UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

Refer to NMFS No: WCRO-2020-00102

May 7, 2020

Chad Hamel
Supervisory Environmental Protection Specialist
Environment, Fish and Wildlife
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Fish and Wildlife Habitat Improvement Program (HIP 4) in Oregon, Washington and Idaho

Dear Mr. Hamel:

Thank you for your letter of September 9, 2019, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the reinitiation of the Fish and Wildlife Habitat Improvement Program (HIP 4) in Oregon, Washington and Idaho. We received additional information from you on January 6, 2020, adding an additional activity category to the proposed action. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. We have included the results of that review in Section 3 of this document.

In this opinion, NMFS concluded that the actions authorized, funded, or carried out under HIP 4 are not likely to jeopardize the continued existence of the following 13 species or result in the destruction or adverse modification of their critical habitats:

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. Columbia River (CR) chum salmon (*O. keta*)
7. LCR coho salmon (*O. kisutch*)
8. SR sockeye salmon (*O. nerka*)
9. LCR steelhead (*O. mykiss*)
10. UWR steelhead

11. Middle Columbia River (MCR) steelhead
12. UCR steelhead
13. Snake River Basin (SRB) steelhead

NMFS also concurs with the BPA determination that the proposed action is not likely to adversely affect Southern distinct population segment (DPS) of eulachon (*Thaleichthys pacificus*) or Southern DPS of green sturgeon (*Acipenser medirostris*).

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 two 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, BPA 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 contact Dr. Nancy Munn of the Interior Columbia Basin Office in Portland, Oregon, at 503-231-6269 or nancy.munn@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Michael Tehan
Assistant Regional Administrator
Interior Columbia Basin Office

Enclosure

cc: Ann Gray, USFWS
Dan Gambetta, BPA
Ken Troyer, NMFS
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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Fish and Wildlife Habitat Improvement Program (HIP 4) in Oregon, Washington and Idaho

NMFS Consultation Number: WCRO-2020-00102

Action Agency: Bonneville Power Administration

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Upper Willamette Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
Upper Willamette steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Lower Columbia River Chinook salmon (*O. kisutch*)	Threatened	Yes	No	Yes	No
Lower Columbia River steelhead	Threatened	Yes	No	Yes	No
Columbia River chum salmon (*O. keta*)	Threatened	Yes	No	Yes	No
Middle Columbia River steelhead	Threatened	Yes	No	Yes	No
Upper Columbia River spring-run Chinook salmon	Endangered	Yes	No	Yes	No
Upper Columbia River steelhead	Threatened	Yes	No	Yes	No
Snake River spring/summer Chinook salmon	Threatened	Yes	No	Yes	No
Snake River fall-run Chinook salmon	Threatened	Yes	No	Yes	No
Snake River steelhead	Threatened	Yes	No	Yes	No
Snake River sockeye	Endangered	Yes	No	Yes	No
Green sturgeon	Threatened	No	N/A	No	N/A
Eulachon	Threatened	No	N/A	No	N/A

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast groundfish	Yes	Yes
Coastal pelagic species	Yes	Yes
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Michael Tehan
Assistant Regional Administrator

Date: May 7, 2020

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ACRONYMS

BA	Biological Assessment
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practice
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
BRT	Biological Review Team
CFR	Code of Federal Regulations
CHART	Critical Habitat Analytical Review Team
CORPS	US Army Corps of Engineers
CR	Columbia River
DDT	Dichlorodiphenyltrichloroethane
DIP	Demographically Independent Population
DPS	Distinct Population Segment
DQA	Data Quality Act
EC	Environmental Compliance
EEC	Expected Environmental Concentration
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR	Federal Register
GEEC	Generic Estimated Environmental Concentrations
HIP	Habitat Improvement Program
HUC	Hydrologic Unit Code
HWM	Ordinary High Water Mark
ITS	Incidental Take Statement
LAA	Likely to Adversely Affect
LCR	Lower Columbia River
MCR	Middle Columbia River
MPG	Major Population Group
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NAWQA	National Water-Quality Assessment
NMFS	National Marine Fisheries Service
NWPCC	Northwest Power and Conservation Council
ODFW	Oregon Department of Fish and Wildlife
Opinion	Biological Opinion
PBF	Physical and Biological Feature
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
RM	River Mile
RPM	Reasonable and Prudent Measure
RQ	Risk Quotient
SR	Snake River
SRB	Snake River Basin

UCR	Upper Columbia River
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
UWR	Upper Willamette River
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife

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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, as amended.

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 within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at 1201 NE Lloyd Blvd, Suite 1100, Portland, Oregon.

1.2 Consultation History

The Bonneville Power Administration (BPA) proposes to continue to fund their fish and wildlife habitat improvement projects through their Habitat Improvement Program (HIP). BPA funds the implementation of about 110 habitat restoration projects a year in fulfillment of its obligations under the Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program and as mitigation within various biological opinions issued to BPA. The Pacific Northwest Electric Power Planning and Conservation Action of 1980 (Public Law 96-501) authorized the creation of the Northwest Power Planning Council (now called the Northwest Power and Conservation Council, NWPCC) with representatives from Oregon, Washington, Idaho and Montana. The Act directs NWPCC to prepare a program to "protect, mitigate and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries affected by the development, operation, and management of [hydroelectric projects] …" BPA's authority and responsibility to fund fish and wildlife habitat improvement actions are derived in large part from this law.

BPA first consulted on HIP in 2003 (HIP I; 2003/00750). The second HIP consultation was completed in 2008 after we designated critical habitat for certain species of salmon and steelhead (HIP II; 2007/03996). The HIP II opinion was issued January 10, 2008. When this opinion expired, NMFS issued the HIP III opinion on March 22, 2013 (2013/9724). Over the more than fifteen plus years since the first consultation, BPA and NMFS have gained insight from both program and project monitoring, as summarized in the annual monitoring reports; we know what activity categories are implemented most often, and which activity categories have the greatest challenges complying with the conservation measures in the proposed action and the Reasonable and Prudent Measures' (RPM) terms and conditions. Although HIP III does not have an expiration date, BPA has asked, through their reinitiation request, to modify the activity categories based on feedback from monitoring results and from requests from stakeholders to include additional activity categories.

BPA proposes to continue to fund their modified HIP (now called HIP 4). BPA provided a biological assessment (BA) to NMFS on September 11, 2019, and requested formal ESA consultation. In the request, BPA concluded that the proposed program is likely to adversely affect (LAA):

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. Columbia River (CR) chum salmon (*O. keta*)
7. LCR coho salmon (*O. kisutch*)
8. SR sockeye salmon (*O. nerka*)
9. LCR steelhead (*O. mykiss*)
10. UWR steelhead
11. Middle Columbia River (MCR) steelhead
12. UCR steelhead
13. Snake River Basin (SRB) steelhead

In addition, BPA determined that their proposed program is not likely to adversely affect southern green sturgeon (*Acipenser medirostris*), and Pacific eulachon (*Thaleichthys pacificus*).

To determine the number and type of activities expected to be carried out under HIP 4, BPA provided information on the number and types of projects approved, per recovery domain, under HIP III (Table 1). To develop a projection of projects to be approved and implemented under HIP 4, we considered previous levels of activity under the previous HIP opinions. BPA also provided information on the type of activity categories implemented from 2013 through 2018 (Table 2). These data for 2019 are not available at this time.

Table 1. Number of habitat restoration projects authorized by BPA per recovery domain from 2014-2018. BPA assigned each activity category a risk level based on project impact and stream response potential. A project's risk is based on the highest level of risk category in the project. For example, projects that include channel realignment are considered to be high risk.

Year	Total Number of Projects Authorized[1]	Number of Projects within the Interior Columbia Basin			Number of Projects within the Willamette/Lower Columbia Basin		
		Low Risk	Medium Risk	High Risk	Low Risk	Medium Risk	High Risk
2014	106	63	21	4	2	0	1
2015	97	63	13	3	10	2	0
2016	97	55	17	3	6	4	0
2017	88	52	18	6	9	3	0
2018	97	58	17	9	10	3	0

Table 2. The number of activities authorized per category in each year from 2013 through 2018. Note that each project likely includes more than one activity category. For example, a project that replaces a culvert may include invasive plant control as well as riparian plantings.

Activity Category	2013	2014	2015	2016	2017	2018
Fish Passage Restoration	17	28	29	24	31	23
River, Stream, Floodplain, and Wetland Restoration	44	71	78	81	100	118
Invasive and Non-native Plant Control	57	77	65	53	56	52
Piling Removal	0	0	0	1	0	2
Road and Trail Erosion Control, Maintenance, and Decommissioning	2	7	3	2	4	6
In-channel Nutrient Enhancement	0	0	0	0	0	0
Irrigation & Water Delivery/Management Actions	12	19	13	29	746	787

BPA, NMFS and the U.S. Fish and Wildlife Service (USFWS) met on September 12, 2019, to review and discuss the annual monitoring results from HIP III. The meeting was useful to provide detailed program-level information on variance requests, conservation measure non-compliance and modifications to activity categories moving forward. Based on this discussion, BPA and NMFS decided to further explore amending the BA to add an additional activity category to the proposed action.

[1] Projects that were withdrawn, or projects that were authorized by the U.S. Fish and Wildlife Service only, are not included in the number of projects in the Interior Columbia Basin or the Willamette/Lower Columbia Basin.

BPA and NMFS met on October 17, 2019, and agreed to add an additional activity to the proposed action. On January 6, 2020, NMFS received an addendum to the BA that proposed herbicide treatment of the invasive weed, *Ludwigia*, in the Willamette Basin.

Consultation was initiated on January 6, 2020.

1.3 Proposed Federal Action

For the ESA consultation, "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 the EFH consultation, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The biological assessment provides a comprehensive description of the proposed action. *Section 2: Proposed Action* of the biological assessment (pages 3-14 to 3-80) is incorporated here by reference and summarized briefly in Table 1 below (50 CFR 402.14(h)(3)). A description of the proposed action is also attached in Appendix A. The proposed action includes conservation measures that are applicable to all activities. These include measures such as in-water work timing, erosion control and work area isolation measures as well as post-construction measures. The proposed action also includes activity-specific measures.

To ensure compliance with the proposed action and the restoration goals of the program, each site-specific action will be individually reviewed by BPA's environmental compliance (EC) staff through the BPA Review Process as outlined in the HIP 4 Handbook and briefly summarized on page 1-5 of the biological assessment. To determine if the project needs BPA Engineering Review or NMFS review, BPA EC staff will make a preliminary determination of the level of risk.[2] The risk levels for the categories of activity are rates as low, medium, and high (Table 3), and take into consideration both project impact and stream/habitat response potential. If BPA EC staff determine that the project is within the medium to high-risk categories the project shall be submitted to the BPA Engineering Technical Services for review. Certain projects shall require NMFS engineering, biologist or branch chief review as well. Review requirements are detailed in the HIP 4 Handbook (which is provided to every project applicant).

Table 3. Categories and activities covered under HIP 4 and the level of risk for each activity. The level of risk dictates the type of review by BPA and NMFS before a project gets approved. The level of risk is determined by BPA's EC staff.

Proposed Category of Activity	RISK CATEGORY
Category 1: Fish Passage Restoration (Profile Discontinuities and Transportation Infrastructure)	
Dams, water control, or legacy structure removal	Low, medium or high risk depending on the size of the structure being removed
Consolidate or replace existing irrigation diversions	Low or medium risk depending on the size of the structure
Headcut and grade stabilization	Low risk for headcuts <18 in; medium risk for headcuts >18in
Low flow consolidation	Medium or high risk
Providing fish passage at an existing facility	Low, medium or high risk

[2] If no risk category is assigned by BPA, then the risk category is assumed to be low.

Proposed Category of Activity	RISK CATEGORY
Category 1: Fish Passage Restoration (Profile Discontinuities and Transportation Infrastructure)	
Bridge and culvert removal or replacement	Medium risk
Bridge and culvert maintenance	Low risk
Installation of fords	Low or medium risk
Category 2: River, Stream, Floodplain, and Wetland Restoration	
Improve secondary channel and floodplain connectivity	Medium or high risk
Set-back or removal of existing berms, dikes and levees	Medium or high risk
Protect streambanks using bioengineering methods	Medium or high risk
Install habitat-forming natural material instream structures (large wood, small wood and boulders)	Low, medium or high risk
Riparian vegetation planting	Low risk
Channel reconstruction	Medium or high risk
Install habitat-forming natural material (sediment and gravel)	Low or medium risk. All structures require NMFS engineering review
Category 3: Invasive Plant Control	
Manage vegetation using physical controls	Low risk
Manage vegetation using herbicides (riverine)	Low risk
Manage vegetation using herbicides (estuarine)	High risk (NMFS branch chief approval required)
Manage *Ludwigia* in the Willamette basin	High risk (NMFS branch chief approval required)
Juniper removal	Low risk
Prescribed burning	Low risk
Category 4: Piling Removal	
Piling removal	Low risk
Category 5: Road and Trail Erosion Control, Maintenance and Decommissioning	
Maintain roads	Low risk
Decommission roads	Low risk
Category 6: Nutrient Enhancement	
Nutrient enhancement	Low risk
Category 7: Irrigation and Water Delivery/Management Actions[3]	
Convert delivery system to drip or sprinkler irrigation	Low or medium risk
Convert water conveyance from open ditch to pipeline or line leaking ditches or canals	Low or medium risk
Convert from instream diversions to groundwater wells for primary water sources	Low risk
Install or replace return flow cooling systems	Low risk
Install irrigation water siphon beneath waterway	Low or medium risk
Livestock watering facilities	Low risk
Install new or upgrade/maintain existing fish screens	Low risk
Category 8: Fisheries, Hydrologic and Geomorphologic Surveys	
Fisheries, hydrologic and geomorphologic Surveys	Low risk

The proposed action does not include any post-implementation monitoring for fish presence or absence. An ESA section 10 research permit is required for all electroshocking and fish handling for research purposes.

[3] The HIP 4 will only cover irrigation efficiency actions within this activity category that use state-approved regulatory mechanisms for ensuring that water savings will be protected as instream water rights, or in cases for which project sponsors identify how the water conserved will remain instream to benefit fish without any significant loss of the instream flows to downstream diversions.

We considered whether or not the proposed action would cause any other activities (i.e., consequences of the proposed action) and determined that it would not.

2.0 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, each Federal agency must ensure that its 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 provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, 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 RPMs and terms and conditions to minimize such impacts.

BPA determined the proposed action is not likely to adversely affect the North American green sturgeon (*Acipenser medirostris*) and the southern distinct population of Pacific eulachon (*Thaleichthys pacificus*) or their critical habitat. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (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 "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably 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 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological 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 as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced 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.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly 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, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest 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' "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 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; 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 percent 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; Raymondi et al. 2013; Wainwright and Weitkamp 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^{o}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

For Pacific salmon, steelhead, and certain other species, we commonly use the four “viable salmonid population” (VSP) criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species’ “reproduction, numbers, or distribution” as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population’s capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment.

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

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

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

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

Table 4, 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 4. Summarized listing, recovery plan, status review, status summary, and limiting factor information 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 2013	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 Evolutionarily Significant Unit (ESU), although there are some positive trends. Increases in abundance were noted in about 70 percent of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline viable salmonid population (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. In terms of risk, the recent trend[4] for the ESU is considered to be stable/improving (NWFSC 2015).	• 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

[4] Recent risk trend summarizes the overall trends in risk status for each ESU/DPS since the prior status review, in the judgement of the chapter author considering all four VSP criteria; abundance, productivity, spatial structure, diversity (NWFSC 2015).

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
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. In terms of risk, the recent trend for the ESU is considered to be stable (NWFSC 2015).	• 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
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	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. In terms of risk, the recent trend for the ESU is considered to be stable (NWFSC 2015).	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River Chinook salmon	Threatened 6/28/05	NMFS 2011	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 ESU since the last review, so the ESU remains at moderate risk. In terms of risk, the recent trend for the ESU is considered to be declining (NWFSC 2015).	• 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
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017b	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. In terms of risk, the recent trend for the ESU is considered to be improving (NWFSC 2015).	• 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.

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 2013	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. In terms of risk, the recent trend for the ESU is considered to be stable (NWFSC 2015).	• 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
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	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	• 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
				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. In terms of risk, the recent trend for the ESU is considered to be stable/improving (NWFSC 2015).	

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015a	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. In terms of risk, the recent trend for the ESU is considered to be improving (NWFSC 2015).	• 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
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 percent 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. In terms of risk, the recent trend for the DPS is considered to be improving (NWFSC 2015).	• 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 2013	NWFSC 2015	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 demographically independent populations (DIPs), none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability. In terms of risk, the recent trend for the DPS is considered to be stable (NWFSC 2015).	• 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 2011	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. In terms of risk, the recent trend for the DPS is considered to be declining (NWFSC 2015).	• 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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009b	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. In terms of risk, the recent trend for the DPS is considered to be stable/improving (NWFSC 2015).	• 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 2017a	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 major population groups (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. In terms of risk, the recent trend for the DPS is considered to be stable/improving (NWFSC 2015).	• 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

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 (PBFs) 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). The PBFs for ESA-listed salmon and steelhead include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas.

