do contain alkyl phenol ethoxylates (APEOs). Alkylphenols, including nonylphenol (NP) and nonylphenol ethoxylates (NPE), have been detected in the natural environment, including ambient air, sewage treatment plant effluent, sediment, soil, and surface waters, in wildlife, household dust, and human tissues. NP and NPE are toxic to aquatic organisms, and the breakdown products of nonylphenol ethoxylates (NP and shorter-chained ethoxylates) are more toxic and more persistent than their parent chemicals. NP has been shown to have estrogenic effects in a number of aquatic organisms (Environment Canada and Health Canada 2001; Lani 2010; Servos 1999). Environment Canada and Health Canada (2001) concluded that nonylphenol and its ethoxylates are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. Zoller (2006) reported that egg production by zebrafish, exposed to 75, 25 and 10 µg/L of a typical industrial APEO was reduced up to 89.6%, 84.7% and 76.9%, respectively, between the 8th and 28th days of exposure.

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 include limitations on the herbicides, adjuvants, carriers, handling procedures, application methods, drift minimization measures, and riparian buffers. The PCD also specify a maximum herbicide treatment area, specifically, limiting treatment to a maximum of 1.0% of the acres of riparian habitat within a 6th-field HUC with herbicides per year. This is a limiting threshold that, together with the other limitations, 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 on riparian condition 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.

In summary, the application of manual, mechanical, biological, or chemical plant controls will adversely affect ESA-listed salmonids by reducing vegetative cover, disturbing soil, and degrading water quality, which will cause injury to fish in the form of sublethal adverse physiological effects as described above that include increased respiration, reduced feeding success, and subtle behavioral changes that can result in increased predation and adverse impacts on aquatic macrophytes and aquatic invertebrates. Chemical plant controls that enters the water column will likely be minimized by the annual limitation on the extent of treated area, *i.e.*, less than, or equal to, 1.0% of the acres of riparian habitat within a 6th-field HUC per year (PDC 35) and therefore will limit exposure of fish to the adverse effects of herbicide application.

Post- Construction

Post-construction activities for transportation, restoration, and in-water and over-water structure related projects typically include stormwater management, site restoration and revegetation, and compensatory mitigation. Post-construction activities are likely to have short-term adverse effects by altering the physical characteristics of the aquatic environment and are also likely to have long-term positive effects by treating stormwater from construction related activities, restoring and revegetating project sites after the work has been completed, and provide compensatory mitigation for actions that have displaced riparian and aquatic habitats or otherwise prevented the development of properly functioning condition of natural habitat processes.

Stormwater Management. Pollutants in the post-construction stormwater runoff produced by each FEMA funded project will come from many diffuse sources. The runoff itself comes from rainfall or snowmelt moving over and through the ground. As the runoff travels along its path, it picks up and carries away natural and anthropogenic pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters (USEPA 2016). Pollutants in post-construction stormwater runoff typically include (Buckler and Granato 1999; Colman *et al.* 2001; Driscoll *et al.* 1990; Kayhanian *et al.* 2003; Van Metre *et al.* 2006):

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas
- Oil, grease, PAHs and other toxic chemicals from roads and parking areas used by motor vehicles
- Bacteria and nutrients from pet wastes and faulty septic systems
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the decay of building and other infrastructure
- Atmospheric deposition from surrounding land uses
- Erosion of sediment and attached pollutant due to hydromodification

Those pollutants will become more concentrated on impervious surfaces until they either degrade in place or are transported by wind, precipitation, or active site management. Although stormwater discharge from most proposed projects will be small in comparison to the flow of the nearby waterways, it will have an incremental impact on pollutant levels. The adverse effects of stormwater runoff from FEMA funded projects will occur primarily at the watershed scale due to persistent additions of pollutants or the compounding effects of many environmental processes.

Stormwater runoff from the proposed projects will contribute to the total incremental effect on the environment caused by all development activities within the range of ESA-listed species in Washington, Oregon, and Idaho. At this scale, the additive effect of persistent pollutants contributed by many small, unrelated land developments has a greater impact on natural processes than the input from larger, individual projects, and the impacts of many small and large projects are all compounded together (NRC 2009; Vestal and Rieser 1995).

The following brief summaries from toxicological profiles (ATSDR 1995; ATSDR 2004a; ATSDR 2004b; ATSDR 2005; ATSDR 2007) show how the environmental fate of each contaminant and the subsequent exposure of listed species and critical habitats varies widely, depending on the transport and partitioning mechanisms affecting that contaminant, and the impossibility of linking a particular discharge to specific water body impairment (NRC 2009):

- DDT and its metabolites, dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyltrichloroethane (DDD) (all collectively referred to as DDx) may be transported from one medium to another by the processes of solubilization, adsorption, remobilization, bioaccumulation, and volatilization. In addition, DDx can be transported within a medium by currents, wind, and diffusion. These chemicals are only slightly soluble in water, therefore loss of these compounds in runoff is primarily due to transport of particulate matter to which these compounds are bound. For example, DDx have been found to fractionate and concentrate on the organic material that is transported with the clay fraction of the wash load in runoff. Sediment is the sink for DDx released into water

where it is can remain available for ingestion by organisms, such as bottom feeders, for many years.

- The environmental fate of each type of PAH depends on its molecular weight. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms, with bioconcentration factors often in the 10-10,000 range. In sediments, PAHs can biodegrade or accumulate in aquatic organisms or non-living organic matter. Some evaporate into the air from the surface but most do not easily dissolve in water, some evaporate into the air from surface waters, but most stick to solid particles and settle into sediments. Changes in pH and hardness may increase or decrease the toxicity of PAHs, and the variables of organic decay further complicate their environmental pathway (Santore *et al.* 2001).
- PCBs are globally transported and present in all media. Atmospheric transport is the most important mechanism for global dispersion of PCBs. PCBs are physically removed from the atmosphere by wet deposition (*i.e.*, rain and snow scavenging of vapors and aerosols); by dry deposition of aerosols; and by vapor adsorption at the air-water, air-soil, and air-plant interfaces. The dominant source of PCBs to surface waters is atmospheric deposition; however, redissolution of sediment-bound PCBs also accounts for water concentrations. PCBs in water are transported by diffusion and currents. PCBs are removed from the water column by sorption to suspended solids and sediments as well as from volatilization from water surfaces. Higher chlorinated congeners are more likely to sorb, while lower chlorinated congeners are more likely to volatilize. PCBs also leave the water column by concentrating in biota. PCBs accumulate more in higher trophic levels through the consumption of contaminated food.
- Due to analytical limitations, investigators rarely identify the form of a metal present in the environment. Nonetheless, much of the copper discharged into waterways is in particulate matter that settles out. In the water column and in sediments, copper adsorbs to organic matter, hydrous iron and manganese oxides, and clay. In the water column, a significant fraction of the copper is adsorbed within the first hour of introduction, and in most cases, equilibrium is obtained within 24 hours.
- For zinc, sorption onto hydrous iron and manganese oxides, clay minerals, and organic material is the dominant reaction, resulting in the enrichment of zinc in suspended and bed sediments. The efficiency of these materials in removing zinc from solution varies according to their concentrations, pH, redox potential, salinity, nature and concentrations of complexing ligands, cation exchange capacity, and the concentration of zinc. Precipitation of soluble zinc compounds appears to be significant only under reducing conditions in highly polluted water.
- A significant fraction of lead carried by river water occurs in an undissolved form, which can consist of colloidal particles or larger undissolved particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of surface particulate matters from runoff. Lead may occur either as sorbed ions or surface coatings on sediment mineral particles, or it may be carried as a part of suspended living or nonliving organic matter in water. The ratio of lead in suspended solids to lead in dissolved form has been found to vary from 4:1 in rural streams to 27:1 in urban streams. Sorption of lead to polar particulate matter in freshwater and estuarine environments is an important process for the removal of lead from these surface waters.

Pollutants travel long distances in rivers either in solution, adsorbed to suspended particles, or else they are retained in sediments, particularly clay and silt, which can only be deposited in areas of reduced water velocity, such as behind dams or backwater and off-channel areas, until they are mobilized and transported by future sediment moving flows (Alpers *et al.* 2000a; Alpers *et al.* 2000b; Anderson *et al.* 1996). Santore *et al.* (2001) indicates that the presence of natural organic matter and changes in pH and hardness affect the potential for toxicity (both increase and decrease). Additionally, organics (living and dead) can adsorb and absorb other pollutants such as PAHs. The variables of organic decay further complicate the path and cycle of pollutants. The persistence and speciation of these pollutants also cause effects and, consequently, the action area, to extend from the point where runoff discharges into a stream to the downstream terminus.

Treatment of post-construction stormwater runoff reduces the amount of these contaminants entering the freshwater and estuary habitats of listed species. The treatment protocols proposed by FEMA will be based on a design storm (50% of the 2-year, 24 hour storm) that will generally result in more than 95% of the runoff from all impervious surfaces within the action area being infiltrated at or near the point at which rainfall occurs.

Stormwater infiltration treatment practices, such as such as bioretention, bioslopes, infiltration ponds, and porous pavement, supplemented with appropriate soil amendments as needed, as proposed by FEMA, are highly effective treatments to reduce or eliminate contaminants from runoff (Barrett *et al.* 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Hirschman *et al.* 2008; National Cooperative Highway Research Program 2006; Spromberg, et al. 2016; Washington State Department of Ecology 2004; Washington State Department of Ecology 2014).

Flow control best management practices (BMPs) proposed by FEMA will control the volume rate, frequency, and flow duration of stormwater surface runoff. The need to provide flow control BMPs depends on whether a development site discharges to a stream system or wetland, either directly or indirectly. Stream channel erosion control can be accomplished by BMPs that detain runoff flows or that physically stabilize eroding streambanks.

Although FEMA proposes to capture, manage, and treat runoff up to the design storm level from most proposed projects, treatment will not eliminate all pollutants in the post-construction runoff produced at FEMA funded project sites. Thus, adverse effects of post-construction stormwater runoff will persist for each FEMA funded project completed under the proposed action.

Site restoration & Revegetation. After each project is complete, FEMA will require any significant disturbance of riparian vegetation, soils, streambanks, or stream channel that was caused by the construction to be cleaned up and restored to reestablish those features within reasonable limits of natural and management variation. Thus, site restoration will typically include replacement of natural materials or other geomorphic characteristics that were previously altered or degraded there in some way, so that ecosystem processes that form and maintain productive fish habitats are replaced and can function at those sites.

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 immediately dissipate erosive energy associated with precipitation and increase soil infiltration. It also will accelerate vegetative succession necessary to restore the delivery of LW to the riparian area and aquatic system, root strength necessary for slope and bank stability, leaf and other particulate organic matter input, sediment filtering and nutrient absorption from runoff, and shade. Microclimate will become cooler and moister, and wind speed will decrease. Whether recovery occurs over weeks or years, the disturbance frequency, considered as the number of actions funded per year within a given recovery domain, is likely to be extremely low, as is the intensity of the disturbance, considered as a function of the total number of miles of critical habitat present within each watershed.

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. The time necessary for recovery of functional habitat attributes sufficient to support species recovery following any disturbance will vary by the potential capacity of each habitat attribute. Recovery mechanisms such as soil stability, sediment filtering and nutrient absorption, and vegetation succession may recover quickly (*i.e.*, months to years) after completion of the project. Recovery of functions related to LW recruitment and microclimate may require decades or longer. Functions related to shading of the riparian area and stream, root strength for bank stabilization, and organic matter input may require intermediate lengths of time. The rate and extent of functional recovery is also controlled in part by watershed context. Proposed actions will likely occur in areas where productive habitat functions and recovery mechanisms are absent or degraded. 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.

Compensatory Mitigation. When projects result in requiring stormwater management, include riprap revetments, or displaces riparian or aquatic habitats or otherwise prevent development of properly functioning condition of natural habitat processes, compensatory mitigation is required. These compensatory actions are part of this proposed action and these compensatory mitigation actions include the activity categories included in this opinion. The effects of implementing compensatory mitigation actions are specific to the compensatory action proposed. The effects then are similar to the effects discussed below.

2.4.1.2 Activity Category-Specific Effects

Road, Culvert, and Bridge Repair, Rehabilitation and Replacement

The effects of these projects includes all of the preconstruction, construction, and site restoration effects described above. This includes actions necessary to complete geotechnical surveys, such as access road construction, drill pad preparation, mobilization and set up, drilling and sampling operations, demobilization, boring abandonment, and access road and drill pad reclamation. Excavation, grading, and filling necessary to maintain, rehabilitate, or replace existing roads, culverts, and bridges, and to construct and maintain stormwater facilities are also included.

Stormwater runoff from the highway system, including roads, culverts, and bridges, delivers a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals used in highway maintenance (Buckler and Granato 1999; Colman *et al.* 2001; Driscoll *et al.* 1990; Kayhanian *et al.* 2003). These ubiquitous pollutants are a source of potent adverse effects to salmon and steelhead, even at ambient levels (Hecht *et al.* 2007; Johnson *et al.* 2007; Loge *et al.* 2006; Sandahl *et al.* 2007; Spromberg and Meador 2006), and are among the identified threats to sturgeon. Feist *et al.* (2017) surveyed and modeled distinct coho salmon spawning reaches across a gradient of urbanization in the Puget Sound basin and found that contaminants in stormwater runoff from the regional transportation grid likely cause coho mortality. Furthermore, Feist *et al.* (2017) concluded that coho in more urbanized watersheds are vulnerable to non-point source pollution regardless of the timing, intensity, and frequency of storms. The proposed design criterion for stormwater management will treat stormwater flows associated with more than 95% of the annual average rainfall. Runoff from impervious surfaces within each project area being treated at or near the point at which rainfall occurs using low impact development, bioretention, filter subsoils, and other practices that have been identified as excellent treatments to reduce or eliminate contaminants for highway runoff (Barrett *et al.* 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Feist *et al.* 2017; Herrera Environmental Consultants 2006; Hirschman *et al.* 2008; National Cooperative Highway Research Program 2006).³⁸

Stormwater treatment practices, such as bioretention, bioslopes, infiltration ponds, and porous pavement, supplemented with appropriate soil amendments as needed,³⁹ are excellent treatments to reduce or eliminate contaminants from runoff (Barrett *et al.* 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Hirschman *et al.* 2008; National Cooperative Highway Research Program 2006; Washington State Department of Ecology 2004; Washington State Department of Ecology 2014). Stormwater treatment may also include source control BMPs, which prevent pollution, or other adverse effects of stormwater, from occurring. Source control BMPs include methods as various as using mulches and covers on disturbed soil, putting roofs over outside storage areas, and berming areas to prevent stormwater run-on and pollutant runoff.

Flow control BMPs typically control the volume rate, frequency, and flow duration of stormwater surface runoff. The need to provide flow control BMPs depends on whether a development site discharges to a stream system or wetland, either directly or indirectly. Stream channel erosion control can be accomplished by BMPs that detain runoff flows and also by those which physically stabilize eroding streambanks. Both types of measures may be necessary in urban watersheds. Construction of a detention pond is the most common means of meeting flow

³⁸ See also Memos from Ronan Igloria, HDR (Henningson, Durham, and Richardson, Inc.), to Jennifer Sellers and William Fletcher, Oregon Department of Transportation, dated December 28, 2007 (Stormwater Treatment Strategy Development – Water Quality Design Storm Performance Standard), February 28, 2008 (Stormwater Treatment Strategy Development – Water Quantity Design Storm Performance Standard - Final), and April 15, 2008 (Stormwater Treatment Strategy Development – BMP Selection Tool).

³⁹ See also Memos from Ronan Igloria, HDR (Henningson, Durham, and Richardson, Inc.), to Jennifer Sellers and William Fletcher, Oregon Department of Transportation (Igloria 2007; Igloria 2008a; Igloria 2008b).

control requirements. Construction of an infiltration facility is the preferred option but is feasible only where more porous soils are available.

Although FEMA proposes that actions will capture, manage, and treat runoff up to the design storm level from most proposed projects, treatment will not eliminate and may not even significantly reduce all pollutants in the runoff currently produced at project sites. Thus, adverse effects of non-point source pollution will persist for the design life of the proposed action.

Structural failure of road, culvert, or bridge infrastructure causes extensive and long-lasting damage to aquatic habitats. Consequences of infrastructure failure include erosion and sedimentation, release of toxic materials or structural debris into the water, rerouting of flows into neighboring drainages that may be unable to adjust to the increase in peak flow, or onto unchanneled slopes. Structural failure may be caused by inadequate design, poor construction, damage accumulated from vehicles, inadequate maintenance, or extreme natural events, but most often is a result of flooding and improper or inadequate engineering and design, particularly at stream crossings but also where roads cross headwater swales and other areas of convergent groundwater. A typical failure occurs when culverts that are sized only to accommodate the flow of water, but not the additional sediment and wood typically transported during higher flows, becomes obstructed, thus causing water and debris to overflow. In more serious cases, diversion and concentration of overflow then leads to a “cascading failure,” a series of adverse events that end with loss of the structure or initiation of landslides and debris flows (Furniss *et al.* 1998; Gucinski *et al.* 2001).

Although flooding will always be a threat to this type of infrastructure, FEMA’s proposed action will minimize this danger of structural failures by requiring road, culvert, and bridge designs that anticipate and accommodate the movement of water, sediment and debris during infrequent but major storms and reduce stormwater runoff. Reduced maintenance costs will be a significant ancillary benefit for grantees. Moreover, the proposed action will allow FEMA to fund projects in which road, culvert, bridge, or utility line infrastructure fails, or is about to fail. This will allow a public transportation manager to act immediately, or before the next appropriate in-water work window, as necessary to repair or prevent infrastructure failure that poses an imminent threat to human life, property, or natural resources.

Stormwater Facilities

Most direct and indirect effects of stormwater facility actions are similar to the effects of general construction discussed above, and will follow the PDC for general construction as applicable. Water quality throughout most of the action area is degraded to various degrees because of contaminants that are harmful to species considered in this consultation. Aerial deposition, discharges of treated effluents, and stormwater runoff from residential, commercial, industrial, agricultural, recreational, and transportation land uses are all source of these contaminants. For example, the U.S Environmental Protection Agency (EPA) found that 4.7 million pounds of toxic chemicals were discharged into surface waters of the Columbia River Basin (a 39% decrease from 2003) and another 91.7 million pounds were discharged in the air and on land in 2011 (USEPA 2011). This reduction can be attributed, in part, to significant state, local and

private efforts to modernize and strengthen tools available to treat and manage stormwater runoff (USEPA 2009; USEPA 2011).

Treatment of post-construction stormwater runoff reduces the amount of these contaminants entering the freshwater and estuary habitats of listed species. The treatment protocols proposed by FEMA will be based on a design storm (50% of the 2-year, 24 hour storm) that will generally result in more than 95% of the runoff from all impervious surfaces within the action area being infiltrated at or near the point at which rainfall occurs. Stormwater infiltration treatment practices, such as such as bioretention, bioslopes, infiltration ponds, and porous pavement, supplemented with appropriate soil amendments as needed, as proposed by FEMA, are highly effective treatments to reduce or eliminate contaminants from runoff (Barrett *et al.* 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Hirschman *et al.* 2008; National Cooperative Highway Research Program 2006; Spromberg, et al. 2016; Washington State Department of Ecology 2004; Washington State Department of Ecology 2014).

Utilities

Proposed utility line actions consist of stream crossings for pipes, pipelines, cables, and wires. Most direct and indirect effects of utility line actions are similar to the effects of general construction discussed above, and will follow the PDC for general construction as applicable. Aerial utility lines hung from an existing bridge are likely to add no additional effects to those of the bridge; drilled lines are likely to have a smaller subset of the construction effects discussed above, including drilling effects, or will express those effects to a lesser degree. However, trenched utility lines are likely to cause additional adverse effects related to erosion and horizontal directional drilling that spans the channel migration zone and any associated wetland has potential risk of a frac-out occurring.

Excavation and subsequent filling of a trench in a streambank or dry channel is likely to make the area of the trench more or less resistant to erosion, depending on the substrate composition, the type of excavation, and the type of fill. If the trench area is less resistant to erosion, due to loosening of the substrate or through the use of fill with smaller substrate particles than were originally present, then high stream flows are likely to erode the disturbed substrate, thus mobilizing sediment or abruptly altering the bottom contours or bank stability of the stream. If the trench area is more resistant to erosion, through compaction of the substrate or through the use of fill with larger substrate particles than were originally present, then high stream flows may be less likely to erode the disturbed substrate than the remainder of the streambed or bank, possibly creating hydraulic control points and altering fluvial processes. Similarly, pipelines, cables, and materials used to armor them may create hydraulic control points (“jumps”) that degrade channel conditions and impede fish passage, if they remain at the same elevation after being exposed by streambed or bank erosion.

Horizontal directional drilling operations is considered to be a less intrusive method than traditional open-cut trenching for crossing a waterway or wetland by minimizing riparian vegetation and limiting construction to established entry and exit points (Keykha et al. 2011). However, an inadvertent return of drilling fluids to the surface (“frac-out” release) may occur

and have negative effects on riparian and aquatic habitats. A frac-out is typically caused by over-pressurization of the borehole beyond the containment capability of the near-surface geological material and drilling fluid seepage through fractures or weak points to the surface (Kang et al. 2016). If a frac-out occurs, and a large volume of drilling fluid such as bentonite is released, the increase in sediment will have negative effects on water quality, benthic invertebrates, aquatic plants, fish and egg survival (Newcombe and MacDonald 1991; Slade 2000; Newcombe 2003; Cott et al. 2015). FEMA will require grantees to carry out on-site visual monitoring during drilling operations and grantees will include a frac-out contingency plan that will be reviewed and verified by NMFS staff to address any potential frac-out releases that occur during drill operations.

Streambank and Channel Stabilization

In this FESP programmatic opinion, the primary streambank stabilization method proposed is vegetated riprap with large woody debris. Other proposed methods, to be used alone or in combination, include a log or roughened rock toe, a partially spanning porous weir, woody plantings, herbaceous cover, deformable soil reinforcement, coir logs, bank reshaping and slope grading, floodplain flow spreaders, floodplain roughness, and engineered log jams. Damaged streambanks will be restored to a natural slope, pattern, and profile suitable for establishment of permanent woody vegetation, without changing the location of the bank toe. Rock and other hard structures within the functional floodplain reduce water quality by reducing or eliminating riparian vegetation that regulates the quantity and quality of runoff and, together with channel complexity, help to maintain and reduce stream temperatures. The benefits of using rock or other hard structures for this purpose are often speculative or minimal, at best, particularly in contrast to the multiple habitat benefits provided by other erosion control methods that do not require hardening of the stream bank or bed (Cramer *et al.* 2003; Cramer 2012).

Upstream and downstream channel effects occur when bank and channel hardening and channel narrowing alter stream velocity. Downstream, loss of stream roughness and channel narrowing causes water velocity and erosion to increase. Upstream, channel narrowing reduces water velocity and leads to backwater effects during high flows that typically result in upstream deposition (Legasse, Schall and Richardson, 2001). Then, when flows recede, erosion occurs around or through the new deposition. Thus, a hardened bank or channel creates chronically unstable conditions that increase bed and bank erosion upstream and downstream, and often affect either the subject structure or an unrelated structure in a way that grantees prefer to address by further hardening. This sets in motion another round of upstream and downstream channel effects that perpetuates and extends the extent of aquatic habitat damage.

Channel maintenance is another very serious source of upstream and downstream channel effects. Channel maintenance refers to the periodic (sometimes annual) dredging necessary to counteract natural deposition which occurs around structures where they impinge on the edge of a functional floodplain, particularly where a smaller tributary enters the floodplain and creates an alluvial fan. These areas tend to fill with alluvial material that will be dredged to prevent a road, culvert, or other structure from being overtopped during high flow events. This chronic source of bed removal is a major cause of channel instability and loss of spawning and rearing habitat for

long distances upstream and downstream, and is a source of mechanical disturbance in bays, estuaries, and lower elevation mainstem reaches where sturgeon occur.

Ecological connectivity refers to the capacity of the landscape to support the movement of energy, water, sediment, organisms, and other material. Ecological connectivity is adversely affected by rock or other hard structures in the functional floodplain when bed material and aggrading channel processes cannot cycle throughout the reach, and when the upstream or downstream movements of organisms are restricted. The conservation of salmon, steelhead, green sturgeon, and eulachon is intimately linked to the health of their underlying ecosystems. This, in turn, depends on more than just the ability of these fish to move upstream and downstream during different life history stages and under a wide variety of different stream conditions. Ecological health also requires ecological connectivity for a wide range of physical and biotic processes that are more difficult to quantify than fish passage, such as seasonally shifting channel patterns, the upstream flight and downstream drift of insects, and delivery of large wood from terrestrial sources to the stream, estuary and coastal ocean (Maser *et al.* 1988). Installation of rock or structures that require channel maintenance captures large wood, accelerates or delays fish movements, or otherwise inhibits the movement of energy and material also reduces ecological connectivity.

The proposed activity may alter river channels for flood control, road engineering, habitat improvements such as engineered log jams, and erosion control. Channel stabilization reduces areas of bare channel and may change the dimensions of the channel thus stopping the input of fine sediments. Channel stabilization produces some overhead cover that may be used by fish, but reduces the channel's ability to move in a natural way, thus resulting in a minor reduction of channel complexity over time.

Streambank Restoration

Under the proposed action, bare earth along streambanks will be protected by seeding, planting woody shrubs and trees, and mulching. This immediately dissipates erosive energy associated with precipitation and increases soil infiltration. It also accelerates vegetative succession necessary to restore the delivery of large wood to the riparian area and stream, root strength necessary for slope and bank stability, leaf and other particulate organic matter input, sediment filtering and nutrient absorption from runoff, and shade. Microclimate will become cooler and moister, and wind speed will decrease.

The primary proposed streambank restoration as part of the action is the use of large wood and vegetation to increase bank strength and resistance to erosion in an ecological approach to engineering streambank stabilization (Mitsch 1996; WDFW *et al.* 2003). The proposed actions explicitly do not include any other type of structure built entirely of rock, concrete, steel or similar materials, other streamflow control structures, or any type of channel-spanning structure. The primary means of streambank stabilization proposed is the use of large wood and vegetation to increase resistance to bank erosion (bioengineering). This approach protects banks by using natural materials to increase erosion resistance and bank roughness to disrupt stream energy. Roots and other small and large pieces of vegetation are used to collect and bind bank sediments. This helps to avoid or minimize loss of riparian function associated with more traditional

approaches to streambank stabilization that rely primarily on rock, cement, steel, and other hard materials. Bioengineered bank treatments develop root systems that are flexible and regenerative, and respond more favorably to hydraulic disturbance than conventional hard alternatives. 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. Most effects from this activity on listed fish and their habitat are expected to be positive, but in some limited circumstances, a project could slow natural channel migration, resulting in a small loss of channel complexity over time.

Boulder and Large Wood Placement

The effects of boulder and large wood placement are likely to include construction effects discussed above, and reestablishment of native riparian forests or other appropriate native riparian plant communities, provide increased cover (large wood, 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.

Off- and Side-Channel Habitat Restoration

Restoration of off and side-channel habitat as proposed by FEMA includes removal of fill material to passively reconnect existing stream channels to historical off- and side-channels. The effects on the environment of reconnecting stream channels with historical river floodplain swales, abandoned side channels, and floodplain channels are likely to include relatively intense construction effects, as discussed above. The 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 and/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).

Set-back Existing Berms, Dikes, and Levees

The effects of setting back existing berms, dikes, and levees are 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. Set-back or removal of levees will result in a long-term increase in

floodplain function. The scale of that improvement will depend on the size of the proposed action.

Water Control Structure Removal

Removal of water control structures, such as a small dam, earthen embankment, subsurface drainage features, tide gate, or gabion, as proposed by FEMA is likely to have significant local and landscape-level effects to processes related to sediment transport, energy flow, stream flow, and temperature (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, and are likely to be either intentionally removed by parties concerned about liability that may arise from failure, or fail due to lack of maintenance. Thus, it is likely that in some cases, the best outcome of a restoration action based on removal of a water control structure will be a minimization of adverse effects that may have followed an unplanned failure, such as reducing the size of a contaminated sediment release, or preventing an unplanned sediment pulse, controlling undesirable species, or ensuring fish passage around any remnant of the structure.

When a water control structure is specifically targeted for removal, it may have less significant adverse effects and more beneficial effects than a structure that is removed primarily for safety or economic reasons, but 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 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).

In-Water or Over-Water Structures

Overwater structures include recreational boating facilities and dock and wharf facilities operated by ports, municipalities, and other public entities. Recreational boating requires construction and maintenance of a variety of types and sizes of structures. Some are water

dependent, and will be placed in riparian, nearshore, and overwater areas. Others are “related facilities” (*e.g.*, parking lots, picnic areas), that are not water dependent. For purposes of this consultation, actions proposed to support recreational boating facilities are re-construction of boat ramps; re-construction of a residential pier, ramp and float; repair and relocation of structures within an existing marina; structures in fleeting and anchorage areas; installation of small temporary floats; and repair of navigational aids.

Public dock and wharf facilities also entail many different types and sizes of structures, often installed and operated over large areas. For purposes of this consultation, however, the proposed action includes the following work: (1) Replacement of existing pilings, fender piles, group pilings, walers, and fender pads; (2) installation of new mooring dolphins and structural pilings; (3) height extension of existing pilings; and (4) recycling of large wood obstructions that limit the usefulness of public dock and wharf facilities.