For most salmon and steelhead, NMFS's 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.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 5 below.

Table 5. 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 PCEs 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 PCEs 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 PCEs 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.
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 PCEs for

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		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.
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 PCEs 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.
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 2015a). 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 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 PCEs 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 PCEs 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 PCEs 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 PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		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.

2.3 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 all areas within the Columbia River Basin in Oregon, Washington and Idaho where the environmental effects of actions funded under the HIP 4 may occur that is also within the range of ESA-listed salmon and steelhead and their designated critical habitats (Figure 1).

Because of the potential for downstream and cumulative effects within watersheds, the action area encompasses entire subbasins where the listed fish or designated critical habitat occur. This includes all upland, riparian and aquatic areas affected site preparation, construction, site restoration, and any offsite conservation measures at each project site. Individual action areas also cover up to 300 feet downstream from the project footprint where aquatic habitat conditions may be temporarily degraded by increased runoff and erosion until site restoration is complete.

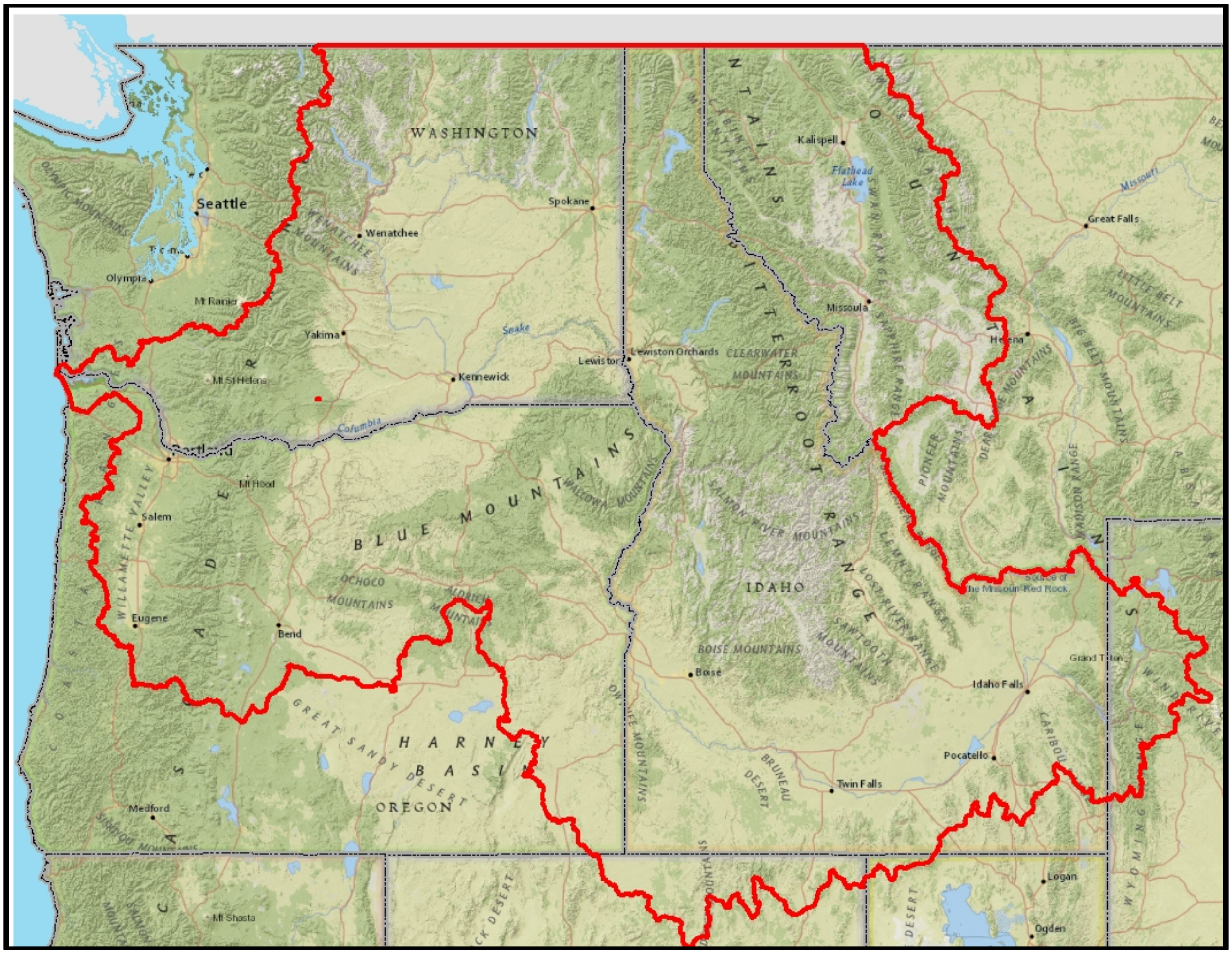

Figure 1. The action area for the HIP 4 includes the portion of the Columbia Basin in Oregon Washington and Idaho only.

2.4 Environmental Baseline

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

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. Dam operations have 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, fish passage has been restored through both improvements to existing fish passage facilities and 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).

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 percent 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 two 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 contaminants increase in downstream reaches (Fuhrer et al. 1996; Johnson et al. 2013; Johnson et al. 2005). 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).

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.

The existing highway system contributes to a poor environmental baseline condition in several 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 (U.S. Army Corps of Engineers (Corps), BPA) and Bureau of Reclamation, (BOR) 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. NMFS issued biological opinions for implementation of the National Flood Insurance Program in Oregon and in the Puget Sound area of Washington. Both opinions concluded that implementation of the National Flood Insurance Program would jeopardize the continued existence of listed species

The 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, 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.

The PBFs for ESA-listed salmon and steelhead within the action area include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas.

2.5 Effects of the Action

Under the ESA, “effects of the action” are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

Habitat improvement projects, implemented consistently with the proposed action, will have long-term beneficial effects to salmonids and their habitats. These beneficial effects will improve three salmon and steelhead VSP parameters: abundance, productivity, and spatial structure. These improvements will translate into decreased risk of extinction and increased probability of recovery for all of the species addressed by this consultation. Habitat improvement projects carried out in critical habitat will improve the conservation value of the essential biological and physical features of habitat at the site and watershed scales. The categories of actions proposed all have predictable effects regardless of where in the action area they are implemented. This assessment is based on 16 years of program implementation and monitoring results.

NMFS estimates that the BPA will implement approximately 100 projects per year under HIP 4 based on past implementation as reported in BPA's annual monitoring reports. In 2018, 94 individual projects were implemented under HIP III (BPA 2018). In 2018, many of the projects were implemented in the Interior Columbia basin, with a high number of projects evenly distributed geographically through the Snake River basin. A smaller number of projects were in the Willamette River basin and lower Columbia River estuary. We anticipate that individual projects under HIP 4 will be similarly distributed through the action area, and that both short-term adverse effects and long-term beneficial effects will therefore be similarly distributed across the species and populations in the action area.

2.5.1 Program Administration

BPA 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, special maintenance needs, or the project's potential for contribution to species recovery is resolved as the project is being designed. Additionally, BPA will obtain verification from NMFS for activities with complicated design elements or an engineering component. Furthermore, the BPA will notify NMFS before each project begins construction.

As an additional program-level check on the continuing effects of the action, BPA and NMFS will meet at least annually to review implementation of this program and opportunities to improve conservation, or make the program overall more effective or efficient. Application of consistent best management practices (BMPs) and engineering improvements to the maximum extent feasible in each recovery domain is likely to slowly improve habitat conditions across the landscape, improve ecosystem resilience, and contribute to restoration actions necessary for the recovery of ESA-listed species and critical habitats in Oregon, Washington, and Idaho. This level of program administration is necessary to ensure that projects are being implemented consistently with project design measures and program intent, thus ensuring that the effects are consistent with the analysis in this opinion.

2.5.2 General Effects

Restoration projects generally follow a sequence of four stages: pre-construction; site preparation; construction; site restoration and ongoing operations and maintenance. Pre-construction activity can include surveying, minor vegetation clearing, placement of stakes and flagging guides, and minor movements of machines and personnel within the action area, and other actions as needed. Site preparation typically requires development of access roads, construction staging areas, and materials storage areas that affect more of the project area, and clears vegetation that will allow rainfall to strike the bare earth surface. The construction phase may include additional earthwork to clear, excavate, fill and shape the site (often within the active channel) and to reshape the banks as necessary for successful revegetation.

The final stage involves the restoration of ecological function and habitat-forming processes to maintain or promote a site along a trajectory toward conditions that support functional aquatic habitats. Site restoration is essentially the reverse of the construction activities that go before it. Bare earth is protected by seeding, planting woody shrubs and trees, and mulching, which act to dissipates erosive energy associated with precipitation. Covering bare earth increases soil infiltration and 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 regrowth of shade plants.

General Effects for Projects that include In-water or Near Water Work

The effects generally fall under the general effects and usually involve: vegetation removal, exposure and compaction of soil, heavy equipment operation, work-area isolation and relocation of fish, exposure to toxic materials from heavy equipment use and site restoration. These construction activities cause a number of negative effects on anadromous fish and their habitat. The effects occur through pathways including:

- Elevated suspended sediment
- Fish handling
- Riparian and streambank disturbance
- Reduction of water quantity/flow
- Small spills or leaks of fuel, lubricants, hydraulic fluid, coolants, and other contaminants
- Physical injury or death of fish through contact with heavy equipment
- Fish displacement
- Temporary reduction in aquatic invertebrate prey in the dewatered work isolation area
- Water quality impacts from construction discharge water

Each of these actions has impacts on fish and their habitats and general description of the effects to fish and their habitats are provided in the sections below, and summarized in Table 6. The table also includes a description of how proposed design requirements and BMPs minimize the effects.

Table 6. Summary of effect pathways from near- and in-water construction on anadromous fish and their habitat and evaluation of measures to avoid or limit effects.

Effect pathway	Summary of effects on anadromous fish and their habitat	Evaluation of measures to avoid or limit effects of near- and in-water construction
Elevated suspended sediment	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. Multi-year projects are likely to cause more sedimentation. This increases total suspended solids. 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. Turbidity may have beneficial or detrimental effects on fish, depending on the intensity, duration and frequency of exposure (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids may be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjorn and Reiser 1991), although these events may produce behavioral effects, such as gill flaring and feeding changes (Berg and Northcote 1985). Deposition of fine sediments reduces incubation success (Bell 1991), interferes with primary and secondary productivity (Spence *et al.* 1996), and degrades cover for juvenile salmonids (Bjornn and Reiser 1991). Chronic, moderate turbidity can harm newly-emerged salmonid fry, juveniles, and even adults by causing physiological stress that reduces feeding and growth and increases basal metabolic requirements (Redding *et al.* 1987, Lloyd 1987, Bjornn and Reiser 1991, Servizi and Martens 1991, Spence *et al.* 1996). Juveniles avoid chronically turbid streams, such as glacial streams or those disturbed by	Erosion control measures will be applied to any project that involves soil disturbance. These measures constrain and secure the site against erosion and inundation during high flow events. This minimizes the amount of fine sediments entering streams. The selection of properly sized heavy and equipped heavy machinery minimizes soil disturbance. In-water construction is proposed to occur during in-water work windows established by Oregon, Idaho, and Washington state agencies. For wade-able streams, these work windows typically coincide with the lowest flows of the year. Conducting in-water work during these times results in less mobilization of fine sediments, because during low water velocity associated with low flows, the stream has less ability to mobilize fine sediments. In addition, this analysis considers working outside the in-water work window if effects to fish are the same or less in terms of exposure to project effects, or when the effects to listed salmon and steelhead are no greater than within the in-water work window in terms of scale and scope of habitat effects.

Effect pathway	Summary of effects on anadromous fish and their habitat	Evaluation of measures to avoid or limit effects of near- and in-water construction
	human activities, unless those streams must be traversed along a migration route (Lloyd *et al.* 1987). Older salmonids typically move laterally and downstream to avoid turbid plumes (McLeay *et al.* 1984, 1987, Sigler *et al.* 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1991). On the other hand, predation on salmonids may be reduced in waters with turbidity equivalent to 23 Nephelometric Turbidity Units (NTU) (Gregory 1993, Gregory and Levings 1998), an effect that may improve overall survival.	
Work area isolation and fish relocation	Effects from in-water work are generally avoided and minimized through use of: (1) In-water work isolation strategies that often involve capture and release of trapped fish and other aquatic invertebrates, and (2) performing the work during work windows when the fewest individuals of a species are present. Capturing and handling all 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). The primary contributing factors to stress and death from handling are differences in water temperatures (between the river 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 salmonids increases rapidly from handling if the water temperature exceeds 18ºC (64ºF) or dissolved oxygen is below saturation. 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. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.	The BMPs proposed for 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). Key conservation measures in the guidance such as avoiding work during times of high stream temperatures significantly reduces mortality that can occur during work area isolation. Use of properly sized screens during water withdrawal can reduce or nearly eliminate injury or death of fish caused by entrainment.
Riparian Disturbance	Near-water construction causes 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	Environmentally sensitive areas, equipment entry and exit points, road and stream crossings, and staging areas will be clearly marked to avoid or minimize disturbance. Obliteration of temporary roads and paths will ensure soil is de-

Effect pathway	Summary of effects on anadromous fish and their habitat	Evaluation of measures to avoid or limit effects of near- and in-water construction
	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 increases the supply of sediment to lowland drainage areas and eventually to aquatic habitats, where they increase total suspended solids and sedimentation.	compacted so riparian vegetation can become reestablished quickly. Heavy-duty equipment and vehicles for each project will 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). Disturbed areas will be revegetated to ensure recovery of riparian vegetation. These proposed conservation measures help ensure that disturbance in riparian areas in minimized and the recovers in one to two seasons.
Reduction of water quantity/flow	The withdrawal of water for construction activities decreased the amount of water in streams and rivers. This can reduce the depth of wetted width of streams, decreasing the amount of habitat available for listed fish. Withdrawal without an adequate fish screen can entrain juvenile fish, which typically injures or kills them. These impacts are typically short duration, lasting a few hours at a time during active construction. Other than temporary reduction in aquatic invertebrate prey (as further described below), impacts from reduction of water quantity are not long lasting.	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). This will ensure that juvenile fish are not entrained during withdrawal of water for construction purposes. Any actions diverting surface water at a rate that exceeds 3.0 cfs are individually reviewed and verified by NMFS. This will ensure water withdrawal will not dewater streams or have other significant adverse impacts on listed fish or their habitat.

Effect pathway	Summary of effects on anadromous fish and their habitat	Evaluation of measures to avoid or limit effects of near- and in-water construction
Spills or leaks of fuel or lubricants	The use of heavy equipment creates a risk of accidental spills of fuel, lubricants, hydraulic fluid, coolants, and other contaminants. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons (PAHs), which can be acutely toxic to salmonid fish and other aquatic organisms at high levels of exposure and can cause sublethal adverse effects to aquatic organisms at lower concentrations (Heintz et al. 1999; Incardona et al. 2005; Incardona et al. 2004; Incardona et al. 2006).	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. Heavy equipment will have regular inspection and cleaning before operation to ensure that vehicles remain free of external oil, grease, mud, and other visible contaminants. Pollution control measures will be applied at project sites for the use and disposal of all hazardous products, the disposal of construction debris.
Physical injury or death of fish through contact with heavy equipment	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 as they come in contact with the equipment.	The risk of physical injury or death of fish through contact with heavy equipment is limited by the timing of 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 ordinary high water (OHW) (riverine) where adult or juvenile fish are reasonably certain to be present, or 300 feet or less upstream from spawning habitats, the area will 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, the program requires that passage for adult and juvenile fish meets NMFS's (2011a) criteria, or most recent version, will be provided around the project area during and after construction.

Effect pathway	Summary of effects on anadromous fish and their habitat	Evaluation of measures to avoid or limit effects of near- and in-water construction
Fish displacement	Work involving the presence of equipment or vehicles in the active channel when ESA-listed fish are present is likely to cause some fish to experience elevated stress or leave the area. Essential behaviors such as feeding and sheltering are also interrupted during in-water work. Fish relocating to an undisturbed area may become more vulnerable to avian or piscine predation. These fish are typically injured or killed during predation attempts.	Fish displacement will be limited by timing proposed work to avoid vulnerable life stages of ESA-listed fish, including migration, spawning and rearing, where possible. Further, when work in the active channel involves substantial excavation, backfilling, embankment construction, or similar work below OHW (riverine) where adult or juvenile fish are reasonably certain to be present, or 300 feet or less upstream from spawning habitats, the area will be effectively isolated from the active channel to reduce the likelihood of direct, mechanical interactions with fish, or indirect interactions through environmental effects.
Temporary reduction in aquatic invertebrate prey in the dewatered work isolation area	In-water construction often kills or injures aquatic invertebrates in the construction area. Invertebrates can be killed during dewatering caused by work area isolation. They can also be killed by elevated suspended sediment which may interfere with respiration or other essential behaviors such as feeding. Minor spills of fuel or lubricants can kill aquatic invertebrates, as many species are highly sensitive to these substances. The reduction in invertebrates typically persists for one to two seasons, resulting is a temporary loss of forage for salmonids. Invertebrates from upstream and downstream of the project site will recolonize the area.	The BMPs to minimize the impacts of water withdrawal and elevated suspended sediment will also minimize impacts on aquatic invertebrates. The BMPSs limit the size of the dewatered area.
Water quality impacts from construction discharge water.	Water discharges from construction sites into streams or river can contain chemicals such as green concrete, drilling, fluids and petroleum products. These chemicals can be toxic to fish, invertebrates, and other aquatic life.	The BMPs require that all discharge water from construction activities, such as concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids, or other construction work will be treated to remove 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. Green concrete or washout water should never directly enter water with anadromous fish.

Frequency of Effects from Near and In-Water Construction
BPA provided information on the expected frequency of activities covered under the proposed action. In their 2018 annual monitoring report, BPA reported that they authorized 43 projects that included in-water work in 2018 (range of 35-45 each year from 2013 to 2018)(BPA 2018). Based on that information, we expect a maximum of about 50[5] projects involving in or near-water construction to be implemented per year under HIP 4. The projects are spread across a large geography although there is some geographic clumping of projects in the Interior Columbia Basin.

Duration of Effects from Near and In-Water Construction
The effects of construction such as elevated suspended sediment and increased risk of injury or death from contact with heavy equipment occur continuously while construction is underway. This can vary from a few hours to a few months depending on the scale of the project. For most projects, the construction phase lasts for a few weeks. Most projects involve a single construction phase. Some projects require an initial construction phase followed by periodic maintenance. Most projects that require in-water work will be done in the dry, which will avoid extended periods of elevated suspended sediment. In these cases, the risk auld be highest as areas are being re-watered.

The indirect effects of construction such as riparian and streambank disturbance typically last for a year or two until the project site recovers from the disturbance. During this time, habitat quality for anadromous fish will remain impaired to some extent.

2.5.3 Fish Passage Restoration

The goal of this activity category is to fund fish passage projects to allow all life stages of salmonids access to historical habitat from which they have been excluded and focuses on restoring safe upstream and downstream fish passage to stream reaches that have become isolated by obstructions, non-functioning structures, or instream profile discontinuities. These activities also prevent streambank and roadbed erosion, facilitate natural sediment and wood movement, and eliminate or reduce excess sediment locating and dynamic changes in streamflow that cause streambank erosion, undermine roadbeds, and washout culverts. The short-term construction-related effects are discussed above.

Proper road drainage upgrades and culvert replacements likely diminish the potential adverse effects of roads, including turbidity, sedimentation, by allowing drainage design features to work properly. Removing fish passage barriers and restoring hydrologic function will be beneficial in the long-term. Thousands of human-made barriers block passage to thousands of miles of freshwater spawning and rearing habitat in the Columbia River basin. Any contribution to reducing this number of passage barriers will have long-term benefits to salmonid productivity. These projects will allow or improve access to habitat. In addition, they can improve connectivity to the floodplain and improved movement of sediment and large wood, thus

[5] While we anticipate a maximum of 50 projects involving in- or near-water construction per year based on past implementation numbers. However, our analysis later in this effects analysis assumes up to 75 projects per year will be implemented in- or near-water. This increased number is to ensure that we do not limit the number of beneficial restoration actions that could be implemented.

improving the quality of existing habitat. Access can lead to increased spawning and rearing success, and can improve growth and condition of fish (improved movement of fish and prey), leading to improved survival.

The activity category also includes culvert and ditch maintenance, which will ensure fish passage and floodplain connectivity, allow for dynamic flows, and maintain access to spawning and rearing habitats.

This activity category also includes the installation, upgrade or maintenance of fish exclusion devices and bypass systems within irrigation ditches and diversions (e.g., screens and ladders). All proposed screen installations or replacements must meet NMFS fish passage criteria. No additional water withdrawals will be established and no greater water withdrawal will be authorized. The long-term effect will be beneficial, reducing the mortality of fish in diversions. This effect will occur at the project reach scale.

When upstream spawning habitat is made available, passage restoration will improve population spatial structure and possible abundance and productivity. Improved passage for juveniles allows for access to upstream thermal refuges during summer and off-channel rearing habitat in winter. Improved habitat conditions and fish passage will provide greater access to spawning and rearing habitat, less energy expenditure in movement, greater access to diverse habitats that foster the development and maintenance of populations. The benefit is likely to begin immediately following construction, with improvements to productivity, survival, spatial structure and diversity at the population scale where projects are being implemented.

2.5.4 River, Stream Floodplain, and Wetland Restoration

BPA proposed to fund projects that improve secondary channels and wetland habitats; set back or remove existing berms, dikes and levees; protect streambanks using bioengineering methods; install habitat-forming instream structures using native materials; plant riparian vegetation; and reconstruct channels. The purpose of these projects is to restore habitat condition and processes, and hydrologic function. Again, the short-term negative consequences of implementing projects in the category are discussed above in the general effects section.

Implementing these projects will have a long-term, beneficial effect. These are some of the potential effects:

- Re-establish wetland processes and function such as flood water attenuation, nutrient and sediment storage, removal of pollutants;
- Better support native communities which supports complex and diverse habitat, especially for rearing juvenile salmonids;
- Improved access to rearing areas;
- Creation of resting areas for fish at various flow levels;
- Protective cover for fish; and
- Create suitable conditions for beaver dams, which will entrain substrate, grade the channel bottom and reconnect the stream to the floodplain, increase pool frequency, increase channel sinuosity, etc.

Addition of large wood is a common and effective stream restoration technique used throughout the Pacific Northwest (Roni et al. 2002). Roni and Quinn (2001a) found that large wood placement can lead to higher densities of juvenile coho salmon during summer and winter and higher densities of steelhead and cutthroat trout in the winter. These authors also found addition of large wood to streams with low levels of wood can lead to greater fish growth and less frequent and shorter fish movements (Roni and Quinn 2001b).

Channelization of estuaries and streams through berm, dike, and levee construction eliminates the floodplain benefits during floods, producing many of the same changes to living communities and ecosystems as those resulting from dams. Berms, dikes, and levees are commonly found along mid-to large-sized rivers for flood control or infrastructure protection and can severely disrupt ecosystem function (Gergel et al. 2002) and fish community structure (Freyer and Healey 2003).

The effects of setting back or removing existing berms, dikes, and levees are similar to off-channel, side-channel, and floodplain 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. For constructability, many activities will be timed with low tidal cycles which also minimizes short-term effects including sediment generation. Because of their locations and elevations, work area isolation is not needed for most berm, dike, and levee projects. Thus, they do not result in fish capture and handling.

Salmonids and other fishes benefit from restoring the processes that maintain floodplain complexity (Bellmore et al. 2013). Set-back or removal of existing berms, dikes, and levees increases habitat diversity and complexity, moderates flow disturbances, and provides refuge for fish during high flows. Floodplain heterogeneity is associated with the occurrence of a mosaic of food webs, all of which are utilized by anadromous salmonids and other estuarine fishes, and all of which may be important to their recovery and persistence. Other restored ecological functions include overland flow during flood events, dissipation of flood energy, increased water storage to augment low flows, sediment and debris deposition, growth of riparian vegetation, nutrient cycling, and development of side channels and alcoves. Set-back or removal of berms, dikes, and 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.

Channelized streams have increased flow velocities and bed and bank erosion. Greater water depth and discharge are now required for the stream to spread onto the floodplain because bed elevations decreased in response to channelization and streambank heights increased. Increased streambank heights and bankfull discharge have resulted in increased bank erosion and may be responsible for a significant portion of sediment loads in streams.

Channel restoration and relocation activities have the potential for significant local and landscape-level effects to processes related to sediment transport, energy flow, stream flow, temperature, and biotic fragmentation. Although NMFS can predict the worst-case effects of this activity, with the proposed PDCs stream ecological condition will be measurably improved and pre-notification design coordination will result in the best possible outcome. Typically, stream channel reconstruction/relocation projects are conducted in phases that will end with the full return of river flows to the historical channel and the filling of the old shortened channel. Channel reconstruction/relocation activities will be implemented to improve aquatic and riparian habitat diversity and complexity, reconnect channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, provide long-term nutrient storage, provide substrate for macroinvertebrates, moderate flow disturbance, increase retention of organic material, and provide refuge for fish and other aquatic species. Significant mechanical manipulation and grading may be required to recover floodplain width and elevations. However, because in-water work timing occurs during low water periods and isolation of the work area is required, the release of suspended sediment is expected to be a short-term event. Sediment is likely to be carried by surface runoff when the newly configured channel(s) are reactivated and erosion control structures are removed.

Many historical off- channels and side-channels have been blocked from main stream channels for flood control or by other land management activities, or have ceased functioning due to other in-stream sediment imbalances. Restoration of off-channel, side-channel, and floodplain habitat includes removal of fill material to reconnect existing stream channels to historical off- channel habitat and side-channels. Side channel wetlands and ponds provide important benefits such as high value as summer and winter rearing habitat for coho salmon (Cramer 2012).

This activity category will increase habitat diversity and complexity, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macroinvertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refuge for fish during high flows. Long-term benefits will include 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).

Post-construction, this activity category will result in short and long-term environmental benefits by restoring hydrologic function of stream channels to more natural conditions. Functional floodplains will promote riparian vegetation and stable banks. The restored corridor will provide an adequate riparian buffer zone. Aquatic habitat will be greatly improved by making streams more self-sustaining and resilient to external perturbation will lead to improved aquatic habitat, which will help improve fish population abundance and productivity.

All in-water construction will occur during recommended site-specific in-water work windows outside of out-migration and spawning migration periods, therefore, smolt and adult ESA-listed salmon and steelhead are unlikely to be present during project construction. For bigger projects, minor pulses of suspended sediment will occur over a period of a few years until the channel stabilizes. This may reduce egg-to-fry survival in some reaches due to increased fine sediment deposition on downstream spawning gravels. These minor sediment pulses are unlikely to affect migrating adults or juveniles.

The projects funded in this activity category have the potential to improve survival and increase productivity at the reach scale. These projects will also improve spatial structure and diversity. This was a very common category in HIP III with many tens of projects implemented each year in the Columbia River basin. If that trend continues in HIP 4, population-scale VSP parameters may improve.

2.5.5 Non-native and Invasive Plant Control

Manual, mechanical, and herbicidal treatments of invasive and non-native plants are often conducted after ground-disturbing construction activities. BPA also proposes to treat invasive plants in fluvial and estuarine systems to improve the ecological function of habitat where ESA-listed species live. The effects of managing vegetation using physical controls (manual and mechanical) are subject to special conservation measures (page 3-51 of the biological assessment) that limit the amount and extent of disturbance, including no disturbance buffers that prevents or reduces the amount of sediment that reaches a stream. If sediment does reach a stream or river, the effects will be consistent with those described in Table 6 above.

BPA describes how projects they review and fund under their HIP 4 program will use herbicides in river systems (pages 3-51 to 3-59 of the biological assessment), and describes the effects of herbicide use in this context (page 4-103 to 4-111 of the biological assessment, plus Appendix B Detailed Environmental Fate and Risk Assessment for Herbicide Use and Appendix C Analysis of Effects for Herbicide Use in the Lower Columbia Estuary). Aerial application of herbicides is not proposed by BPA.

NMFS has previously analyzed the effects of these activities using the similar active ingredients and project design criteria for proposed USDA Forest Service and USDOI Bureau of Land Management invasive plant control programs (NMFS 2010a; 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 and updated using the best available information. Each type of treatment is likely to affect fish and riparian vegetation through a combination of physical, chemical, and biological endpoints, including disturbance, chemical toxicity, dissolved oxygen and nutrients, water temperature, sediment, instream habitat structure, forage, and riparian and emergent vegetation (Table 7).

Table 7. Potential types of stressors for activities associated with invasive and non-native plan control.

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

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

Mechanical and herbicide treatments of invasive plants in riparian areas are not likely to result in disturbance to or displacement of ESA-listed fish because no treatments will be applied within the stream channel. 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 riparian 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.

BPA proposes three different types of herbicide applications: 1) manage vegetation using herbicides in river systems; 2) manage vegetation using herbicides in estuarine systems;

and 3) using herbicides to manage invasive water primrose (*Ludwigia hexapetala*) in the Willamette River basin. We address the effects of each separately below.

The effects of managing vegetation using herbicides in river systems

It is helpful to understand how herbicides were applied with HIP III because this informs the extent of herbicide use that is likely to occur in the future. Table 8 describes the acres of herbicide applied each year under HIP III. This type of treatment does not allow any application of herbicide within the wetted channel.

Table 8. Acres of herbicide applied per year under BPA's HIP III. Riparian application of herbicide is any application within 300 feet of a stream or river channel.

YEAR	RIPARIAN ACRES	
2013	409	2482
2014	449	8282
2015	715	7399
2016	836	8940
2017	831	5561
2018	548	2485

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) accidental application within perennial stream channels (e.g., via drift); and (3) runoff from intermittent stream channels and ditches. Each of these could occur via surface water or groundwater.

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 TEA, as well as many other herbicides and pesticides, are detected frequently in freshwater habitats within the action area (NMFS 2011c).

Several conservation measures 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. BPA proposed action requires the use of these conservation measures.

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, and is not a component of the proposed action. Accidental contamination of surface waters can occur when irrigation ditches are sprayed with herbicides or when no-application 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 minimum buffer BPA has proposed for ground-based broadcast application is 100 feet, and the minimum buffer with a backpack sprayer is 15 feet (aerial application is not included in the proposed action). For some herbicides, BPA has proposed hand application techniques that are applied to a specific portion of the target plant (herbicide does not touch the soil). These restrictions limit the opportunity for 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 (with hand application techniques). Any juvenile fish in the margins of those streams are more likely to be exposed to herbicides as a result of overspray (highly unlikely to occur with hand application only within the buffer), 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 and restrictions on application method.

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 (DiTomaso 1997). 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. Proposed conservation measures 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 conservation measures minimize this danger by restricting the formulas used and staging areas, and the time, place and manner of their application to minimize offsite movement.

Herbicide toxicity. Herbicides included in this restoration program were selected due to their low to moderate aquatic toxicity to listed salmonids compared to those with higher risk. The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is mitigated by reducing stream delivery potential to waterbodies by restricting application methods. Near wetted stream channels, BPA proposes to allow nine aquatic labeled herbicides applied using only hand application methods (wicking/wiping/injection). BPA will allow other herbicide formulations (see Table 8 of the biological assessment for the list) and other application methods (backpack sprayer, broadcast application using truck or ATV) with no-application buffers varying from 15 feet to 100 feet. 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 are available from studies focused specifically on the listed species in this opinion. This leads to uncertainty in risk assessment analyses. Environmental stressors (e.g., high temperatures) and other chemicals that co-occur with the applied herbicide (known as environmental mixtures) can 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 rainbow trout, a salmonid, is frequently used in standard toxicity tests and serves as a good surrogate for other ESA-listed salmonids. 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 project design criteria and conservation measures will minimize the risk of drift and contamination of surface and ground water, any 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 may 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.

In Appendix B of the biological assessment, BPA analyzed the aquatic toxicity of all herbicides proposed for use in HIP 4. Adverse effect threshold values for each species group were defined as either 1/20th of the LC50 value for listed salmonids, or the lowest acute or chronic "no observable effect concentration," whichever was lower. BPA calculated a risk quotient (RQ) from a no adverse effect level divided by an Expected Environmental Concentration (EEC). The EEC is derived from a direct application of the active ingredient to a one-acre pond that is one foot deep, using the maximum application rate BPA is proposing to use. BPA also developed generic estimated environmental concentrations (GEEC) for all herbicides using EPA's GENEEC modeling software; GENEEC simulates an application of herbicide near a water body. The GEEC (or EEC) is an extreme level that is unlikely to occur during implementation (because of conservation measures) and should be viewed as a worst-case situation. If a RQ is greater than 10, then the risk to an individual fish is low. If the RQ is less than 1, then the risk to an individual fish is high. For more information on input values and assumptions that BPA used in their assessment, refer to Appendix B of the biological assessment.

Table 9 summarizes the risk quotient and level of concern calculated by BPA for the herbicides they propose to use. These data were taken from Table B-2 of the biological assessment; we only include data for herbicides that are proposed for use within 300 feet of a waterbody or have a viable pathway to reach a riparian area (e.g., slope).