The reconstruction, repair, and relocation of in-water and over-water structures will adversely affect juvenile salmonid migration by extending the life of a pre-existing structure. Juvenile salmon in the marine nearshore as well as in freshwater have been reported to migrate along the edges of shadows rather than through them (Nightingale and Simenstad, 2001; Southard et al., 2006; Celedonia et al., 2008a; Celedonia et al., 2008b; Ono, 2010; Moore et al., 2013; Munsch et al., 2014). In freshwater, about three-quarters of migrating Columbia River fall Chinook salmon smolts avoided a covered channel and selected an uncovered channel when presented with a choice in an experimental flume setup (Kemp et al. 2005). In Lake Washington, actively migrating juvenile Chinook salmon appeared to change course when they approached a structure, swimming around structures through deeper water rather than remaining in shallow water and swimming underneath a structure (Celedonia et al. 2008b). Structure width, light conditions, water depth, and presence of macrophytes appeared to influence the degree of avoidance, with juvenile Chinook salmon appearing less hesitant to pass beneath narrower structures. Finally, juvenile Chinook salmon appeared to move into deeper water to travel beneath or around structures (Celedonia et al. 2008b).

In the marine nearshore, there is also substantial evidence that over-water structures impede the nearshore movements of juvenile salmonids with fish stopping at the edge of the structure and avoiding swimming into the shadow or underneath the structure (Heiser and Finn 1970; Able et al., 1998; Simenstad 1999; Southard et al., 2006; Ono 2010). In the Puget Sound nearshore, 35 millimeter to 45 millimeter juvenile chum and pink salmon were reluctant to pass under docks (Heiser and Finn 1970). Southard et al. (2006) snorkeled underneath ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but only moved underneath the terminals at low tides when there was more light penetrating the edges. Ono (2010) reports that juveniles tended to stay on the bright side of the shadow edge, two to five meters away from the dock, even when the shadow line moved underneath the dock. These findings suggest that overwater-structures can disrupt juvenile migration in the nearshore.

To determine the maximum size of public overwater structures typically constructed in the Pacific Northwest, we reviewed implementation data from our programmatic consultation on over- and in-water structures with the Portland District of the Corps of Engineers (SLOPES IV).

Under the SLOPES IV in-water and over-water structures programmatic biological opinion, there have been 61 repair and replacement of public over-water structure implementation records in the last five years (excluding private recreational structures). These projects have included the replacement and repair of boat ramps, docks, wharfs, gangways, boarding floats, and boat slides. The sizes of the over-water structures that were identified in the implementation records varied from 100 square feet to 13,124 square feet. The largest repair of a public structure was a crabbing dock with a gangway and landing along the coast of Oregon that was in need of repair to replace deteriorated decking, stringers, pile caps, bracing, and piles. The size of replacement and repaired over-water structures is based on the assumption that a Corps permit was issued and that the amount that was proposed was implemented. The data analyzed were strictly from Oregon permitted over-water structures that met the SLOPES IV programmatic project design criteria. Although these were implemented under SLOPES IV in-water and over-water structures programmatic biological opinion, it is our best available indicator for the maximum total square footage of over-water structures created pursuant to the proposed action.

The majority of repairs and replacements of in-water and over-water structures in the action area occur in Puget Sound, the Columbia River, and the coasts of Oregon and Washington. Since 2013, 20 projects were funded through FEMA associated with in-water and over-water structures that included boat ramps, floats, marina structures, moorage docks, and bulkhead repairs. This has resulted in an average of about 4 over-water structures per year with the highest amount of replacements (n=6) having occurred in Puget Sound over a five year period. Assuming an increase in the repair and replacement of over-water structures, NMFS would not expect to see more than 2 repairs and replacements of over-water structures per year per recovery domain with a maximum square footage of 13,124 for a public over-water structure.

Predation. Predation increases where juvenile salmon avoid shaded areas under large structures, concentrate at the edge of structures, and/or are pushed into deeper waters. Predation has been identified as one of the limiting factors for all salmonid species in the Columbia River basin (except chum salmon) (NMFS 2008b) and other areas of the Pacific Northwest. Increased predator abundance may result from climate change (ISAB 2007). The ISAB recommend reducing predation by introduced piscivorous species to mitigate these anticipated effects. Predator species such as northern pikeminnow (*Ptychocheilus oregonensis*), and introduced predators such as largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), black crappie (*Pomoxis nigromaculatus*) white crappie (*P. annularis*) and, potentially, walleye (*Stizostedion vitreum*) (Ward *et al.* 1994, Poe *et al.* 1991, Beamesderfer and Rieman 1991, Rieman and Beamesderfer 1991, Pflug and Pauley 1984, and Collis *et al.* 1995) may use habitat created by overwater structures (Ward and Nigro 1992, Pflug and Pauley 1984) such as piers, float houses, floats and docks (Phillips 1990). Carrasquero (2001) reports that smallmouth and largemouth bass have a strong affinity to structures; forage and spawn in the vicinity of docks, piers and pilings; and, largemouth and smallmouth bass are common predators of juvenile salmonids.

Major habitat types used by largemouth bass include vegetated areas, open water and areas with cover such as docks and submerged trees (Mesing and Wicker 1986). During the summer, bass prefer pilings, rock formations, areas beneath moored boats, and alongside docks. Colle *et al.* (1989) found that, in lakes lacking vegetation, largemouth bass distinctly preferred habitat

associated with piers, a situation analogous to slack water areas of the Columbia River. Marinas also provide wintering habitat for largemouth bass out of mainstem current velocities (Raibley *et al.* 1997). Wanjala *et al.* (1986) found that adult largemouth bass in a lake were generally found near submerged structures suitable for ambush feeding. Bevelhimer (1996), in studies on smallmouth bass, indicates that ambush cover and low light intensities create a predation advantage for predators and can also increase foraging efficiency.

Pribyl *et al.* (2005), in studies on piscivorous fish in the Lower Willamette River found that smallmouth bass were the most prevalent species captured. They found that smallmouth bass were found near beaches and rock outcrops more frequently in the winter and spring, and highly associated with pilings regardless of the season. For largemouth bass, they found that they were found near pilings and beach sites in summer and autumn and near pilings, rock and beach areas during winter and spring. They also indicated that large sized predators were present at very low densities, but juveniles were fairly abundant. Smallmouth densities were highest in riprap, mixed riprap/beach and rock outcrop areas. Largemouth bass densities were low throughout the year, with riprap sites and alcoves being the highest density areas. Zimmerman (1999) and Sauter *et al.* (2004) both indicate that wild fall Chinook are the most vulnerable to smallmouth predation due to their smaller size during emigration.

Black crappie and white crappie are known to prey on juvenile salmonids (Ward *et al.* 1991). Ward *et al.* (1991), in their studies of crappies within the Willamette River, found that the highest density of crappies at their sampling sites occurred at a wharf supported by closely spaced pilings. They further indicated that suitable habitat for crappies includes pilings and riprap areas. Walters *et al.* (1991) also found that crappie were attracted to overwater structures.

Ward (1992) found that stomachs of northern pikeminnow in developed areas of Portland Harbor contained 30% more salmonids than those in undeveloped areas, although undeveloped areas contained more northern pikeminnow. Pribyl *et al.* (2005) found no fish in the stomachs of pikeminnow, but did find fish remains in the stomachs of smallmouth bass.

There are four major predatory strategies used by piscivorous fish: They run down prey; ambush prey; habituate prey to a non-aggressive illusion; or stalk prey (Hobson 1979). Ambush predation is probably the most common strategy. Predators lie in wait, then dart out at the prey in an explosive rush (Gerking 1994). Predators may use sheltered areas that provide slack water to ambush prey fish in faster currents (Bell 1991).

The above analysis pertains to predator species that occupy freshwater areas covered by this opinion. Within estuarine and marine areas, typical piscivorous juvenile salmonid predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk to being preyed upon by other fish increases. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette, 2001).

Light. Light plays an important role in defense from predation. Prey species are better able to see predators under high light intensity, thus providing the prey species with an advantage (Hobson 1979, Helfman 1981). Petersen and Gadomski (1994) found that predator success was higher at lower light intensities. Prey fish lose their ability to school at low light intensities, making them vulnerable to predation (Petersen and Gadomski 1994). Howick and O'Brien (1983) found that in high light intensities prey species (bluegill) can locate largemouth bass before they are seen by the bass. However, in low light intensities, the bass can locate the prey before they are seen. Walters *et al.* (1991) indicate that high light intensities may result in increased use of shade-producing structures. Helfman (1981) found that shade, in conjunction with water clarity, sunlight and vision, is a factor in attraction of temperate lake fishes to overhead structure.

We expect artificial lighting will influence juvenile salmon behavior in the areas adjacent to pier lights. However, because ambient light conditions at night already allow predators to forage, we do not expect artificial lighting to increase the predation risk to juvenile salmon. Also, juvenile salmon typically migrate during the day and are inactive at night (Celedonia *et al.* 2008a; Tabor and Piaskowski 2002), therefore, the attraction of lighting at night is unlikely to delay their migration. We do not expect lighting to have any effect on adult salmon or juvenile or adult steelhead. Adult Chinook salmon and steelhead are too large to be preyed upon by piscivorous fish. Juvenile steelhead smolts are larger and better able to avoid predation and are less likely than juvenile Chinook salmon to change their behavior due to artificial lighting (Newcomb and Coon 1997; McComas *et al.* 2008).

In addition to piscivorous predation, overwater structures (tops of pilings) also provide perching platforms for avian predators such as double-crested cormorants (*Phalacrocorax auritus*), from which they can launch feeding forays or dry plumage. Krohn *et al.* (1995) indicate that cormorants can reduce fish populations in forage areas, thus possibly affecting adult returns as a result of smolt consumption. Because their plumage becomes wet when diving, cormorants spend considerable time drying out feathers (Harrison 1983) on pilings and other structures near feeding grounds (Harrison 1984).

Boating. The direct effects from replacement or repair of in-water and over-water structures will generally result in the continued use of boating recreation. The replacement of a boat ramp will generally result in continued permanent loss of some riparian habitat. The extent of area of that loss associated with a ramp is usually small. The majority of ramps are one or two lanes, each roughly 15' wide, extending from the top of bank to up to 10' below the water line. Upland parking lots, picnic areas, walking trails, and toilet facilities will also result in losses to riparian vegetation if placed close to the water's edge. In addition, construction activities associated with ramp construction will also result in impacts to the riparian area. These effects can be offset with compensatory mitigation. The proposed use of hard scour protection is limited to preventing scouring at a boat ramp.

Construction of pavement and other permanent soil coverings to build water-dependent structures (*e.g.* boat ramps), roads linking those structures to the transportation system, and road upgrades can also reduce site permeability and infiltration. Permeability and infiltration are inversely related to the rate and volume of runoff. The effects of reduced soil permeability and infiltration are most significant in upland areas where runoff processes and the overall storm

hydrograph are controlled mainly by groundwater recharge and subsurface flows. These effects are less significant in riparian areas, where saturated soils and high water tables are more common and runoff processes are dominated by direct precipitation and overland flow (Dunne and Leopold 1978). Stormwater runoff from roads and parking lots delivers a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals (copper and zinc in particular), petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals used in road maintenance (Driscoll *et al.* 1990; Buckler and Granato 1999, Colman *et al.* 2001, Kayhanian *et al.* 2003).

The indirect effects of scour protection for public infrastructures are similar, with the area occupied by the hard structure itself being analogous to an area of new impervious surface. However, this effect will be offset with the requirement of offset with additional planting of riparian trees and shrubs or restoration of nearshore habitats.

Riparian habitats are one of the most ecologically productive and diverse terrestrial environments (Kondolf *et al.* 1996, Naiman *et al.* 1993). Vegetation in riparian areas influences channel processes through stabilizing bank lines, and providing large wood terrestrial food sources rather than autochthonous food production, and regulating light and temperature regimes (Kondolf *et al.* 1996, Naiman *et al.* 1993). Revegetation of any riparian areas disturbed by construction activities in time is likely to maintain or improve habitat conditions for salmonids within the action area by increasing plant densities in degraded areas or changing plant species at the site to those that are more beneficial to aquatic species.

Many direct and indirect effects of recreational boating activities are similar to those of general construction described above. Among those are construction of new impervious surfaces for a boat ramp or other water-dependent structure that will be offset by an action like planting additional riparian trees and shrubs or restoration of nearshore habitats. Other direct physical and chemical effects are unique to overwater structures. These are disruption of nearshore habitat, shading and ambient light changes, water flow pattern, and energy disruption (Carrasquero 2001), although these effects have been avoided or minimized by conservation measures described above. Overwater structures can alter predator prey relationships by improving predator success (Hobson 1979, Bell 1991, Metcalfe *et al.* 1997), although the environmental conditions created by overwater structures that can increase predation on salmon can be avoided or minimized using project design criteria that reduce shaded area and avoid placement in shallow water and other low velocity locations (Carrasquero 2001).

The obvious indirect effects of recreational boating facilities are those associated with boating activities. Boating can result in discharges of many pollutants from boats and related facilities, and physical disruption to wetland, riparian and benthic communities and ecosystems through the actions of a boat hull, propeller, anchor, or wakes (USEPA 1993, Carrasquero 2001, Kahler *et al.* 2000, Mosisch and Arthington 1998). Boats may interact with the aquatic environment by a variety of mechanisms, including emissions and exhaust, propeller contact, turbulence from the propulsion system, waves produced by movement, noise, and movement itself (Asplund 2000). Sediment resuspension, water pollution, disturbance of fish and wildlife, destruction of aquatic plants, and shoreline erosion are the major areas of concern (Asplund 2000).

Wakes derived from boat traffic may also increase turbidity in shallow waters, uproot aquatic macrophytes in shallow waters, or cause pollution through exhaust, fuel spills, or release of petroleum lubricants (Warrington 1999, McConchie and Toleman 2003). Hilton and Phillips (1982) in their studies on boat traffic and increased turbidity in the River Ant determined that boat traffic definitely had a large effect on turbidity levels in the river. Nordstrom (1989) says that boat wakes may also play a significant role in creating erosion in narrow creeks entering an estuary (areas extensively used by rearing juvenile salmonids). Kahler *et al.* (2000) indicates that wake erosion results in continuous low level sediment input with episodic large inputs from bank failure.

Dorava (1999) indicates that boat wake erosion was the cause of substantial bank erosion on the Kenai River, Alaska (whose primary traffic is 10- to 26-foot-long recreational boats) and the reason for substantial bank stabilization measures to arrest that erosion. The result of the erosion in important salmon areas is a reduction in numbers of salmon (Dorava 1999). Dorava (1999) further indicates that juvenile Chinook salmon rearing habitat features are easily altered by boat wake induced streambank erosion and streamside development.

McConchie and Toleman (2003) in their studies on the Waikato River found that effects from boat wakes are site specific and dependent on bank vegetation, bed and bank material, availability of sediment, channel profile, water depth and vessel speed. They further found that boat generated wakes have a greater potential effect where the river channel is narrow and where boat use is regular, concentrated and close to shore, and also in systems where systems are regulated and not subject to high erosive flows.

Klein (1997), citing several EPA studies, indicates that boat traffic in waters less than 8.2 feet in depth result in substantial impacts to submerged vegetation and benthic communities. Klein (1997) also indicates that sediment resuspension is substantial if a boat operates in less than 7.2 feet of water and that a slight increase in depth would prevent the resuspension of sediment. Asplund (2000) evaluated the literature on boating effects to the aquatic environment and found that impacts were few in waters greater than 10 feet. Limiting the placement of structures to areas where any moored boats are in waters deeper than 10 feet (as measured at OLW) would minimize any resuspension and submerged vegetation impacts.

Bauer *et al.* (2002) developed algorithms to predict erosion rates from boat traffic. They verified their models by using data measured during a field experiment in which a 7.5 m (24.6 feet) boat was driven past the site over a range of speeds to generate waves of varying size in a levee bank in the Sacramento–San Joaquin River Delta. Based on their test findings, erosion rates averaged about 0.01 to 0.03 mm/boat passage. The models predicted erosion estimates from their two models were similar, and ranged from less than 0.01 mm/boat passage for the weakest boat-wake event to 0.22 mm for the most energetic boat-wake event. They judged that the uppermost values overestimate the true erosion rate associated with single boat passages. However, two multiple boat-passage experiments yielded erosion rates of roughly 0.01–0.03 mm/boat passage, which agree with the lower estimates from the analytical methods.

Aquatic vegetation. Some of the proposed activities suppress or destroy aquatic vegetation in the freshwater, estuarine, and marine environments. Aquatic vegetation provides cover and is

important to the feeding success of salmonids, steelhead, eulachon, green sturgeon, and rockfish. Proposed activities that reduce aquatic vegetation are likely to incrementally reduce the food sources and cover for the ESA listed species mentioned above. The reduction in food source includes epibenthos (Haas et al. 2002) as well as forage fish.

Coastal fish populations depend upon both the quantity and quality of the available estuarine and tidal marsh habitats (Peters and Cross 1992). Most marine and intertidal waters, wetlands, swamps and marshes are critical to fish (Fedler and Crookshank 1992). For example, seagrass beds protect young fish from predators, provide habitat for fish and wildlife, improve water quality, and control sediments (Lockwood 1990, Thayer *et al.* 1984, Hoss and Thayer 1993, Phillips 1984). In addition, seagrass beds are critical to nearshore food web dynamics (Wyllie-Echeverria and Phillips 1994). For example, some invertebrates that are principal prey items for fish of commercial and ecological importance (*e.g.*, chum salmon, Pacific herring, And Pacific Sand Lance) in the Pacific Northwest only occur in eelgrass beds (Simenstad *et al.* 1982, Simenstad 1994).

Four anadromous fish species (pink, chum, coho, and Chinook salmon) are found in association with eelgrass meadows (Phillips 1984). Coho, yearling Chinook, and sockeye salmon spend little time in the estuary; pink salmon traverse through the estuary relatively quickly; and chum and subyearling Chinook salmon use the estuary quite extensively (Pearcy 1992, Fisher and Pearcy 1996). Pearcy (1992) states that chum salmon in Netarts Bay, Oregon use shallow marshes, sloughs, and tidal creeks in the upper reaches extensively during high tides in the spring. During low tides they move into deep water channels. As the fish grow in size, they begin to use the lower portions of the estuary.

For Puget Sound Chinook and Hood-Canal summer-run chum salmon, herring is an important food source. Puget Sound herring spawn at depths where submerged aquatic vegetation grows and use several species of macroalgae, in addition to native eelgrass, as spawning substrate (Penttila, 2007; Millikan and Penttila, 1974). Proposed activities that suppress or destroy aquatic vegetation within Puget Sound are likely to reduce the number of herring. The number of proposed activities (over-water and in-water structures & dredging operations) that would suppress or destroy aquatic vegetation is expected to be less than 10 projects a year and are small compared to the entire area of Puget Sound.

Activities that are likely to result in direct long-term adverse effects to estuarine and tidal marsh functions are those that will cause permanent coverage of estuarine and tidal marsh areas by the footprint of replaced water-dependent structures and the reduction of benthic invertebrates caused by maintenance dredging. Indirect, long-term effects may be caused by vessel wakes and propeller washing due to recreational boat operations above seagrass beds (Peterson *et al.* 1987, Lockwood 1990, Fonseca *et al.* 1998). Mooring boats in or next to seagrass beds can also cause similar damage. These effects will be avoided or minimized by not constructing new facilities in areas containing aquatic vegetation.

Bulkhead Repair and Removal

NMFS expects up to 7 bulkhead repair projects per year with no more than 4 bulkhead repair projects in a given recovery domain. Bulkhead repairs within Puget Sound are excluded from this opinion and therefore have not been analyzed. The short-term effects that may occur during construction include noise, increased suspended sediment, potential stranding behind the bulkhead repair during construction, and general construction-related disturbance. Long-term effects include repairing hardening banks that will impact intertidal habitat, and maintaining structures that are within mean higher high water.

ICF Jones & Stokes and Illingworth and Rodkin, Inc. (2009) reported peak sound pressure from vibratory driving of steel sheet pile of 182 decibels (dB) (reference value for dB peak pressure = 1 μ Pa) and sound exposure level of 165 dB (reference value for dB SEL = 1 μ Pa²-sec). These values are below thresholds that could injure fish (206 dB peak and 187 dB accumulated sound exposure level) (FHWG 2008). Sound levels above 160 dB root mean square (RMS) (reference value for dB RMS pressure is 1 μ Pa) could affect migration behavior of adults, but the area of potential exposure will be small (approximately 100 yard radius around the sheet pile), and will include some intertidal zone where we do not expect adults to occur.

All work will occur during low tide in the approved in-water work window and in phases to coordinate with tidal exposure and allowing for curing time before tidal inundation to reduce sedimentation and pollutants from entering into the water column. Some suspended sediment is expected as tides return to work areas. The exact intensity extent, and duration of resulting sedimentation is not known, but plumes would likely consist of low concentrations of sediments that would settle back to the bottom within several minutes to a couple of hours after the work ends. Temporary avoidance of the plume may occur, should a fish be exposed to project-related suspended sediment. No other measurable direct effects on behavior or fitness would result from the exposure. The low concentration of mobilized sediments that would settle out of the water column would be undetectable compared to ambient conditions, and would cause no measureable effect on the marine vegetation and invertebrates that may inhabit the action area. NMFS expects short-term construction-related effects of bulkhead repair projects to be minor and not of any biological importance.

There is the potential that fish could get stranded behind the bulkhead repair during construction. Prior to high tide, block nets will be used to prevent fish from accessing the area behind the new sheet pile section and work will occur during low tide to prevent fish strandings. Restricting construction activities to the in-water work window and at low tide when juvenile fish are least likely to be present in the project vicinity, prohibiting construction equipment from being stationed or operated below mean high tide (MHT), setting block nets to prevent fish from accessing the area will make it unlikely that fish will be injured or killed during the bulkhead repair. NMFS expects juvenile fish will not occupy the bulkhead footprint during construction with the use of block nets, avoidance behavior from noise and suspended sediment, and working at low tide.

The long-term effects of repairing and maintain an armored shoreline from eroding will continue to hinder sediment transport, natural wave dissipation, and reduce habitat for ESA listed species,

their prey, and other marine resources. The armoring of the shoreline can reduce or eliminate shallow water habitats through the disruption of sediment sources and sediment transport. Shoreline hardening cuts off the input of sediment and large woody debris. The impoundment of shoreline sediment can have indirect long-term effects on the physical structure of the beach, including coarsening of the substrate, beach lowering, and increased erosion of beaches located in front of, and down drift from shoreline armoring (Dean 1986; Everts 1985). Evidence collected by the Corps suggests that shoreline armoring results in a coarsening of the beach material in front of the armor (Macdonald et al. 1994). As wave action and littoral drift continue to remove the finer sediment from a beach and there is no bank erosion to replenish this finer material, the sediment in front of, and down drift from, the armoring will become coarser. The beach profile is also likely to lower and narrow (Galster and Schwartz 1990). Thus, the loss of material, over time, can affect the migration of juvenile salmon by reducing the amount of available shallow habitat they rely on for food and cover.

Under this opinion we expect less than 7 bulkhead repair projects to occur within a given year with less than 4 bulkhead repair projects within a single recovery domain and we expect the removal of bulkheads. Because the proposed action does not allow any increase in shoreline armoring, is limited to coastal marine waters, existing marinas, and existing parks, and promotes the removal of armoring, we expect it to reduce the amount of shoreline armoring to some degree. This will result in modest improvements for nearshore salmon habitat. The continued presence of bulkheads will maintain the steep shorelines which lack the shallow water habitat upon which juvenile salmon depend for predator avoidance. Migration of juvenile salmon leaving nearshore waters, inlets, and estuaries into the open ocean in large numbers occurs by June (Healey 1980a, b). We do not expect any effects to juvenile salmonids due to the bulkhead repairs occurring during the appropriate approved in-water work window which will typically occur from November to February as to avoid injury or harm to juvenile salmonids migrating through nearshore marine waters. Juvenile steelhead generally migrate offshore into oceanic waters and are rarely found in the nearshore environment other than migrating through the area (Percy and Masude 1982; Hartt and Dell 1986). We do not expect any effects to juvenile or adult steelhead or adult salmon because they are not shoreline dependent. Shoreline construction including the repair of bulkheads in coastal marine waters has been identified as a very low to moderate threat to eulachon critical habitat (Gustafson et al. 2016). Nearshore marine foraging habitat is essential for juvenile and adult eulachon survival. The continued presence of bulkheads will reduce the lack of shallow water habitat and continue the lack of prey availability. The use of the action by eulachon is limited by the timing of their presence in the action area. Furthermore, effects may occur to eulachon critical habitat however, we expect effects to be minor and limited by the number of bulkhead repair projects per year allowed within this opinion. Green sturgeon subadults and adults migrate seasonally along the coast and congregate at specific sites in nearshore marine waters. Tagging studies indicate that green sturgeon typically occupy depths of 20-70 m in marine environments (Erickson and Hightower 2007) making rapid vertical ascents, often at night (Erickson and Hightower 2007; Huff *et al* 2012). Bulkhead repair projects will occur in the nearshore environment but will occur at low tide and during the day when green sturgeon are not within the immediate area therefore we do not expect any effects to green sturgeon. We also do not expect any effects to Puget Sound/Georgia Basin yelloweye rockfish and bocaccio because under this opinion bulkhead repairs may not occur

within Puget Sound or inland marine waters of Washington and therefore do not overlap with yelloweye rockfish and bocaccio distribution.

Dredging to Maintain Access and Functionality

Dredging will occur to remove sediments necessary to maintain access to existing docks, marinas, port terminals, industrial docks and wharfs, and water diversions. Dredging and disposal of the dredged material speed up the natural processes of sediment erosion, transportation, and deposition (Morton 1977). Dredging and disposal temporarily increases turbidity, changes bottom topography with resultant changes in water circulation, and changes the mechanical properties of the sediment at the dredge and disposal sites (Morton 1977). The effects of turbidity on salmonids are discussed below. These effects are significant in proportion to the ratio of the size of the dredged area to the size of the bottom area and water volume (Morton 1977).

In all areas covered by this consultation, resuspension of toxic sediments may be a problem. Adequate testing of sediments prior to dredging to limit resuspension of toxic materials is necessary under the proposed action. Many areas within the action area have contaminated sediments. The Corps and resource agencies have developed a methodology/protocol to analyze sediments for toxicity and suitability for in-water disposal ((USACE Northwest Division 2009). Sediment testing results should be submitted to NMFS with the Project Implementation Worksheet for review.

Extraction of bed material with upland disposal causes bed degradation (NMFS 2005b). Gravel extraction sites trap incoming bedload sediment, passing 'hungry water' downstream, which typically erodes the channel bed and banks to regain at least part of its sediment load (Kondolf 1997). Gravel removal may cause downstream erosion if the area subsequently receives less bed material from upstream than is being carried away by fluvial transport. Thus, gravel removal not only impacts the extraction site, but also reduces gravel delivery to downstream areas. In some areas, there are sufficient amounts of material being delivered that upland disposal is not problematic. The requirement to dispose of the material within the stream/river will prevent this from happening. Upland disposal from dredging in the estuary has minimal effects on channel process due to the estuarine sediment transport processes and the small ratio of anticipated volumes of dredge sediment to basin sediment delivery. Under the proposed action, the locations where dredging will occur is limited to one time dredge events and the total scale of dredging impacts will likely be small. No large-scale dredging or channel maintenance is proposed.

Entrainment During Dredging. For a fish to avoid entrainment into the draghead it must first detect and react to the ship, cutterhead, or pipeline, and then the fish must react quickly to avoid exposure to the zone of influence around the cutterhead or pipeline. Smolt and juvenile ESA listed fish will be passing through the riverine/estuarine portions of the individual project action areas on route to the ocean, and therefore are at an increased risk of exposure due to the presence of the cutterhead or pipeline in the migratory corridor. Noise and vibration from the dredge vessel and cutterhead or pipeline during operation may discourage most fish from getting close and thereby avoid encountering the zone of influence.

When juvenile salmonids come within the zone of influence of the cutter head, they may be drawn into the suction pipe (Dutta 1976; Dutta and Sookachoff 1975a). Dutta (1976) reported that salmon fry were entrained by hydraulic pipeline dredging in the Fraser River. During studies by Braun (1974a, 1974b) almost 99% of entrained juveniles were killed. Hydraulic pipeline dredging operations caused a partial destruction of the anadromous salmon fishery resource of the Fraser River (Dutta and Sookachoff 1975b). Hydraulic pipeline dredges operating in the Fraser River during fry migration took substantial numbers of juveniles (Boyd 1975). Further testing in 1980 by Arseneault (1981) found entrainment of chum and pink salmon but in low numbers relative to the total of salmonids outmigrating (0.0001 to 0.0099%).

The Corps conducted extensive sampling during hydraulic dredging within the Columbia River in 1985-88 (Larson and Moehl 1990) and again in 1997 and 1998 in Oregon coastal bays and estuaries. In the 1985-88 study no juvenile salmon were entrained, and in the 1997-98 study two juvenile salmon were entrained (R2 Resource Consultants 1999). Examination of fish entrainment rates in Grays Harbor from 1978 to 1989 detected only one juvenile salmon entrained (McGraw and Armstrong 1990). Dredging was conducted outside peak migration times. No evidence of fish mortality was found while monitoring dredging activities along the Atlantic Intracoastal Waterway (Stickney 1973). These conflicting Fraser and Columbia River studies examined deep-water areas associated with main channels. There is little information on the extent of entrainment in shallow-water areas, such as those associated with the proposed action.