Table 9. The risk quotient (RQ) and level of concern for herbicides proposes for use in riparian areas of restoration projects. A low level of concern is for active ingredients with a RQ greater than 10. A moderate level of concern is for active ingredients with a RQ between 1 and 10.

ACTIVE INGREDIENT	RISK QUOTIENT	LEVEL OF CONCERN
2,4-D (amine)	34.6	Low
Aminopyralid	417	Low
Chlorsulfuron	240	Low
Clethodim	6.43	Moderate
Clopyralid	47.3	Low
Dicamba	3.3	Moderate
Glyphosate1 (aquatic)	214	Low
Glophosate 2	7.9	Moderate
Imazapic	714	Low
Imazapyr	110	Low
Metsulfuron	163	Low
Picloram	3.5	Moderate
Sethoxydim	3.5	Moderate
Sulfometuron	321.7	Low
Triclopyr (TEA)	75.5	Low

Most toxicity experiments evaluate mortality to the tested population, whereas NMFS is interested in whether an individual ESA-listed fish's fitness is compromised. As well, 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 sometimes 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. These factors contribute to uncertainty in our understanding of effects of herbicide use on ESA-listed fish. Below is a description of the known toxicity of herbicides proposed for use.

2,4-D amine. 2,4-D amine acts as a growth-regulating hormone on broad-leaf plants, being absorbed by leaves, stems and roots, and accumulating in a plant's growing tips. EPA analyzed the risk of 2,4-D to ESA-listed fish species in the Pacific Northwest (Borges et al. 2004). They concluded that the use of this herbicide (when used according to its label, in the amine form) posed no direct risk to listed salmon and steelhead. They found, however, there could be an indirect risk when used for aquatic weed control (not a use approved by BPA) because of a loss of cover in rearing habitat. In their analysis, BPA reports results of various lab studies looking at the response of various life stages of fish, including Chinook salmon. While they note various LC50 concentrations, they note that most of the potential sub-lethal effects from exposure to 2,4-D amine have not been investigated with respect to endpoints that are considered import to the overall fish of salmonids. Exposure to 2,4-D has been reported to cause changes in schooling behavior, red blood cells, reduced growth, impaired ability to capture prey, and physiological stress (Gomez 1998, Cox 1999). Sublethal effects include a reduction in the ability of rainbow trout to capture food (Cox 1999). 2,4-D can combine with other pesticides and have a synergistic effect, resulting in increased toxicity. NMFS (2011d) consulted with USEPA on the effects of 2,4-D on listed Pacific salmonids. NMFS concluded that ESP's registration of 2,4-D will jeopardize all species considered in the consultation, and will adversely modify critical habitat for UWR Chinook salmon and UWR steelhead, and three species in California not included in this consultation. As a reasonable and prudent alternative (RPA), NMFS (2011d) restricted the use of 2,4-D during windy conditions (to minimize drift) and did not allow the use of the ester form when applied to water with listed salmonids. The use of the ester formulation is not part of BPA's proposed action, and BPA has imposed restrictions during windy conditions consistent with the RPA.

If an applicant uses 2,4 D amine, BPA requires a 15-feet buffer when hand applied, and a 50-foot buffer when it is applied using a backpack sprayer. These buffers are designed to prevent 2-4-D amine from reaching a waterbody. The risk of exposure to ESA-listed salmon and steelhead is very low.

Aminopyralid. This is a relatively new selective herbicide first registered for use in 2005. It is used to control broadleaf weeds, and is from the same family of herbicides as clopyralid, picloram and triclpyr. BPA proposes to use aminopyralid for the selective control of broadleaf weeds.

Aminopyralid shows moderate mobility through the soil, but it does not bioconcentrate in the food web. The primary means of exposure for fish and aquatic invertebrates is through direct contact with contaminated surface waters. Acute toxicity tests show aminopyralid to be practically non-toxic, with aquatic invertebrates showing more sensitivity. Thus, if aminopyralid does end up in surface waters, the most likely pathway of effect for salmon and steelhead is through loss of prey.

Chlorsulfuron. This herbicide is used to control broadleaf weeds and some annual grasses. Chlorsulfuron is readily absorbed from the soil by plants. This herbicide does not bioaccumulate in fish. The EPA Fact Sheet from 2005 states that chlorsulfuron is practically nontoxic to both freshwater and estuarine/marine fish on an acute exposure basis and is slightly toxic to estuarine/marine invertebrates. However, they offer no data or studies to support this finding. The only aquatic toxicity information BPA found indicates than less than 50 percent of rainbow trout and daphnia died when trout were exposed to 250 mg/L for 96 hours, and daphnia were exposed to 370 mg/L for 48 hours (Ahrens 1994). No information is available on sublethal effects. BPA calculated a hazard quotient of 240, indicated a low level of concern. The conservation measures (including buffers and application methods) greatly minimize the risk of exposure to listed fish and their prey species.

Clethodim. Clethodim is a post emergence herbicide for control of annual and perennial grasses, and is applied as a ground broadcast spray or as a spot or localized spray. BPA is proposing to use it to control grasses in areas where they are affecting growth of desirable woody vegetation. It works for this application because it is selectively toxic to plants, affecting only grass species. BPA is not allowing it for broadcast application; it is allowed for hand application and backpack sprayer, both with a 50-foot buffer.

Based on the calculated HQ, clethodim is of moderate concern. It is slightly toxic to fish and aquatic invertebrate species. According to the EXTOXNET website, under likely conditions of use, it is unlikely to pose a hazard to aquatic species. The buffers and application methods, plus other conservation measures, are highly likely to prevent clethodim from reaching the aquatic environment.

Clopyralid. Clopyralid is a relatively new and very selective herbicide. It is toxic to some members of only three plant families. It is very effective against knapweeds, hawkweeds and Canada thistle. Clopyralid does not bind tightly to soil, and thus would seem to have a high potential for leaching. That potential is functionally reduced by the relatively rapid degradation of clopyralid in soil. It is one of the few herbicides that BPA proposes to allow up to the waterline (for hand application), but requires a 100-foot buffer for broadcast application. BPA only allows for one treatment per year.

Clopyralid has a very low level of toxic risk to aquatic species based on field studies and the calculated HQ is 47.3 suggesting low potential for toxicity. Most of the potential sub-lethal effects from exposure to clopyralid have not been investigated, but it shows little tendency to bio accumulate and does not have long-term persistence in food chains.

Dicamba. BPA proposes to use dicamba to control broadleaf weeds, brush and vines using any of the three application methods including up to the waterline using hand application methods. Leaves and roots absorb dicamba and it moves through the plant.

The U.S. Forest Service recommends special precautions for application of dicamba (USFS 2001). It should be applied during active plant growth periods, with spot and basal bark periodic application during dormancy. It does not bind to soil particles, and microbes appear to be the primary source of chemical breakdown in soil. The HQ calculated by BPA is 3.3, with an associated moderate level of concern.

Dicamba is categorized by EPA as slightly toxic to fish and practically non-toxic to aquatic organisms. EPA states that despite this categorization, studies have reported different results. One study found no effects on yearling coho salmon at concentrations up to 100 ppm, but another study of yearling coho salmon found they were killed by a quarter of that dose during a seawater challenge test that simulated their migration from river to ocean (Cox 1994). Little is known about sublethal effects on fish. It is a moderately persistent herbicide and highly mobile in soils, and is a likely groundwater contaminant. Dicamba has been the subject of recent lawsuits because of crop damage caused by drift of Dicamba, with recent science showing the Dicamba is subject to drift even in stable air applications (Bish et al. 2019).

Because of its potential for toxicity and application methods, there is a risk of exposure and sub-lethal response from salmon and steelhead, particularly juvenile salmonids in shallow habitats adjacent to treatment areas.

Glyphosate 1 (aquatic). Glyphosate is a nonselective herbicide used to control grasses and herbaceous plants; it is the most commonly used herbicide in the world. It is moderately persistent in soil, with an estimated average half-life of 47 days (range 1-174 days). Glyphosate is relatively non-toxic for fish. There is a low potential for the compound to build up in the tissues of aquatic invertebrates. In resident freshwater fish, toxicity appears to increase with increasing temperature and pH.

The U.S. Forest Service and Bureau of Land Management looked at the exposure of ESA-listed fish from the treatment of emergent knotweed with glyphosate. They looked at three pathways: overspray, foliar wash-off and leakage from stem injections. They found that potential for exposure varied with application rates, and that there was a potential for adverse effects at the higher application rate with all three application methods. They concluded, however, that adverse effects were not likely to occur with the stem injection methods because only a few milliliters of glyphosate would be injected per stem, and it is unlikely that enough stems would be broken to result is instream concentrations exceeding the salmonid effects threshold.

Imazapic. Imazapic is used to control grasses, broadleaves, vines, and for turf height suppression in non-cropland areas. BPA proposes to use imazapic in noxious weed control and rights-of-way management. BPA proposes to allow its use up to the waterline with hand injection methods, and 15-foot buffers for backpack sprayer application, and 100-foot buffers for broadcast application.

Imazapic has an average half-life of 120 days in soil, is rapidly degraded by sunlight in aqueous solutions, but is not registered for use in aquatic systems. Even though BPA reports a hazard quotient of 714 (low level of concern), Tu et al. (2001) reports that it is moderately toxic to fish. They do say that its rapid degradation in water renders it relatively safe to aquatic animals, and they also note that there is no potential for the herbicide to move from soils with surface water. Thus, the likelihood of imazapic exposure to ESA-listed salmon and steelhead is very low.

Imazapyr. Imazapyr is used to control a variety of grasses, broadleaf weeds, vines and brush species. BPA proposes four different formulations for use. The persistence and movement of Imazapyr in soil is highly complex and differs substantially depending of site-specific factors. Further, imazapyr has only been tested in a limited number of species and conditions. The best available data support no adverse effects on animals.

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 buffers and conservation measures are likely to be sufficient to keep imazapyr out of the water.

Metsulfuron methyl. BPA proposes to use the Escort formulation. It is used to control brush and certain woody plants, broadleaf weeds and annual grasses. It is active in soil and is absorbed from the soil by plants. Metsulfuron dissolves easily in water, and has the potential to contaminate groundwater at very low concentrations. It has a half-life in water, when exposed to sunlight, of 1 to 8 days. Metsulfuron does not bioaccumulate in fish, and EPA considers it to be practically nontoxic to fish. The biological cites studies of sublethal effects to early life stages of rainbow trout. Aquatic invertebrates do not appear to be sensitive to this herbicide.

BPA calculate the HQ to be 163 (low level of concern). At proposed application rates and conservation measures, it is unlikely to cause sublethal effects in any exposed salmonids.

Picloram. This is a restricted-use pesticide labeled for non-cropland forestry, rangeland, right-of-way, and roadside weed control. It is a growth inhibitor and is used to control a variety of broadleaf weed species. It is absorbed through the leaves and roots, and accumulates in new growth.

Picloram does not bind strongly with soil particles and is not degraded rapidly in the environment, allowing it to be highly mobile and persistent (half-life of picloram in soils can range from one month to several years). Picloram is not highly toxic to birds, mammals and aquatic species, but because of the persistence of picloram in the environment, chronic exposure is a concern (Tu et al. 2001). Picloram does not volatilize readily although the potential to volatize increases with increasing temperature and soil moisture, and decreasing clay and organic matter content. Picloram is readily degraded when exposed to sunlight in water or on the surface of plant foliage and soils. Because picloram is water-soluble and does not bind strongly to soil, it is capable of moving into local waterways through surface and subsurface runoff (Michael et al.

1989). The extent to which it enters a waterway depends largely on the type of soil, rates of application, rainfall received post-application, and distance from point of application to nearest waterbody or groundwater. Once in the water, picloram may be degraded through photolysis, especially in clear and moving water, with a half-life of two to three days (Woodburn et al. (1989).

Picloram is slightly too moderately toxic to aquatic species (EXTOXNET 1996). The HQ of 3.5 calculated by BPA corroborates this. Mayes et al. (1987) evaluated the toxicity of picloram to rainbow trout life stages and concluded that it is not an acute or chronic hazard to aquatic species when used as directed. 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=3.5) 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. Conservation measures designed to eliminate or minimize the opportunity for exposure are very important, and for picloram, the potential for chronic exposure is most worrisome.

Sethoxydim. This herbicide is a selective post-emergence pesticide for control of annual and perennial grasses. Its mode of action is lipid biosynthesis inhibition. In 2005, USEPA (2005) found that sethoxydim is unlikely to contaminate ground or surface waters because it is not persistent under most conditions. It has a half-life of less than one day. However, transformation products may be persistent and mobile enough to be a threat to water resources. BPA calculated the HQ to be 3.5, a moderate risk of concern. EPA reports no concerns with respect to acute responses for fish and aquatic invertebrates, and that chronic risks for estuarine fish and invertebrates are below the EPA's level of concern. As of that date, they had no data to conduct a risk assessment for freshwater fish and invertebrates. However, some formulations use naphthalene; this increases the acute risk to aquatic animals from the use of sethoxydim formulated with this petroleum solvent that may be in fact attributable to the solvent. BPA proposes to use the POAST formulation that contains naphthalene. They confirm (in Appendix B of the biological assessment) the lack of any chronic toxicity studies on freshwater fish or invertebrates.

Project design criteria and conservation measures sharply reduce the risk of exposure. BPA imposes a 50 foot no-application buffer for both spot spraying and hand application, and a 100-foot buffer for broadcast application. Other measures for wind speed, weather, etc., also reduce the risk of exposure. Thus the risk of acute or chronic exposure to sethoxydim is low.

Sulfometuron-methyl. At proposed application rates, sulfometuron methyl is highly toxic to seedlings of several broadleaves and grasses. However, the HQ calculated by BPA is 321.7, indicating a low level of concern for aquatic toxicity. A review of potential lethal effects of the active ingredient on aquatic species including rainbow trout found no effects. There are no data available on the potential sub-lethal effects on fish. Similarly, sulfometuron methyl does not appear to kill daphnia. There is potential for adverse effects in sensitive aquatic macrophytes and algal species; a slight decrease in forage availability for juvenile salmonids may result from adverse effects to aquatic macrophytes in some areas. Sulfometuron methyl shows little tendency to bio-accumulate and does not have long-term persistence in food chains. BPA posits that no chronic exposure would occur because the herbicide degrades relatively rapidly.

Based on the calculated HQ and the proposed conservation measures, the risk of exposure to concentrations that result in acute lethal effects or chronic effects is low. However, there is potential for sublethal effects if conservation measures, including buffers, are not adhered too.

Triclopyr (TEA). The environmental fate of triclopyr has been studied extensively. This formulation of triclopyr is not highly mobile, although soil adsorption decreases with decreasing organic matter and increasing pH (Pusino et al. 1994). Similarly, the toxicity of triclopyr to fish and their prey is relatively well characterized. BPA calculated at HQ of 75.5, indicating a low level of concern. In the biological assessment, Appendix B Table B-3., Wan et al (1987) present 96-hour LC 50 values for Garlon 3A (triclopyr TEA) for Chinook Salmon, coho salmon, chum salmon , sockeye salmon and rainbow trout based on bioassays. These data showed relatively low toxicity for all species compared to different formulations. 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. NMFS's (2011) no-jeopardy consultation on USEPA's registration of triclopyr only considered the BEE formulation, not the TEA formulation proposed for use by BPA.

Adjuvants. BPA proposes to allow three categories of surfactants: colorants, surfactants and drift retardants (refer to Table 10) for the list. These are included in the typical application rates for invasive plant control. BPA developed generic estimated environmental concentrations (GEEC2) for the adjuvants where data were available. In addition, NMFS found LC50 data for a surrogate fish species and *Daphnia* (prey) (refer to Table 10).

Table 10. The acute toxicity to rainbow trout and Daphnia for the adjuvants that BPA proposes to use in their restoration projects. ND indicates no data available. Some numbers come from Table B-4 of the biological assessment, others come from the primary literature (refer to Appendix B of the biological assessment).

Adjuvant		Acute toxicity to rainbow trout (mg/L LC50, 96 hrs)	Acute toxicity to *Daphnia* spp. (mg/L LC50), 48 hrs)	BPA calculated level of concern
Colorant	Dynamark™ U.V. (red)	ND	ND	
	Aquamark™ Blue	ND	ND	
	Dynamark™ UV (blu)	ND	ND	
	Hi-Light® (blu)	ND	ND	
Surfactants	Activator 90®	12.7 (guppy)	ND	Moderate
	Agri-Dex®	271->1000	377	Low
	Bond®	190	614	
	Competitor®	95	>100	
	Entry II®	4.2	ND	High
	Hasten®	73.8	ND	Low
	LI 700®	130	170	Moderate
	Liberate®	18	9	
	R-11®	4-5.6	19	Moderate

Adjuvant		Acute toxicity to rainbow trout (mg/L LC50, 96 hrs)	Acute toxicity to *Daphnia* spp. (mg/L LC50), 48 hrs)	BPA calculated level of concern
	Super Spread MSO®	53	ND	Low
	Syl-Tac®	18-29.7	ND	Moderate
Drift Retardants	41-A®	1000	ND	Low
	Valid®	10	ND	Moderate
	Compadre®	ND	ND	

BPA proposes to use four different color markers. We could not do a risk assessment because no aquatic risk data are available. For riparian areas, the available colorants are agriculturally registered, food grade, colorants. BPA says the amount of colorants used is very small and highly unlikely to cause toxicity.

BPA proposes to use 11 surfactants. Despite increased scrutiny and concern over recent years, there is still a lack of data to evaluate their toxicity, particularly for effects to prey species (aquatic invertebrates). Based on weight of evidence, surfactants with a low level of concern or LC50>50, are unlikely to result in acute or chronic effects to listed species if applied consistently with proposed conservation measures. Our greater concern is with the use of R-11 and Entry II where the risk of adverse effects (injury or death) to ESA-listed salmon and steelhead is greater.

BPA proposes to use three drift retardants to control (maximize) droplet size during spraying operations. Little data are available for these three adjuvants. BPA reports that risk with 41-A is low and the risk is moderate with Valid. Since drift retardants are only used with spray applications, the minimum buffer with their use is 15 feet. Based on these limited data, the potential for adverse effects is greatest with Valid and Compadre.

For the most part, the discussion above looked at acute and chronic response to exposure to a single chemical. The complexity of the real world, including exposure to multiple stressors (including other chemicals or high temperatures) and sublethal responses, will increase the likelihood to adverse reactions resulting in reduced survival over the long term. Sub-lethal effects can occur at levels substantially lower than lethal effects.

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 project design criteria (including all conservation measures) include limitations on the herbicides, adjuvants, carriers, handling procedures, application methods, drift minimization measures, and riparian buffers. These are limiting thresholds 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. In their biological assessment, BPA concluded, that even when used according to the EPA label and the proposed conservation measures, herbicides are reasonably likely to reach streams with listed fish. This is because of the uncertainty associated with the effectiveness of the conservation measures. BPA asserts that there may be some sub-lethal effects to listed fish as a result of herbicide and adjuvant exposure. It is reasonable to expect that effects will include direct and indirect mortality, and increase or decrease in growth, changes in reproductive behavior, reduction in number of eggs produced, developmental abnormalities, reduction in ability to osmoregulate or adapt to salinity gradients, reduced ability to respond to stressors, etc. Stream margins, adjacent to areas treated with herbicides, have the greatest potential for exposure to herbicides.

Lower exposures are likely when the treatment area is small, further from the stream, when intermittent channels or ditches are not completely treated, or when rainfall occurs more than 24 hours after application. BPA proposes to uses some formulas of herbicide within the bankfull elevation of stream, in some cases up to the water's edge. Any juvenile fish in the margins of those streams may 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.

BPA asserts that the herbicides were selected for their low to moderate aquatic toxicity to listed salmonids and their prey species, and the risk is mitigated by reducing the stream delivery potential. Only aquatic labeled formulations will be applied within wet stream channels. Other restrictions apply, and the associated application methods were selected for their low risk of introducing herbicides to streams. Based on previously analyses (e.g., NMFS 2012) and information presented in the biological assessment, adverse effects may occur in stressed populations of fish as a result of the application of herbicides, but it is less likely that effect would be observed in healthy populations.

Generally, herbicide active ingredients have only been tested on a limited number of species and mostly under laboratory conditions. Inferring risk to species from laboratory studies to how a species responds in a complex world is more uncertain. The risk analysis presented above and described in Appendix B of the biological assessment describes how safety factors were included in the risk calculations. However, inferring actual risk based on laboratory analyses leads to uncertainty in the 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. Given their longer residency in freshwater, juveniles have a greater likelihood of exposure. Under Hip I, Hip II and HIP III, herbicide application was the most commonly implemented activity category, with 409 to 836 riparian acres treated each year in the Columbia Basin under HIP III (2013-2018).

The design of the BPA's invasive plant control program, including herbicide treatment, is intended to improve habitat for ESA-listed salmon and steelhead by improving habitat quality at the reach scale by replacing invasive plants with native plants that improve the function of the riparian ecosystem. The short-term effect of herbicide application is an increased potential of herbicide (and adjuvant) exposure. The conservation measures are designed to limit the potential for exposure. If the conservation measures work as intended, no fish should be exposed to any herbicide or adjuvant. Realistically, the conservation measures may not be enough to prevent movement of herbicides (via drift, surface water, and groundwater) in all cases. Exposure is most problematic for chemicals that have an increased likelihood of a lethal or sub-lethal response in juveniles or adults exposed. These include herbicides such as Dicamba and Sethoxydim, and adjuvants such as R-11. For these chemicals, it is likely that individual juvenile and adult salmon and steelhead may respond with adverse effects.

The proposed action allows for combinations of herbicides to be applied throughout the action area. This creates the possibility of interactions when these herbicides mix. If mixing does occur, Choudhury et al. (2000) found that adverse effects are most likely to be additive, not synergistic, because mixtures with components that affect the same endpoint by the same mode of action, and behave similarly with respect to uptake, metabolism, distribution and elimination tend to follow a dose addition formula. NMFS agrees with BPA conclusion that even with an additive model, the risk to species is low because of the types of herbicides allowed and the conservation measures controlling their use.

In summary, the proposed conservation measures, including limitations on the herbicides, adjuvants, carriers, handling procedures, application methods, drift minimization measures, and riparian buffers, will greatly reduce the likelihood that significant amounts of herbicide will be transported to aquatic habitats, although some herbicides are still likely to enter streams through aerial draft, in association with eroded sediment in runoff, and dissolved in runoff, including runoff from intermittent streams and ditches. Some individual fish are likely to be negatively impacted as a consequence of that exposure. The long-term consequences of invasive, non-native plant control will depend on the success of follow-up management actions to exclude undesirable species from the action area, and establish a secure native plant community that supports suitable habitat for salmon and steelhead.

The effects of managing vegetation using herbicides in estuarine systems

The application of herbicides within tidally influenced areas of the Columbia River estuary is more restrictive than the application of herbicides in riparian areas. The rationale is that the type of projects being treated in the estuary have the potential to have greater risk of movement of herbicide (and adjuvants) into the water because of tidal inundation. BPA divides projects with herbicide application in the estuary into three categories based on risk. Low risk projects include projects where all applications of herbicides are in the uplands, more than 300 feet from the channel, and the project is able to comply with all conservation measures. Medium risk projects are projects that cannot comply with the conservation measures. And high-risk projects are projects that include the application of herbicides within the low marsh or high marsh in the estuary where inundation of water is likely.

For all medium and high-risk projects, BPA and project applicants will prepare a Herbicide Application Memo that meets the criteria outlined in the biological assessment. The memo will be submitted to the NMFS Branch Chief for the Lower Columbia area (NMFS Washington

Coast-Lower Columbia Branch) and the Branch Chief must agree that the project is within the scope of the analysis here. The Branch Chief may require additional conservation measures or restrictions to ensure the project is consistent with this analysis (the alternative is the project applicant and BPA can go through individual project consultation).

The two main goals of projects in this category is that they restore (or aid in the restoration) of estuarine habitat for ESA-listed fish, and the application methods severely limit the potential for chemicals to enter water. The goal is to prevent fish from being exposed to herbicides and adjuvants. The conservation measures do this by timing work so applications can occur in the dry, acreage limits, wind direction restrictions, and limiting the type of herbicides that can be used to the least toxic. In high marsh areas, herbicide application is limited to be between July to October. If the application must occur between November to July, only glyphosate and imazapyr shall be used with a minimum dry time of 4 hours prior to tidal inundation. In the low march, only glyphosate and imazapyr shall be used. Again the goal is to avoid exposure, but also limit the herbicides to the least toxic chemicals (see previous section for discussion of the aquatic toxicity of these herbicides). Refer to Table 10 for a description of the method of application, herbicides allowed, timing and acreage limit within in of the treatment areas. For example, in tidal flat areas, only hand application techniques are allowed, using glyphosate or imazapyr, with a limit of less than 2 acres treated per year. Only Hasten and Agri-dex surfactants are allowed within the estuary.

As stated above, the design of this activity category is intended to minimize the risk to ESA-listed salmon and steelhead by keeping the herbicides out of the water, and to restrict chemical use to the least toxic herbicides and adjuvants. If overspray occurs, or a small spill, effects to fish will be limited in scale to those immediately adjacent to the treatment area, and at most a few individual fish will experience sub-lethal effects, primarily reduced prey abundance. Species most affected are those that spend the most time in the estuary: LCR steelhead, LCR coho salmon, UWR Chinook salmon, LCR Chinook salmon, and MCR steelhead. These species spend extended time rearing as juveniles throughout the lower Columbia River. They exhibit stream type life histories (Fresh et al. 2005) and are most likely to spend time adjacent to treatment area.

The effects of using herbicides to manage invasive water primrose in the Willamette River basin

With HIP 4, BPA has proposed a new activity category to treat water primrose *(Ludwigia hexapetala)* within floodplain wetlands at a series of confluences of the mainstem Willamette River. The problematic species of *Ludwigia* are non-native and can be highly invasive. BPA has funded these projects in the past, and has done individual ESA consultations for each project in the past. The activity category has reached a place where the project components are standardized and project effects are predictable, hence their inclusion as an activity category in HIP 4. The activity will include one to four projects per year as part of the Willamette River Anchor Habitat program, each with an average size of 25 acres. The sites will be in one of the four target areas in the Willamette Basin.

The proposed action allows the use of glypohosate (aquatic formulation) only, with the surfactant Agri-Dex, and an application method requiring direct with the *Ludwigia* plant foliage. All efforts will be made to prevent the herbicide from contact the water. The application will be done by hand (either waders or a canoe) using the spot spray method. The projects will remove invasive *Ludwigia* from sloughs, side channels and wetlands (that are up to 100 acres), with repeat treatments up to three years. Herbicide treatment will only occur after trying mechanical removal. The purpose is to re-establish diverse and resilient floodplain plant communities. The long-term effect will be to improve habitat complexity, water quality and will reduce fragmentation of suitable refugia for UWR Chinook salmon and UWR steelhead.

BPA will consider all herbicide treatments of Ludwigia to be medium to high risk. BPA staff (or the project applicant) will prepare a Herbicide Application Memo for review by the NMFS branch chief to verify that all appropriate conservation measures are included and the project effects are consistent with effects described in this opinion.

We expect that this activity category will have some minor, short-term adverse effects, in addition to the long-term beneficial habitat effects. The adverse effects are reasonably certain to occur. During the proposed work period of summer and early fall, it is unlikely that these off-channel habitats will have UWR Chinook salmon or steelhead. These habitats will likely be too warm with low dissolved oxygen. Despite low water quality in late summer, these habitats do provide excellent rearing and refuge to out-migrating salmonid smolts from late-fall through spring. During this period, the habitats have an open hydrologic connection to the river, and temperature and dissolved oxygen are within a suitable range. The work to remove *Ludwigia* will further improve water quality.

Even though it is highly soluble in water, it has a low runoff potential because it is strongly adsorbed to most soil types. Microbial degradation appears to be the primary pathway for degradation. Vitalization is minimal. Although glyphosate has a low propensity for leaching, it can enter water bodies by overspray, drift and erosion of contaminated soil. Once in water, it is strongly adsorbed to suspended organic matter and is then broken down by microbes. The half-life of glyphosate in pond water ranges from 12 days to 10 weeks. Because of its propensity to adsorb to sediment, it can accumulate in the sediment or stream bottom.

The aquatic toxicity of glyphosate is discussed above. According to the EXOTOXNET website, glyphosate is considered relatively non-toxic to fish, and compared to other herbicides, is least likely to have any sub-lethal effects. It does not appear to affect prey resources. However, based on an old study, toxicity appears to increase significantly with temperature (USFWS 1980). More recent work by BLM and USFS looked at the potential for toxicity, assuming 25 percent overspray, by calculating hazard quotients for fish, aquatic invertebrates, algae and macrophytes. For salmonids, they calculated a low potential for toxicity.

The most likely scenario for exposure is overspray and accidental spills. Laetz et al (2014) notes that exposures to pesticide mixtures are the rule rather than the exception in most aquatic habitats and assessments based on individual chemicals are likely to underestimate actual risk where mixtures occur. Laetz et al. (2014) further assert that given the baseline of chemicals in the environment, and the little known effects of adjuvants, that it is likely that the addition of glyphosate may have behavioral and olfactory effects to UWR Chinook salmon and steelhead. These effects may make juveniles more vulnerable to predation, decreasing survival. We cannot rule out additional sub-lethal adverse effects because data are limited on the effect of real world exposures.

Conservation measures limit the potential for overspray and accidental spills. For example, spot spraying by hand, under calm conditions in a limited geography, greatly reduces the risk of drift. The time of year of application, also minimizes risk of exposure because juvenile fish are unlikely to be in these habitats because they tend to be too warm during late summer and early fall. Thus, in the unlikely event of exposure, a few individual juveniles UWR Chinook salmon and steelhead may experience behavioral effects.

2.5.6 Pile Removal

This activity category includes the removal of untreated and chemically treated wood pilings, piers, and boat docks. Construction and water quality impacts of removing piles were also analyzed in our assessment of construction impacts earlier in this document.

Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to nearshore dependent species. Removal will also restore impacted substrates because the presence of the structure prevents recovery of important freshwater, intertidal, and subtidal habitats.

During removal, sediments will be re-suspended because they are inevitably pulled up with, or attached to, the piles, fishing gear, vessels or other items. If sediment in the vicinity of the removed item is contaminated, or if the pile is creosote treated, those contaminants will be included with the re-suspended sediments, especially if a creosote-treated pile is damaged during removal. Due to the relatively small amount of sediment disturbed during pile removal, re-suspended sediment will be localized and temporary. The long-term effects of structure removal will be beneficial, including substrate recovery and reduction of resting areas for piscivorous birds, hiding habitat for aquatic predators such as largemouth bass, and, in the case of preservative-treated piles, a chronic source of contamination.

2.5.7 Road and Trail Erosion Control, Maintenance and Decommissioning

BPA proposes to fund projects that include activities that maintain or decommission roads and trails to eliminate or reduce erosion and mass-wasting hazards, and thus reduce the sedimentation potential to downslope habitats. The activities will also eliminate or reduce human access and use/disturbance-associated impacts, such as timber theft, disturbance to wildlife, road density, poaching, illegal dumping of waste, erosion of soils, particularly in sensitive areas such as riparian habitats or unstable zones. In the past, this activity category was implemented a handful of times per year. We expect that trend to continue with HIP 4.

There are short-term negative effects associated with this activity. The general effects associated with vegetation removal; compaction of soil; heavy equipment operation, site restoration, increase in turbidity and suspended sediments are discussed above in section 2.5.2. With the incorporation of conservation measures, the amount of sediment that enters a stream from this activity is expected to be small, infrequent, and of short duration. In general, these effects last for hours to days, and will not result in a decrease in substrate quality.

Some road maintenance activities may involve asphalt resurfacing; this can leach hydrocarbons, which can influence pH is runoff reaches a waterbody. Because routine maintenance will consist of small road segment patches applied during dry conditions, the risk of hydrocarbon leaching to streams is very low, and thus the potential to impact water quality is low. The conservation measures limit the opportunity for exposure. Asphalt application during wet periods would pose a greater risk and is not included in HIP 4.

Dust abatement is included in HIP 4. The materials used to control dust can negatively affect water quality if not applied consistently with the conservation measures. Further, the use of oil-based abatement products is not allowed with this program. The most common dust abatement materials include calcium chloride, magnesium chloride and ligninsufonates. With the required 25-foot application buffer, it is unlikely that these materials will enter a waterbody with ESA-listed fish. Thus the risk to water quality and listed species is low.

Sediment contribution from roads and trails is a major concern in many watersheds in the Columbia Basin. These activities will minimize the risk of catastrophic road failure, and mass wasting of soil into stream channels. Implementation will minimize the risk of more minor types of erosion and sediment delivery to channels. Severe erosion is almost inevitable if roads are not regularly maintained. Road obliteration and decommissioning will also benefit streams because nearly all sediment delivery from road surfaces should be eliminated from those areas. Long-term beneficial effects will result from these activities, including rehabilitation of hydrologic functions, reduced risk of washouts and landslides, and reduction of sediment delivery to streams. These projects will tend to rehabilitate habitat substrate and will restore passage when the fish barrier is caused by a road. Road decommissioning will also tend to rehabilitate hydrology by reducing peak flows and reducing the drainage network. Watershed condition will improve as road densities are reduced and riparian reserves are rehabilitated. They may also improve floodplain connectivity.