In the absence of definitive information, the NMFS makes the biologically conservative assumption that hydraulic and/or pipeline dredging in shallow-water areas of existing docks, marinas, port terminals, industrial docks and wharfs, and water diversions are likely to entrain some juvenile salmon, if they are present during operations. The timeframe for dredging operations vary by project, but some are scheduled to occur during the outmigration period, and will continue into the over-summer period when green sturgeon are present.

Estimating the number of individual fish injured or killed from entrainment during dredging is difficult because the number of fish passing through each of the individual project action areas will vary from day-to-day and the number of individuals moving into the site between dredging events is unknown. Further, dredging primarily occurs outside of peak migration periods for ESA listed aquatic species. Dredging does not typically occur over the entire navigational channel footprint and dredging events proposed under this programmatic opinion are a result of natural disaster declared events and will focus on maintenance of existing structures (docks, marines, water intakes) in order to maintain vessel access and functionality to these structures. Furthermore, while individuals may be present at the initial start-up of operations, NMFS is reasonably certain that during operations, individual fish could easily move out of the area to avoid the discharge plume. Based on these, the number of ESA listed aquatic species to be exposed to dredging operations is likely low.

Disposal quantities and discharge time are important variables to consider while assessing the likelihood for juvenile ESA listed aquatic species to be adversely affected through a physical injury from disposed material. The amount and weight of dredged material is significant for a small fish in order to resist from being entrained by the descending material and dragged down to

the river/estuarine floor. The quantity of dredge material displaces a large volume of water; therefore, if some fish are pushed ahead of the discharge plume they would be entrained within the vortices of the turbulent flow. Accurately determining the number of individual ESA listed aquatic species is difficult because there is no accurate or precise way to count the number of individuals exposed in the area or volume of water adversely affected by disposal with each disposal event. Thus, the most appropriate indicator that describes the quantitative magnitude of physical injury from disposed material is the amounts of materials dredged at each project dredging location.

Due to the emergency nature of the proposed action, it is difficult to estimate the amount of dredged material, however, in reviewing previous programmatic implementation records, we were able to determine an expected maximum amount of dredged material for vessel access and dredging for the maintenance of water intake structures. To determine the maximum amounts of materials dredged, we reviewed implementation records from our programmatic consultation on over- and in-water structures with the Portland District of the Corps of Engineers (SLOPES IV). Under SLOPES IV In-water and over-water structures programmatic biological opinion, there have been 46 dredging maintenance implementation records for vessel access and 11 implementation records for the dredging maintenance of water intake structures from 2013-2017. Dredging for improved vessel access ranged from 25 to 80,000 cubic yards of material volume being removed. Dredging for the maintenance of water intake structures ranged from 2 cubic yards to 5,000 cubic yards of material volume being removed. The amount of dredged material is based on the assumption that a Corps permit was issued and that the amount that was proposed was dredged to that full extent and did not exceed that extent. The data analyzed were strictly from Oregon permitted over-water structures that met the SLOPES IV programmatic project design criteria. Although these were implemented under SLOPES IV in-water and over-water structures programmatic biological opinion, it is our best available indicator for total maximum amount of dredged material pursuant to the proposed action. Since 2013, FEMA has funded a total of 25 projects with dredging operations, averaging 5 dredging projects per year. Puget Sound and the Interior Columbia recovery domains constituted almost half (n=13) of the dredging projects that have been funded in the last five years.

Debris Removal

The removal of debris will improve fish passage, improve habitat by removing anthropogenic debris from the channel, and the downstream placement of the removed natural debris (large wood, organic, and mineral debris) will contribute to channel complexity and continue the transport of sediment and organic material further downstream. The stockpiling or downstream placement of large wood will further provide increased rearing habitat and cover.

The construction process for removing debris will in some cases adversely affect water quality by resulting in a short-term increase in suspended during construction, and shortly thereafter. As discussed above, increased suspended sediment in the freshwater environment can result in increased substrate embeddedness and pool filling during and after debris removal. In the estuarine and marine environment, increased suspended sediment in the near-shore may be so great as to affect juvenile ESA listed species in at least two ways: 1) causing juvenile fish to move offshore to avoid areas of high turbidity, therefore increasing their exposure to predation

by larger fish; and 2) reduce forage opportunities. Finally, debris removal for some projects may involve partial worksite isolation (lateral cofferdams) and dewatering to avoid ESA listed aquatic species exposure to the acute effects of in-stream and nearshore mineral debris removal (including all substrate sizes). While worksite isolation is a minimization practice, consisting of several measures meant to decrease fish exposure to the effects of debris removal, it will likely injure or kill some juvenile ESA listed aquatic species. Worksite isolation practices are discussed above.

2.4.2 Effects of the Action on ESA-Listed Salmonids

As noted above, each individual project will be completed as proposed with full application of PDCs. Each action is likely to have the following effects on individual fish at the site and reach scale. The nature of these effects will be similar between projects because each project is based on a similar set of underlying construction activities that are limited by the same PDC and the individual salmon and steelhead ESUs or DPSs have relatively similar life history requirements and behaviors regardless of species.

The intensity of the effects, in terms of changes in the condition of individual fish and the number of individuals affected, and severity of these effects will also vary somewhat between projects because of differences at each site in the scope of work area isolation and construction, the particular life history stages present, the baseline condition of each fish present, and factors responsible for those conditions. However, no project will have effects on fish that are beyond the full range of effects described here. The effects of most of the proposed action are also reasonably certain to result in some degree of ecological recovery at each project site due to the requirements for bioengineered bank treatments, fish passage and stormwater treatment where it may have been partial or nonexistent before, site restoration, and compensatory mitigation projects that should provide a high level of ecological function, even when compensating for degraded or low quality resources.

The proximity of spawning adults, eggs, and fry of most salmon and steelhead species to any construction-related effects of projects completed under the proposed program that could injure or kill them will be limited by the PDC that require work within the active channel to be isolated from that channel and completed in accordance with the Oregon, Washington, and Idaho guidelines for timing of in-water work to protect fish and wildlife resources. The Oregon, Washington, and Idaho guidelines for timing of in-water work are primarily based on the average run timing of salmon and steelhead populations, although the actual timing of each run varies from year to year according to environmental conditions. Moreover, because populations of salmon and steelhead have evolved different run timings, work timing becomes less effective as a measure to reduce adverse effects on species when two or more populations occur in a particular area. It is unknown whether the Oregon and Washington guidelines for timing of in-water work are also protective of eulachon and green sturgeon because their migration and rearing times are less well known and were not considered when the guidelines were prepared.

In general, direct effects are ephemeral (instantaneous to hours) or short-term (days to months), and indirect effects are long-term (years to decades, or the life of the project). Effects are described by life history stage in outline form below. Projects with a more significant

construction aspect are likely to adversely affect more fish, and to take a longer time to recover, than projects with less construction.

Except for fish that are captured during work area isolation, individual fish whose condition or behavior is impaired by the effects of a project authorized or completed under this opinion are likely to suffer primarily from ephemeral or short-term sublethal effects during construction, including diminished rearing and migration as described below. Projects that will require two or more years to complete are also likely to adversely affect more fish because their duration will be longer, but those effects are also likely to be less intense during each subsequent year as a result of work area isolation that will only be completed once per work area.

Any construction impacts to stream margins are likely to be most important to fish because those areas often provide shallow, low-flow conditions, may have a slow mixing rate with mainstem waters, and may also be the site at which subsurface runoff is introduced. Juvenile salmon and steelhead, particularly recently emerged fry, often use low-flow areas along stream margins. Wild Chinook salmon rear near stream margins until they reach about 60 mm in length (Bottom *et al.* 2005; Fresh *et al.* 2005). 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.

The peak number of projects that are anticipated to occur under the FEMA Endangered Species Programmatic- FESP opinion is 128 per year, with 40 or fewer projects in any recovery domain. Over the period 2012-2016, the average number of projects per year funded by FEMA has been about 86 projects, with 27 or fewer projects in any recovery domain. The number of projects per year is highly driven by the intensity and frequency of disaster events. In 2009, FEMA consulted on 98 projects just within 8 Washington Counties (FEMA personal communication, June 12, 2017). In most domains, far fewer projects will likely be implemented but a level of uncertainty remains which is why FEMA anticipates a higher average number of projects to occur in a given year under this opinion than previous years. Measured as miles of streambank disturbance, the average physical impact of these projects combined is very small compared to the total number of miles of critical habitat available in each recovery domain. The likelihood of additive effects on species at the program level due to projects occurring in close proximity within the same watershed, or even within sequential watersheds, is very remote, whether those effects are adverse or beneficial.

Based on previous flooding events in Oregon, Washington, and Idaho, it is likely at the program level that the action area for two or more projects will occur in proximity to each other in the same 5th field HUC watershed, during the same year. However, the total streamside footprint that will be physically disturbed by the full program each year due to flood and other natural disaster events, which corresponds to the area where almost all direct construction impacts will occur, is relatively small compared to the total number of watersheds or critical habitat miles in each recovery domain.

Of the ESA-listed species considered in this opinion, only juvenile salmon and steelhead are likely to be captured during work area isolation. Restrictions on timing and location of projects

will not overlap with juvenile eulachon, making their capture extremely unlikely. Adult salmon, steelhead, eulachon, and green sturgeon that may be present when the in-water work area is isolated are likely to leave by their own volition, or can otherwise be easily excluded without capture or direct contact before the isolation is complete.

Most direct, lethal effects of authorizing and carrying out the proposed actions are likely to be caused by the isolation of in-water work areas, though lethal and sublethal effects would be greater without isolation. Any individual fish present in the work isolation area will be captured and released. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis. Stress and death from handling occur because of differences in water temperature and dissolved oxygen between the river and transfer buckets, as well as physical trauma and the amount of time that fish are held out of the water. Stress on salmon and steelhead increases rapidly from handling if the water temperature exceeds 64°F, or if dissolved oxygen is below saturation. Debris buildup and predation within minnow traps can also kill or injure listed fish if they are not monitored and cleared on a regular basis. Design criteria 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 (NMFS 2002).

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 = 31, *i.e.*, number of juveniles to be captured per project, based on ODOT’s data for site isolation⁴⁰
- c = 0.05, *i.e.*, rate of juvenile injury or death caused by electrofishing during capture and release, primarily steelhead and coho salmon. Consistent with observations by Cannon (2008; 2012) and data reported in McMichael *et al.* (1998).
- t = 0.02, *i.e.*, an estimated average smolt to adult survival ratio, see Smoker *et al.* (2004) and Scheuerell and Williams (2005). This is very conservative because many juveniles are likely to be captured as fry or parr, life history stages that have a survival rate to adulthood that is exponentially smaller than for smolts.

Thus, the effects of work area isolation on the abundance of juvenile or adult salmon or steelhead in any population is likely to be small, no more than three adult-equivalent per year in any recovery domain (Table 6).

⁴⁰ 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 fish salvage operations.

Table 6. Number of salmon and steelhead affected, per year, by recovery domain.

Recovery Domain	Estimated Maximum Number of Projects (per year) (n)	Estimated Maximum Number of Juveniles Captured (per year)(n*p)	Estimated Maximum Number of Juveniles Injured or Killed (per year)(n*p*c)	Estimated Maximum Number of Adult Equivalents “Killed” (per year)(n*p*c*t)
WLC	35	1,085	54	1.1
IC	25	775	39	0.8
OC	20	620	31	0.6
SONCC	8	248	12	0.2
Puget Sound	40	1,240	62	1
Total	128	3,968	198	4.0

Rapid changes and extremes in environmental conditions caused by construction are likely to cause a physiological stress response that will change the behavior of salmon and steelhead (Moberg 2000; Shreck 2000). For example, reduced input of particulate organic matter to streams, the addition of fine sediment to channels, and mechanical disturbance of shallow-water habitats are likely to lead to under use of stream habitats, displacement from or avoidance of preferred rearing areas, or abandonment of preferred spawning grounds, which may increase losses to competition, disease, predation, or, for juvenile fish, reduce the ability to obtain food necessary for growth and maintenance (Moberg 2000; Newcombe and Jensen 1996; Sprague and Drury 1969).

The ultimate effect of these changes in behavior, and on the distribution and productivity of salmon and steelhead, will vary with 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). Projects that affect stream channel widths are also likely to impair local movements of juvenile fish for hours or days, and downstream migration maybe similarly impaired. Moreover, smaller fry are likely to be injured or killed due to in-water interactions with construction activities, including work area isolation, and due to the adverse consequences that displacement and impaired local movement will have on rearing activities, at each restoration site subject to those activities.

Fish may compensate for, and adapt to, some of these perturbing situations 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 action combined with poor environmental baseline conditions will likely suffer a metabolic cost that will be sufficient to impair their rearing, migrating, feeding, and sheltering behaviors and thereby increase the likelihood of injury or death.

In addition to the general effects of construction on listed species described above, each type of action will also have the following effects on individual fish. Fish passage restoration will

increase the quantity of spawning and rearing habitat accessible to affected species. Removal of pilings is likely to decrease predation on juvenile salmon and steelhead by reducing resting areas for piscivorous birds and cover for aquatic predators, and by reducing long-term exposure to toxics.

Population level responses to habitat alterations can be thought of as the integrated response of individual organisms to environmental change. Thus, 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).

At the species level, direct 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 effects of any action authorized or completed under this opinion will be too minor, localized and brief to affect the VSP characteristics of any salmon or steelhead population, they also will not have any effects at the species level.

Given the small reduction in the growth and survival of fish that will be directly affected by individual projects, primarily at the fry, parr, and smolt life stages, the relatively low intensity and severity of that reduction at the population level, and the low frequency in a given population, any adverse effects to fish growth and survival are likely to be inconsequential. Moreover, the proposed action is also reasonably certain to lead to some degree of species recovery within each action area, including more normal growth and development, improved survival, and improved spawning success. Projects that improve fish passage through culverts or better longitudinal connectivity (up and downstream), habitat complexity, and ecological connectivity between streams and floodplains will likely have long-term beneficial effects on population structure.

Summary of the effects of the action by fish life history stage:

1. Freshwater spawning

a. Salmon and steelhead

- i. Adult. *Direct* – Chemical contaminants from machinery impair reproductive behavior. No holding or spawning is likely to occur in the immediate project area due to in-water timing and work restrictions. However, pre-spawning mortality and less spawning success will occur downstream of long-term project sites due to higher bioenergetic cost, more sublethal effects of contaminants, less adaptive behavior and movement, and an increased likelihood of competition, predation, and disease. The occurrence of these effects is likely to be infrequent and spread over a very large area. Long term positive effects on population abundance or productivity are expected for some projects particularly those that improve fish passage. *Indirect* – Better pre-spawning survival and spawning success after the completion of projects due to improved migration conditions and fewer adult fish passage barriers.

- ii. Egg. *Direct* – Chemical contaminants and sediment in runoff during construction activities reduce egg survival. *Indirect* – No effect if spawning areas are upstream of construction areas. Survival of eggs may be reduced for some years in some limited areas that are downstream of construction sites if sufficient fine sediment is deposited to reduce the availability of interstitial space and impede delivery of sufficient oxygen to incubating embryos until natural scouring effects restore the preferred sediment distribution size. Where fine sediment is not deposited, or after it is scoured, more normal egg development is likely to occur due to improved water quality.
- iii. Alevin. *Direct* – Temporary increase in chemical contaminants and sediment during construction reduces alevin survival. No other direct effects due to in-water timing and work restrictions. *Indirect* – More normal growth and development after site construction due to improved water quality and cover, and less disease and predator induced mortality, and improved conditions for local movements.

2. Freshwater rearing

a. Salmon and steelhead

- i. Fry. *Direct* – Temporary increase in chemical contaminants and sediment during construction activities reduces forage and impairs behavior. Capture, with some injury and death, during in-water work isolation and construction of projects, reduced growth and development due to higher bioenergetic cost, more sublethal effects of contaminants, less adaptive behavior and movement, an increased likelihood of competition, predation, and disease, and a degraded biological community. These effects may be stronger when projects take place beside or in small tributaries where aquatic habitat areas are correspondingly small and easily modified. Conversely, fewer individuals are likely to occur in those habitats. In larger tributaries and main stem rivers, aquatic habitat areas are larger and less likely to be modified by construction activities, although more individual fish may be affected. Piling removal projects will improve water quality by eliminating chronic sources of toxic contamination. In-water and over-water structure projects will continue support predation, decrease feeding success, and decrease visual ability of fry. *Indirect* – More normal growth and development after site restoration due to better forage, less disease and predator induced mortality, more effective migration and distribution due to improved water quality and cover, better forage, more functional floodplain conditions, and fewer juvenile passage barriers.
- ii. Parr. Same as for fry, although probably fewer individuals directly affected due to greater swimming ability.

3. Freshwater migration

a. Salmon and steelhead

- i. Adult. *Direct* – Temporary increase in chemical contaminants and sediment during construction activities impairs orientation and migratory behavior. Delayed upstream migration and increased pre-spawning

mortality during instream activities due to higher bioenergetic cost, more sublethal effects of contaminants, less adaptive behavior and movement, and an increased likelihood of competition, predation, and disease. These effects are likely to occur at a very limited number of sites in any given year. *Indirect* – More normal upstream migration and pre-spawning mortality after site restoration due to less disease induced mortality, improved migration conditions, and fewer fish passage barriers.

- ii. Kelt (steelhead). *Direct* – Same as for adults, plus delayed seaward migration and increased post-spawning mortality during instream activities due to higher bioenergetic cost, more sublethal effects of contaminants, less adaptive behavior and movement, and an increased likelihood of competition, predation, and disease. *Indirect* – More normal seaward migration and post-spawning mortality after site restoration due to less disease induced mortality, improved migration conditions, and fewer adult fish passage barriers.
- iii. Fry. *Direct* – Same as for freshwater rearing, plus capture (with some injury and death) during in-water work isolation, delayed seaward migration, increased avoidance behavior from in-water and over-water structures, and reduced growth and development during instream activities due to higher bioenergetic cost, more sublethal effects of contaminants, less adaptive behavior and movement, and an increased likelihood of competition, predation, and disease. *Indirect* – More normal seaward migration, growth and development after site restoration due to improved water quality and cover, better forage, more functional floodplain conditions, and fewer juvenile passage barriers.
- iv. Parr. Same as for fry, although probably fewer individuals affected due to greater swimming ability.

4. Estuary rearing and smoltification

a. Salmon and steelhead

- i. Fry. *Direct* – Same as for freshwater rearing and migration.
- ii. Parr. Same as for fry.
- iii. Smolt. Same as for fry and parr, although probably fewer individuals affected due to greater swimming ability.

5. Nearshore marine growth and migration

- i. Juvenile: Near-shore migration of juvenile salmon is a critical time for feeding and rapid growth before movement toward the open ocean. *Direct* – Pile driving would disrupt migration and feeding. *Indirect* – Piles provide perches for avian predators. Overwater structures increase predation at some sites. Habitat alteration by roads, culverts, bridges, bulkhead repairs will reduce important beach forage habitat. Stormwater from these surfaces will introduce contaminants that may affect survival.

6. Offshore marine growth and migration – These life history stages do not occur in the action area.

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 specific sites that will be affected by the proposed programmatic action are distributed across such a large action area, 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 the primary VSP attributes of abundance or productivity for any single population.

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). 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 measurable effect on species-level abundance, productivity, or ability to recover.

2.4.3 Effects on ESA-Listed Green Sturgeon, Eulachon, Puget Sound/Georgia Basin Yelloweye Rockfish and Puget Sound/Georgia Basin Bocaccio

Green Sturgeon and Eulachon

Little is known about southern DPS of green sturgeon and eulachon although key differences in the distribution and biology of these two species make it reasonable to assume that the effects of the proposed action on them are likely to be within range of effects on salmon and steelhead described above. Both species are broadly distributed in marine areas along the western coast of North America and enter the action area in subtidal and intertidal areas.

In the case of southern green sturgeon, subadult and adult individuals enter the action area for non-breeding, non-rearing purposes. Impacts from construction to green sturgeon are the same as those described above for salmonids. Because of their age, location, and life history, these individuals are relatively distant from, and insensitive to, the effects of a majority 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 sturgeons are likely to be far less sensitive to suspended solids than salmonids. It is also reasonably certain that elevated suspended sediment concentrations will result in little to no

behavioral and physical response due to the higher tolerance of green sturgeon, which usually inhabit much more turbid environments than do salmonids.

In the Columbia, major spawning runs of eulachon 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.

Some individual green sturgeon are likely to be adversely affected by the activities covered under Stafford Act funded projects described in this opinion. However, there should be few green sturgeon in the vicinity of most of the actions. Pile driving and dredging would be the most likely activity to affect individuals. The restrictions on pile driving and dredging should minimize those impacts. The impacts from these activities are not expected to result in a change at the population level.

Effects to eulachon would primarily result from instream and streambank work on the few streams where they occur. Due to the dispersed nature of the proposed action, and the fact that few if any projects would likely overlap with eulachon habitat in any given year, impacts to eulachon are likely to be very limited. 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 viable population characteristics of any eulachon population, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover.

Puget Sound/Georgia Basin Yelloweye Rockfish and Bocaccio

The effects of the proposed action on yelloweye rockfish and bocaccio are likely to be similar to the effects on salmon and steelhead described above including short-term construction-related effects and long-term effects resulting from habitat modifications, in particular as it relates to pile driving/removal, in-water and over-water structures, and habitat modification actions within Puget Sound.

Yelloweye rockfish and bocaccio juveniles and sub-adults tend to be more common than adults in shallower water and are associated with rocky reefs, kelp canopies, and artificial structures such as piers and docks. Adults generally move into deeper water (most commonly found between 160 to 820 feet) as they increase in size and age, but usually exhibit strong site fidelity

to rocky bottoms and outcrops. Due to the depth preference of adult yelloweye rockfish and bocaccio, it is extremely unlikely that adult rockfish would be exposed to any of the effects of the proposed action.

Unlike salmonids, juvenile and adult rockfish behaviors (such as foraging and migration) and risk of predation are not known to be adversely impacted by artificial structures such as piers and docks (Love et. al. 2002). The aggregation of some rockfish near docks, piers, and other artificial structure suggests that, harm is unlikely to occur from those structures. As they select for habitat types with submerged structure also suggests that, different from salmonids, associated elevated noise levels from boat traffic near these structures may not significantly disturb rockfish. Larval and juvenile rockfish will likely be exposed to cumulative sound impacts from pile driving actions that are above the harm threshold of 150 dB temporarily. FEMA will require a bubble curtain for sound attenuation thus reducing any sound impacts from pile driving below the harm threshold of 150 dB.

Effects to individual fish from habitat modifications include harm and reduction in individual fitness from an incremental increase in stress (boating noise), reduction in foraging success (reduced submerged aquatic vegetation, shading, reduced riparian vegetation), alteration of migration patterns (forcing juveniles to leave the nearshore), and impairment of predator avoidance (shading). While we cannot quantify these long-term structure-related effects on abundance and productivity of listed fish, we believe them to be proportional to the relatively small proportion of affected habitat within Puget Sound. Because the likely adverse effects of any action funded or carried out under this opinion is a relatively small proportion of affected habitat, the proposed action will not have any measurable effect on species-level abundance, productivity, or ability to recover.

2.4.4 Effects of the Action on Critical Habitat

Each individual project, completed as proposed, including full application of the PDC for site restoration, is likely to have the following effects on critical habitat PBFs or physical and biological features. These effects will vary somewhat in degree between actions because of differences in the scope of construction at each site, and in the current condition of PBFs and the factors responsible for those conditions. This assumption is based on the fact that all of the actions are based on the same set of underlying actions, and the PBFs 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. The intensity of each effect, in terms of change in the PBF from baseline condition, and severity of each effect, measured as recovery time, will vary somewhat between projects because of differences in the scope of the work. However, no individual project is likely to have any effect on PBFs that is greater than the full range of effects summarized here.

We anticipate 40 or fewer projects will be completed in a single recovery domain, in a single year, using this opinion and most domains will have many fewer (Table 6). This number of projects is already small compared to the total number of watersheds in each recovery domain, but the intensity of those project effects appears far smaller when considered as a function of

their average streamside footprint relative to the total streamside area in each recovery domain. The streamside footprint that will be temporarily disturbed by the full program each year corresponds to the area where almost all direct construction impacts will occur.

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, PBF conditions and conservation value of critical habitat at the site level or reach level are likely to quickly return to, and in some cases, improve beyond, critical habitat conditions that existed before the action. Moreover, most projects completed under the proposed program, and thus the proposed action as a whole, is also reasonably certain to lead to some degree of ecological recovery within each action area, including the establishment of environmental conditions associated with functional aquatic habitat and high conservation value. This is because most actions are 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.

Summary of the effects of the action on salmon and steelhead critical habitat PBFs:

1. Freshwater spawning sites

- 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 stormwater management, 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 more normal temperature and sediment load, reduced contaminants, and increased dissolved oxygen due to improved stormwater management, riparian, streambank, and channel conditions, ecological connectivity, and more normative community structure.
- c. Substrate – Short-term reduction in quality due to increased compaction and sedimentation; some long-term increases in quality due to a more functional sediment balance, with increased gravel and large wood supply, improved riparian, streambank, and channel conditions, improved ecological connectivity, and more normative community structure.

2. Freshwater rearing sites

- a. Water quantity – as above.
- b. Floodplain connectivity – Short-term decrease due to increased compaction and riparian disturbance; some long-term improvements due to improvements in stormwater management, riparian, streambank and channel conditions, and ecological connectivity.
- 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 increased quantity and quality of forage due to increased habitat diversity and productivity caused by improved riparian, streambank, and channel conditions, improved ecological

- connectivity, and more normative community structure.
- e. Natural cover – Short-term decrease due to riparian and channel disturbance; long-term increase due to improved habitat diversity and productivity, including space, width-depth ratio, pool frequency, pool quality, and off-channel habitat caused by improved riparian, streambank, and channel conditions, improved ecological connectivity, and more normative community structure.
3. Freshwater migration corridors
 - a. Free passage – Short-term decrease due to decreased water quality and in-water work isolation; long-term increase due improved water quantity and quality, greater habitat diversity, more natural cover, and more normative community structure caused by improved riparian conditions, streambank conditions, and ecological connectivity.
 - 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.
 5. Nearshore marine areas
 - a. Free passage – no effect.
 - b. Water quality – Short-term increase in contaminants, impoverished community structure; long-term reduced contaminants, more normative community structure.
 - c. Water quantity – no effect.
 - d. Forage – as above.
 - e. Natural cover – Short-term decrease in natural cover quantity and quality due to reduced large wood; long-term increase in natural cover due to increased large wood.
 6. Offshore marine areas – These PBFs do not occur in the action area.

Summary of the effects of the action on green sturgeon critical habitat physical and biological features: Critical habitat for the southern DPS of green sturgeon 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 the 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 2009).

1. Estuarine areas
 - a. Food – Short-term decrease due to stream and river-bottom disturbance.
 - b. Migratory corridor – Short-term decrease due to stream and river-bottom channel disturbance.

- c. Sediment quality – Short-term decrease due to stream and river-bottom disturbance.
 - d. 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 more normal temperature and sediment load, reduced contaminants, and increased dissolved oxygen due to improved stormwater management, riparian, streambank, and channel conditions, ecological connectivity, and more normative community structure
2. Coastal marine areas
- a. Food resources– no effect.
 - b. Migratory corridor – no effect.
 - c. Water quality – Short-term increase in contaminants, impoverished community structure; long-term reduced contaminants, more normative community structure.

Summary of the effects of the action on eulachon critical habitat physical and biological features: 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 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 due to soil compaction; slight long-term increase based on improved riparian function and floodplain connectivity.
 - b. Water quality – Short-term releases of suspended sediment and contaminants, increased dissolved oxygen demand, and increased temperature due to riparian and channel disturbance. Long-term water quality will improve as riparian vegetation becomes established.
 - c. Water temperature – Slight long-term improvement based on improved riparian function and floodplain connectivity.
 - d. Substrate – Short-term reduction due to increased compaction and sedimentation and removal. Long-term benefit from the restoration of natural sediment transport.
 - e. Free passage – Short-term decrease due to decreased water quality and in-water work isolation. Long-term improvement after stream connectivity is improved as a result of improved stream crossings structures.
2. Freshwater and estuarine migration corridors
- a. Free passage – Short-term decrease due to decreased water quality and in-water work isolation. Long-term improvement after stream connectivity is improved as a result of improved stream crossings structures.
 - b. Flow – as above.

- c. Water quality – as above.
 - d. Water 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 the effects of the action on Puget Sound/Georgia Basin yelloweye rockfish and bocaccio critical habitat physical and biological features: Critical habitat for bocaccio and yelloweye rockfish includes: (1) adult bocaccio and adult and juvenile yelloweye rockfish: benthic habitats or sites deeper than 30 m (98 ft) that possess or are adjacent to areas of complex bathymetry consisting of rock and or highly rugose habitat are essential to support growth, survival, reproduction, and feeding opportunities by providing the structure for rockfish to avoid predation, seek food, and persist for decades; and (2) juvenile bocaccio only: juvenile settlement habitats located in the nearshore with substrates such as sand, rock, and/or cobble compositions that also support kelp (families Chordaceae, and Laminaricea) to create forage opportunities, refuge from predators, and enable behavioral and physiological changes needed for juveniles to occupy deeper adult habitats. The essential features for rockfish critical habitat are as follows:

1. Estuarine areas
- a. Food – Short-term decrease due to stream and river-bottom disturbance and long-term reduction in food supply with the repair and maintenance of over-water structures
 - b. Passage – Short-term decrease due to stream and river-bottom channel disturbance and long-term alteration of migration patterns with the repair and maintenance of over-water structures.
 - c. Substrate quality – Short-term decrease due to stream and river-bottom disturbance.
 - d. 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 more normal temperature and sediment load, reduced contaminants, and increased dissolved oxygen due to improved stormwater management, riparian, streambank, and channel conditions, ecological connectivity, and more normative community structure
 - e. Natural cover – Short-term decrease due to riparian and channel disturbance; long-term decrease due to the repair and replacement of in-water and over-water structures.
2. Coastal marine areas
- a. Food resources– no effect.
 - b. Migratory corridor – no effect.
 - c. Water quality – Short-term increase in contaminants, impoverished community structure; long-term reduced contaminants, more normative community structure.

Summary of effects to critical habitat for all listed species. Projects covered by this opinion, both individually and collectively, are likely to have some short-term impacts, but none of those impacts will be severe enough to impair the ability of critical habitat to support

recovery. The frequency of disturbance will usually be limited to a single project 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, will have a severe enough adverse effect on the function of PBFs (physical and biological features) to affect the conservation value of critical habitat in the project-level action area, watershed, or designation area. Also, on the whole, the proposed action is 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. Road crossings that improve fish passage, 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 program is narrowly prescribed, and is further limited by PDC tailored to avoid or minimize direct and indirect adverse effects of those activities. 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 juvenile 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 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 6), the number of projects in a single recovery domain have varied greatly. In the last five years, the most projects (134, 31%) occurred in the Puget Sound recovery domain, while 27% (n=117) occurred in the WLC recovery domain. (Many fewer projects occurred in the IC, OC, and SONCC recovery domains.) The intensity of the predicted effects within the action area, in terms of the total condition and value of PBFs after each action is completed, and the severity of the effects, given the recovery rate for those same PBFs, are such that the function of PBFs and the conservation value of critical habitat are likely to be only impaired for a short time due to actions funded or carried out under this opinion. The PBF 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, will have an important adverse effect on the function of PBFs 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 properly 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 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 PBFs 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. 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 the 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, K. 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 the Pacific Northwest may be declining, general resource demands are increasing with growth in the size and standard of living of the local and regional human population (Metro 2010; Metro 2011). Population growth is a good proxy for multiple, dispersed activities and provides the best estimate of general resource demands because as local human populations grow, so does the overall consumption of local and regional natural resources. Between 2000 and 2010, the combined population of Oregon and Washington grew from 9.3 to 10.5 million, an increase of approximately 13.3 percent. Washington grew somewhat faster than Oregon, 14.1 percent and 12.0 percent, respectively (U.S. Census Bureau 2012). By 2020, the population of Oregon and Washington is projected to grow to 12 million (Oregon

Office of Economic Analysis 2017; Washington Office of Financial Management 2016). 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 adverse effects of non-Federal actions stimulated by general resource demands are likely to continue in the future driven by changes in human population density and standards of living. These effects are likely to continue to a similar or reduced extent in the rural areas in the action area. Areas of growing population in the action area are likely to experience greater resource demands, and therefore more adverse environmental effects. Land use laws and progressive policies related to long-range planning will help to limit those impacts by ensuring that concern for a healthy economy that generates jobs and business opportunities is balanced by concern for protection of farms, forests, rivers, streams and natural areas (Metro 2000; Metro 2008; Metro 2011). In addition to careful land use planning to minimize adverse environmental impacts, larger population centers may also partly offset the adverse effects of their growing resource demands with more river restoration projects designed to provide ecosystem-based cultural amenities, although the geographic distribution of those actions, and therefore any benefits to ESA-listed species or critical habitats, may occur far from the centers of human populations.

Similarly, demand for cultural and aesthetic amenities continues to grow with human population, and is reflected in decades of concentrated effort by Tribes, states, and local communities to restore an environment that supports flourishing wildlife populations, including populations of species that are now ESA-listed (CRITFC 1995, OWEB 2017). Reduced economic dependence on traditional resource-based industries has been associated with growing public appreciation for the economic benefits of river restoration, and growing demand for the cultural amenities that river restoration provides. Thus, many non-Federal actions have become responsive to the recovery needs of ESA-listed species. Those actions included efforts to ensure that resource-based industries adopt improved practices to avoid, minimize, or offset their adverse impacts. Similarly, many actions are focused on completion of river restoration projects specifically designed to broadly reverse the major factors now limiting the survival of ESA-listed species at all stages of their life cycle. Those actions have improved the availability and quality of estuarine and nearshore habitats, floodplain connectivity, channel structure and complexity, riparian areas and LW recruitment, stream substrates, stream flow, water quality, and fish passage. In this way, the goal of ESA-listed species recovery has become institutionalized as a common and accepted part of the economic and environmental culture. We expect this trend to continue into the future as awareness of environmental and at-risk species issues increases among the general public.

It is not possible to predict the future intensity of specific non-Federal actions related to resource-based industries at this program scale due to uncertainties about the economy, funding levels for restoration actions, and individual investment decisions. However, the adverse effects of resource-based industries in the action area are likely to continue in the future, although their net adverse effect is likely to decline slowly as beneficial effects spread from the adoption of industry-wide standards for more protective management practices. These effects, both negative and positive, will be expressed most strongly in rural areas where these industries occur, and therefore somewhat in contrast to human population density. The future effects of river restoration are also unpredictable for the same reasons, but their net beneficial effects may grow

with the increased sophistication and size of projects completed and the additive effects of completing multiple projects in some watersheds.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the rangewide status of the species and critical habitat (Section 2.2).

In summary, resource-based activities such as timber harvest, agriculture, mining, shipping, and energy development are likely to continue to exert an influence on the quality of freshwater and estuarine habitat in the action area. The intensity of this influence is difficult to predict and is dependent on many social and economic factors. However, the adoption of industry-wide standards to reduce environmental impacts and the shift away from resource extraction to a mixed manufacturing and technology based economy should result in a gradual decrease in influence over time. In contrast, the population of Oregon, Washington, and Idaho is expected to increase in the next several decades with a corresponding increase in natural resource consumption. Additional residential and commercial development and a general increase in human activities are expected to cause localized degradation of freshwater and estuarine habitat. Interest in restoration activities is also increasing as is environmental awareness among the public. This will lead to localized improvements to freshwater and estuarine habitat. When these influences are considered collectively, we expect trends in habitat quality to remain flat or improve gradually over time. This will, at best, have positive influence on population abundance and productivity for the species affected by this consultation. In a worst cases scenario, we expect cumulative effects will have a relatively neutral effect on population abundance trends. Similarly, we expect the quality and function of critical habitat PBFs or physical and biological features to express a slightly positive to neutral trend over time as a result of 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 because 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 Synthesis of the Analysis of Listed Species

As described in Section 2.2, individuals of many ESA-listed salmon and steelhead species, eulachon, green sturgeon, and rockfish use the program action area to fully complete the

migration, spawning and rearing parts of their life cycle; some salmon, steelhead, eulachon, green sturgeon, and rockfish 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.

The status of each salmonid and steelhead 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.

Eulachon use the estuaries and the first few miles of river mainstems for spawning, incubation, growth, maturation, and migration. Eulachon population abundance has declined significantly since the early 1990s. 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. The Southern DPS green sturgeon generally migrate in coastal waters of Washington and Oregon within the action area and prefer marine waters of less than a depth of 110 meters. Limiting factors of green sturgeon within the action area include the lack of water quantity, poor water quality and poaching. Listed rockfish abundances continue to decline with little to no signs of any effects of recent protective measures. The critical status of rockfish is related to their degraded habitat, poor baseline conditions, and overharvesting.

The environmental baseline varies across the program area, but habitat will generally be degraded at sites selected for FEMA Stafford Act actions. Climate change is likely to exacerbate several of the ongoing habitat issues, in particular, increased summer temperatures, decreased summer flows in the freshwater environment, ocean acidification, and sea level rise in the marine environment

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 must be carried out using the carefully designed project design criteria. The application of the PDCs to each action then, ensures that environmental outcomes of each activity can be readily predicted in a manner that enables a comprehensive synthesis of the effects of carrying out the program across the action area. As described in the analysis of the effects of the action (Section 2.4), the effects of the proposed activities will cause only short-term, localized, and minor effects.

The effects to eulachon, green sturgeon, Puget Sound/Georgia Basin yelloweye rockfish and bocaccio are likely to be within the range of effects on salmon and steelhead as described in Section 2.4. However, adult and subadult green sturgeon are likely to be far less sensitive to

suspended solids than salmonids and it is reasonably certain that elevated suspended sediment concentrations will result in little to no behavioral and physical response. In addition, unlike salmonids, juvenile and adult rockfish (such as foraging and migration) and risk of predation are not known to be adversely impacted by artificial structures. Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the viable population characteristics of any eulachon, green sturgeon, Puget Sound/Georgia Basin yelloweye rockfish and bocaccio population, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover. Cumulative effects described in Section 2.5 are likely to have neutral effects on salmon, steelhead, eulachon, green sturgeon, and rockfish population abundance, productivity, and spatial structure.

Over the long-term, the result of applying the PDC to the actions carried out under the program is contribution to a lessening of many of the factors limiting the recovery of these species, particularly those factors related to fish passage, degraded floodplain connectivity, and improvement of ecological conditions over the currently-degraded environmental baseline, particularly at the site scale. Because NMFS can determine that program wide application of the PDCs acutely minimizes the effects of each project carried out under the programmatic, we find that application of the program is likely to adversely affect a very small number of individual fish per year over the term of the program. In fact, the adverse effects of each project will bear on far too few to affect the viable salmonid population criteria of abundance, productivity, distribution, or genetic diversity of any salmon or steelhead population to which those individual fish belong.

This conclusion also holds true for eulachon, green sturgeon, Puget Sound/Georgia Basin yelloweye rockfish and bocaccio. The adverse effects of the program on individual fish will be far too few to affect the abundance, productivity, distribution, or diversity of eulachon, green sturgeon, Puget Sound/Georgia Basin yelloweye rockfish and bocaccio. At the ESU or species scale, the status of individual populations determines the ability of the species to sustain itself or persist well into the future, thus impacts to the populations are important to the survival and recovery of the species. 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.

2.6.2 Synthesis of the Analysis of Critical Habitat

Many streams, river, estuaries, and nearshore marine locations in the action area are designated as critical habitat for ESA-listed salmon, steelhead, eulachon, green sturgeon, Puget Sound/Georgia Basin yelloweye rockfish and bocaccio. CHART teams determined that most designated critical habitat for ESA-listed species has a high conservation value, based largely on its restoration potential.

Baseline conditions for these PBFs vary widely, from poor to excellent. 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 all biological requirements of individual fish of ESA-

listed species at sites where FEMA 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 increase where fish passage projects occur.

In the analysis of the effects of the action on critical habitat PBFs, we found that effects 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 their life cycles. Because of this, critical habitat will remain functional, or retain the ability for its PBFs to become functionally established and serve the intended conservation role for the species. By contributing to improve the critical habitat PBFs, this proposed action will, over the long-term, improve PBF site conditions that support various life history events, and contribute to recovery of each species considered in this consultation. Furthermore, the scope of each type of activity that could be authorized under the proposed program is narrowly prescribed, and is further limited by PDCs tailored to avoid or minimize direct and indirect adverse effects of those activities.

As described in Section 2.5, the cumulative effects are likely to have a positive to neutral influence on critical habitat PBFs. Based on the above analysis, when considered in light of the status of the species, the effects of the proposed action, when added to the effects of the environmental baseline, and anticipated cumulative effects and climate change, critical habitat will remain functional or retain the current ability for the PBFs to become functionally established, to serve the interested conservation role for ESA listed salmonids, steelhead, eulachon, green sturgeon, and Puget Sound/Georgia Basin bocaccio. Thus, the proposed program is not likely to result in appreciable reductions in the value of designated 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, green sturgeon, or eulachon, Puget Sound/Georgia Basin yelloweye rockfish, bocaccio, or result in the destruction or adverse modification of critical habitat that has been designated for these species.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations 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 this consultation, we interpret “harass” is to create 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. 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.

2.8.1 Amount or Extent of Take

Work necessary to construct and maintain the projects authorized under the FEMA Endangered Species Programmatic, FESP, will take place beside and within aquatic habitats that are reasonably certain to be occupied by individuals of the 23 ESA-listed species considered in this consultation. As described below, the proposed action is reasonably certain 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 projects occur in coastal areas, the Willamette Valley, Puget Sound, cascade or interior Columbia streams, and when projects 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 stormwater outfalls, roads, culverts, bridges, and utility lines. 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 certain to result in injury or death of some individual fish.

Similarly, adult and juvenile fish are reasonably certain to be harmed by construction-related disturbance of upland, riparian and in-stream areas for actions related to stormwater facilities, boulder placement, LW restoration, pile driving or removal, streambank restoration, spawning gravel restoration, 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, as described in PDC# 34f and Table 5., 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. These effects are also reasonably certain to result in injury or death of some individual fish.

This take will typically occur within an area that includes the streamside, channel, estuary, or marine footprint of each project, and downstream for pathways that are caused by diminished water quality. 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 construction 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

NMFS does not anticipate that any green sturgeon or eulachon will be captured as a result of work necessary to isolate in-water construction areas, although as described in Section 2.4.1, up to 3,968 juvenile individuals (but no adults), per year, of the salmon and steelhead species considered in this consultation will be captured, and this capture results in take even though the vast majority of the fish are likely to be released (Table 6). Because the captured 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. In addition, it is not possible to measure the exact number of fish that die as a result of handling (but there is a relationship between the number of fish handled and the number that die, and handling in and of itself causes harm). Therefore, the amount of take that is exempted under this Incidental Take Statement is the capture and related handling of 3,968 juvenile salmonids and represented by recovery domains in Table 7.

Entrainment from dredging operations. Juvenile fish will be captured by entrainment during dredging operations with a suction dredge. The use of a clamshell or bucket to dredge is less likely to entrain juveniles. Most fish that are entrained will be injured or killed. The exact number of juveniles that would be entrained cannot be determined due to extensive variables. The best available indicator of take is one that best describes the dredging efforts relative to the amount of materials dredged at each project dredging location. The extent of take for entrainment is the maximum volume of material dredged at each project site where take from entrainment would occur. This indicator is appropriate for this proposed action because it is directly related to the quantitative magnitude of take caused by entrainment during dredging. Due to the emergency nature of the actions, it is difficult to estimate the amount of dredged material, however, in reviewing previous programmatic implementation records we were able to determine an expected maximum amount of dredged material for vessel access and dredging for the maintenance of water intake structures. To determine the maximum volume amounts of materials dredged, we reviewed implementation records from our programmatic consultation on over- and in-water structures with the Portland District of the Corps of Engineers (SLOPES IV). Dredging for improved vessel access ranged from 25 to 80,000 cubic yards of material volume being removed. Dredging for the maintenance of water intake structures ranged from 2 cubic yards to 5,000 cubic yards of material volume being removed. The volume of materials proposed for dredging at each proposed dredging location where entrainment will occur will not exceed 80,000 cubic yards of dredged material volume for vessel access and will not exceed 5,000 cubic yards of dredged material volume for the maintenance of water intake structures within this programmatic consultation. Since 2013, FEMA has funded a total of 25 projects with dredging operations, averaging 5 dredging projects per year. Puget Sound and the Interior Columbia recovery domains constituted almost half (n=13) of the dredging projects that have been funded in the last five years. NMFS does not expect a large number of projects with dredging operations

to occur under this programmatic opinion nor does NMFS expect the total amount of dredged material to exceed 80,000 cubic yards of volume material for vessel access or exceed 5,000 cubic yards of volume material for the maintenance dredging of water intake structures. FEMA can monitor the volume of material being dredged for each project location funded on a yearly basis and if the expected amount of dredged material exceeds the maximum allowable amount, FEMA can initiate individual consultation for that particular project. If the grantee exceeds the volume of material dredged at a project location, reinitiation of consultation of this proposed action will be warranted.

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 can use 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.

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 amount of harm that the proposed action is likely to cause through short-term degradation of water quality and physical habitat because those actions will cause increased sediment, temperature, and contaminants, and reduced dissolved oxygen and streambank vegetation in amounts that correlate to the length of stream reach modified. Based on our estimate of the annual number of projects that will be implemented (Table 7), NMFS assumes that up to 128 actions per year may be funded or carried out under this opinion. We estimate that each action may modify up to 300 lineal feet of riparian and shallow-water habitat; therefore, the extent of take for construction-related disturbance of streambank and channel areas is 38,400 linear stream feet per year partitioned between recovery domains (Table 7). This take indicator functions as an effective reinitiation trigger because it is calculated and monitored on an annual basis, and thus will serve as a check on the proposed action on a regular basis.

Construction-related disturbance of upland and wetland areas. The best available indicator for the extent of take caused due to construction-related disturbance of upland and wetland areas during road, culvert, bridge, and utility line projects, is an increase in visible suspended sediment. This variable is proportional to the water quality impairment those actions will cause, including increased sediment, temperature, and contaminants, and reduced dissolved oxygen.

NMFS assumes that an increase in sediment will be visible in the immediate vicinity of the action area and for a distance downstream, and the distance that increased sediment will be visible is proportional both to the size of the disturbance and to the width of the wetted stream (Rosetta 2005) and therefore the amount of take that will occur. Also, a turbidity flux may be greater at project sites that are subject to tidal or coastal scour.

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 as follows: A visible increase in suspended sediment (as estimated using turbidity measurements, as described below) 50 feet from the project area in streams that are 30 feet wide or less, 100 feet from the discharge point or nonpoint source of runoff for streams between 30 and 100 feet wide, 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, or 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour.

Application of herbicides to control invasive and non-native plant species. Application of manual, mechanical, biological or chemical plant controls will result in short-term reduction of vegetative cover, soil disturbance, and degradation of water quality, which is reasonably certain to 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) is impracticable 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 indicator for the extent of take due to the proposed invasive plant control is the annual limitation on the extent of treated areas, *i.e.*, less than, or equal to, 1.0% of the acres of riparian habitat within a 6th-field HUC per year (PDC 35). The area over which herbicides will be applied is proportional to the amount of take expected given the design criteria and best management practices for herbicide application. This is because as the amount of area treated increases, the amount of chemical applied generally increases, raising the chance that some of that chemical will reach water occupied by listed species resulting in take. This take indicator functions as an effective reinitiation trigger because it is calculated and monitored on an annual basis, and thus will serve as a check on the proposed action on a regular basis.

Stormwater runoff. Stormwater runoff from new and contributing impervious surface will result in delivering a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals used under this programmatic consultation. Stormwater inputs will result in short-term reduction of water quality and an increase in water quantity due to concentrated flows derived from

impervious surfaces which are reasonably certain to cause injury to fish depending on the level of exposure. Stormwater contaminants cause a variety of lethal and sublethal effects on fish, including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Fresh *et al.* 2005; Hecht *et al.* 2007; Lower Columbia River Estuary Partnership 2007). Stormwater treatment practices and flow control best management practices described in the proposed project design criteria will prevent pollution, or other adverse effects of stormwater from occurring up to the design storm level.

This take cannot be accurately quantified as a number of ESA-listed species because, although the relationship between numerical concentrations of stormwater pollutants are easily demonstrated in the lab, the pollutants in actual runoff come from many small sources that cannot be distinguished after they reach a given waterbody. The distribution of those pollutants also vary widely within that waterbody as a function of surrounding land use, pre-rainfall conditions, rainfall intensity and duration, and mixing from other drainage areas. Stormwater runoff events are often relatively brief, especially in urban streams, so that large inputs of runoff and pollutants can occur and dissipate within a few hours. Moreover, the distribution and abundance of fish that occur within the action area is inconsistent over time, affected by habitat quality, interactions with other species, harvest programs and other influences that cannot be precisely determined by observation or modelling. In the context of this programmatic consultation addressing emergency actions (which, by definition are somewhat unpredictable in nature and scope), the best available take indicator reflects the stormwater management requirements and practices that we assumed in analyzing the stormwater effects of the proposed action. The extent of take surrogate for stormwater effects is as follows:

All grantees who apply for FEMA funding under this programmatic consultation that requires post-construction stormwater management shall complete a stormwater management plan and receive review and verification from NMFS that the stormwater management plan is adequate in minimizing adverse effects from stormwater runoff.

All FEMA funded projects that require post-construction stormwater management, FEMA shall submit the Stormwater Information Worksheet in Appendix A of this opinion along with the grantee's stormwater management plan before any FEMA funds are obligated for that project.

Submission of a stormwater management plan and the stormwater information worksheet with review and verification by NMFS will not provide a specific measurement of watershed health. However, compliance with the plan development and review requirements reflects the extent of take because they correlate with the level of stormwater treatment that was assumed in the Opinion; any non-compliance with the stormwater plan requirements will result in take at levels that was not analyzed in the Opinion. Although the surrogate is somewhat coextensive with the proposed action it nevertheless functions as a meaningful reinitiation triggers because FEMA, grantees, and NMFS can track them in real time and it will be obvious if and when these indicators are exceeded.

If FEMA fails to receive NMFS review and verification of a submitted stormwater management plan and stormwater information worksheet before FEMA obligates funds for a particular

project, then FEMA will exceed an indicator for extent of take and trigger the reinitiation provisions of this opinion.

In-water and over-water structures. The best available indicator for the extent of take associated with the repair and replacement of in-water and over-water structures that support favorable habitat conditions for predators and have long-term habitat disturbances from boat noise and sound pressure is the maximum square footage of in-water and over-water structures (except for stand-alone pilings, which have a separate extent of take surrogate discussed below). Because FEMA typically funds public in-water and over-water structures, the total maximum square footage of a particular structure can vary and the number of replacements and repairs are dependent on national disaster declared events. To determine the maximum size of overwater structures typically constructed in the Pacific Northwest, we reviewed implementation data from our programmatic consultation on over- and in-water structures with the Portland District of the Corps of Engineers (SLOPES IV). Under SLOPES IV In-water and Over-water structures programmatic biological opinion, there have been 61 repair and replacement of over-water structure implementation records in the last five years (excluding private recreational structures). These projects have included the replacement and repair of boat ramps, docks, wharfs, gangways, boarding floats, and boat slides. The sizes of the over-water structures varied from 100 square feet to 13,124 square feet. Although these were implemented under SLOPES IV In-water and Over-water structures programmatic biological opinion, it is our best available indicator for total maximum square footage of over-water structures created pursuant to the proposed action.

The majority of repairs and replacements of in-water and over-water structures in the action area occur in Puget Sound, the Columbia River, and the coasts of Oregon and Washington. Since 2013, 20 projects were funded through FEMA associated with in-water and over-water structures that included boat ramps, floats, marina structures, moorage docks, and bulkhead repairs. This has resulted in an average of about 4 over-water structures per year with the highest amount of replacements (n=6) having occurred in Puget Sound over a five year period. Assuming an increase in the repair and replacement of over-water structures, NMFS would not expect to see more than 2 repairs and replacements of over-water structures per year per recovery domain. With a maximum square footage of 13,124 for a public over-water structure per year per recovery domain. These indicators are related to the amount of take caused by the replacement or repair of overwater structures because the magnitude of most effect pathways associated with overwater structures such as shading, increased predation, and suppression of aquatic vegetation increase with the size of the structure. Even though the square footage of the structures and the number of projects may be coextensive with the proposed action, they nonetheless serves as valid reinitiation triggers. FEMA can monitor the number of projects and the amount of square footage of overwater structures funded on a yearly basis and discontinue funding similar projects as they reach the surrogate threshold. Or, FEMA can reinitiate consultation. Exceeding the total number of repair and replacement projects and the total square footage per recovery domain will trigger the reinitiation provisions of this opinion.

Pile structures related to take are associated with predator habitat because of shade and perch points for avian predation, and take associated with noise and sound pressure. The number of piling projects is harder to determine. It is dependent on many factors such as accidental

breakage or deterioration. Over a five year period, FEMA has funded 10 piling projects, averaging 2 piling projects per year. Assuming a substantial increase, NMFS would not expect to see more than 5 piling projects issued under this programmatic per year. FEMA can monitor the number of piling projects funded on a yearly basis and discontinue funding similar projects as they reach the surrogate threshold or FEMA can reinitiate consultation. Exceeding this limit will trigger the reinitiation provisions of this opinion.

In summary, the best available indicators for amount and extent of take for these proposed actions are as follows. For actions that involve:

- ***Capture of juvenile fish during in-water work area isolation*** – The amount of take is 3,968 juvenile salmonids handled per year, as proportioned by recovery domain (Table 7).
- ***Entrainment from dredging operations***- The extent of take is the maximum volume of 80,000 cubic yards of materials proposed for vessel access and the maximum volume of 5,000 cubic yards of material for the maintenance of water intake structures at each proposed dredging location where entrainment will occur.
- ***Construction-related disturbance of streambank and channel*** – The extent of take indicator is 38,400 linear stream feet per year, as proportioned by recovery domain (Table 7).
- ***Construction-related disturbance of upland and wetland areas*** – 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.
- ***Application of herbicide within the riparian area*** – The extent of take indicator is a treated area of up 1.0% of the acres of riparian habitat within a 6th-field HUC per year.
- ***Stormwater runoff*** – The extent of take indicator for stormwater management is NMFS review and verification of a stormwater management plan and the stormwater information worksheet prior to FEMA obligating funds to a particular project as described above and all grantees will inspect, maintain, and report stormwater facilities to assure that the stormwater treatment system continues to reduce the concentration of pollutants in stormwater runoff as designed
- ***In-water and over-water structures***- The extent of take indicator for the repair and replacement of in-water and over-water structures is a maximum total square footage per recovery domain that does not exceed 13,124 square foot per recovery domain per year, and no more than 5 piling projects per year.

NMFS assumes that the proposed actions will continue to be distributed among the recovery domains in the same proportion as in the past and has assigned this take to individual recovery domains whenever possible (Table 7).

Table 7. Extent of take indicators for actions authorized or carried out under the FEMA Endangered Species Programmatic (FESP), by NMFS recovery domain. “WLC” means Willamette/Lower Columbia; “IC” means Interior Columbia; “OC” means Oregon Coast; “SONCC” means Southern Oregon/Northern California Coast, “PS” means Puget Sound; and “n” is the estimated number of projects per year, as described in Section 2.4.1.

Extent of Take Indicator	Recovery Domains				
	WLC n=35	IC n=25	OC n=20	SONCC n=8	PS n=40
Listed ESA Salmonids & rockfish captured (number salvaged)	1,085	775	620	248	1,240
Entrainment from dredging operations (cubic yards)	≤ 80,000 cubic yards of volume of material dredged for vessel access and ≤ 5,000 cubic yards of volume material dredged for the maintenance of water intake structures				
Streambank alteration (linear feet)	10,500	7,500	6,000	2,400	12,000
Visible suspended sediment (turbidity)	≤10% increase in natural stream turbidity				
Herbicide applications (linear feet)	1.0% of a riparian habitat within a 6 th -field HUC/year				
Stormwater management	NMFS review and verification of stormwater management plan and stormwater information worksheet prior to FEMA obligating funds; Stormwater facility inspection, maintenance, recording, and reporting by the grantee				
In-water and over-water structures	≤ 13,124 square feet of in-water and over-water structures per recovery domain/year and ≤ 5 piling projects/year				

2.8.2 Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the proposed program, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed program.

1. Minimize incidental take due to funding projects by ensuring that all such projects use the conservation measures described in the proposed action and analyzed in this opinion, as appropriate.
2. Ensure completion of a comprehensive monitoring and reporting program regarding all projects authorized or conducted by the FEMA by preparing and providing NMFS with plan(s) and report(s) describing how impacts of the incidental take on listed species in the action area would be monitored and documented.
3. Ensure all grantees receiving FEMA funding shall report and monitor for take pathways that extend beyond FEMA's involvement to NMFS (i.e. the maintenance of stormwater facilities).

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and FEMA, or any other party affected by these terms and conditions must comply with them to implement the reasonable and prudent measures (50 CFR 402.14). FEMA has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will likely lapse.

1. To implement reasonable and prudent measure #1 (conservation measures for projects), FEMA shall ensure that:
 - a. Every action funded or carried out under this opinion will be administered by the FEMA consistent with conservation measures 1 through 11.
 - b. For each action involving construction, conservation measures 12 through 38, as appropriate, will be added as an enforceable grantee condition.
 - c. For specific types of actions, the FEMA will apply criteria 39 through 52 as appropriate.
2. To implement reasonable and prudent measure #2 (monitoring and reporting), the FEMA shall ensure that:
 - a. The following notifications and reports (Appendix A) are submitted to NMFS for each project to be completed under this opinion. All notifications and reports are to be submitted electronically to NMFS at femaprogrammtic.wcr@noaa.gov.
 - i. Project notification at least 30-days before start of construction (Part 1).
Early coordination is recommended prior to 30 days before the start of construction.
 - ii. Project completion within 90-days of end of construction (Part 1 with Part 2 completed).
 - iii. Fish salvage within 90-days of work area isolation with fish capture (Part 1 with Part 3 completed).
 - b. The FEMA Region X will each submit a monitoring report to NMFS by February 15 each year that describes FEMA's efforts to carry out this opinion. The report will include an assessment of overall program activity, a map showing the location and type of each action authorized and carried out under this opinion, and any other data or analyses the FEMA deems necessary or helpful to assess habitat trends as a result of actions authorized under this opinion.