2.5.8 In-channel Nutrient Enrichment

BPA proposes to fund projects that place salmon carcasses, processed fish cakes or inorganic fertilizers into stream channels. Although HIP has included this activity category in the past, the first project in this category was not funded until 2018. In-channel nutrient supplementation may introduce piscine diseases into streams, and the chemicals specifically used to control those diseases. Other concerns include causing eutrophic conditions in downstream waterbodies, altering the dynamic equilibrium of a functioning ecosystem, supplying nutrients at a time of the year when they are not available to the fish, or introducing excess nutrients or toxic substances to streams (Compton et al. 2006).

BPA proposes to minimize the potential for adverse effects by only using fish carcasses that are certified as disease free by WDFW. BPA will not add nutrients to naturally oligotrophic systems, and will not allow the addition of nutrients to eutrophic systems where nutrient levels are unnaturally elevated. Carcass additions will occur during normal spawning periods, so some spawning activities could be temporarily interrupted by the addition activities. Qualified biologists will do the placement, and they will be careful to not disturb spawning behaviors.

The goal of this activity is to enhance primary and secondary productivity in streams, thus enhancing the prey based of ESA-listed fish (Reeves et al. 1991). If successful, the consequence will be increased growth of juvenile fish and increased survival, which contribute to improved productivity of affected populations. Studies in British Columbia have shown that adding inorganic fertilizers can increase salmonid production in oligotrophic streams (Slaney and Ward 1993).

Given the scale at which this activity is likely to be conducted, it may improve survival and productivity for a targeted population that has been shown to lack adequate prey. It is unlikely that the negative consequences discussed above will occur because of the conservation measures BPA has developed for this activity.

2.5.9 Irrigation and Water Delivery/Management Actions

BPA proposes to fund irrigation and water delivery projects whose purpose is to increase the amount of instream flow for fish and to restore or improve aquatic and riparian function to affected streams. This will be accomplished by promoting irrigation efficiencies, reducing water losses from evaporation and transpiration, and reducing diversions of water to allocated water rights. Construction and installation of these systems will require in-stream work and results in effects described in the general effects section 2.5.2. BPA commits to only funding projects that can demonstrate actual instream water savings.

The effects of these efficiencies and upgrades include the conservation of water instream for fish. Much less water is needed to irrigate crops via drip or sprinkler irrigation than via flood irrigation because less water is lost through evaporation, and because the application is more precise. The delivery can be controlled to meet the needs of the plant with less waste. The application of water via drip and sprinkler irrigation can also reduce the amount of soil erosion and nutrient and pesticide runoff that is normally associated with furrow irrigation systems (Ebbert and Kim 1998).

In addition, less water is needed to deliver irrigation water via pipeline or lined ditches and canals than via unlined open ditches or canals, since the conveyance losses are smaller. Pipelines also eliminate water losses via evaporation. The replacement of canals with pipes will reduce the amount of herbicides and fertilizers entering streams, as these substances can easily drain to streams through open ditch networks in agricultural fields.

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. These structures 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 greatest benefit of a restoration action based on removal of a water control structure will be minimizing adverse effects of an unplanned failure. Benefits are likely to include reducing the size of a contaminated sediment release, preventing an unplanned sediment pulse, controlling undesirable species, or ensuring fish passage around any remnant of the structure. Over the long-term, this activity category results in beneficial effects by reconnecting stream corridors, floodplains, and estuaries, reestablishing wetlands, improving aquatic organism passage, and restoring more natural channel and flow conditions. Removal of water control structures, such as a small dams, earthen embankments, subsurface drainage features, and gabions is likely to have significant local and landscape-level beneficial effects to processes related to sediment transport, energy flow, stream flow, and temperature (Poff and Hart 2002). These activities will maintain or increase the amount of instream flow for fish, and improve riparian complexity and processes. Improved flow, particularly in late summer when flows are typically the lowest, will improve juvenile survival, thus enhancing productivity at the reach scale.

2.5.10 Habitat, Hydrologic and Geomorphology Surveys

BPA is proposing to conduct these activities to collect information about habitat type, condition and impairment; species presence (direct observance only), abundance and habitat use; and conservation, protection and rehabilitation opportunities or effects. For the most part, the effect of these activities is very minor. There is likely to be minor tramping of vegetation during floodplain surveys. Snorkel surveys may startle individual fish, but this effect is short-lived and fish recover very quickly with no loss of fitness. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind rocks or vegetation. It is highly unlikely that fish will be injured. NMFS does not expect this activity category to result in effects to any populations in the action area.

2.5.11 Long-term Benefits to Salmonids and their Habitat

The implementation of many activities in the proposed action will have some minor, unavoidable, short-term adverse effects such as increased stream turbidity and riparian disturbance, to achieve more permanent habitat improvements. Conservation measures that are part of the proposed action will reduce the scale and intensity of the adverse effects, but short-term effects are unavoidable. Most short-term adverse effects of the proposed activities would result from riparian or instream construction, fish handling when isolating inwater work sites, or application of chemical herbicides. This analysis first summarizes the long-term benefits to salmon and steelhead habitat from the proposed action, and then describes the short-term adverse effects.

The activities covered by this consultation are designed to restore and protect aquatic and riparian habitat and ecological processes associated with these habitats, with long-term benefits for ESA-listed species and their habitat. Projects that improve stream habitat conditions can lead to increased population abundance, productivity, spatial structure and diversity.

- Fish passage restoration (profile discontinuities and transportation infrastructure) projects will restore fish passage at human-made barriers, increasing access for all salmonid life stages to historical habitat or to habitat that is seasonally blocked. These activities have the potential to increase population spatial structure. Culvert replacement project will be designed to prevent streambank and roadbed erosion and facilitate natural sediment and wood movement.

- River, stream, floodplain, and wetland restoration. These projects will improve the complexity of habitat. These projects will restore and provide access to historic side-channel habitat and will increase floodplain function. Restoring side-channels will improve aquatic and riparian habitat diversity and complexity, reconnect stream channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, provide long-term nutrient storage, provide substrate for macroinvertebrates, moderate high flow disturbance, increase retention of organic material, and provide refuge for fish and other aquatic species when flows or temperatures are unsuitable in the main channel. Levee modification or removal can improve fish habitat, reduce erosion, improve water quality, reduce high flow velocities, enhance groundwater recharge, and reduce flooding in other sections of the river. These improvements in stream habitat can increase salmonid population productivity and abundance.

- 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 a few individual fish at the reach scale 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. These effects are expected to last hours to days. Over the long term, this activity category will benefit fish through improved habitat (reduced temperature, increased habitat complexity) that will likely result in improved survival.

- Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to nearshore dependent species. Removal will also restore impacted substrates because the presence of the structure prevents recovery of important freshwater, intertidal, and subtidal habitats.

- Road and trail erosion control, maintenance and decommissioning will address a major source of excess sediment inputs to streams for many watersheds. Road obliteration and decommissioning will benefit streams because nearly all sediment delivery from road surfaces should be eliminated from those areas. Long-term beneficial effects include rehabilitation of hydrologic functions, reduced risk of washouts and landslides, and reduction of sediment delivery to streams. These projects will tend to rehabilitate habitat substrate and will restore passage when a road causes the fish barrier. Road decommissioning will also tend to rehabilitate hydrology by reducing peak flows and reducing the drainage network. Watershed condition will improve as road densities are reduced and riparian reserves are rehabilitated. They may also improve floodplain connectivity.

- The goal of in-channel nutrient enrichment is to enhance primary and secondary productivity in streams, thus enhancing the prey based of ESA-listed fish. If successful, the consequence will be increased growth of juvenile fish and increased survival, which contribute to improved productivity of affected populations.

- Over the long term, irrigation and water delivery and management actions results in beneficial effects by reconnecting stream corridors, floodplains, and estuaries, reestablishing wetlands, improving aquatic organism passage, and restoring more natural channel and flow conditions. Removal of water control structures, such as a small dams, earthen embankments, subsurface drainage features, and gabions is likely to have significant local and landscape-level beneficial effects to processes related to sediment transport, energy flow, stream flow, and temperature. These activities will maintain or increase the amount of instream flow for fish, and improve riparian complexity and processes. Improved flow, particularly in late summer when flows are typically the lowest, will improve juvenile survival, thus enhancing productivity at the reach scale.

- Habitat, hydrologic and geomorphologic surveys support the restoration activities described above, and provide the capacity for adaptive management to like HIP 4 restoration projects to ESA-listed species survival and recovery.

2.5.12 Effects of the Action on ESA-Listed Salmon

The purpose of the proposed HIP 4 is to fund activities that improve fish and wildlife habitat. These activities will have negative, short-term construction related effects, but will provide a net benefit to listed salmon and steelhead in the long term. Each individual project will be completed as proposed with full application of conservation measures. Each action, involving in or near water construction, 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 conservation measures 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 many of the activities are also reasonably certain to result in some degree of ecological recovery at the project site due to the of each activity category.

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 conservation measures that require work within the active channel to be isolated from that channel and completed in accordance with the state guidelines for timing of in-water work (with some minor allowance for work outside the window as long as effects are no greater than described here) to protect fish and wildlife resources. The state 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.

In general, the consequences can be ephemeral (instantaneous to hours) or short-term (days to months), or they can be 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 program 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. Multi-year projects are rare with HIP.

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 anticipated to occur under the HIP III is about 100 per year; with HIP III, project numbers ranged from 88 projects in 2017 to 106 projects in 2014. Most of these projects are in the Interior Columbia Recovery Domain, with 10-13 projects per year in the Willamette/Lower Columbia Recovery Domain. 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 low, whether those effects are adverse or beneficial.

Of the ESA-listed species considered in this opinion, only juvenile salmon and steelhead are likely to be captured during work area isolation. Adult salmon and steelhead 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. It is rare for adult fish to be captured during work area isolation.

Most direct, lethal effects of authorizing and carrying out the proposed actions are likely 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 64ºF, or if dissolved oxygen is below saturation. Conservation measures 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).

Table 11 describes the number of fish captured and killed during work area isolation (fish handling) each year under HIP III. Most projects requiring work area isolation have been in the Interior Columbia Recovery Domain. The large mortality in 2018 was a reflection of the addition of Oregon Department of Fish and Wildlife's (ODFW) maintenance of fish screens to HIP III. The number of fish handled each year was substantially less than the actual number of fish handled per year. This is because NMFS assumed that up to 150 projects per year would be funded by BPA under HIP III with 50 percent of these requiring in-water work. Only about two thirds of the estimated number of projects were actually implemented (although the 50 percent requiring in-water work was a reasonable assumption).

Table 11. The incidental take of ESA-listed salmon and steelhead in the Interior Columbia (IC) and Willamette/Lower Columbia recovery domains each year under HIP III. Data for 2019 are not available at this time.

Recovery Domain	Category	Take Limit/yr	2013	2014	2015	2016	2017	2018
IC	capture	5925	841	3593	3541	2435	2446	3282
IC	mortality	296	12	8	59	130	78	189
W/LC	capture	1200	0	0	0	0	0	26
W/LC	mortality	60	0	0	0	0	0	0

An estimate of the maximum effect that capture and release operations for projects authorized or completed under HIP 4 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 require work area isolation in a recovery domain each year
p = 100, *i.e.*, number of juveniles to be captured per project, based on HIP III data for site isolation
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 six adult-equivalent per year in any recovery domain for all species (Table 11) plus no more than 4 adults (3 from the Interior Columbia Recovery Domain, 1 from the Willamette =/Lower Columbia Recovery Domain. This is a tiny fraction of returning adults in all but the most imperiled populations.

Table 12. Number of salmon and steelhead affected, per year, by recovery domain.

Recovery Domain	**Estimated Maximum Number of Projects with In-Water Work (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)**
IC	60	6000	300	6
W/LC	15	1500	75	1
Total	75	7500	375	7

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.

The maximum total number of projects likely to be funded each year under HIP 4 is 150. Many of these projects will involve multiple activity categories. The project may be localized (e.g., culvert replacement), or much larger in scope (e.g., channel reconstruction). Because we do not want to limit the scope of large, beneficial restoration projects, we assume that all of the projects per year includes near or in-water work. Our experience with the types of projects likely to be funded under Hip 4 indicates that 300 feet of streambank/in-channel disturbance is a reasonable estimate for the extent of the area typically affected by an in-water or near-water activity. Based on these assumptions, 45,000 feet (8.5 miles) of streambank or in-channel area would be disturbed annually. This is a very small fraction of the number of stream miles in the Columbia Basin. It is important to note that, as discussed earlier, 150 is likely an overestimate of the number of project likely to be funded in any year. Also, most of the streambank and in-channel disturbance caused by construction will be temporary until the site is restored.

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).

The Action Agencies have been implementing tributary habitat improvement actions as part of mitigation for the CRS since 2007. These actions have been targeted toward addressing the limiting factors identified above, and include protecting and improving instream flow, improving habitat complexity, improving riparian area condition, reducing fish entrainment, and removing barriers to spawning and rearing habitat (BPA et al. 2020). Cumulative metrics for these action types for SR spring/summer Chinook salmon from the years 2007 to 2018 are shown in Table 13.

Table 13. Tributary habitat improvement metrics: SR spring/summer Chinook salmon, 2007 to 2018 (BPA et al. 2020).

Action Type*	**Amount completed**
Acre-feet/year of water protected (by efficiency improvements and water purchase/lease projects)	84,075
Riparian acres protected (by land purchases or conservation easements)	3,221

Action Type*	**Amount completed**
Riparian acres improved (to improve riparian habitat, such as planting native vegetation or control of noxious weeds)	6,651
Miles of enhanced or newly accessible habitat (by providing passage or removing barriers)	1,301
Miles of improved stream complexity (by adding wood or boulder structures or reconnecting existing habitat, such as side channels)	193
Miles protected (by land purchases or conservation easements)	184
Screens installed or addressed (for compliance with criteria or by elimination/consolidation of diversions)	85

*Several of these categories (acres protected, acres treated, miles of enhanced stream complexity, miles protected) also encompass actions directed at reducing sediment and reconnecting floodplains.

Available empirical evidence supports our view that these actions are improving tributary habitat capacity and productivity, and that fish are responding.

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 project funded under this program 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.

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 many independent populations within ESUs or DPSs. 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 populations (McElhany *et al.* 2000). Because the likely adverse effects of any project funded under this program will not adversely affect the VSP characteristics of any salmon or steelhead population, the proposed actions also will not have any measurable negative effect on species-level abundance, productivity, or ability to recover. In fact, if enough projects accrue in a watershed, we may see positive demographic responses by populations and ESUs/DPSs.

2.5.13 Effects of the Action on Critical Habitat

Completion of each restoration project is expected to have the following set of effects on the PBFs or habitat qualities essential to the conservation of each species. These effects will vary between projects because of differences in the scope of both construction and restoration at each, and the condition of PBFs at each site. The general, negative effects of construction activities are expected to last hours to days, and the beneficial effects are expected to last into the future. Actions or projects with more significant construction component are likely to have direct adverse effects to a larger area, and to take a longer time to recover, than actions based in restoration of a single habitat element. However, they are also likely to have correspondingly grater conservation benefits.

Essential habitat for listed salmonids includes summer and winter rearing areas, juvenile migration corridors, areas for growth and development to adulthood, and adult migration corridors, and spawning areas. Juvenile summer and winter rearing areas and spawning areas are often in small headwater streams and side channels, while juvenile migration corridors and adult migration corridors include tributaries, mainstem river reaches and estuarine areas. Growth and development to adulthood occurs primarily in near- and off-shore marine water, although final maturation takes place in freshwater tributaries when the adults return to spawn. Of these, the action area has been designated as essential for spawning and rearing, juvenile migration, and adult migration. The Pacific Ocean areas used by listed salmon for growth and development to adulthood are not well understood, and essential areas and features have not been identified for this life stage. The essential features of critical habitat for listed salmonids are substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, access and safe passage conditions.

Freshwater spawning sites

a. Water quantity. Ephemeral reduction due to construction effects including reduced riparian soil permeability, and riparian runoff; long-term improvement based on restoration actions targeting irrigation improvements, reconnection of side channels and alcoves, and improved riparian function and floodplain connectivity.
b. Water quality. Short-term increase in turbidity, dissolved oxygen demand, and temperature due to riparian and channel disturbance, and nutrient enrichment as a result of placement of carcasses in nutrient-poor streams. Water quality may be impaired by inputs of herbicides and fertilizers. Concentrations of herbicides in the stream depend on the rate of application, methodology and size of the receiving waterbody. Effects are likely to be short-term, with attenuation, dilution and thermal and microbial breakdown. While this is likely the most common type of restoration activity, the analysis conducted by BPA in Appendix B of the biological assessment indicates that the proposed conservations measures and buffers will keep herbicide concentrations in streams to nearly insignificant levels.
c. Substrate. Short-term reduction due to increased compaction and sedimentation, with a long-term improvement because of reduced sediment transport as a consequence of restoration activities designed to store sediment in the channels, increase channel complexity, and increase the shoreline length.