- c. The FEMA Region X will each attend an annual coordination meeting with NMFS by April 15 each year to discuss the annual monitoring report and any actions that will improve conservation under this opinion, or make the program more efficient or more accountable.
 - d. All FEMA funded projects that require post-construction stormwater management, FEMA shall submit the Stormwater Information Worksheet in Appendix A of this opinion along with the grantee's stormwater management plan before any FEMA funds are obligated for that project.
 - e. All FEMA funded projects that require water quality observations to ensure that any increases in suspended sediment do not exceed background levels, FEMA will require that the grantee will:
 - i. Take a turbidity sample using an appropriately and regularly calibrated turbidimeter, or a visual turbidity observation, every four 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 upstream from the project area if it is subject to tidal or coastal scour. Record the observation, location, and time before monitoring at the downstream point.
 - ii. Take a second visual observation, immediately after each upstream observation, approximately 50 feet downstream from the project area in streams that are 30 feet wide or less, 100 feet from the project area for streams between 30 and 100 feet wide, 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, and 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour. Record the downstream observation, location, and time. For tidally influenced areas, make the observations during the ebb tide.
 - iii. Compare the upstream and downstream observations. If more turbidity or pollutants are visible downstream than upstream, the activity must be modified to reduce pollution. Continue to monitor every four hours.
 - iv. If the exceedance continues after the second monitoring interval (after 8 hours), the activity must stop until turbidity returns to background levels.
 - f. Failure to provide timely reporting may constitute a modification of FESP that has an effect to listed species or critical habitat that was not considered in the biological opinion and thus may require reinitiation of this consultation.
3. To implement reasonable and prudent measure #3 (grantee monitoring and reporting), the grantee shall ensure that:
- a. All grantees who apply for FEMA funding under this programmatic consultation that requires post-construction stormwater management shall complete a stormwater management plan and receive review and verification from NMFS that the stormwater management plan is adequate in minimizing adverse effects from stormwater runoff.
 - b. All grantees will inspect and maintain stormwater facilities to assure that the stormwater treatment system continues to reduce the concentration of pollutants in stormwater runoff as designed, and thus reflect the amount of incidental take analyzed in this opinion (Claytor and Brown 1996; Santa Clara Valley Urban

Runoff Pollution Prevention Program 1999; Santa Clara Valley Urban Runoff Pollution Prevention Program 2001).

- i. Each part of the stormwater system, including the catch basin and flow-through planter, must be inspected and maintained at least quarterly for the first three years, at least twice a year thereafter, and within 48-hours of a major storm event, i.e., a storm event with greater than or equal to 1.0 inch of rain during a 24-hour period (City of Portland 2008a; Valentine 2012).
- ii. All stormwater must drain out of the catch basin within 24-hours after rainfall ends, and out of the flow-through planter within 48-hours after rainfall ends.
- iii. All structural components, including inlets and outlets, must freely convey stormwater.
- iv. Desirable vegetation in the flow-through planter must cover at least 90% of the facility – excluding dead or stressed vegetation, dry grass or other plants, and weeds.

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 recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the FEMA:

- 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. The NMFS recommends that the FEMA 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>.
- The NMFS recommends that FEMA seek opportunity to carry out large wood placement and floodplain connectivity as part of FEMA restoration projects.

Please notify NMFS if FEMA carries out these recommendations so that we will be kept informed of actions that minimize or avoid adverse effects and those that benefit the listed species or 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 could have 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/Washington Coastal Area Office of NMFS and refer to the NMFS Number assigned to this consultation.

2.11 “Not Likely to Adversely Affect” Determinations

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. NMFS does not anticipate the proposed action will result in take of southern resident killer whale or the Mexico and Central America DPS of humpback whale.

Southern Resident Killer Whale and their Critical Habitat Determination.

The final rule listing Southern Resident (SR) killer whales as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species (73 FR 4176).

SR 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 2008a). 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 2008a).

SR killer whales travel along the Washington, Oregon, and California coasts and usually stay relatively close to shore. It is possible, although uncommon, that Southern Resident killer whales travel into coastal bays, especially if it is a major river system. Any potential occurrence would be infrequent and transitory. Southern Residents primarily eat salmon and prefer Chinook salmon.

The proposed action includes sufficient conservation measures to avoid exposure of SR killer whales to potential sound effects from vibratory pile driving: “If SR Killer whales have been documented more than four times during the proposed work window in the quadrant the project area is located in, a MMMP must be prepared and submitted with this application. This information will be reviewed by a NMFS biologist.” The objective of a MMMP is to observe for marine mammals within the area of potential sound effect and stop or not start work while a marine mammal is within the area of potential sound effect. Thus, any direct harm from construction effects is extremely unlikely and thus discountable.

The proposed program may affect the quantity of the SR killer whale’s preferred prey, Chinook salmon. Any salmonid take including Chinook salmon up to the aforementioned amount and extent of take will 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 SR killer whales, including indirect effects on their prey, is likely to be discountable. Therefore, NMFS finds that the proposed program may affect, but is not likely to adversely affect SR killer whales and their critical habitat.

Mexico and Central America DPSs Humpback Whale Determination.

Humpback whales migrate from high latitude feeding grounds to low latitude calving areas. They are typically found in coastal or shelf waters in summer and close to islands and reef systems in winter (Clapham 2009). Humpbacks primarily occur near the edge of the continental slope and deep submarine canyons, where upwelling concentrates zooplankton near the surface for feeding. Humpback whales feed on euphausiids and various schooling fishes, including herring, capelin, sand lance, and mackerel (Clapham 2009).

In April 2015, NMFS published a proposed rule to identify 14 DPSs of humpback whales and list two as threatened and two as endangered (80 FR 22304). On September 8, 2016, NMFS published a final rule to divide the globally listed endangered humpback whale into 14 DPSs, remove the species-level listing, and place four DPSs as endangered and one as threatened (81 FR 62259). NMFS has identified three DPSs of humpback whales that may be found off the coasts of Washington, Oregon and California. These are the Hawaiian DPS (found predominately off Washington and southern British Columbia) which is not listed under the ESA; the Mexico DPS (found all along the coast) which is listed as threatened under the ESA; and the Central America DPS (found predominately off the coasts of Oregon and California) which is listed as endangered under the ESA.

At times, both the endangered Central America DPS and the threatened Mexico DPS travel and feed off the U.S. west coast and occasionally into southern Puget Sound. Current estimates of abundance for the Central America DPS range from approximately 400 to 600 individuals (Bettridge et al. 2015). The size of this population is relatively low compared to most other North Pacific breeding populations. The population trend for the Central America DPS is unknown (Bettridge et al. 2015). Calambokidis, et al. (2009) and Bettridge, et al. (2015) estimated the Mexico DPS at 6,000 to 7,000 individuals. Until new stock assessment reports (SARs) are

available reflecting the new DPS listings, we will describe the status of the two ESA-listed populations that are found in the action area using the previous SARs (California/Oregon/Washington stock and the Central North Pacific stock).

There are at least two separate ESA-listed populations that may occur in the action area, the formerly known California/Oregon/Washington stock and the Central North Pacific stock. The California/Oregon/Washington stock spends the winter primarily in coastal waters of Mexico and Central America, and the summer along the West Coast from California to British Columbia. The Central North Pacific stock primarily spends winters in Hawaii and summers in Alaska, and its distribution may partially overlap with that of the California/Oregon/Washington stock off the coast of Washington and British Columbia (Clapham 2009). There is some mixing between these populations, though they are still considered distinct stocks. Humpbacks in northern Washington and southern British Columbia may be a distinct feeding population or stock (Calambokidis et al. 2009).

The current best estimate of 1,918 whales for the California/Oregon/Washington stock is the sum of recent abundance estimates for California/Oregon (1,729) and Washington/southern British Columbia (189) feeding groups (Carretta et al. 2015). The feeding aggregation off Washington was previously estimated to be approximately 500 animals, most of which occur in the northwest Washington-British Columbia border area; a small number are periodically seen within Puget Sound (Calambokidis et al. 2009). The minimum estimate for humpback whales in the California/Oregon/Washington population based on line-transect and mark-recapture methods is 1,876. The population was increasing at a rate of approximately 7.5 percent per year, but recent trends are more variable (Calambokidis 2013, Carretta et al. 2015). The Potential Biological Removal (PBR)⁴¹ level for this stock is 22 whales. This stock spends approximately half its time outside the U.S. Exclusive Economic Zone, so the PBR allocation for U.S. waters is 11 whales per year.

The minimum population estimate for the Central North Pacific stock of humpback whales, based on counts of unique individuals, is 7,890 whales, with a calculated PBR for this stock of 82.8 whales (Allen and Angliss 2015). The minimum population estimate for the Southeast Alaska/northern British Columbia feeding aggregation component of the Central North Pacific stock is 2,251, with a PBR of 23.6 (Allen and Angliss 2015).

Potential effects from the proposed action include sound disturbance from pile driving. While humpback sightings in PS occur during the proposed work window, the likelihood for exposure to vibratory pile driving is discountable because of the proposed conservation measures to shut down if a humpback whale enters the zone of influence. The FEMA proposes that applicants will have to submit a MMMP if in one or both of the previous two years there were four or more humpback whale sightings during the month in which pile driving will occur in the basin where pile driving will occur. Each MMMP will be subject to NMFS review. The objective of a

⁴¹ Which is defined by the Marine Mammal Protection Act as the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

MMMP is to observe for marine mammals within the area of potential sound effect and stop or not start work while a marine mammal is within the area of potential sound effect.

In this biological opinion, NMFS concludes that the proposed action is not likely to adversely affect, Puget Sound/Georgia Basin yelloweye rockfish critical habitat, Mexico and Central America DPS humpback whale, or southern resident killer whales, or their designated critical habitats.

3. MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT

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 effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration 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 of it 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 FEMA and descriptions of EFH for Pacific Coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

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 groundfish, coastal pelagic species, and chinook, pink, and coho salmon. In addition, the following habitat areas of particular concern (HAPCs) are present in the action area: estuarine and seagrass areas.

3.2 Adverse Effects on Essential Fish Habitat

Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed action will have adverse effects on EFH designated for Pacific Coast salmon in freshwater where projects will occur. Pacific salmon, groundfish and coastal pelagic species will also be adversely affected in estuaries, including estuarine areas designated at habitat areas of particular concern (HAPCs) in the Lower Columbia River, Puget Sound, and at other river mouths, bays, estuaries, and coastal waters where projects will occur.

1. Water Quality (spawning, rearing, and migration). The project has the potential to increase temperature through vegetation removal, introduce chemical contaminants through construction activities, and increase sediment, stormwater runoff, and dissolved oxygen demand from vegetation disturbance and construction. BMPs such as erosion control measures utilizing silt fences, straw wattles, relief culvert, vegetated ditches, and work in the dry and short duration of activities will minimize effects to water quality. Because of the BMPs that FEMA will implement, the low probability of a large spill, and the low intensity and short duration of any resulting effect from small drips/leaks, effects to water quality will be very minor. Long-term beneficial effects includes the potential to improve riparian function, floodplain connectivity, and improved stormwater treatment.
2. Water Quantity (rearing and migration). The project has the potential to reduce water quantity due to short-term construction needs, reduced riparian permeability, and increased riparian runoff. Long-term beneficial effects includes the potential to improve water quantity based on improved riparian function and floodplain connectivity.
3. Safe Passage (migration). 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 stream-road crossing structures, water quantity and quality, habitat diversity and complexity, forage, and natural cover.
4. Substrate (migration & spawning). Substrate will have a short-term reduction in quality due to increased compaction and sedimentation, and a long-term increase in quality due to gravel placement, and increased sediment storage from boulders and large wood.
5. Forage (rearing and migration). Forage will have a short-term decrease in availability due to riparian and channel disturbance and a long-term increase in availability due to improved habitat diversity and complexity, and improved riparian function and floodplain connectivity.
6. Cover/shelter (rearing and migration). Natural cover will have short-term decrease due to riparian and channel disturbance, and a long-term increase due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity.
7. Floodplain Connectivity (rearing and migration). The project will have a short-term decrease due to increased compaction and riparian disturbance during construction, and a long-term improvement due to streambank stabilization methods that incorporate riparian vegetation.
8. Estuarine and nearshore EFH quality (rearing and migration) will be temporarily reduced due to short-term releases of suspended sediment, benthic disturbance, and damage to submerged aquatic vegetation. Affected habitats includes:
 - Water column
 - Estuary (HAPC)

Long-term reduction in nearshore habitat through the disturbance associated with in-water and over-water structures, boat use, and removal of riparian vegetation resulting in the reduction of allochthonous input to the nearshore.

9. Localized, short-term increase in creosote-associated contaminants from the removal of treated-wood materials, including piles. Affected habitat includes:
 - Water column
 - Estuary (HAPC)
 - Substrate
 - Benthic productivity
 - Prey
10. Shading of submerged aquatic vegetation and resulting reduction in submerged aquatic vegetation density and abundance related primarily from over-water structures.

3.3 Essential Fish Habitat Conservation Recommendations

Because the properties of EFH that are necessary for the spawning, breeding, feeding or growth to maturity of managed species in the action area are the same or similar to the biological requirements of ESA-listed species as analyzed above, NMFS has provided four conservation recommendations.

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

1. Ensure completion of a monitoring and reporting program as described in term and condition numbers 1 and 2 in the accompanying opinion to verify the action is meeting its objective of minimizing habitat modification from funded activities.
2. As appropriate to each action funded under this opinion, include the PDC for general construction and types of actions (*i.e.*, 12 through 52) as enforceable grantee conditions, except 14 (fish capture and release and electrofishing).
3. Include each applicable PDC for construction and types of actions (*i.e.*, 12 through 52) as a final action specification of every funded action carried out under this opinion, except 14 (fish capture and release and electrofishing).

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, FEMA must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final verification of the action if the response is inconsistent with any of NMFS's EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal 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 the Conservation Recommendations, the Federal 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

FEMA 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' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these 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 document is helpful, serviceable, and beneficial to the intended users. The intended users is the Federal action agency, FEMA.

The opinion in this document concludes that the proposed action for the FEMA Endangered Species Programmatic will not jeopardize the affected listed species or result in the adverse modification of their critical habitat. Therefore, FEMA can fund this action in accordance with its authority under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended and Emergency Management-related Provisions of the Homeland Security Act, as amended FEMA 692, August 2016.

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.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and 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 West Coast Region ESA quality control and assurance processes.

5. REFERENCES

- AASHTO (American Association of State Highway and Transportation Officials). 2013. AASHTO LRFD Bridge Design Specifications, 2013 Interim Revisions. 6th edition. American Association of State Highway and Transportation Officials. <http://www.aashtojournal.org/Pages/042613Publication.aspx>.
- Abatzoglou, J.T., D.E. Rupp, and P.W. Mote. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. *Journal of Climate* 27(5): 2125-2142.
- Abbott, R. and E. Bing-Sawyer. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Othodon microlepidotus*). Draft report prepared for Caltrans District 4. October 10.
- Able, K.W., J.P. Manderson, and A.L. Studholme. 1998. The distribution of shallow water juvenile fishes in an urban estuary: The effects of manmade structures in the lower Hudson River. *Estuaries*. 21:731-744.
- Ali, M.A. 1959. The Ocular Structure, Retinomotor and Photo-Behavioral Responses of Juvenile Pacific Salmon. *Canadian Journal of Zoology*. 37.
- Alpers, C.N., R.C. Antweiler, H.E. Taylor, P.D. Dileanis, and J.L. Domagalski (editors). 2000a. Volume 2: Interpretation of metal loads. *In: Metals transport in the Sacramento River, California, 1996-1997, Water-Resources Investigations Report 00-4002*. U.S. Geological Survey. Sacramento, California.
- Alpers, C.N., R.C. Antweiler, H.E. Taylor, P.D. Dileanis, and J.L. Domagalski (editors). 2000b. Volume 1: Methods and Data. *In: Metals transport in the Sacramento River, California, 1996-1997, Water-Resources Investigations Report 99-4286*. U.S. Geological Survey. Sacramento, California.
- Anderson, J.J., E. Gurarie, and R.W. Zabel. 2005. Mean free-path length theory of predator-prey interactions: Application to juvenile salmon migration. *Ecological Modelling*. 186:196-211.
- Anderson, C.W., F.A. Rinella, and S.A. Rounds. 1996. Occurrence of selected trace elements and organic compounds and their relation to land use in the Willamette River Basin, Oregon, 1992-94. U.S. Geological Survey. Water-Resources Investigations Report 96-4234. Portland, Oregon.
- Arsenault, A., J. Teeter-Balin, W. White, and S. Velinsky. 2008. Alternatives to labor intensive tasks in roadside vegetation maintenance. University of California-Davis, Advanced Highway Maintenance and Construction Technology Research Center, Department of Mechanical and Aerospace Engineering, and California Department of Transportation. UCD-ARR-08-06-30-04. Davis, California.

- Arseneault, J.S. 1981. Memorandum to J.S. Mathers on the result of the 1980 dredge monitoring program. Fisheries and Oceans, Government of Canada.
- Asplund, T.R. 2000. the effects of motorized watercraft on aquatic ecosystems. Wisconsin Department of Integrated Science Services. University of Wisconsin, PUBL-SS-948-00, Madison. 12 p.
- ATSDR (Agency for Toxic Substances and Disease Registry). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.
- ATSDR (Agency for Toxic Substances and Disease Registry). 2004a. Toxicological profile for copper. U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.
- ATSDR (Agency for Toxic Substances and Disease Registry). 2004b. Toxicological profile for polychlorinated biphenyls (PCBs). U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.
- ATSDR (Agency for Toxic Substances and Disease Registry). 2005. Toxicological profile for zinc. U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.
- ATSDR (Agency for Toxic Substances and Disease Registry). 2007. Toxicological profile for lead. U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.
- AWPA (American Wood Protection Association). 2016. Standard p 20-15: All protective barrier systems. 2016 AWPA book of standards. American Wood Protection Association.
- Baldwin, D.H., J.F. Sandahl, J.S. Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: Impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. *Environmental Toxicology and Chemistry* 22:2266-2274.
- Baldwin, D.H., and N.L. Scholz. 2005. The electro-olfactogram: An *in vivo* measure of peripheral olfactory function and sublethal neurotoxicity in fish. Pages 257-276. *In: Techniques in Aquatic Toxicology*. G.K. Ostrander (editor). CRC Press, Inc. Boca Raton, Florida.
- Baldwin, D.H., J.A. Spromberg, T.K. Collier, and N.L. Scholz. 2009. A fish of many scales: extrapolating sublethal pesticide exposures to the productivity of wild salmon populations. *Ecological Applications* 19(8):2004-2015.
- Baldwin, D.H., C.P. Tatara, and N.L. Scholz. 2011. Copper-induced olfactory toxicity in salmon and steelhead: Extrapolation across species and rearing environments. *Aquatic Toxicology* 101:295-297.

- Barnard, R.J., J. Johnson, P. Brooks, K.M. Bates, B. Heiner, J.P. Klavas, D.C. Ponder, P.D. Smith, and P.D. Powers. 2013. Water Crossings Design Guidelines. Washington Department of Fish and Wildlife. Olympia, Washington.
<http://wdfw.wa.gov/publications/01501/>.
- Barrett, M.E., R.D. Zuber, E.R. Collins, J.F. Malina, R.J. Charbeneau, and G.H. Ward (editors). 1993. A review and evaluation of literature pertaining to the quantity and control of pollution from highway runoff and construction. 2nd edition. Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin. Austin, Texas.
- Bauer, B.O., M.S. Lorang, and D.J. Sherman. 2002. Estimating Boat-Wake-Induced Levee Erosion using Sediment Suspension Measurements. *Journal of Waterway, Port, Coastal and Ocean Engineering*. July/August 2002. P. 152-162.
- Beamesderfer, R.C., and B.E. Rieman. 1991. Abundance and Distribution of Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. *Transactions of the American Fisheries Society* 120:439-447.
- Bell, M.C. 1991. Fisheries handbook of Engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers, North Pacific Division.
- Bettridge, S., C.S. Baker, J. Barlow, P.J. Clapham, M. Ford, D. Gouveia, D.K. Mattila, R.M. Pace, P.E. Rosel, G.K. Silber, and P.R. Wade. 2015. Status Review of the Humpback Whale (*Megaptera novaeangliae*) under the Endangered Species Act. NOAA-TMNMFS-SWFSC-540.
- Bevelhimer, M.S. 1996. Relative importance of temperature, food, and physical structure to habitat choice by smallmouth bass in laboratory experiments. *Transactions of the American Fisheries Society* 125:274-283.
- 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.
- Boyd, F.C. 1975. Fraser River dredging guide. Tech. Rpt. Series No. PAC/T-75-2. Fisheries and Marine Service, Environment Canada.
- Braun, F. 1974a. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase I. Department of Public Works, Pacific Region, Canada.
- Braun, F. 1974b. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase II. Department of Public Works, Pacific Region, Canada.

- Brette, F., B. Machado, C. Cros, J.P. Incardona, N.L. Scholz, and B.A. Block. 2014. Crude oil impairs cardiac excitation contraction coupling in fish. *Science* 343:772-776.
- Bricker, O.P. 1999. An overview of the factors involved in evaluation the geochemical effects of highway runoff on the environment. U.S. Geological Survey, and Federal Highway Administration. Open-File Report 98-630. Northborough, Massachusetts.
- Brown, B. 2011. The effectiveness of a plastic encasement as a timber preservative. Technical white paper. Crane Materials International.
- 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.
- Buckler, D.R., and G.E. Granato. 1999. Assessing biological effects from highway-runoff constituents. U.S. Geological Survey, Open File Report 99-240. Northborough, Massachusetts. 45 p.
- Burla, M., A.M. Baptista, Y. Zhang, and S. Frolov. 2010. Seasonal and interannual variability of the Columbia River plume: A perspective enabled by multiyear simulation databases. *Journal of Geophysical Research* 115:C00B16.
- Calambokidis, J., E. Falcone, A. Douglas, L. Schlender, and J. Huggins. 2009. Photographic identification of humpback and blue whales off the U.S. West Coast: results and updated abundance estimates from 2008 field season. Final Report for Contract AB133F08SE2786 from Southwest Fisheries Science Center. 18pp.
- Calambokidis, J. 2013. Updated abundance estimates of blue and humpback whales off the US west coast incorporating photo-identifications from 2010 and 2011. Document PSRG-2013-13 presented to the Pacific Scientific Review Group, April 2013.
- CCC (California Coastal Commission). 2005. Regular coastal development permit. Applicant number 3-04-072:1-15
- CCC (California Coastal Commission). 2012. Water quality fact sheet: pilings- treated wood and alternatives. California Coastal Nonpoint Source Program. April.
- California Department of Fish and Game. 2009. California salmonid stream habitat restoration manual: Part XII, Fish passage design and implementation.
<https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=12512>.
- Caltrans. 2001. Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project, August. 9 p.

- CALTRANS (California Department of Transportation). 2015. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. November 2015.
http://www.dot.ca.gov/hq/env/bio/files/bio_tech_guidance_hydroacoustic_effects_110215.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.
- Carls, M.G., and J.P. Meador. 2009. A perspective on the toxicity of petrogenic PAHs to developing fish embryos related to environmental chemistry. *Human and Ecological Risk Assessment: An International Journal* 15(6):1084-1098.
- 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.
- Carrasquero, J. 2001. Overwater structures: Freshwater issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. Olympia, Washington.
- Carretta, J.V., E.M. Oleson, J. Baker, D.W. Weller, A.R. Lang, K.A. Forney, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2016. U.S. Pacific Marine Mammal Stock Assessments: 2015. U.S. Department of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFSSWFSC-561.
- Celedonia, M.T., R.A. Tabor, S. Sanders, S. Damm, D.W. Lantz, T.M. Lee, Z. Li, J.-M. Pratt, B.E. Price, and L. Seyda. 2008a. Movement and Habitat Use of Chinook Salmon Smolts, Northern Pikeminnow, and Smallmouth Bass Near the SR 520 Bridge, 2007 Acoustic Tracking Study. U.F.a.W. Service, editor. 139.
- Celedonia, M.T., R.A. Tabor, S. Sanders, D.W. Lantz, and I. Grettenberger. 2008b. Movement and Habitat Use of Chinook Salmon Smolts and Two Predatory Fishes in Lake Washington and the Lake Washington Ship Canal, Western WS Fish and Wildlife Office Lacey, WA.

- Center for Watershed Protection, and Maryland Department of the Environment. 2000 (revised 2009). 2000. Maryland stormwater design manual: Volumes I and II. Maryland Department of the Environment. Baltimore, Maryland.
http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Pages/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.aspx.
- Chadwick, D.B., A. Zirino, I. Rivera-Duarte, C.N. Katz, and A.C. Blake. 2004. Modeling the mass balance and fate of copper in San Diego Bay. *Limnology and Oceanography* 49:355-366.
- Christopherson, A., and J. Wilson. 2002. Technical Letter Report Regarding the San Francisco-Oakland Bay Bridge East Span Project Noise Energy Attenuation Mitigation. Peratrovich, Nottingham & Drage, Inc. Anchorage, Alaska. 27 p.
- City of Portland. 2008. Stormwater Management Manual. Bureau of Environmental Services. Portland, Oregon. <http://www.portlandoregon.gov/bes/47952>.
- City of Seattle. 2003. Seattle's Urban Blueprint for Habitat Protection and Restoration. City of Seattle's Salmon Team. Seattle, WA. Clapham P.J. 2009. Humpback whale *Megaptera novaeangliae*. In W.F. Perrin et al. (eds.): *Encyclopedia of marine mammals*. Pp. 582–584. Amsterdam: Elsevier.
- Claytor, R.A., and W.E. Brown. 1996. Environmental indicators to assess stormwater control programs and practices: Final report. Center for Watershed Protection. Silver Spring, Maryland.
- Colle, D.E., R.L. Cailteux, and J.V. Shireman. 1989. Distribution of Florida largemouth bass in a lake after elimination of all submersed aquatic vegetation. *North American Journal of Fisheries Management* 9:213-218.
- Collis, K., R.E. Beaty, and B.R. Crain. 1995. Changes in Catch Rate and Diet of Northern Squawfish Associated With the Release of Hatchery-Reared Juvenile Salmonids in a Columbia River Reservoir. *North American Journal of Fisheries Management* 15:346-357.
- Colman, J.A., K.C. Rice, and T.C. Willoughby. 2001. Methodology and significance of studies of atmospheric deposition in highway runoff. U.S.G. Survey, Open-File Report 01-259. Northborough, Massachusetts. 63 p.
- Cott, P.A., A. Schein, B.W. Hanna, T.A. Johnston, D.D. McDonald, and J.M. Gunn. 2015. Implications of linear developments on northern fishes. *Environ. Rev.* 23(2):177-190.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service. Dec. 31, 1979.

- Cramer, M., K. Bates, D. Miller, K. Boyd, L. Fotherby, P. Skidmore, and T. Hoitsma. 2003. Integrated streambank protection guidelines. Washington Department of Fish and Wildlife, Habitat Technical Assistance. Olympia, Washington.
<http://wdfw.wa.gov/publications/00046/wdfw00046.pdf>.
- 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.
- CRITFC (Columbia River Inter-Tribal Fish Commission). 1995. Wy-Kan-Ush-Mi Wa-Kish-Wit: Spirit of the salmon, the Columbia River anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. Two volumes. Columbia River Inter-Tribal Fish Commission and member Tribes. Portland, Oregon.
<http://www.critfc.org/fish-and-watersheds/fish-and-habitat-restoration/the-plan-wy-kan-ush-mi-wa-kish-wit/>.
- Crozier, L.G., A.P. Hendry, P.W. Lawson, T.P. Quinn, N.J. Mantua, J. Battin, R.G. Shaw, and R.B. Huey. 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. *Evolutionary Applications* 1(2): 252-270.
- Crozier, L.G., M.D. Scheuerell, and E.W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. *The American Naturalist* 178 (6): 755-773.
- Dagget, A. 2017. Email from Anna Dagget, Federal Emergency Management Agency transmitting description of the Public Assistance Program to Jennie Franks, National Marine Fisheries Service. March 7, 2017.
- 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.
- Dean, R.G. 1986. Coastal Armoring: Effects, Principles, and Mitigation. Proceedings of Conference, American Society of Civil Engineers. pp. 1843-1857.
- Dethier, M.N. 1990. A marine and estuarine habitat classification system for Washington State. Washington Natural Heritage Program, Dept. Natural Resources.
- DiTomaso, J.M. 1997. Risk analysis of various weed control methods. California Exotic Pest Plant Council. 1997 Symposium Proceedings. California Invasive Plant Council, Berkeley, California.

- 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>.
- Donohoe, S., B. Schauer, W. White, and S.A. Velinsky. 2010. Vegetation and debris control methods for maintenance-friendly roadside design. University of California-Davis, Advanced Highway Maintenance and Construction Technology Research Center, Department of Mechanical and Aerospace Engineering, and California Department of Transportation, Division of Research and Innovation. Report Number CA10-1104. Davis, California.
- Douglas, A. B., J. Calambokidis, S. Raverty, S. J. Jeffries, D. M. Lambourn, and S. A. Norman. 2008. Incidence of ship strikes of large whales in Washington State. *Journal of the Marine Biological Association of the United Kingdom*. 88(6):1121-1132.
- Driscoll, E.D., P.E. Shelley, and E.W. Strecher. 1990. Pollutant loadings and impacts from highway runoff, Volume III: Analytical investigation and research report. Federal Highway Administration, Office of Engineering and Highway Operations Research and Development. FHWD-RD-88-008. McLean, Virginia.
- Dolat, S.W. 1997. Acoustic measurements during the Baldwin Bridge demolition. Prepared for White Oak Construction by Sonalysts, Inc, Waterford, CT.. 34 p. plus appendices. March 14.
- Dominguez, F., E. Rivera, D.P. Lettenmaier, and C.L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. *Geophysical Research Letters* 39(5).
- Doney, S.C., M. Ruckelshaus, J.E. Duffy, J.P. Barry, F. Chan, C.A. English, H.M. Galindo, J.M. Grebmeier, A.B. Hollowed, N. Knowlton, J. Polovina, N.N. Rabalais, W.J. Sydeman, and L.D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science* 4: 11-37.
- Dorava, J.M. 1999. Effectiveness of Streambank-Stabilization Techniques along the Kenai River, Alaska. USGS Water-Resources Investigations Report 99-4156. 27 p.
- Dunne, T., and L.B. Leopold. 1978. *Water in Environmental Planning*. W. H. Freeman, San Francisco.
- Dutta, L.K., and P. Sookachoff. 1975a. Assessing the impact of a 24-inch suction pipeline dredge on chum salmon fry in the Frasier River. Fish. And Marine Serv., Environment Canada, Tech. Rep. Ser. No. PAC/T-75-26. 24 p.
- Dutta, L.K., and P. Sookachoff. 1975b. A review of suction dredge monitoring in the lower Frasier River, 1971-1975. Fish. And Marine Serv., Environment Canada, Tech. Rep. Ser. No. PAC/T-75-27. 100 p.

- Dutta, L.K. 1976. A review of suction dredge monitoring in the Lower Fraser River, 1971-1975. Pages 301-319 in Proceedings of WODCON VII (World Dredging Conference) 10-12 July 1976, San Francisco, California. WODCON Assoc, San Pedro, California.
- Enger, P.S., H.E. Karlsen, F.R. Knudsen, and O. Sand. 1993. Detection and reaction of fish to infrasound. Fish behavior in relation to fishing operations. ICES Marine Science Symposia 196:108-112.
- Environment Canada, and Health Canada. 2001. Canadian Environmental Protection Act, 1999, Priority substances list assessment report: Nonylphenol and its ethoxylates.
- Erickson, D.L., and J.E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon (*Acipenser medirostris*). In Munro, J., J.E. Hightower, K. McKown, K.J. Sulak, A.W. Kahnle, and F. Caron, eds. Anadromous sturgeons: habitats, threats, and management. AFS Symposium 56: 197-211.
- Everts, C.H. 1985. Effects of Small Protective Devices on Beach. California's Battered Coast: Proceedings of Conference on Coast Erosion. California Coastal Commission. pp. 127-137.
- Feist, B.E., E.R. Buhle, D.H. Baldwin, J.A. Spromberg, S.E. Damm, J.W. Davis, and N. L. Scholz. 2017. Roads to ruin: conservation threats to a sentinel species across an urban gradient. *Ecological Applications* 0(0): 1-15. 2017.
- FEMA (Federal Emergency Management Agency). 2009. Engineering with nature: alternative techniques to riprap bank stabilization.
- FEMA (Federal Emergency Management Agency). 2017. Conference call between the Federal Emergency Management Agency and the National Marine Fisheries Service. Personal communication June 12, 2017.
- Fedler, A.J., and S.L. Crookshank. 1992. Measuring the value of coastal fisheries habitat. Pages 23-30 in R.H. Stroud, editor Stemming the tide of coastal fish habitat loss. Proceedings of a symposium on conservation of coastal fish habitat. National Coalition for Marine Conservation, Inc., Savannah, Georgia.
- Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.
- Feist, B.E., E.R. Buhle, P. Arnold, J.W. Davis, and N.L. Scholz. 2011. Landscape ecotoxicology of coho sapawner mortality in urban streams. *PLoS ONE* 6(8): e23424.

- FEMAT (Forest Ecosystem Management Assessment Team). 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.
- Fischenich, J.C. 2003. Effects of riprap on riverine and riparian ecosystems. U.S. Army Corps of Engineers, Engineer Research and Development Center. ERDC/EL TR-03-4. Vicksburg, Mississippi.
- Fisher, J.P., and W.G. Pearcy. 1996. Dietary overlap of juvenile fall- and spring-run Chinook salmon *Oncorhynchus tshawytscha* in Coos Bay, Oregon. *Fishery Bulletin* 95:25-38.
- FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. June 12.
- Fonseca, M.S., J. Kenworthy, and G. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12. NOAA Coastal Ocean Office, Silver Spring, Maryland.
- Ford, M.J. 2013. Status review update of Southern Resident killer whales. U.S. Dept. of Commerce, Northwest Fisheries Science Center. 41p. Available at (Accessed July 2015): http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/srkw_status_review_update_final_july_31_2013.pdf
- FPL (Forest Products Laboratory). 2001. Environmental impact of preservative-treated wood. USDA-Forest Service, Forest Products Laboratory. Madison, Wisconsin. <http://www.fpl.fs.fed.us/documnts/techline/environmental-impact-of-preservative-treated-wood.pdf>.
- FPL (Forest Products Laboratory). 2004. Changes in pressure-treated wood for residential construction. USDA-Forest Service, Forest Products Laboratory. Madison, Wisconsin. <http://www.fpl.fs.fed.us/documnts/techline/changes-pressure-treated-wood-for-residential-construction.pdf>.

- 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.
- Fuhrer, G.J., D.Q. Tanner, J.L. Morace, S.W. McKenzie, and K.A. Skach. 1996. Water quality of the Lower Columbia River Basin: Analysis of current and historical water-quality data through 1994. U.S. Geological Survey. Water-Resources Investigations Report 95-4294. Reston, Virginia.
- Furniss, M.J., T.S. Ledwith, M.A. Love, B.C. McFadin, and S.A. Flanagan. 1998. Response of road-stream crossings to large flood events in Washington, Oregon, and Northern California. USDA Forest Service, Technology and Development Program. San Dimas Technology and Development Center. San Dimas, California.
- Gall, B. 2017. Email from Barry Gall, Federal Emergency Management Agency transmitting the number of projects funded for pile installation, dredging, and in-water and over-water structures to Jennie Franks, National Marine Fisheries Service. October 23, 2017.
- Galster, R.W., and L. Schwartz. 1990. Ediz Hook-A Case History of Coastal Erosion and Rehabilitation. Journal of Coastal Research. Special Issue No. 6: 103-113.
- Gerking, S.D. 1994. Feeding Ecology of Fish. Academic Press Inc., San Diego, California. 416 p.
- Giannico, G., and J.A. Souder. 2004. The effects of tidegates on estuarine habitats and migratory fish. Oregon State University, Oregon Sea Grant.
- Giannico, G., and J.A. Souder. 2005. Tidegates in the Pacific Northwest: operation, types, and environmental effects. Vol5. No. 1. Oregon State University, Oregon Sea Grant.
- 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.
- Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.
- Goode, J.R., J.M. Buffington, D. Tonina, D.J. Isaak, R.F. Thurow, S. Wenger, D. Nagel, C. Luce, D. Tetzlaff, and C. Soulsby. 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. *Hydrological Processes* 27(5): 750-765.

- 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.
- Gustafson, R.G., L. Weitkamp, Y.W. Lee, E. Ward, K. Somers., V. Tuttle, and J. Jannot. 2016. Status Review Update of Eulachon (*Thaleichthys pacificus*) Listed under the Endangered Species Act: Southern Distinct Population Segment. US Department of Commerce, NOAA, Online at:
http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/other_species/eulachon/eulachon_2016_status_review_update.pdf.
- Harrison, C.S. 1984. Terns Family Laridae Pages 146-160 in D. Haley, D. editor. Seabirds of eastern North Pacific and Arctic waters. Pacific Search Press. Seattle. 214 p.
- Harrison, P. 1983. Seabirds: an Identification Guide. Houghton Mifflin Company. Boston. 448 p.
- Hartt, A.C., and M.B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. Int.North Pac. Fish. Comm. Bull. No. 46.105p.
- Haas, M.E., C.A. Simenstad, J.R. Cordell, D.A. Beauchamp, and B.S. Miller. 2002. Effects of Large Overwater Structures on Epibenthic Juvenile Salmon Prey Assemblages in Puges Sound, WA.
- Hastings, M.C., and A.N. Popper. 2005. Effects of Sound on Fish. Prepared by Jones and Stokes for the California Department of Transportation.
- Healey, M.C. 1980a. Utilization of the nanaimo River estuary by juvenile chinook salmon, *Onchorhynchus tshawytscha*. Fish. Bull. 77:653-668.
- Healy, M.C. 1980b. The ecology of juvenile salmon in Georgia Strait, British Columbia. In Salmonid ecosystems of the North Pacific. Edited by W.J. McNeil and D.C. Himsworth. Oregon State University Press, Corvallis, Oregon. pp. 203-229.

- Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross, and N.L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. U.S. Department of Commerce, NOAA Fisheries, NOAA Technical Memorandum NMFS-NWFSC-83. 39 p.
- 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.
- Heintz, R.A., S.D. Rice, A.C. Wertheimer, R.F. Bradshaw, F.P. Thrower, J.E. Joyce, and J.W. Short. 2000. Delayed effects on growth and marine survival of pink salmon *Oncorhynchus gorbuscha* after exposure to crude oil during embryonic development. *Marine Ecology Progress Series* 208:205-216.
- Heiser, D.W., and E.L. Finn 1970. Observations of Juvenile Chum and Pink Salmon in Marina and Bulkheaded Areas. State of Washington Department of Fisheries.
- Helfman, G.S. 1981. The advantage to fishes of hovering in shade. *Copeia*. 1981(2):392-400.
- Herrera Environmental Consultants, Inc. 2006. Technology Evaluation and Engineering Report: Ecology Embankment. Washington State Department of Transportation. Olympia, Washington. <http://www.wsdot.wa.gov/NR/rdonlyres/3D73CD62-6F99-45DD-B004-D7B7B4796C2E/0/EcologyEmbankmentTEER.pdf>.
- Hicken, C.E., T.L. Linbo, D.H. Baldwin, M.L. Willis, M.S. Myers, L. Holland, M. Larsen, M.S. Stekoll, S.D. Rice, T.K. Collier, N.L. Scholz, and J.P. Incardona. 2011. Sublethal exposure to crude oil during embryonic development alters cardiac morphology and reduces aerobic capacity in adult fish. *Proceedings of the National Academy of Sciences* 108(17):7086-7090.
- Hilton, J., and G.L. Phillips. 1982. The Effect of Boat Activity on Turbidity in a Shallow Broadland River. *The Journal of Applied Ecology*, Vol. 19, No. 1. (Apr., 1982), p. 143-150.
- Hingston, J.A., C.D. Collins, R.J. Murphy, and J.N. Lester. 2001. Leaching of chromated copper arsenate wood preservatives: A review. *Environmental Pollution* 111:53-66.
- Hirschman, D., K. Collins, and T. Schueler. 2008. Technical Memorandum: The Runoff Reduction Method. Center for Watershed Protection. Ellicott City, Maryland. April 18. <http://www.region9wv.com/Bay/Calculators/RRTechMemo.pdf>.
- Hobson, E.S. 1979. Interactions between piscivorous fishes and their prey. Pages 231-242 in R. H. Stroud and H. Clepper, editors. *Predator-Prey Systems in Fisheries Management*. Sport Fishing Institute, Washington, D.C.

- Hood Canal Coordinating Council. 2005. Hood Canal & Eastern Strait of Juan de Fuca summer chum salmon recovery plan. Hood Canal Coordinating Council. Poulsbo, Washington.
- Hoss, D.E., and G.W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. American Fisheries Society Symposium. 14:147-158.
- Howick, G.L., and W.J. O'Brien. 1983. Piscivorous feeding behavior of largemouth bass: an experimental analysis. Transactions of the American Fisheries Society 112:508-516.
- Huff, D.D., S.T. Lindley, B.K. Wells, and F. Chai. 2012. Green sturgeon distribution in the Pacific Ocean estimated from modeled oceanographic features and migration behavior. PLoSONE 7(9): e45852. doi:10.1371/journal.pone.0045852.
- Husain, A., O. Al-Shamali, and A. Abduljaleel. 2004. Investigation of marine environmental related deterioration of coal tar epoxy paint on tubular steel pilings. Desalination 166:295-304.
- Hutton, K.E., and S.C. Samis. 2000. Guidelines to Protect Fish and Fish Habitat From Treated Wood Used in Aquatic Environments in the Pacific Region. Habitat and Enhancement Branch, Fisheries and Oceans Canada, Vancouver.
- Hydroacoustic Working Group, F. 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities.
- ICF Jones and Stokes and Illingworth and Rodkin. 2009. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. Prepared by ICF Jones and Stokes, Sacramento, CA, and Illingworth and Rodkin, Inc., Petaluma, CA. Prepared for California Department of Transportation, Sacramento, CA. February 2009.
- Idaho Department of Environmental Quality. 2005. Catalog of stormwater best management practices for Idaho cities and counties. September 2005.
<http://www.deq.idaho.gov/media/622263-Stormwater.pdf>
- Igloira, R. 2007. Stormwater Treatment Strategy Development – Water Quality Design Storm Performance Standard. Personal Communication to Jennifer Sellers and William Fletcher, Oregon Department of Transportation. Memo from Ronan Igloria, HDR (Henningson, Durham, and Richardson, Inc.). December 28, 2007.
- Igloira, R. 2008a. Stormwater Treatment Strategy Development – Water Quantity Design Storm Performance Standard - Final. Personal Communication to Jennifer Sellers and William Fletcher, Oregon Department of Transportation. Memo from Ronan Igloria, HDR (Henningson, Durham, and Richardson, Inc.). February 28, 2008.

- Igloria, R. 2008b. Water Quantity Design Storm Performance Standard – Final Personal Communication to Jennifer Sellers and William Fletcher, Oregon Department of Transportation. Memo from Ronan Igloria, HDR (Henningson, Durham, and Richardson, Inc.). April 15, 2008.
- 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.
- IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- Isaak, D.J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. *Climatic Change* 113(2): 499-524.
- Johnson, L. 2000. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, Washington. 29 p.
ftp://ftp.pcouncil.org/pub/Salmon%20EFH/302-Johnson_2000.pdf.
- Johnson, L., B. Anulacion, M. Arkoosh, O.P. Olson, C. Sloan, S.Y. Sol, J. Spromberg, D.J. Teel, G. Yanagida, and G. Ylitalo. 2013. Persistent organic pollutants in juvenile Chinook salmon in the Columbia River Basin: Implications for stock recovery. *Transactions of the American Fisheries Society* 142:21-40.
- Johnson, L.L., G.M. Ylitalo, M.R. Arkoosh, A.N. Kagley, C.L. Stafford, J.L. Bolton, J. Buzitis, B.F. Anulacion, and T.K. Collier. 2007. Contaminant exposure in outmigrant juvenile salmon from Pacific Northwest estuaries. *Environmental Monitoring and Assessment* 124:167-194.

- Johnson, V.G., R.E. Peterson, and K.B. Olsen. 2005. Heavy metal transport and behavior in the lower Columbia River, USA. *Environmental Monitoring and Assessment* 110:271-289.
- Kahler, T., M. Grassley, and D. Beauchamp. 2000. A summary of the effects of bulkheads, piers and other artificial structures and shorezone development on ESA-listed salmonids in lakes. Final Report to the City of Bellevue. The Watershed Company, Kirkland, Washington. 74 p.
- Kang, J., J.D. Wiseman, M.A. Welch, and R.A. McLaughlin. 2016. Chemical flocculation for removing bentonite spills in water. *International Journal of Agriculture and Environmental Research*. ISSN: 2455-6939 2(4):735-749
- Kayhanian, M., A. Singh, C. Suverkropp, and S. Borroum. 2003. Impact of annual average daily traffic on highway runoff pollutant concentrations. *Journal of Environmental Engineering* 129:975-990.
- Keevin, T.M. 1998. A review of natural resource agency recommendations for mitigating the impacts of underwater blasting. *Rev. Fish. Sci.* 6(4):281-313.
- Kelly, R., and S. Bliven (editors). 2003. Environmental and aesthetic impacts of small docks and piers – Workshop report: Developing a science-based decision support tool for small dock management, Phase 1: Status of the science. *In: Coastal Ocean Program Decision Analysis Series, No.22*. National Oceanic and Atmospheric Administration.
- Kemp, P.S., M.H. Gessel, and J.G. Williams. 2005. Seaward migrating subyearling Chinook salmon avoid overhead cover. *Journal of Fish Biology*. 67:10.
- Kendall, A., and S. Picquelle. 2003. Marine Protected Areas and the Early Life History of Fishes, AFSC Processed Report 2003-10.
- Keykha, H.A., B.B. Huat, H. Moayedi. 2011. The significance of using horizontal directional drilling in utility services. *EJGE* 16:709-715.
- 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.
- Kilcher, L.F., J.D. Nash, and J.N. Moum. 2012. The role of turbulence stress divergence in decelerating a river plume. *Journal of Geophysical Research* 117:C05032.
- Klein, R. 1997. The effects of marinas and boating activity upon tidal waterways. Community and Environmental Defense Services. Owings Mills, Maryland. 23 p.

- Knudsen, F.R., C.B. Schreck, S.M. Knapp, P.S. Enger, and O. Sand. 1997. Infrasound produces flight and avoidance responses in Pacific juvenile salmonids. *Journal of Fish Biology*, 51:824-829.
- Kondolf, G.M., R. Kattlemann, M. Embury, and D.C. Erman. 1996. Status of riparian habitat. Pages 1009-1029 in *Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, assessments and scientific basis for management options*. University of California, Davis, Centers for Water and Wildland Resources.
- Kondolf, G.M. 1997. Hungry water: Effects of dams and gravel mining on river channels. *Environmental Management* 21(4): 533-551.
- Konkler, M., and J. Morrell. 2017. Ability of polyurea barriers to limit metal migration from ammoniacal copper zinc arsenic treated Douglas-fir piling. American Wood Protection Association Annual Meeting 2017.
- Krohn, W.B., R.B. Allen, J.R. Moring, and A.E. Hutchinson. 1995. Double-crested cormorants in New England; population and management histories. Pages 99-109 in *The Doublecrested Cormorant: biology, conservation and management* (D.N. Nettleship and D.C. Duffy, editors) *Colonial Waterbirds* 18 (Special Publication 1).
- Kunkel, K.E., L.E. Stevens, S.E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K.T. Redmond, and J.G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.
- Laetz, C.A., D.H. Baldwin, V.R. Herbert, J.D. Stark, N.L. Scholz. 2014. Elevated temperatures increase the toxicity of pesticide mixtures to juvenile coho salmon. *Aquatic Toxicology* 146:38-44.
- Lagasse, P.F., J.D. Schall, and E.V. Richardson. 2001. Hydraulic engineering circular No. 20: Stream stability at highway structures.
- Lagasse, P.F., L.W. Zevenbergen, J.D. Schall, and P.E. Clopper. 2001. Bridge scour and stream instability countermeasures: Experience, selection, and design guidance, Second Edition. F.H.A. U.S. Department of Transportation, National Highway Institute. Publication No. FHWA NHI 01-003, Hydraulic Engineering Circular No. 23. Arlington, Virginia. March. <http://isddc.dot.gov/OLPFiles/FHWA/010592.pdf>.
- Lagasse, P.F., L.W. Zevenbergen, W.J. Spitz, and L.A. Arneson. 2012. Stream Stability at Highway Structures, Fourth Edition. U.S. Department of Transportation, Federal Highway Administration, Office of Bridge Technology and National Highway Institute. Publication No. FHWA-HIF-12-004, Hydraulic Engineering Circular No. 20. Arlington, Virginia. April. <http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif12004.pdf>.

- Lani, A. 2010. Basis statement for chapter 883, designation of the chemical class nonylphenol and nonylphenol ethoxylates as a priority chemical and safer chemicals program support document for the designation as a priority chemical of nonylphenol and nonylphenol ethoxylates. Maine Department of Environmental Protection, Bureau of Remediation and Waste Management.
- Larson, K.W., and C.E. Moehl. 1990. Entrainment of anadromous fish by hopper dredge at the mouth of the Columbia River. Pages 104-112 in C.A. Simenstad (ed.). Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant. Seattle, WA.
- Lawson, P.W., E.A. Logerwell, N.J. Mantua, R.C. Francis, and V.N. Agostini. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 61(3): 360-373
- Lebow, S. 2004. Alternatives to chromated copper arsenate (CCA) for residential construction. USDA-Forest Service, Forests Products Laboratory. Research Paper. FPL-RP-618.
- Lebow, S.T., and M. Tippie. 2001. Guide for minimizing the effect of preservative-treated wood on sensitive environments. USDA-Forest Service, Forest Products Laboratory. FPL-GTR-122. Madison, Wisconsin. 18 p.
<http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr122.pdf>.
- Lee, D.C., J.R. Sedell, B.E. Reiman, R.F. Thurow, and J.E. Williams. 1997. Broad-scale 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.
- Linbo, T.L., C.M. Stehr, J. Incardona, and N.L. Scholz. 2006. Dissolved copper triggers cell death in the peripheral mechanosensory system of larval fish. *Environmental Toxicology and Chemistry* 25(2):597-603.
- Lockwood, J.C. 1990. Seagrass as a consideration in the site selection and construction of marinas. Environmental Management for Marinas Conference, September 5-7, 1990, Washington D.C. Technical Reprint Series, International Marina Institute, Wickford, Rhode Island.
- Loge, F., M.R. Arkoosh, T.R. Ginn, L.L. Johnson, and T.K. Collier. 2006. Impact of environmental stressors on the dynamics of disease transmission. *Environmental Science & Technology* 39(18):7329-7336.
- Longmuir, C., and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Fraser River Pile & Dredge Ltd. New Westminster, British Columbia. 9 p.

- Love, M.S., M. Carr, and L. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. *Environmental Biology of Fishes*. Volume 30, pages 225 to 243.
- Love, M.S., M. Yoklavich, and L.K. Thorsteinson. 2002. *The rockfishes of the northeast Pacific*. University of California Press.
- Lower Columbia River Estuary Partnership. 2007. Lower Columbia River and estuary ecosystem monitoring: Water quality and salmon sampling report. Portland, Oregon.
http://www.estuarypartnership.org/sites/default/files/resource_files/WaterSalmonReport.pdf.
- MacDonald, K.B., D. Simpson, B. Paulsen, J. Cox, and J. Gendron. 1994. Shoreline armoring effects on the physical coastal processes in Puget Sound, Washington. *Coastal Erosion Management Studies, Volume 5. Shorelands and Coastal Zone Management Program*, Washington Department of Ecology, Olympia, WA.
- Macneale, K.H., P.M. Kiffney, and N.L. Scholz. 2010. Pesticides, aquatic food webs, and the conservation of Pacific salmon. *Frontiers in Ecology and the Environment* 8(9):475-482.
- Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *In The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate*, edited by M. M. Elsner, J. Littell, L. Whitely Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington.
- Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change* 102(1): 187-223.
- Maser, C., R.F. Tarrant, J.M. Trappe, and J.F. Franklin (editors). 1988. From the forest to the sea: a story of fallen trees. *In: General Technical Report, Pacific Northwest Experiment Station PNW-GTR-229*. U.S. Department of Agriculture, Forest Service. Portland, Oregon.
- McComas, L.R., B.P. Sandford, J.W. Ferguson, and D.M. Katz. 2008. *Biological Design Criteria for Fish Passage Facilities: High-Velocity Flume Development and Improved Wet-Separator Efficiency, 2001*. Walla Walla District, U.S. Army Corps of Engineers. Walla Walla, Washington.
- McConchie, J.A., and I.E.J. Toleman. 2003. Boat wakes as a cause of riverbank erosion: a case study from the Waikato River, New Zealand. *Journal of Hydrology (NZ)* 42(2):163-179.
- 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.

- McGraw, K.A., and D.A. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. Pages 113-131 in *Effects of dredging on anadromous Pacific coast fishes*. C.A. Simenstad, editor. Washington Sea Grant. Seattle, WA.
- 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.
- McIntyre, J.K., D.H. Baldwin, J.P. Meador, and N.L. Scholz. 2008. Chemosensory deprivation in juvenile coho salmon exposed to dissolved copper under varying water chemistry conditions. *Environmental Science & Technology* 42(4):1352-1358.
- McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1551–1557.
- 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.
- Mesing, C.L., and A.M. Wicker. 1986. Home range, spawning migrations, and homing of radio-tagged Florida largemouth bass in two central Florida lakes. *Transactions of the American Fisheries Society* 115:286-295.
- Metcalf, N.B., S.K. Valdimarsson, and N.H.C. Fraser. 1997. Habitat profitability and choice in a sit-and-wait predator: juvenile salmon prefer slower currents on darker nights. *Journal of Animal Ecology* 66:866-875.
- Metro. 2000. The nature of 2040: The region's 50-year plan for managing growth. Metro. Portland, Oregon. <http://library.oregonmetro.gov/files/natureof2040.pdf>.
- Metro. 2008. The Portland metro region: Our place in the world – global challenges, regional strategies, homegrown solutions. Metro. Portland, Oregon. http://library.oregonmetro.gov/files/our_place_in_the_world.pdf.
- Metro. 2010. Urban Growth Report: 2009-2030, Employment and Residential. Metro. Portland, Oregon. January. <http://library.oregonmetro.gov/files/ugr.pdf>.
- Metro. 2011. Regional Framework Plan: 2011 Update. Metro. Portland, Oregon. http://library.oregonmetro.gov/files/rfp.00_cover.toc.intro_011311.pdf.
- Meyer, J.L., M.J. Sale, P.J. Mulholland, and N.L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. *JAWRA Journal of the American Water Resources Association* 35(6): 1373-1386.

- Millikan, A. and D. Penttila. 1974. Puget Sound baitfish study, July 1, 1973-June 30, 1974. Washington Department of Fisheries Progress Report. 32 p
- Mitsch, W.J. 1996. Ecological engineering: A new paradigm for engineers and ecologists. Pages 111-128 in P.C. Schulze, editor. Engineering within ecological constraints. National Academy of Engineering, National Academy Press, Washington, D.C.
- 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.
- Moore, M.E., B.A. Berejikian, and E.P. Tezak. 2013. A Floating Bridge Disrupts Seaward Migration and Increases Mortality of Steelhead Smolts in Hood Canal, Washington State. *PloS one*. 8.
- Morace, J.L. 2012. Reconnaissance of contaminants in selected wastewater-treatment-plant effluent and stormwater runoff entering the Columbia River, Columbia River Basin, Washington and Oregon, 2008–10. U.S. Geological Survey. Scientific Investigations Report 2012-5068. Reston, Virginia.
- Morrell, J. 2017. Email from Dr. Jeffrey Morrell, Oregon State University transmitting polyurea coating specifications to Jennie Franks, National Marine Fisheries Service. September 5, 2017.
- Morton, J.W. 1977. Ecological effects of dredging and dredge spoil disposal: a literature review. U.S. Fish and Wildlife Service Technical Paper No. 94. 33 p.
- Mosisch, T.D., and A.H. Arthington. 1998. The impacts of power boating and water skiing on lakes and reservoirs. *Lakes & Reservoirs: Research and Management* 3:1-17.
- Mote, P.W., A.K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R.R. Raymondi, and W.S. Reeder. 2014. Ch. 21: Northwest. In *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 487-513.
- Mote, P.W., D.E. Rupp, S. Li, D.J. Sharp, F. Otto, P.F. Uhe, M. Xiao, D.P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, *Geophysical Research Letters*, 43, doi:10.1002/2016GLO69665.
- Munsch, S.H., J.R. Cordell, J.D. Toft, and E.E. Morgan. 2014. Effects of Seawalls and Piers on Fish Assemblages and Juvenile Salmon Feeding Behavior. *North American Journal of Fisheries Management*. 34:814-827.
- Naiman, R.J., H. DeCamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. *Ecological Applications* 3(2):209-212.