Freshwater rearing sites

a. Water quantity. As above. Improved irrigation efficiencies must show that in-stream flow will not be reduced.
b. Floodplain connectivity. Short-term negative impacts during construction, but significant long-term benefits as side channels and alcoves are reconnected, and riparian function improved.
c. Water quality. As above. Forage. Minor, short-term decreased at a local scale is expected due to construction effects (riparian and channel disturbance). In the long term, restoration activities will improve riparian function and reduce inputs of fine sediments. Secondary productivity is expected to increase because of nutrient enrichments, improvements in habitat diversity and complexity, riparian function and floodplain connectivity and leaf litter retention. If herbicides is expected; the scale of the effect would depend on the amount (concentration and length of time) of the herbicide in the water, but is expected to be short term.
d. Natural cover. Short-term decrease due to riparian and channel disturbance; long-term improvements as a consequence of restoration action to improve channel complexity, riparian function and off-channel and alcove habitats.

Freshwater migration corridors

a. Free passage. Short-term decrease due to in-water work isolation; long-term improvement due to restoration actions.
b. Water quantity. As above.
c. Water quality. As above.
d. Forage. As above.
e. Natural cover. As above.

Estuarine areas

a. Free passage. As above. Long-term improvements due to restoration of an estuarine transition zone; restoration of estuarine functions such as temperature, tidal currents and salinity; reduced number of sites for avian predators to rest and hunt; and removal of tide gates.
b. Water quality. As above.
c. Water quantity. As above.
d. Natural cover. As above. Long-term improvements due to shirt in vegetative community composition and distribution toward more native species including salt marsh species; reestablishment of cover in historical distributary channels; increase in riparian vegetation and habitat complexity; increase fish access for cover habitat in tributaries and floodplain habitats; and reduced filling of estuaries by fine sediment.
e. Juvenile forage. As above. Long-term improved foraging habitat abundance from reestablishing historical distributary channels that increase in size after tidal flows are allowed to inundate and scour twice a day; increased access into tributaries and floodplain habitats to forage.
f. Adult forage. Short-term decrease due to riparian and channel disturbance; long-term improvements due to restoration activities that improve habitat quality.

Nearshore marine areas. No effects are anticipated because no projects will be implemented in these areas.

Offshore marine areas. No effects are anticipated because no projects will be implemented in these areas.

The PBFs for ESA-listed salmon and steelhead affected by the proposed action include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. Each project, when implemented as proposed, is likely to have predictable short-term and long-term effects on critical habitat PBFs. The effects will vary depending on the scope of construction or project implementation and the current condition of the PBFs. This assumption is based on the fact that all of the actions are based on the same set of underlying restoration actions, and the PBFs and conservation needs identified for each species are very similar.

In general, construction-related effects will be ephemeral, lasting for hours to days. Long-term beneficial effects will last for months, years or longer. Most of the projects will be in the Interior Columbia recovery domain; fewer than 15 percent have been in the Willamette-Lower Columbia recovery domain in the past (Table 1). Again, based on past implementation of the program in the past, the number of projects is small compared to the total number of watershed within each recovery domain. BPA continues to fund HIP because of the program's expected improvements in ecosystem functions for aquatic and riparian habitat for ESA-listed salmon and steelhead. The frequency of disturbance will usually be limited to a single event or, at most, a few projects within the same watershed each year. Therefore, the temporary negative effects of PBFs will occur at the scale of the watershed. We expect long-term benefits under HIP 4 at the scale of the watershed. As restoration projects mature and riparian function improves, the habitat quality will increase and PBF function will accrue.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). 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.

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 environmental baseline (Section 2.4).

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 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 2010 and 2020, Oregon's population grew from 3.8 million to 4.3 million, an increase of 12 percent. Washington grew somewhat faster than Oregon, a 14 percent increase in the last ten years to a current population of 7.8 million. Whereas most of Oregon's population lives in the Willamette Valley, part of the Columbia Basin, Washington's most populous cities lie outside of the Columbia Basin. Population growth in Idaho has been similarly strong with 20 percent growth between 2010 and 2020[6], although the counties that provide habitat for listed salmonids average 0.8 percent growth (Idaho, Custer and Lemhi Counties). 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

[6] U.S. Census Bureau data accessed on March 29, 2020. https://www.census.gov/quickfacts/ID

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 large wood 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.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 Species

As described in the Status of the Species section (Section 2.2), individuals of many of the 13 ESA-listed salmon and steelhead species use the program action area to fully complete the migration, spawning and rearing parts of their life cycle. The status of each species addressed by this consultation varies considerably from very high risk (SR sockeye salmon) to moderate risk (MCR steelhead). Similarly, the individual populations affected by the proposed program vary considerably in their biological status. 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.

The environmental baseline varies across the program area, but habitat is generally degraded at sites where projects will occur. Climate change is likely to exacerbate several of the ongoing habitat issues, in particular, increased summer temperatures, and decreased summer flows in the freshwater environment, ocean acidification, and prey availability.

The design of HIP 4 is a crucial aspect of our analysis of the program. The HIP 4 activities and their associated conservation measures were developed and refined over time to ensure that environmental outcomes of each activity can be readily predicted. As described in the analysis of the effects of the action, the effects of the proposed activities primarily cause short-term, localized, and minor effects. These effects are mostly caused by in- and near-water construction that will extend from a few weeks to a year or two.

The location of HIP 4 projects will be spread across three states and two recovery domains. The geographic extent of short-term adverse effects from projects does not typically overlap. The short-term adverse effects of projects will bear on far too few individual fish 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.

Habitat restoration activities will result in long-term beneficial effects on habitat quality of listed fish. The number of habitat restoration actions varies year to year based on available funding, timing of project development, and the type of projects being funded (when a larger project is funded, fewer projects will be implemented). From the years 2014-2018, the fewest project implemented in any one year was 88, and the most was 106. These occurred in both recovery domains, although the majority of projects were in the Interior Columbia recovery domain. Although we cannot predict the benefit to productivity resulting from the restoration projects, the habitat benefits that began with the first HIP in 2007 are accruing and making a strategic difference in many reaches and watersheds. Projects are getting larger, and more aggressively targeting reach scale deficiencies in natural processes that also address limiting factors for affected populations. Specifically, floodplain reconnections and multi-thread channel systems are being restored in strategic reaches to benefit overwintering survival and summer growth. Practitioners are targeting reaches with the most potential to respond and where substantial proportions of those populations can actually benefit from the actions. Over time, we expect those benefits will result in reduced risk for many MPGs where habitat quality and access is limiting.

In summary, many projects carried out under HIP 4 will have short-term adverse effect. These effects will be experienced by too few individual fish to negatively influence the VSP parameters of any population. Restoration projects will result in a long-term improvement in habitat quality that will improve survival, productivity, spatial structure and diversity for targeted populations; these will reduce the risk for those MPGs over time. Further, these projects will increase the resilience of targeted populations to the negative effects of climate change. Thus, HIP 4 will not appreciably reduce the likelihood of survival and recovery of any of the 13 ESA-listed species addressed in this biological opinion.

2.7.2 Critical Habitat

Most of the HIP 4 projects sites in the action area are within designated critical habitat for ESA-listed salmon and steelhead. CHART teams determined that most designated critical habitat has a high conservation value, largely based on its potential for restoration.

Baseline conditions for critical habitat PBFs in the Interior Columbia and Willamette/Lower Columbia vary widely from poor to excellent. Climate change and human development have and continue to adversely impact critical habitat, and continue to be a crucial limiting factor and threat to the recovery of all 13 listed species addressed in this consultation. As described in the Environmental Baseline section, the habitat is not meeting all the biological requirements of individual fish at sites where HIP 4 projects will occur. This is due to one or more impaired aquatic habitat functions related to any of the habitat factors limiting recovery.

In the analysis of effects, we found that implementation of some projects will have short-term adverse effects on PBFs as the project scale. These sites will be widely dispersed in the two recovery domains. Measures to assure site restoration and project goals to assure habitat improvement will result in the long-term improvement in PBFs at the reach scale. These long-term effects are expected to extend for many years, and to accrue habitat benefits (and improved PBFs) as projects mature.

Thus we expect critical habitat quality and availability to improve over time as a result of projects carried out under HIP 4, as has been demonstrated with HIP, HIP II, and HIP III. We anticipate the conservation value for spawning, migration and rearing PBFs to improve at the reach or watershed scale, at a minimum. Thus, the proposed program is not likely to result in the appreciable reduction in the value of designated critical habitat as a whole for the conservation of the species addressed in this biological opinion.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead or SRB steelhead, or destroy or adversely modify designated critical habitat for these species.

2.9 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 actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). 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 ITS.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Projects authorized under HIP 4 will take place within or adjacent to aquatic habitats that are reasonably certain to be occupied by individuals of the 13 ESA-listed species considered in this opinion. 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 Columbia Basin streams or rivers.

Juvenile and a few adult fish will be captured during work area isolation necessary to minimize construction-related disturbance of streambank and channel areas. 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 potentially 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.

Herbicide applications, as constrained by the conservation measures, are reasonably to result in herbicide drift or movement into streams that will harm listed species.

This take will typically occur within an area that includes the streamside, channel, or estuary footprint of each project, and downstream for pathways that are caused by diminished water quality. Restoration projects that require two or more years of work (typically major channel reconstruction projects) 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 (and a few) adult fish during in-water work area isolation

NMFS anticipates the capture of juvenile and adult fish during in-water work area isolation, as described in Section 2.5.12. NMFS anticipates the capture of 7,500 juveniles (6000 juveniles in the Interior Recovery Domain, 1500 juveniles from the Willamette/Lower Columbia Recovery Domain), and the capture of up to 4 adults (3 from the Interior Columbia Recovery Domain and one from the Willamette/Lower Columbia Recovery Domain of the salmon and steelhead species considered in this consultation. This capture results in take even though the vast majority of the fish are likely to be release unharmed. 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 adverse effects). Therefore, the amount of take that is exempted under this Incidental Take Statement is the capture and handling of 7,500 juvenile salmonids (and 4 adults) and represented by recovery domains in Table 12 above.

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 both within and outside the action area. 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 an numerical level of habitat disturbance.

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. We estimate that a maximum of 150 projects will be implemented each year under HIP 4. 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 in 45,000 linear stream feet (8.5 miles) per year partitioned between recovery domains. This take indicator functions as an effective reinitiation trigger because it is 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.

The best available indicator for the extent of take caused due to construction-related disturbance in instream, riparian and upland areas is an increase in visible suspended sediment in the water column. 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 project 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. The extent of take will be exceeded if the turbidity plume generated by construction activities is visible above background levels, about a 10 percent 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 sources 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. The compliance point shall be measured/observed every four hours, and take is exceeded when activities continue to result in visible suspended sediment beyond two consecutive monitoring intervals.

Application of herbicides to control invasive and non-native plant species

Application of manual, mechanical or chemical plant controls will result in short-term reduction of vegetative cover, soil disturbance, and degradation of water quality, which 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 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., mass spectrometry) 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 herbicides as a simple and economical vegetation management 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 olfactory tests, do not correlate well with measured levels of the airborne pesticides. 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 riparian acres. To limit the potential negative effects from herbicide use while still allowing use of herbicides in this restoration program, NMFS limits BPA's take to 1,500 riparian acres of treatment each year. In BPA's 2018 Annual Monitoring Report for HIP III, BPA reported they treated an annual average of 628 riparian acres. Further, BPA reported no non-compliance cases for the herbicide program for the past two years, attributing this success to the experience and thorough training of BPA's restoration partners and their familiarity with the regulations. New invasive species management activities are proposed for HIP 4 in the estuary and the Willamette (*Ludwigia*), and therefore we expect the acreage being treated each year will increase. Thus, BPA shall reinitiate consultation if more than 1,500 riparian acres are treated in a calendar year under HIP 4.

In Summary, the best available indicators for amount and extent of take for the proposed action are described in Table 14 below.

Table 14. Extent of take indicators for actions authorized or carried out under HIP 4 by NMFS recovery domain. IC means Interior Columbia and WCL means Willamette/Lower Columbia. N is the estimated number of projects per year requiring work area isolation.

Extent of Take Indicator	Recovery Domain	
	IC (n=60)	WLC (n=15)
ESA-listed salmonids captured annually (number salvages)	6000	1500
Annual streambank alteration (linear feet)	36,000	9,000
Visible suspended sediment (turbidity	<10 percent increase in natural stream turbidity as measured at downstream compliance point (distance based on size of stream), or visible turbidity observed at downstream compliance point over two consecutive monitoring intervals	
Annual herbicide applications	1500 acres	

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of 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 HIP 4.

1. Minimize incidental take by ensuring all applicable conservation measures are fully implemented for projects implemented under HIP 4.
2. Minimize incidental take associated with invasive and non-native plant control activities.
3. Ensure the completion of a comprehensive monitoring and reporting program for all projects completed carried out under HIP 4, and for the program.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and BPA or any project sponsor or their contractor comply with them in order to implement the RPMs (50 CFR 402.14). BPA or any project sponsor 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 ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. BPA and their applicants shall follow each applicable project design element and conservation measure described in the biological assessment and approved version of the HIP 4 Handbook. This includes participating in project review teams for projects categorized as either medium or high risk.
    b. When dewatering a project site for work area isolation, dewater the site slowly to allow fish to better escape the work area.
    c. No variances shall be approved under HIP 4.
    d. BPA shall submit a project notification form to NMFS for each project to facilitate creation of an implementation record.
2. The following terms and conditions implement reasonable and prudent measure 2:
    a. BPA shall not allow the use of the adjuvants R-11 or Entry II for any project funded or authorized under HIP 4.
    b. BPA shall not allow any broadcast application of Dicamba (because of issues associated with drift) for any project funded or authorized under HIP 4.

c. For projects using herbicides in the Columbia River estuarine system and in the Willamette to treat *Ludwigia*, Herbicide Application Memos shall be required for every project until NMFS notifies BPA that they are no longer needed. This is to ensure that the risk of herbicides reaching water, and thus exposure to ESA-listed species, is greatly minimized.

3. The following terms and conditions implement reasonable and prudent measure 3:
   a. BPA will submit a monitoring report to NMFS by June 15th each year that describes BPA's efforts to implement HIP 4. The report shall include an assessment of program implementation and compliance, a map showing the location and type of each project (organized by recovery domain), compliance with conservation measures and terms and conditions, and the number, condition, and species of fish handled during work area isolation activities.
   b. BPA will host an annual coordination meeting with USFWS and NMFS by June 15th each year to discuss the annual monitoring report, compliance with the HIP 4 biological opinion, and any actions that will improve implementation and conservation for the program.

2.10 Reinitiation of Consultation

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

<u>2.11.1 Southern DPS of Green Sturgeon Determination</u>

On April 7, 2006, NMFS listed the Southern DPS of North American green sturgeon as a threatened species under the ESA (71 FR 17757, April 7, 2006). This determination was based on the fact that the Sacramento River basin contains the only known Southern DPS spawning population, information suggesting population decline, and habitat loss and degradation in the Sacramento River basin. Since the listing of the DPS, a number of habitat restoration actions within the Sacramento River basin have occurred, and spawning has been documented in the Feather and Yuba Rivers (Seesholtz et al. 2015; Beccio 2018). However, many significant threats have not been addressed. Currently, the majority of Southern DPS green sturgeon spawning occurs within a single reach of the mainstem Sacramento River, placing the species at increased risk of extinction due to stochastic events. NMFS completed a five-year review in 2015 (NMFS

2015b), and published a final recovery plan for this DPS in 2018 (NMFS 2018). NMFS is currently reviewing the status of this species.

Green sturgeon are broadly distributed in nearshore marine areas from Mexico to the Bering Sea. They are commonly observed in bays, estuaries, and sometimes the deep riverine mainstem in lower elevation reaches of non-natal rivers along the west coast of North America, including the lower Columbia River estuary. However, the distribution and timing of estuarine use are poorly understood (NMFS 2015b). Green sturgeon consist of two DPSs that co-occur throughout much of their range, but use different river systems for spawning. All naturally spawned populations of green sturgeon originating from coastal watersheds south of the Eel River in Humboldt County, California (known spawning populations are in the Sacramento River system) are considered part of the Southern DPS. The Northern DPS consists of populations originating from coastal watersheds north of, and including, the Eel River (known spawning populations in the Eel, Klamath, and Rogue Rivers). The Northern DPS is not listed as threatened or endangered, but is a NMFS Species of Concern.