- National Cooperative Highway Research Program. 2006. Evaluation of Best Management Practices for Highway Runoff Control. Transportation Research Board. NCHRP Report 565. Washington, D.C. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_565.pdf.
- Newcomb, T. J., and T. G. Coon. 1997. Evaluation of alternate methods for estimating numbers of outmigrating steelhead smolts. Michigan Department of Natural Resources, Fisheries Research Report 2045, Ann Arbor.
- Newcombe, C.P. 2003. Impact assessment model for clear water fishes exposed to excessively cloudy water. Journal of American Water Resources Association. 39(3):529-544
- 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.
- Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fish Management 11(1):72-82
- Nickelson, S. 2013. Knotweed treatment through 2012 Cedar River Municipal Watershed, Annual Report Libraries, Utilities, and Center Committee Seattle City Council. Seattle Public Utilities, Watershed Services Division. Seattle.
- Nightingale, B., and C.A. Simenstad. 2001. Overwater Structures: Marine Issues. University of Washington, Washington State Transportation Center. 133.
- NMFS. 1991. Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland, 105 pp.
- NMFS (National Marine Fisheries Service). 1998. Position Document for the Use of Treated Wood in Areas within Oregon Occupied by Endangered Species Act Proposed and Listed Anadromous Fish Species. National Marine Fisheries Service, Portland, Oregon. (December).
- NMFS (National Marine Fisheries Service). 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 (National Marine Fisheries Service). 2002. Biological opinion on the collection, rearing, and release of salmonids associated with artificial propagation programs in the middle Columbia River steelhead evolutionarily significant unit (ESU). National Marine Fisheries Service. Portland, Oregon. February 14, 2002.

- NMFS (National Marine Fisheries Service). 2004. Programmatic Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revised Standard Local Operating Procedures for Endangered Species (SLOPES III) to Administer Certain Activities Authorized or Carried Out by the Department of the Army in the State of Oregon and on the North Shore of the Columbia River. National Marine fisheries service, Portland, Oregon. November 30, 2004.
- NMFS (National Marine Fisheries Service). 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Protected Resources Division, Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2005b. 2005 Report to Congress Pacific Coastal Salmon Recovery Fund 2000-2004. NMFS, Northwest Region, Seattle, Washington. 51 p.
- NMFS (National Marine Fisheries Service). 2006. Final supplement to the Shared Strategy's Puget Sound salmon recovery plan. National Marine Fisheries Service, Northwest Region. Seattle.
- NMFS (National Marine Fisheries Service). 2007. Final Supplement to the 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 (National Marine Fisheries Service). 2008a. 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 (National Marine Fisheries Service). 2008b. 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). National Marine Fisheries Service, Northwest Region. Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2009a. The Use of Treated Wood Products in Aquatic Environments: Guidelines to West Coast NOAA Fisheries Staff for Endangered Species Act and Essential Fish Habitat Consultations in Alaska, Northwest, and Southwest Regions. http://www.westcoast.fisheries.noaa.gov/publications/habitat/treated_wood_guidelines_final_2010.pdf.
- NMFS (National Marine Fisheries Service). 2009b. Recovery plan for Ozette Lake sockeye salmon, West Coast Region, Protected Resources Division, Seattle, WA.

- NMFS (National Marine Fisheries Service). 2009c. 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 (National Marine Fisheries Service). 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 (National Marine Fisheries Service). 2011a. Anadromous salmonid passage facility design. NMFS, Northwest Region, Portland, Oregon.
http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf. National Marine Fisheries Service, Northwest Region. Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2011b. Endangered Species Act - Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. Portland, Oregon. August 5, 2011.
- NMFS (National Marine Fisheries Service). 2011c. 2011 Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000 – 2010. National Marine Fisheries Service, Northwest Region. Portland, Oregon. <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/upload/PCSRF-Rpt-2011.pdf>.
- NMFS (National Marine Fisheries Service). 2011d. 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).
- NMFS (National Marine Fisheries Service). 2012. 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). National Marine Fisheries Service, Northwest Region. Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2013a. 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. June.

- NMFS (National Marine Fisheries Service). 2013b. 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) (April 25, 2013) (Refer to NMFS Nos.: NWP-2013-9664). National Marine Fisheries Service, Northwest Region. Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2013c. Endangered Species Act Section 7 Formal Programmatic Biological and Conference Opinion, Letter of Concurrence, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Bonneville Power Administration's Habitat Improvement Program III (HIP III) KEC-4. (March 22, 2013) (Refer to NMFS No.: 2013/9724). National Marine Fisheries Service, Northwest Region. Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2013d. Endangered Species Act Section 7 Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species to Administer Stream Restoration and Fish Passage Improvement Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES V Restoration). (March 19, 2013) (Refer to: NMFS No.: 2013-9717). National Marine Fisheries Service, Northwest Region. Portland, Oregon.
- NMFS (National Marine Fisheries Service). 2014. Final recovery plan for the Southern Oregon/Northern California Coast evolutionarily significant unit of coho salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service. Arcata, California.
- NMFS (National Marine Fisheries Service). 2015a. Proposed ESA Recovery for Snake River Fall Chinook Salmon. West Coast Region, Protected Resources Division, Portland, OR, 97232.
- NMFS (National Marine Fisheries Service). 2015b. ESA Recovery Plan for Snake River Sockeye Salmon. West Coast Region, Protected Resources Division, Portland, OR.
- NMFS (National Marine Fisheries Service). 2015c. Southern Distinct Population Segment of the North American Green Sturgeon (*Acipenser medirostris*) 5-Year Review: Summary and Evaluation. West Coast Region, Long Beach, California. 42 p.
- NMFS (National Marine Fisheries Service). 2016a. Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead. West Coast Region, Protected Resources Division, Portland, OR.
- NMFS (National Marine Fisheries Service). 2016b. Recovery plan for Oregon Coast coho salmon evolutionarily significant unit. West Coast Region, Portland, Oregon.

- NMFS (National Marine Fisheries Service). 2016c. 5-year review: summary and evaluation of Southern Oregon/Northern California Coast coho salmon. West Coast Region, Arcata, California.
- NMFS (National Marine Fisheries Service). 2016d. Draft Rockfish Recovery Plan: Puget Sound / Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*Sebastes paucispinis*). National Marine Fisheries Service. Seattle, WA.
- NMFS (National Marine Fisheries Service). 2016e. Five year status review: summary and evaluation, yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio (*Sebastes paucispinis*) of the Puget Sound/Georgia Basin. West Coast Region. Seattle, WA. April. 131 p.
- NMFS (National Marine Fisheries Service). 2017. Recovery Plan for the Southern Distinct Population Segment of Eulachon (*Thaleichthys pacificus*). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR, 97232.
- NMFS (National Marine Fisheries Service) and USFWS (.U.S. Fish and Wildlife Service). 2006. Impact pile driving sound attenuation specification. Revised October 31, 2006. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office. Lacey, Washington.
- Nordstrom, K.F. 1989. Erosion control strategies for bay and estuarine beaches. Coastal Management 17:25-35.
- NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.
- NRC (National Research Council). 2009. Urban Stormwater Management in the United States. National Research Council. The National Academies Press. Washington, D.C.
- NRCS (Natural Resources Conservation Service). 2016. Natural channel and floodplain restoration, applied fluvial geomorphology. Natural Resources Conservation Service. <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/manage/restoration/?cid=stelprdb1247762>.
- ODEQ (Oregon Department of Environmental Quality). 2012. Stormwater Management Plan Submission Guidelines for Removal/Fill Permit Applications Which Involve Impervious Surfaces. July 2005 Updated December 2008 & January 2012. Oregon Department of Environmental Quality. Portland, Oregon.
- ODEQ (Oregon Department of Environmental Quality). 2013. Construction Stormwater Erosion and Sediment Control Manual. 1200-C NPRDES General Permit. January 2013. Oregon Department of Environmental Quality, Portland, Oregon.

- ODEQ (Oregon Department of Environmental Quality). 2016. Water Quality - Section 401 Certification. Post-Construction Stormwater Management Plan Submission Guidelines, accessed June 12, 2017.
<http://www.deq.state.or.us/wq/sec401cert/docs/stormwaterGuidelines.pdf>.
- ODFW (Oregon Department of Fish and Wildlife). 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.
- ODOT (Oregon Department of Transportation). 2014. Routine road maintenance: Water quality and habitat guide, best management practices. Oregon Department of Transportation. Salem, Oregon. http://www.oregon.gov/ODOT/HWY/OOM/docs/blue_book.pdf?ga=t.
- ODOT (Oregon Department of Transportation). 2011. ODOT Hydraulics Manual (2011 Version). Oregon Department of Transportation. ftp://ftp.odot.state.or.us/techserv/geo-environmental/Hydraulics/Hydraulics%20Manual/Table_of_Contents_rev_Nav.pdf.
- Ono, K. 2010. Assessing and Mitigating Dock Shading Impacts on the Behavior of Juvenile Pacific Salmon (*Oncorhynchus* spp.): can artificial light mitigate the effects? *In* School of Aquatic and Fishery Sciences. Vol. Master of Science. University of Washington.
- Oregon Office of Economic Analysis. 2017. Oregon economic and revenue forecast. Appendix C: Population forecast by age and sex.
<http://www.oregon.gov/DAS/OEA/docs/economic/appendixc.pdf>.
- OWEB (Oregon Watershed Enhancement Board). 2017. The Oregon Plan for Salmon and Watersheds: Biennial Report 2015-2017 Executive Summary. Oregon Watershed Enhancement Board. Salem, Oregon. <http://www.oregon.gov/OPSW/docs/OPSW-BR-Exec-2015-17.pdf>
- Pearcy, W.G. 1992. Ocean Ecology of North Pacific Salmonids. University of Washington Press, Seattle.
- Pearcy, W.G., and K. Masude. 1982. Tagged steelhead trout (*Salmo gairdneri* Richardson) collected in the North Pacific by the *Oshor-Maru*, 1980-1981. *Bull.Fac. Fish. Hokkaido University* 33(4):249-254.
- Pendleton, D. 1990. Plastic coatings and wraps for new marine timber piling. TN-1811. Naval Civil Engineering Laboratory. May.
- Peters, D.S., and F.A. Cross. 1992. What is coastal fish habitat? Pages 17-22 *in* R. H. Stroud, editor Stemming the tide of coastal fish habitat loss. Proceedings of a symposium on conservation of coastal fish habitat. National Coalition for Marine Conservation, Inc., Savannah, Georgia.

- Petersen, J.M., and D.M. Gadomski. 1994. Light-Mediated Predation by Northern Squawfish on Juvenile Chinook Salmon. *Journal of Fish Biology* 45 (supplement A), 227-242.
- Peterson, C.H., H.C. Summerson, and S.R. Fegley. 1987. Ecological consequences of mechanical harvesting of clams. *Fishery Bulletin* 85(2):281-298.
- Penttila, D. 2007. Marine Forage Fishes in Puget Sound. *In* Valued Ecosystem Components Report Series. Washington Department of Fish and Wildlife. 30.
- PFMC (Pacific Fishery Management Council), 1998. The coastal pelagic species fishery management plan: Amendment 8. Pacific Fishery Management Council, Portland, Oregon.
- PFMC (Pacific Fishery Management Council). 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.
- PFMC (Pacific Fishery Management Council). 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18 to the Pacific Coast Salmon Plan: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Pacific Fishery Management Council, Portland, OR. September 2014. 196 p. + appendices.
- Pflug, D.E., and G.B. Pauley. 1984. Biology of Smallmouth Bass (*Micropterus dolomieu*) in Lake Sammamish, Washington. *Northwest Science* 58(2):119-130.
- Phillips, R.C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: a community profile. U.S. Fish and Wildlife Service. FWS/OBS-84/24.
- Phillips, S.H. 1990. A guide to the construction of freshwater artificial reefs. Sportfishing Institute. Washington D.C. 24 p.
- Pico, Y., C. Blasco, and G. Font. 2004. Environmental and food applications of LC-tandem mass spectrometry in pesticide-residue analysis: An overview. *Mass Spectrometry Reviews* 23:45-85.
- Poe, T.P, H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of Predaceous Fishes on Out-Migrating Juvenile Salmonids in John Day Reservoir, Columbia River. *Transactions of the American Fisheries Society* 120:405-420.
- Poff, N.L., and D.D. Hart. 2002. How dams vary and why it matters for the emerging science of dam removal. *BioScience* 52(8):659-668

- Poston, T. 2001. Treated wood issues associated with overwater structures in marine and freshwater environments. Olympia, Washington. E. Washington Departments of Fish and Wildlife, and Transportation. April.
<http://wdfw.wa.gov/publications/00053/wdfw00053.pdf>.
- Pribyl, A.L., J.S. Vile, and T.A. Friesen. 2005. Population structure, movement, habitat use and diet of resident piscivorous fishes in the Lower Willamette River. Pages 139-184 in T.A. Friesen editor, Biology, behavior and resources of resident and anadromous fish in the lower Willamette River Final Report of Research 2000-2004. Oregon Department of Fish and Wildlife. Clackamas, Oregon.
- R2 Resource Consultants, Inc. 1999. Entrainment of outmigrating fish by hopper dredge at Columbia River and Oregon coastal sites. Prepared for the U.S. Army Corps of Engineers, Portland OR. 23 pp.
- Raibley, P.T., K.S. Irons, T.M. O'Hara, and K.D. Blodgett. 1997. Winter habitats used by largemouth bass in the Illinois River, a large river-floodplain ecosystem. *North American Journal of Fisheries Management* 17:401-412.
- Randolph, S. 2017. Email from Steven Randolph, Federal Emergency Management Agency transmitting description of the Hazard Mitigation Program to Jennie Franks, National Marine Fisheries Service. March 7, 2017.
- Raymondi, R.R., J.E. Cuhacyan, P. Glick, S.M. Capalbo, L.L. Houston, S.L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation. *In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.
- Reeder, W.S., P.R. Ruggiero, S.L. Shafer, A.K. Snover, L.L. Houston, P. Glick, J.A. Newton, and S.M. Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. *In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.
- Richardson, E.V., and S.R. Davis. 2001. Evaluating Scour at Bridges, Fourth Edition. U.S. Department of Transportation, Federal Highway Administration, National Highway Institute. Publication No. FHWA NHI 01-001, Hydraulic Engineering Circular No. 18. Arlington, Virginia. May. <http://isddc.dot.gov/OLPFiles/FHWA/010590.pdf>.
- Rieman, B.E., and R.C. Beamesderfer. 1991. Estimated Loss of Juvenile Salmonids to Predation by Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. *Transactions of the American Fisheries Society* 120:448-458.

- 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.
- Rogers, P.H., and M. Cox. 1988. Underwater sound as a biological stimulus. p. 131-149 in: Sensory biology of aquatic animals. Atema, J, R.R. Fay, A.N. Popper and W.N. Tavolga (editors). Springer-Verlag. New York.
- 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.
- Rosgen, D.L. 1996. Applied river morphology. Wildlife Hydrology.
- Rosetta, T. 2005. Technical basis for revising turbidity criteria (draft). Oregon Department of Environmental Quality, Water Quality Division. Portland, Oregon. October.
- Reyff, J.A. 2003. Underwater sound levels associated with seismic retrofit construction of the Richmond-San Rafael Bridge. Document in support of Biological Assessment for the Richmond-San Rafael Bridge Seismic Safety Project. January, 31, 2003. 18 p.
- Reyff, J.A., and P. Donovan. 2003. Benicia-Martinez Bridge Bubble Curtain Test - Underwater Sound Measurement Data. Memo to Caltrans dated January 31, 2003. 3 p.
- Sand, O., P.S. Enger, H.E. Karlson, F. Knudsen, and T. Kvernstuen. 2000. Avoidance responses to infrasound in downstream migrating European silver eels, *Anguilla anguilla*. Environmental Biology of Fishes, 57:327-336.
- Sandahl, J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. Environmental Science & Technology 41(8):2998-3004.
- Santa Clara Valley Urban Runoff Pollution Prevention Program. 1999. Stormwater Indicators Pilot Demonstration Project - Technical Memorandum: Indicators 18, 22 and 26. Santa Clara Valley Water District. Oakland, California. http://www.scvurppp-w2k.com/seidp/18_22_26_Industrial-Commercial_Pollution_Prevention.PDF.
- Santa Clara Valley Urban Runoff Pollution Prevention Program. 2001. Stormwater Indicators Demonstration Project – Final Report. Water Environment Research Foundation. Project 96-IRM-3, U.S. Environmental Protection Agency Cooperative Agreement #CX 823666-0102. January. http://www.scvurppp-w2k.com/seidp/SEIDP_final_report.PDF.
- Santore, R.C., D.M. Di Toro, P.R. Paquin, H.E. Allen, and J.S. Meyer. 2001. Biotic ligand model of the acute toxicity of metals. 2. Application to acute copper toxicity in freshwater fish and *Daphnia*. Environmental Toxicology and Chemistry 20(10):2397-2402.

- Sauter, S.T., R.M. Schrock, J.H. Petersen, and A.G. Maule. 2004. Assessment of smolt condition: biological and environmental interactions. Final report: the impact of prey and predators on juvenile salmonids. U.S. Geological Survey, Cook, Washington.
- 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.
- Schmetterling, D.A., C.G. Clancy, and T.M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the western United States. Fisheries 26:6-13.
- Scholz, N.L., M.S. Myers, S.G. McCarthy, J.S. Labenia, J.K. McIntyre, G.M. Yitalo, L.D. Rhodes, C.A. Stehr, B.L. French, B. McMillan, D. Wilson, L. Reed, K.D. Lynch, S. Damm, J.W. Davis, T.K. Collier. 2011. Recurrent die-offs of adult coho salmon returning to spawn in Puget Sound lowland urban streams. Plos ONE 6(8):e28013.
- Schottle, R., and K. Prickett. 2010. Ex-situ loss rates from ACZA treated and wrapped piles. In T. Ward and B.I. Ostbo, editors. Ports 2010: building on the past, respecting the future: 323-29.
- SERA (Syracuse Environmental Research Associates). 1997. Use and assessment of marker dyes used with herbicides. Submitted to: Animal and Plant Health Inspection Service, U.S. Department of Agriculture. TR 96-21-07-03b. Syracuse Environmental Research Associates, Inc. Riverdale, Maryland.
- SERA (Syracuse Environmental Research Associates). 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 (Syracuse Environmental Research Associates). 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 (Syracuse Environmental Research Associates). 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 (Syracuse Environmental Research Associates). 2004c. 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 (Syracuse Environmental Research Associates). 2011a. Imazapyr Human Health and Ecological Risk Assessment – final report. Submitted to: USDA-Forest Service, Southern Region. Syracuse Environmental Research Associates, Inc. S.R. USDA/Forest Service. December. http://www.fs.fed.us/foresthealth/pesticide/pdfs/Imazapyr_TR-052-29-03a.pdf.
- SERA (Syracuse Environmental Research Associates). 2011b. 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.
- SERA (Syracuse Environmental Research Associates). 2011c. 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 (Syracuse Environmental Research Associates). 2011d. 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>.
- Servos, M.R. 1999. Review of the aquatic toxicity and bioaccumulation of alkylphenols and alkylphenol polyethoxylates. *Water Quality Research Journal of Canada* 34(1):123-177.
- 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.
- Simenstad, C.A. 1994. Pages 11-19 *in* S. Wyllie-Echeverria, A. M. Olson and M. J. Hershman, editors. *Seagrass science and policy in the Pacific Northwest: proceedings of a seminar series (SMA 94-1)* EPA 910/R-94-004.
- Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function. Pages 343-364 *in* *Estuarine Comparisons*, Academic Press, New York.
- Simenstad, C. A., B. J. Nightengale, R. M. Thom and D. K. Shreff.er. 1999. Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines, Phase I: synthesis of state of knowledge. Final Res. Rept., Res. Proj. T9903, Task A2, Wash. State Dept. Transportation, Washington State Trans. Center (TRAC), Seattle, WA. 116 pp + appendices.
- Slade, D.A. 2000. Case study: environmental considerations of horizontal directional drills. 2000 International Pipeline Conference Volume 1. ASME 2000. IPC2000-143.

- 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.
- Southard, S.L., R.M. Thom, G.D. Williams, T.J. D., C.W. May, G.A. McMichael, J.A. Vucelick, J.T. Newell, and J.A. Southard. 2006. Impacts of Ferry Terminals on Juvenile Salmon Movement along Puget Sound Shorelines. Battelle Memorial Institute, Pacific Northwest Division
- Spence, B.C., G.A. Lomnický, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc. Corvallis, Oregon. National Marine Fisheries Service, Portland, Oregon.
- 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.
- Spromberg, J.A., and J.P. Meador. 2006. Relating chronic toxicity responses to population-level effects: A comparison of population-level parameters for three salmon species as a function of low-level toxicity. *Ecological Modeling* 199:240-252.
- Spromberg, J.A., and N.L. Scholz. 2011. Estimating future decline of wild coho salmon populations resulting from early spawning die-offs in urbanizing watersheds of the Pacific Northwest. *Integrated Environmental Assessment and Management* 7:648-656.
- Spromberg, J.A., D.H. Baldwin, S.E. Damm, J.K. McIntyre, M. Huff, J.W. Davis, and N.L. Scholz. 2016. Widespread adult coho salmon spawner mortality in western U.S. urban watersheds: lethal impacts of stormwater runoff are reversed by soil bioinfiltration. *Journal of Applied Ecology*, 53:398-407.
- Stadler, J.H., and D.P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. *In inter-noise 2009, Ottawa, CA.* 8. 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.
- Stickney, R.R. 1973. Effects of hydraulic dredging on estuarine animals studies. *World Dredging Mar. Const.* pp: 34-37.

- Stotz, T. and J. Colby. 2001. January 2001 dive report for Mukilteo wingwall replacement project. Washington State Ferries Memorandum. 5 p. plus appendices.
- Stout, H.A., P.W. Lawson, D.L. Bottom, T.D. Cooney, M.J. Ford, C.E. Jordan, R.J. Kope, L.M. Kruzic, G.R. Pess, G.H. Reeves, M.D. Scheuerell, T.C. Wainwright, R.S. Waples, E. Ward, L.A. Weitkamp, J.G. Williams, and T.H. Williams. 2012. Scientific conclusions of the status review for Oregon Coast coho salmon (*Oncorhynchus kisutch*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-118:242 p.
- Stratus Consulting, Inc. 2006a. Treated wood in aquatic environments: Technical review and use recommendations. Stratus Consulting, Inc., Boulder, CO. (October 17.)
- Stratus Consulting, Inc. 2006b. Creosote-treated wood in aquatic environments: technical review and use recommendations. SC10702. Stratus Consulting, Inc., Boulder, Colorado. December, 2006.
- Sunda, W.G., and W.J. Cai. 2012. Eutrophication induced CO₂-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO₂. *Environmental Science & Technology*, 46(19): 10651-10659.
- Tabor, R. A. and R.M. Piaskowski. 2002. Nearshore Habitat Use by Juvenile Chinook Salmon in Lentic Systems of the Lake Washington Basin. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington.
- Tague, C.L., J.S. Choate, and G. Grant. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. *Hydrology and Earth System Sciences* 17(1): 341-354.
- Thayer, G.W., W.J. Kenworthy, and M.S. Fonseca. 1984. The ecology of eelgrass meadows of the Atlantic coast: a community profile. U.S. Fish and Wildlife Service FWS/OBS-84/02.
- Thomas, A.C., and R.A. Weatherbee. 2006. Satellite-measured temporal variability of the Columbia River plume. *Remote Sensing of the Environment* 100:167-178.
- Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.
- 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.

- USACE (U.S. Army Corps of Engineers) Northwest Division. 2009. Sediment Evaluation Framework for the Pacific Northwest. U.S. Corps of Engineers (Portland District, Seattle District, Walla Walla District and Northwest Division); U.S. Environmental Protection Agency, Region 10; Washington Department of Ecology, Washington Department of Natural Resources, Oregon Department of Environmental Quality, Idaho Department of Environmental Quality, National Marine Fisheries Service, U.S. Fish and Wildlife Service. http://www.nwp.usace.army.mil/docs/d_sediment/sef/2009-Final_SEF.pdf
- USBWP (Upper Salmon Basin Watershed Project Technical Team). 2005. Upper Salmon River recommended instream work windows and fish periodicity. Upper Salmon Basin Watershed Program, Salmon, ID. November.
- 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. http://stream.fs.fed.us/fishxing/aop_pdfs.html.
- 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.
- USDC (U.S. Department of Commerce). 2009. 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. October 9, 2009.
- USDC (U.S. Department of Commerce). 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. October 20, 2011.
- USFS (U.S. Forest Service). 2014. Preservative-Treated Wood and Alternative Products in the Forest Service: Alternatives to Treated Wood, webpage accessed Feb 18, 2014, <http://www.fs.fed.us/t-d/pubs/htmlpubs/htm06772809/page05.htm>
- USBR (U.S. Bureau of Reclamation). 2016. Rock weir design guidance. U.S. Department of the Interior, Bureau of Reclamation Technical Service Center, Denver, Colorado. March, 2016. https://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/RockWeirDesignGuidance_final_ADACompliant_031716.pdf

- U.S. Census Bureau. 2012. Statistical Abstract of the United States: 2012. Washington, D.C. <https://www2.census.gov/library/publications/2011/compendia/statab/131ed/tables/pop.pdf>
- USEPA (U.S. Environmental Protection Agency). 1993. Guidance specifying management measures for sources of nonpoint pollution in coastal waters. 840-B-92-002. EPA, Office of Water, Washington, D.C.
- USEPA (U.S. Environmental Protection Agency). 2009. Columbia River Basin: State of the River Report for Toxics. U.S. Environmental Protection Agency, Region 10. Seattle.
- USEPA (U.S. Environmental Protection Agency). 2011. 2011 Toxic Release Inventory National Analysis: Large Aquatic Ecosystems - Columbia River Basin. U.S. Environmental Protection Agency. <http://www2.epa.gov/toxics-release-inventory-tri-program/2011-tri-national-analysis-large-aquatic-ecosystems-columbia>.
- USEPA (U.S. Environmental Protection Agency). 2014. Pesticides: Regulating Pesticides - Chromated Copper Arsenate (CCA): Alternatives to Pressure-Treated Wood, webpage accessed Feb 18, 2014, <http://www.epa.gov/oppad001/reregistration/cca/pressure-treated-wood-alternatives.htm>
- USEPA (U.S. Environmental Protection Agency). 2016. Polluted Runoff: Nonpoint Source Pollution » What is Nonpoint Source? U.S. Environmental Protection Agency website, available at: <https://www.epa.gov/nps/what-nonpoint-source>. Updated May 2, 2017. Accessed August 17, 2017.
- USFWS (U.S. Fish and Wildlife Service). 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.
- Van Metre, P.C., B.J. Mahler, M. Scoggins, and P.A. Hamilton. 2006. Parking lot sealcoat: A major source of polycyclic aromatic hydrocarbons (PAHs) in urban and suburban environments. U.S. Geological Survey. January.
- Vestal, B., and A. Rieser. 1995. Methodologies and mechanisms for management of cumulative coastal environmental impacts. Part 1 – Synthesis, with Annotated Bibliography. NOAA Coastal Ocean Office. Silver Spring, Maryland.
- Wainwright, T.C., and L.A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. *Northwest Science* 87(3): 219-242.
- Walters, D.A., W.E. Lynch Jr., and D.L. Johnson. 1991. How depth and interstice size of artificial structures influence fish attraction. *North American Journal of Fisheries Management* 11:319-329.

- Wanjala, B.S., J.C. Tash, W.J. Matter, and C.D. Ziebell. 1986. Food and habitat use by different sizes of largemouth bass (*Micropterus salmoides*) in Alamo Lake, Arizona. *Journal of Freshwater Ecology* Vol. 3(3):359-368.
- Ward, D.L., C.J. Knutsen, and R.A. Farr. 1991. Status and biology of black crappie and white crappie in the lower Willamette River near Portland, Oregon. Oregon Department of Fish and Wildlife Fish Division Information Reports Number 91-3. Portland, Oregon. 17 p.
- Ward, D.L. (ed). 1992. Effects of waterway development on anadromous and resident fish in Portland Harbor. Final Report of Research. Oregon Department of Fish and Wildlife. 48 p.
- Ward, D.L., and A.A. Nigro. 1992. Differences in Fish Assemblages Among Habitats Found in the Lower Willamette River, Oregon: Application of and Problems With Multivariate Analysis. *Fisheries Research* 13:119-132.
- Ward, D.L., A.A. Nigro, R.A. Farr, and C.J. Knutsen. 1994. Influence of Waterway Development on Migrational Characteristics of Juvenile Salmonids in the Lower Willamette River, Oregon. *North American Journal of Fisheries Management* 14:362-371.
- Warrington, P.D. 1999. Impacts of outboard motors on the aquatic environment. <http://www.nalms.org/bclss/impactsoutboard.htm>.
- Washington Office of Financial Management. 2016. Forecast of the State Population, November 2016 Forecast. http://www.ofm.wa.gov/pop/stfc/stfc2016/stfc_2016.pdf
- WDFW, WDOT, WDOE, and USACE (Washington Department of Fish and Wildlife, Washington Department of Transportation, Washington Department of Ecology, and the U.S. Army Corps of Engineers). 2003. Integrated Streambank Protection Guidelines, various pagination (April 2003) (<http://www.wdfw.wa.gov/hab/ahg/ispdoc.htm>).
- WDFW (Washington Department of Fish and Wildlife). 2015. Times when spawning or incubating salmonids are least likely to be within Washington State Freshwaters. Washington Department of Fish and Wildlife. http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times.pdf.
- Washington State Department of Ecology, Water Quality Program. 2004. Stormwater Management Manual for Eastern Washington. Publication Number 04-10-076. Olympia, WA. September. <https://fortress.wa.gov/ecy/publications/publications/0410076.pdf>.
- Washington State Department of Ecology, Water Quality Program. 2012. Stormwater Management Manual for Western Washington. Publication No. 12-10-030. August. <https://fortress.wa.gov/ecy/publications/publications/1210030.pdf>.

- Washington State Department of Ecology. 2014. 2014 Stormwater Management Manual for Western Washington. Washington State Department of Ecology. Publication Number 14-10-055. December 2014.
<http://www.ecy.wa.gov/programs/wq/stormwater/manual/2014SWMMWWinteractive/2014%20SWMMWW.htm>.
- WSDOT (Washington State Department of Transportation). 2010. Biological Assessment Preparation for Transportation Projects - Advanced Training Manual - Version 02-2011, Part 2 - Guidance on Specific BA Topics.
- WSDOT (Washington State Department of Transportation). 2014. Highway Runoff Manual (HRM). Engineering and Regional Operations, Development Division, Design Office. April 2014. <https://www.wsdot.wa.gov/publications/manuals/fulltext/M31-16/highwayrunoff.pdf>.
- Weis, J.S., and P. Weis. 1996. The effects of using wood treated with chromated copper arsenate in shallow-water environments: A review. *Estuaries* 19:306-310.
- Western Wood Preservers Institute, Wood Preservation Canada, Southern Pressure Treaters' Association, and Southern Forest Products Association. 2011. Best management practices for the use of treated wood in the aquatic and wetland environments (revised November 2011). http://www.wwpinstitute.org/documents/BMP_Revise_%204.3.12.pdf.
- Weston_Solutions. 2006. Jimmycomelately piling removal monitoring project, Final Report. Prepared for Jamestown S'Klallam Tribe, Port Townsend, Washington. 109.
- Willette, T.M. 2001. Foraging behaviour of juvenile pink salmon (*Oncorhynchus gorbuscha*) and size-dependent predation risk. *Fisheries Oceanography*. 10:110-131.
- 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.
- Winder, M. and D.E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. *Ecology* 85: 2100–2106.
- 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.
- Würsig, B., C.R. Greene Jr., and T.A. Jefferson. 2000. Development of an air bubble curtain to reduce underwater noise from percussive piling. *Marine Environmental Research* 49:19-93.
- Wyllie-Echeverria, S., and R.C. Phillips. 1994. Pages 1-4 *in* S. Wyllie-Echeverria, A. M. Olson and M. J. Hershman, editors. *Seagrass science and policy in the Pacific Northwest: proceedings of a seminar series (SMA 94-1) EPA 910/R-94-004*.
- Yamanaka, K.L., L.C. Lacko, R. Witheler, C. Grandin, J.K. Lohead, J.C. Martin, N. Olsen, and S.S. Wallace. 2006. A review of yelloweye rockfish *Sebastes ruberimus* along the Pacific coast of Canada: biology, distribution, and abundance trends. Research Document 2006/076. Fisheries and Oceans Canada. 54 pages.
- 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.
- Zimmerman, M.P. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River basin during outmigration of juvenile anadromous salmonids. *Transactions of the American Fisheries Society* 128:1036-1054.
- Zoller, U. 2006. Estuarine and coastal zone marine pollution by the nonionic alkylphenol ethoxylates endocrine disruptors: Is there a potential ecotoxicological problem? *Environment International* 32(2):269-72.

Appendix A: Guidelines and Implementation Sheets

EMAIL GUIDELINES

The programmatic e-mail box (femaprogrammatic.wcr@noaa.gov) is to be used for actions submitted to the National Marine Fisheries Service (NMFS) by FEMA for formal consultation (50 CFR § 402.14) under **the programmatic opinion for the FEMA Endangered Species Programmatic opinion.**

FEMA must ensure the final project is being submitted to avoid multiple submittals and withdrawals. In rare occurrences, a withdrawal may be necessary and unavoidable. In this situation, please specify in the e-mail subject line that the project is being withdrawn. There is no implementation sheet for a withdrawal, simply state the reason for the withdrawal and submit to the e-mail box, following the email titling conventions. If a previously withdrawn notification is resubmitted later, this resubmittal will be regarded as a new action notification.

An automatic reply will be sent upon receipt, but no other communication will be sent from the programmatic e-mail box; this box is used for **Incoming Only**. All other pre-decisional communication should be conducted **outside** the use of the femaprogrammatic.wcr@noaa.gov e-mail.

FEMA will send only **one** project per e-mail submittal, and will attach all related documents. These documents will include the following:

1. Action Implementation Worksheet, containing Action Notification, Action Completion, and Fish Salvage and Stormwater Information Form (if fish salvage and/or stormwater treatment are conducted).
2. Map(s), project design drawings, and submerged aquatic vegetation (SAV) survey (if applicable).
3. Final project plan.
4. The joint-permit application if a corps permit is associated with the project

The FEMA shall ensure that NMFS receives a Fish Salvage reports (if fish salvage is conducted) and Action Completion Report, within 90 days after in-water work completion.

E-mail Titling Conventions

In the subject line of the email (see below for requirements), clearly identify which FEMA programmatic you are submitting under (**FEMA Programmatic**), the specific submittal category (30-day verification, no verification, project completion, withdrawal, or salvage report), the FEMA Project Number, Project Names, 6th field HUC, County, and State

Use caution when entering the necessary information in the subject line. **If these titling conventions are not used, the e-mail will not be accepted.** Ensure that you clearly identify:

1. Which programmatic you are submitting under (**FEMA Programmatic**). The specific submittal category (30-day verification, no verification, action completion, withdrawal, salvage report, or site restoration/compensatory mitigation);
2. FEMA Project Name;
3. FEMA Project Number;
4. County;
5. 6th field HUC; and
6. State.

Examples:

Programmatic Specific Submittal Category, FEMA Project #, Project Name, County, State

Action Notification

FEMA Programmatic -Verification, DR-4258-OR, Sollie Smith Culvert Replacement Project, Tillamook, Tillamook, Oregon

FEMA Programmatic -30-day No Verification, DR-4258-OR, Sollie Smith Culvert Replacement Project, Tillamook, Tillamook, Oregon

Project Completion

Completion, Programmatic -Verification, DR-4258-OR, Sollie Smith Culvert Replacement Project, Tillamook, Tillamook, Oregon

Salvage Report

FEMA Programmatic -Salvage, DR-4258-OR, Sollie Smith Culvert Replacement Project, Tillamook, Tillamook, Oregon

Withdrawal

FEMA Programmatic -Withdrawal, DR-4258-OR, Sollie Smith Culvert Replacement Project, Tillamook, Tillamook, Oregon

Project Description

Please provide enough information for NMFS to be able to determine the effects of the action and whether the project fits the **FEMA Programmatic** criteria. Attach additional sheets if necessary. The project description should include information such as (but not limited to):

- Proposed in-water work including timing and duration
- Work area isolation and salvage plan including pumping, screening, electroshocking, fish handling, *etc.*
- Discussion of alternatives considered including rationale for why it was not selected.

INSTRUCTIONS: ACTION IMPLEMENTATION WORKSHEET

NMFS Review and Verification. The FEMA project manager shall submit the below implementation sheet for every project submitted along with the pile installation and stormwater information worksheets (if applicable), with the Action Notification portion completed, to NMFS at *femaprogrammatic.wcr@noaa.gov* for notification or verification.

The Following Actions Require Verification from NMFS. NMFS will notify FEMA within 30 calendar days if the actions are verified or disqualified.

- e. Temporary bypass channels (PDC 15)
- f. Alluvium placement that occupies more than 25% of the channel bed or more than 25% of the bankfull cross sectional area (PDC 42e)
- g. Blasting (PDC 31)
- h. Compensatory mitigation (PDC 38)
- i. Engineered log jams (PDC 42i)
- j. Fish screens on pump intakes for dewatering at a rate that exceeds 3 cfs (PDC 16)
- k. Grade stabilization (PDC 39b)
- l. LW placement that occupies greater than 25% of the bankfull cross section area (PDC 42e)
- m. The following minor project modifications are allowed under the proposed action if on a case by case basis, when NMFS verifies the resulting environmental and biological effects of the modification fit within the biological opinion:
 - i. Work outside the in-water work window,
 - ii. Large wood placement outside of the instream work window,
 - iii. Alternate location for equipment, refueling, and staging,
 - iv. Additional heavy equipment in constructing stream fords,
 - v. Revegetating after the first growing season
- n. New or upgraded stormwater outfalls (PDC 35 & 40)
- o. Off- and side-channel habitat restoration (PDC 46)
- p. Pile installation (PDC 25)
- q. Road-stream crossing replacement or retrofit (39c)
- r. Set-back of an existing berm, dike, or levee (PDC 47)
- s. Stormwater facilities (PDC 35 & 40)
- t. Utility crossing that includes directional drilling that spans the channel migration zone or any associated wetland (PDC 41)
- u. Vegetated riprap with LW (PDC 42g)
- v. Water control structure removal (PDC 48)

Attach information to e-mail message if required or relevant to NMFS's review:

- Erosion and pollution control plan
- Engineering designs
- Site assessment for contaminants to identify the type, quantity, and extent of any potential contamination
- Stormwater management plan
- Frac-out release contingency plan
- SAV (submerged aquatic vegetation) survey

The Following Actions Do Not Require Verification from NMFS. Any action that involves (a) routine road surface, culvert and bridge maintenance activity; (b) utility line crossing (excluding directional drilling operations), (c) boulder placement for habitat restoration, (d) streambank restoration, or (e) debris removal.

Project Reporting. The FEMA project manager shall submit the following reports as necessary:

Action Completion Reporting. It is the FEMA project manager responsibility to submit this form to the NMFS within 90 days of completing all work below ordinary high water (OHW) for riverine systems or below the highest astronomical tide (HAT) for marine systems. FEMA will resubmit this form with the Action Completion Report portion completed to NMFS at *femaprogrammatic.wcr@noaa.gov*.

Fish Salvage Reporting. It is the FEMA project manager responsibility to submit this form to the NMFS within 90 days of completing a capture and release as part of an action completed under FEMA's Endangered Species programmatic opinion. The FEMA will submit the Fish Salvage Report completed to NMFS at *femaprogrammatic.wcr@noaa.gov*.

ACTION IMPLEMENTATION WORKSHEET: Action Notification

DATE OF REQUEST:				NMFS TRACKING #: WCR-2016-6048
TYPE OF REQUEST:	<input type="checkbox"/> ACTION NOTIFICATION (NO VERIFICATION) <input type="checkbox"/> ACTION NOTIFICATION (VERIFICATION REQUIRED)			
Statutory Authority:	<input type="checkbox"/> ESA ONLY <input type="checkbox"/> EFH ONLY <input type="checkbox"/> ESA & EFH COMBINED			
Lead Action Agency:	Federal Emergency Management Agency	FEMA Action ID #:	Corps Action ID# (if any):	
Action Agency Contact:				
Have you contacted anyone at NMFS	<input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, Who:			
Project Name:				
6th-Field HUC & Name:				
Proposed Construction Period:	<i>Start Date:</i>		<i>End Date:</i>	
<i>If applicable fill out the relevant information below</i>				
Proposed Length of Channel and/or Riparian Modification in linear feet:				
Proposed Area of Herbicide Application in riparian area in linear feet:				
Proposed square footage of over-water structure				
Proposed amount of volume of material dredged				

Project Description:

ACTION IMPLEMENTATION WORKSHEET: Action Notification

Type of Action:

Identify the type of action proposed.

Actions Requiring **No Verification** from NMFS:

Routine road maintenance
Utility line crossing (excluding directional drilling operations)
Boulder placement
Streambank restoration
LW placement that occupies <25% of the bankfull cross section area
Debris removal

Actions Requiring **Verification** from NMFS:

Temporary bypass channels
Alluvium placement in >50% channel bed or >25% of the bankfull cross sectional area
Blasting
Compensatory mitigation
Utility line crossing (directional drilling)

Engineered log jams
Fish screens for diversion >3 cfs
Grade stabilization
LW placement that occupies >25% of the bankfull cross section area
New or upgraded stormwater outfalls
Off-and side-channel habitat restoration
Pile Installation
Road-stream crossing replacement or retrofit
Set-back of an existing berm, dike, or levee
Stormwater facilities
Vegetated riprap with LW
Water control structure removal
In-water Over-water Structure
Access maintenance
Streambank and Channel Stabilization
Minor project modification

NMFS Species/Critical Habitat Present in Action Area:

Identify the species or designated critical habitat found in the action area:

ESA Species

UWR spring-run Chinook	MCR steelhead	SR sockeye
PS Chinook	PS Steelhead	Lake Ozette sockeye
UWR steelhead	UCR spring-run Chinook	OC coho
LCR Chinook	UCR steelhead	SONCC coho
LCR steelhead	SR spring/summer run Chinook	HC summer-run chum
LCR coho	SR fall-run Chinook	Eulachon
Columbia River chum	SR steelhead	

EFH Species

Salmon, chinook
Salmon, coho
Salmon, pink
Pacific Coast groundfish

ACTION IMPLEMENTATION WORKSHEET: Action Notification

Project Design Elements & Best Management Practices: *Check the Project Design Elements and Best Management Practices from the biological opinion that will be for this proposed action. Please attach all appropriate plan(s) for this proposed action including, but not limited to: design plans, any revegetation or compensatory mitigation plans, and any related stormwater treatment design plans. In general, a minimum of at least 30% completed design plan(s) plans are required for projects that do not involve any in-water work, and a minimum of at 50% completed design plan(s) is typically required for any projects that include in-water work. Some projects that involve complex designs or extensive disturbance may require near 100% design. When in doubt of what is required it is recommended that applicants contact FEMA and/or NMFS staff for direction.*

<p><u>Administrative</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Electronic notification <input type="checkbox"/> Site assessment for contaminants <input type="checkbox"/> Site access <input type="checkbox"/> Salvage notice <p><u>General Construction Measures</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> In-water work timing <input type="checkbox"/> Fish capture and release <input type="checkbox"/> Work area isolation <input type="checkbox"/> Fish screens <input type="checkbox"/> Equipment, vehicles, power tools <input type="checkbox"/> Site layout and flagging <input type="checkbox"/> Staging, storage, and stockpile areas <input type="checkbox"/> Pollution and erosion control <input type="checkbox"/> Hazardous material safety <input type="checkbox"/> Pile installation <input type="checkbox"/> Pile removal <input type="checkbox"/> Broken or intractable pile <input type="checkbox"/> Fish passage <input type="checkbox"/> Surface water withdrawal <input type="checkbox"/> Dust abatement <input type="checkbox"/> Construction discharge water <input type="checkbox"/> Temporary access roads and paths <input type="checkbox"/> Temporary stream crossings <input type="checkbox"/> Drilling and boring <input type="checkbox"/> Pesticide and preservative-treated wood <input type="checkbox"/> Barge use <input type="checkbox"/> Invasive and non-native plant control <input type="checkbox"/> Post-construction stormwater management <input type="checkbox"/> Site restoration <input type="checkbox"/> Revegetation <input type="checkbox"/> Compensatory mitigation 	<p><u>1. Road Maintenance/Rehab/Replacement</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Design criteria <input type="checkbox"/> road/culvert/bridge maintenance <input type="checkbox"/> Grade stabilization <input type="checkbox"/> Structure stabilization <input type="checkbox"/> Permanent stream-road crossing replacement <input type="checkbox"/> Vegetated riprap with LW <input type="checkbox"/> Roughened toe <input type="checkbox"/> Rock structures <p><u>2. Stormwater Management Plan</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Design criteria <input type="checkbox"/> Low Impact Development <input type="checkbox"/> Water quality BMPs <input type="checkbox"/> Water quantity BMPs <input type="checkbox"/> Maintenance plan <input type="checkbox"/> Monitoring and reporting <p><u>3. Utility Stream Crossings</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Design criteria <p><u>4. Streambank/Channel Stabilization</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Alluvium placement <input type="checkbox"/> Large wood (LW) placement <input type="checkbox"/> Vegetated riprap with LW <input type="checkbox"/> Woody plantings <input type="checkbox"/> Herbaceous cover <input type="checkbox"/> Streambank shaping <input type="checkbox"/> Coir logs <input type="checkbox"/> Soil reinforcement <input type="checkbox"/> Engineered log jams <input type="checkbox"/> Floodplain flow spreaders <input type="checkbox"/> Fertilizer <input type="checkbox"/> Fencing <input type="checkbox"/> Filling scour hole <input type="checkbox"/> Slope stabilization with rock <p><u>5. Streambank Restoration</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Non-herbicide methods <input type="checkbox"/> Power equipment <input type="checkbox"/> Herbicide applicator qualifications <input type="checkbox"/> Transportation and safety plan 	<p><u>6. Boulder Placement for Habitat Restoration</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Site selection <input type="checkbox"/> Installation <p><u>7. Large Wood Placement</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Large wood condition <p><u>8. Off- and Side-Channel Habitat</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Needs NMFS Verification <p><u>9. Set-back Berm, Dike, and Levee</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Needs NMFS Verification <p><u>10. Water Control Structure Removal</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Needs NMFS Verification <p><u>11. In-water Over-water structures</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Boat ramps <input type="checkbox"/> Replacement floats <input type="checkbox"/> Relocation of existing structures <input type="checkbox"/> Repair/replacement of covered moorage/boat houses <p><u>12 & 13 Dredging</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Maintenance dredging <input type="checkbox"/> Vessel access dredging <p><u>14. Debris Removal</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Design criteria <p><u>Invasive and Non-native Plant Control</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Non-herbicide methods <input type="checkbox"/> Power equipment <input type="checkbox"/> Herbicide applicator qualifications <input type="checkbox"/> Herbicide transportation and safety plan <input type="checkbox"/> Approved herbicides <input type="checkbox"/> Approved herbicide adjuvants <input type="checkbox"/> Approved herbicide carriers <input type="checkbox"/> Herbicide mixing <input type="checkbox"/> Approved herbicide application rates <input type="checkbox"/> Approved herbicide application methods <input type="checkbox"/> Minimize herbicide drift and leaching <input type="checkbox"/> Required herbicide buffer distances
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**ACTION IMPLEMENTATION WORKSHEET: Pile Installation Worksheet
(If applicable)**

For Vibratory & Impact Hammer		
What is the number of hours/minutes required to drive one pile?		Mins/Hours
What is the number of hours/minutes required to drive all piles?		Mins/Hours
What is the number of hours per day pile driving will occur?		Mins/Hours
What is the depth of water the piles will be driven in?		Ft
Substrate Type:		
What is the diameter of the piles?		Inches
Will pile-driving be continuous?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Will be pile be driven straight or battered?	<input type="checkbox"/> Straight	<input type="checkbox"/> Battered
Will a template be used?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pile type (H, round, etc)?		
When is pile-driving proposed?		
What life-stages are known to occur within the action area.		
If provided, what is the source of hydroacoustic assumptions?		
Installation plan/ schematics included?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pile spacing?		Inches
Piles wrapped or coated? If yes, state type of material being used.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Material Type:		
For Impact Hammer Only		
What is the number of impact hammer strikes per hour?		Hour
If an impact hammer is used, will it be the entire pile or the last few hits per pile?	<input type="checkbox"/> Entire Pile	<input type="checkbox"/> Last Few Hits

**ACTION IMPLEMENTATION WORKSHEET: Stormwater Information Worksheet
(If applicable)**

If you are submitting a project that includes a stormwater plan for review, please fill out the following cover sheet **to be included with** any stormwater management plan and any other supporting materials. Submit this form with the Action Implementation Worksheet to NMFS at *femaprogrammatic.wcr@noaa.gov*

Also include a drawing of the stormwater treatment area including drainage areas, direction of flow, BMP locations and types, contributing areas, other drainage features, receiving water/location, etc.

Project Information		NMFS Project Tracking #: WCR-2016-6048
County:	FEMA Project #:	
Name of Project:		
Type of project (Check all that apply):		
<input type="checkbox"/> Residential	<input type="checkbox"/> Industrial	<input type="checkbox"/> Commercial
<input type="checkbox"/> Redevelopment	<input type="checkbox"/> New Development	<input type="checkbox"/> Institutional
<input type="checkbox"/> Private	<input type="checkbox"/> Public Right-of-way	<input type="checkbox"/> Retrofit
<input type="checkbox"/> Other		
Have you contacted anyone at NMFS <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, Who:		
Nearest receiving water potentially occupied by ESA-listed species or designated critical habitat:		
Distance from nearest receiving water potentially occupied by ESA-listed species or designated critical habitat:		
Lat/Long (DDD.dddd) of Project Location:		
Stormwater Design Manual Used and Year/Version: (example: City of Portland, Clean Water Services, King County, Western Washington)		
Describe which elements of your stormwater plan came from this manual:		
Applicant/Consultant Contact Information		
Name:		
Email:		
Phone:		
Stormwater Designer and/or Engineer Contact Information		
Name:		
Phone:		
Email:		

Design Storms		
2-year 24-hour Design Storm: NOAA Precipitation Atlas: http://nws.noaa.gov/ohd/hdsc/noaaatlas2.htm	Inches	IN/HR
<u>Water Quality</u> Design Storm (50% of 2-year 24-hour Design Storm):		Inches
Does the project treat 50% of the 2-year 24-hour design storm?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If no, project may not meet the FESP opinion criteria. Please provide justification or proposed mitigation to offset the deficiency in the stormwater management plan (e.g. discrepancy due to modeling method)		
<u>Water Quantity</u> Design Storm (10- year, 24-hour storm)		Inches
Total Post-Construction Runoff (PCR) to be Treated		
<u>Total Project Area:</u> (lot/parcel acreage + any additional ground disturbance area)	Acres	FT ²
<u>Total contributing impervious area</u> including all contiguous surface (e.g. roads, driveways, parking lots, sidewalks, roofs, compacted gravel, and similar surfaces)		
<u>Proposed new impervious area:</u> List the type(s) of new impervious area:	Acres	FT ²
<u>Existing impervious area:</u> List the type(s) of existing impervious area:	Acres	FT ²
Total Contributing Impervious Area (CIA) ⁴² FT ² (new + existing impervious area)	Acres	
Water Quality Design Storm (DS)		Ft
Peak Discharge of Design Storm		CFS
Post-Construction Runoff (PCR) = CIA * DS		
Total PCR to be treated:		Ft ³
Site Characteristics		
Will impervious area be reduced from current conditions? If yes, by how much?	<input type="checkbox"/> Yes Acres	<input type="checkbox"/> No FT ²
Is the site contaminated? If yes, provide investigation results to NMFS.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have you treated all stormwater to the design storm within the contributing impervious area? If no, why not and how will you offset the effects from remaining stormwater?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

⁴² Total Contributing Impervious Area (CIA) consists of all impervious surfaces within the strict project limits, plus impervious surface owned or operated by the grantee outside the project limits that drain to the project via direct flow or discrete conveyance.

Water Quality Information

Low Impact Development methods incorporated? Yes No

How much of total stormwater is treated using LID: %

Specific Lid Water Quality Treatment Elements Incorporated

<u>SITE DESIGN ELEMENTS</u>	<u>TREATMENT METHODS</u>
<input type="checkbox"/> SITE LAYOUT	<input type="checkbox"/> VEGETATED ROOF
<input type="checkbox"/> CLUSTERED DEVELOPMENT	<input type="checkbox"/> INFILTRATION RAIN GARDEN / LID SWALE
<input type="checkbox"/> DE-PAVE EXISTING PAVEMENT	<input type="checkbox"/> INFILTRATION STORMWATER PLANTERS
<input type="checkbox"/> CONSERVE SOILS W/ BEST DRAINAGE	<input type="checkbox"/> SOAKAGE TRENCH
<input type="checkbox"/> TREE PROTECTION	<input type="checkbox"/> DRYWELL
<input type="checkbox"/> CONSTRUCTION SEQUENCING	<input type="checkbox"/> WATER QUALITY SWALE
<input type="checkbox"/> REFORESTATION/TREE PLANTING	<input type="checkbox"/> VEGETATED FILTER STRIPS
<input type="checkbox"/> RESTORED SOILS	<input type="checkbox"/> LINED RAIN GARDEN/LID SWALE
<input type="checkbox"/> POROUS PAVEMENT	<input type="checkbox"/> LINED STORMWATER PLANTER

OTHER LID WATER QUALITY TREATMENT METHODS (LIST NAME & SOURCE):

Treatment train, including pretreatment and LID BMPs used to treat water quality:

Why this treatment train was chosen for the project site:

Page in stormwater plan where more details can be found:

Water Quantity Information

Does the project discharge directly into a major water body? Yes No
 (Large waterbody= ocean, estuary, Puget Sound, mainstem Columbia River, Willamette River downstream of Eugene)

Is the post-developed peak discharge >0.5 CFS during the 2-year, 24-hour storm event? YES NO
 If yes, flow control management is required.

Water Quantity Retention for Design Storm CFS % of 2-Year, 24-Hour Storm Event

Water Quantity Runoff Rates	50% of 2-yr, 24-hour storm:		10-yr storm, 24-hour:	
Pre-development runoff rate (i.e., before impervious surface existed at project site)	CFS	FT ³	CFS	FT ³
Post-development runoff rate (i.e., after proposed developments)	CFS	FT ³	CFS	FT ³

**** Post-Development Runoff Rate Must Be Less Than Or Equal To Pre-Development Runoff Rate****

Methods used to treat water quantity:

Page in stormwater plan where more details can be found:

Specific LID Water Quantity Reduction Elements Incorporated

MANAGEMENT ELEMENTS

- POROUS PAVEMENT
- INFILTRATION RAIN GARDEN/LID SWALE
- INFILTRATION STORMWATER PLANTERS
- SOAKAGE TRENCH
- DRYWELL
- DOWNSPOUT DISCONNECTION

OTHER LID WATER QUALITY TREATMENT METHODS
(LIST NAME & SOURCE):

Maintenance and Inspection Plan

Have you included a stormwater maintenance plan with a description of the onsite stormwater system, inspection schedule and process, maintenance activities, legal and financial responsibility, and inspection and maintenance logs?

Yes No

Page in stormwater plan where plan can be found:

*Projects cannot be submitted for review under FESP without a maintenance and inspection plan.

Contact information for the party/parties that will be legally responsible for performing the inspections and maintenance or the stormwater facilities:

Name: _____

Phone number: _____

Email: _____

Name: _____

Phone number: _____

Email: _____

Name: _____

Phone number: _____

Email: _____

Page in stormwater plan where more details can be found:

ACTION COMPLETION REPORT

The FEMA shall submit this form within 90 days of completing all work below ordinary high water (OHW) for riverine systems or below the highest astronomical tide (HAT) for marine systems. The FEMA shall submit this form to NMFS at *femaprogrammatic.wcr@noaa.gov*.

FEMA Action ID #		
Recovery Domain (WLC, IC, OC, SONCC, PS)		
Actual Start and End Dates for the Completion of In-water Work:	<i>Start:</i>	<i>End:</i>
<i>If applicable fill out the relevant information below</i>		
Fish Salvage	<input type="checkbox"/> Yes (Complete and submit fish salvage report)	<input type="checkbox"/> No
Total volume of dredged material		
Actual Linear-feet of riparian and/or channel modification within 150 feet of OHW (riverine) or the HAT (marine)		
Turbidity Monitoring/Sampling Completed	<input type="checkbox"/> Yes (include details below)	<input type="checkbox"/> No
Actual linear feet of herbicide treatment or permanent vegetation removal in the riparian area		
Stormwater monitoring/report completed	<input type="checkbox"/> Yes (include details below)	

Please include the following:

1. Attach any modification(s) that occurred during construction and provide justification for each modification.
2. Attach photos of habitat conditions before, during, and after action completion.
3. Describe compliance with fish screen criteria for any pump used.
4. Summarize results of pollution and erosion control inspections, including any erosion control failure, contaminant release, and correction effort.
5. Describe number, type, and diameter of any pilings removed or broken during removal.
6. Describe any riparian area cleared within the functional floodplain⁴³.

⁴³ **Functional floodplain** as defined in this document comprises the areas of the project delineated by the greatest of the following three boundaries: the floodplain for a 10-year flood event; 150 feet on each side of the active channel;

7. How many fish passage structures were replaced or constructed?
8. Describe turbidity monitoring (visual or by turbidimeter) including dates, times and location of monitoring and any exceedances and steps taken to reduce turbidity observed.
9. Describe site restoration.
10. Attached stormwater management plan
11. Attach stormwater facility inspection, maintenance, and recording plan
12. Attach any mitigation plan.

or a site-potential tree height within the project area. Site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class.

FISH SALVAGE REPORT (IF APPLICABLE)

If applicable: The grantee shall submit a completed Fish Salvage Report and Fish Salvage Data Table (see below) to the FEMA within 90 days of completing a capture and release as part of an action completed under this opinion. The FEMA will submit the report to NMFS at *femaprogrammatic.wcr@noaa.gov*.

FEMA Action ID #: _____

Date(s) of Fish Salvage Operation(s): _____

Supervisory Fish Biologist: _____

Address: _____

Telephone Number: _____

Fish Salvage Data

Water Temperature:

Air Temperature:

Time of Day:

ESA-Listed Salmonid Species per Recovery Domain ⁴⁴	Number Handled		Number Injured		Number Killed	
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
Willamette/Lower Columbia River Domain						
Interior Columbia River Domain						
Oregon Coast Domain						
Southern Oregon/Northern California Coast Domain						
Puget Sound Domain						
Total						

Describe methods that were used to isolate the work area and remove fish:

⁴⁴ Fish should be identified to the degree possible. When species is in doubt, use best professional judgement when filling out table.