No hatchery programs exist for the green sturgeon. Southern DPS green sturgeon are confirmed to occur in the Willamette/Lower Columbia, Oregon Coast, and Southern Oregon/Northern California Coasts recovery domains. In many Oregon coastal systems, inadequate data exists to confirm their presence, but presence has been established in Coos Bay, Winchester Bay (Umpqua River), Yaquina Bay, Nehalem Bay, and the Columbia River estuary (NMFS 2010b).

Research conducted and published since 2006 confirms and enhances our understanding of the biology and life history of Southern DPS green sturgeon, including reproductive characteristics. North American green sturgeon are thought to reach sexual maturity at about 15 years of age (Van Eenennaam et al. 2006), or a total length of 150–155 cm for Southern DPS individuals. They can live to be 70 years old. Unlike salmon, they can spawn several times during their long lives, returning to their natal rivers every three to four years (range two to six years; Brown 2007; Poytress et al. 2013). They are long-lived, late maturing, and spend substantial portions of their lives in marine and estuarine waters (NMFS 2010b).

During spawning runs, adult Southern DPS green sturgeon enter the San Francisco Bay between mid-February and early May before rapidly migrating up the Sacramento River to spawn. In fall, these post-spawn adults move back down the river and re-enter the ocean. After hatching, larvae and juveniles rear in their natal river or estuary before migrating to the ocean. As subadults and adults, Southern DPS green sturgeon migrate seasonally along the West Coast, congregating in bays and estuaries in Washington, Oregon, and California during the summer and fall months. During winter and spring months, they congregate off of northern Vancouver Island, B.C., Canada.

Green sturgeon likely inhabit estuarine waters to feed and optimize growth (Moser and Lindley 2007), and these habitats appear to be important to subadult and adult green sturgeon. Individual green sturgeon exhibit diel movements, using deeper water during the day and moving to shallower water during the night to feed. The movements of green sturgeon are likely influenced by feeding behavior, tidal stage, and possibly light conditions (NMFS 2010b). Little is known about green sturgeon diet in estuaries. Stomach sampling is challenging and most studies have depended on samples collected from specimens at the dock or processing plants where stomachs have been partially or completely empty. The best results are samples collected on the boat immediately after landing. Green sturgeon in Willapa Bay were found to feed primarily on benthic prey (e.g., Dungeness crab, crangonid shrimp, and thalassinid shrimp) and fish (Dumbauld et al. 2008). A very limited sample of green sturgeon stomachs in the Columbia River found mostly crangonid shrimp and some thalassinid shrimp (Dumbauld et al. 2008). The presence of these prey species suggests the sampled green sturgeon fed in the saline and brackish water reaches lower in the Columbia River estuary (downstream of approximately Columbia River mile 30) (NMFS 2010b, 2015b).

Climate change has the potential to impact Southern DPS green sturgeon in the future, but it is unclear how changing oceanic, nearshore and river conditions will affect the Southern DPS overall. In freshwater environments (e.g., Sacramento River system), water flow and temperature are important factors influencing green sturgeon spawning and recruitment success (NMFS 2015b). Changing ocean conditions could also impact Southern DPS green sturgeon since subadults and adults use ocean habitats for migration and potentially for feeding. Based on their use of coastal bay and estuarine habitats, subadults and adults can occupy habitats with a wide range of temperature, salinity, and dissolved oxygen levels, so predicting the impact of climate change in these environments is difficult (Kelly et al. 2007; Moser and Lindley 2007).

Proposed Action and Action Area
The proposed action is described in Section 1.3. The distribution of Southern DPS green sturgeon overlaps with the action area in the lower Columbia River below Bonneville Dam, including the estuary.

Action Agencies' Effects Determination
The Action Agencies determined that the proposed action is not likely to adversely affect Southern DPS green sturgeon or their designated critical habitat.

Effects of the Proposed Action - Species
The best available information indicates the action area is used only for feeding by adult Southern DPS green sturgeon. Hansel et al. (2017) describe areas in the lower Columbia River occupied by green sturgeon (they were not able to discern whether the fish were from the Northern or the listed Southern DPS) during 2010 and 2011 based on acoustic-tag detections between the mouth and river mile (RM) 23.5. The purpose of the study was to identify habitat use, arrival and departure timing, and the extent of upstream migration to help design dredging operations to minimize harm to green sturgeon. A total of nine green sturgeon were detected in 2010, and 10 in 2011. These fish entered the Columbia River during May through October in both years, with the highest numbers present in August and September. Only one green sturgeon was detected at the uppermost receiver station (RM 23.5)[7] and, overall, the number of fish detected decreased rapidly with distance from the estuary mouth. The residence times of fish that were only detected in the lower three miles of the river were generally were less than 24 hours; fish detected farther upriver had a median residence time greater than ten days. Green sturgeon were widely dispersed among channel and non- channel habitats in 2010; fish were more concentrated near the estuary mouth in 2011. Sensor tag data indicated that green sturgeon used a

[7] For reference, Bonneville Dam is at RM 146.1.

mix of habitats — the deep water south and north channel habitats (bottom depths ≥10 m), sandy shoals, shorelines, and bays (bottom depths <10 m).

The effects of the proposed action include:

- The proposed action will not exacerbate the potential negative effects caused by climate change, and may provide additional habitat that is resilient to climate effects. We find this pathway of effect to be neutral to positive.
- The construction of restoration sites in the lower Columbia River may result in short-term turbidity plumes no more than 300 feet downstream of a project site. Minor riparian and channel disturbance may cause a short-term degradation of water quality due to increased total suspended solids and dissolved oxygen demand. Based on data presented in Table 1, we expect no more than one or two projects (with in-water work) per year within the range of Southern DPS green sturgeon in the Columbia River. However, information from fisheries-dependent sampling suggests that Southern DPS green sturgeon only occupy large estuaries during the summer and early fall (Moser and Lindley 2007), and would not be present during the in-water work period of November 1 through February 28. Thus, it is highly unlikely that Southern DPS green sturgeon will be exposed to the effects from in-water construction of restoration projects. The effects of this effect pathway to Southern DPS green sturgeon are discountable.
- Application of herbicides to treat invasive plants in the estuary has the potential result in short-term declines in water quality adjacent to application areas. BPA states in the BA that herbicide application shall be limited to between July and October, which overlaps with the presence of Southern DPS sturgeon in the Columbia River. BPA also limits the type of herbicide used and application methods. BPA and NMFS will closely review all projects prior to project implementation to ensure that the projects are designed to minimize the risk of herbicides reaching the Columbia River. For aquatic herbicides (glyphosate and imazapyr), BPA proposes to time application in a manner that coincides with ebbing tides and apply the herbicide directly to the target plants. These application methods significantly reduce the risk of discharge of herbicides into tidal waters. If these herbicides do reach a waterway, they are expected to rapidly dissipate from the water column into the sediment or breakdown, depending on multiple abiotic factors. Off-target applications will be rapidly diluted as they move into the deeper waters of the Columbia River on ebb tide. The herbicides, adjuvants, and dyes proposed for use by this project in and near tidal waters are considered relatively non-toxic to fish and do not bioaccumulate in the tissues of aquatic organisms (Gardener and Grue 1996, Giesy et al. 2000). Therefore, NMFS does not expect adverse effects to Southern DPS green sturgeon with the application of these herbicides. Thus, the potential effects of herbicide application are expected to be insignificant to green sturgeon.

Effects of the Proposed Action - Critical Habitat

Designated critical habitat for Southern DPS green sturgeon includes the lower Columbia River estuary from the river mouth to RM 74 (74 FR 52300, October 9, 2009) that support aggregations of Southern DPS green sturgeon during summer. The PBFs essential for species conservation are: (a) food resources, including benthic invertebrates (crangonid and callianasid shrimp, Dungeness crab, mollusks, amphipods) and small fish such as sand lances (*Ammodytes* spp.) and anchovies (*Engraulidae*) (Moyle 2002; Dumbauld et al. 2008); (b) suitable water quality (e.g., temperature, salinity, oxygen levels necessary for normal behavior, growth, and viability); (c) migratory corridors necessary for safe and timely passage; (d) a diversity of depths necessary for shelter, foraging, and migration; and (e) sediment quality necessary for normal behavior, growth, and viability.

The effects of the proposed action will overlap with designated critical habitat for green sturgeon in the lower Columbia River below RM 74, an estuarine area within the action area for this consultation. The designated critical habitat in the lower Columbia River estuary contains important summer habitats that support aggregations of green sturgeon, including those from both the unlisted Northern DPS and the listed Southern DPS.

The effects of implementation of the proposed action on green sturgeon critical habitat PBFs include:

- Food resources. The PBF includes abundant prey items within estuarine habitats. Prey species for green sturgeon the estuary primarily consist of benthic invertebrates and fishes, including crangonid shrimp, burrowing thalassinidean shrimp (particularly the burrowing ghost shrimp), amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies (NMFS 2009b). Any adverse effects of implementing the RPA on the primary constituent element of food resources were likely to be insignificant, and in the long term is likely to be beneficial. This conclusion was based on the following considerations: (1) the availability of invertebrate and fish prey favored by green sturgeon in other estuaries appeared to be high in the lower Columbia River and there was no information to indicate that short-term sediment changes due to in-water work decrease the availability of these species in any measurable way; (2) the abundances of marine forage fishes in the Columbia River plume increases and decreases based on a number of variables, including oceanic and climate conditions; and (3) improved habitat in the estuary as a consequence of HIP implementation is likely to contribute to improved conditions for prey species although we do not expect the prey species response to be measureable as a consequence of this action because too few projects will be implemented. The effects to this PBF are insignificant.

- Water quality. The PBFs of critical habitat in estuarine areas include water quality, including temperature, salinity, oxygen content, and other chemical characteristics necessary for normal behavior, growth, and viability of all life stages (NMFS 2009b). Suitable water quality requires adequate temperature, salinity and low levels of contaminants (e.g., pesticides, PAHs, heavy metals) that otherwise may disrupt growth and survival of subadult and adult life stages (NMFS 2009b). Implementation of HIP is not likely to alter temperature or salinity, or concentrate or mobilize contaminants (see discussion above under species) or otherwise affect this aspect of the water quality PBF, thus we consider the effect of this pathway to be insignificant.

- Migratory Corridor. Migratory pathways that allow safe and timely passage in the estuary and in coastal marine areas. Implementation of HIP would have no effect on this PBF.

- Water Depth. Subadult and adult green sturgeon require a diversity of depths in estuarine areas for shelter, foraging, and migration. The proposed action will not alter this PBF for Southern DPS green sturgeon critical habitat.

- Sediment Quality. Sediment quality necessary for normal behavior, growth, and viability of all green sturgeon life stages includes sediments free of elevated levels of contaminants, such as polyaromatic hydrocarbons and pesticides (NMFS 2009b). There is no likely pathway for implementation of the proposed action to affect sediment quality in the estuary, and the effects to sediment quality are discountable.

Conclusion
Based on the above analysis, NMFS concurs with the Action Agencies that the proposed action is not likely to adversely affect Southern DPS green sturgeon and its designated critical habitat because all the effects of the proposed action are either discountable or insignificant.

2.11.2 Southern DPS of Eulachon Determination

NMFS listed the southern DPS of eulachon as threatened under the ESA in 2010, reaffirming this conclusion in its 2016 five-year status review (NMFS 2016). NMFS designated critical habitat for eulachon under the ESA in 2011 (76 FR 65324), and completed the recovery plan in 2017 (NMFS 2017c). More information can be found in the recovery plan and status review for this species (NMFS 2016, 2017c). These documents are available on the NMFS West Coast Region website.

The southern DPS of eulachon (hereafter referred to as eulachon) includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Eulachon in the listed southern DPS are primarily a marine pelagic species that spawn in the lower reaches of coastal rivers and whose primary prey is plankton (Gustafson et al. 2010). Four subpopulations—the Klamath River, the Columbia River, the Fraser River, and the British Columbia coastal rivers—are considered in NMFS' recovery plan as a minimum set of "populations" that are needed to meet biologically based (abundance, productivity, spatial distribution, and genetic and life-history diversity) and threats-based delisting criteria (NMFS 2017c). They are typically found in near-benthic habitats in open marine waters of the continental shelf between 66 and 400 feet in depth (Hay and McCarter 2000). 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.

Presently, most eulachon production south of the U.S.–Canada border originates in the Columbia Basin, including the Columbia, Cowlitz, Grays, Kalama, Lewis, and Sandy Rivers (Gustafson et al. 2010). Historically, eulachon were occasionally reported to spawn in tributaries as far upstream as the Hood River (Oregon) and the Klickitat River (Washington) (NMFS 2017c). Since Bonneville Dam was completed in 1937, there have been occasional observations of eulachon at, or even above (passing through the ship locks), the dam in years when eulachon were highly abundant (NMFS 2017c).

No reliable fishery-independent, historical abundance estimates exist for eulachon. From 2000 to 2017, spawning stock biomass estimates in the Columbia River ranged from a low of about 780 thousand fish in 2005 to a high of nearly 186 million fish in 2014. Spawning stock biomass estimates in the Fraser River (1995–2017) ranged from a low of from about 110 to 150 thousand fish in 2010 to a high of about 42 to 56 million fish in 1996. Fishery-independent estimates are not available for the Klamath River or British Columbia coastal rivers (NMFS 2017c).

The Biological Review Team (BRT) rated climate change impacts on ocean conditions as the highest threat to the persistence of eulachon subpopulations, followed by bycatch in coastal shrimp fisheries, which is likely reduced in recent years due to the adoption of lights and excluder devices developed specifically to reduce eulachon bycatch. Dams and water diversions, climate change impacts on freshwater habitat, predation, water quality, shoreline construction, and dredging were all rated as moderate impacts for at least one subpopulation (NMFS 2017c). Although NMFS considers variation in ocean productivity to be the most important threat affecting the productivity of eulachon, NMFS identified other factors associated with the freshwater phase of their life cycle that limit the recovery of the species. These factors include elevated water temperatures, excessive sediment; reduced access to spawning and rearing areas; reductions in habitat complexity, instream wood and channel stability; degraded floodplain structure, function and reduced flow.

Physical or biological features of critical habitat essential to the conservation of the southern DPS fall into three major categories reflecting key life-history phases of eulachon:

- 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. These features are essential to conservation because without them, the species cannot successfully spawn and produce offspring.

- 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. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas, and they allow larval fish to proceed downstream and reach the ocean.

- Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. Eulachon prey on a wide variety of species, including crustaceans such as copepods and euphausiids (Hay and McCarter 2000; WDFW and ODFW 2001), unidentified malacostracans (Sturdevant 1999), cumaceans (Smith and Saalfeld 1955), mysids, barnacle larvae, and worm larvae (WDFW and ODFW 2001). These features are essential to conservation because they allow juvenile fish to survive, grow, and reach maturity, and they allow adult fish to survive and return to freshwater systems to spawn.

Proposed Action and Action Area
The proposed action is described in Section 1.3. The distribution of Southern DPS of eulachon overlaps with the action area in the lower Columbia River downstream of the Sandy River in Oregon, including the lower reaches of tidally influenced larger rivers such as the Cowlitz, Grays, Elochoman, Kalama, Lewis and Sandy Rivers.

Action Agencies' Effects Determination
The Action Agencies determined that the proposed action is not likely to adversely affect Southern DPS of eulachon or their designated critical habitat.

Effects of the Proposed Action - Species
Eulachon are likely to be temporally and spatially distant from where restoration activities and their construction-related effects will take place. Eulachon adult migration in the Columbia River system usually begins in December, peaks in February and continues through May (WDFW and ODFW 2001). Adult eulachon runs likely proceed directly to spawning areas; they use the lower Columbia River as a migration corridor. These adult migrations occur throughout deeper water in the mainstem channel to the tidally influenced rivers where they spawn. After spawning, eggs adhere to sand particles and travel some distance downriver where they hatch. Larvae are flushed to sea with the current immediately upon hatching (no freshwater rearing) (Hay and McCarter 2000).

A majority of the restoration projects funded by BPA through HIP will occur in the upper reaches and tributaries of these larger rivers, and will not be near the eulachon spawning areas. However, improvement of habitat conditions in the estuary is a priority in the CRS opinion; it is possible that restoration projects will be proposed in the lower reaches of rivers where eulachon may spawn. Based on monitoring information from previous fish salvage operations associated with HIP I, HIP II, and HIP III projects, NMFS believes that it is highly unlikely that eulachon will be encountered during work area isolation and fish salvage for implementation of HIP 4 projects because of the type and location of projects typically funded. Thus capture of eulachon through work area isolation is discountable.

Restoration projects will not result in any impairment of migration corridors for eulachon. Eulachon migrate mid-channel, and are unlikely to encounter any short-term increased levels of sediment or herbicide caused by in-water work adjacent or upstream of project construction. The effects of construction activities are discountable.

Effects of the Proposed Action - Critical Habitat
Designated critical habitat for Southern DPS of eulachon includes portions of 16 rivers in California, Oregon and Washington (76 FR 65324, October 20, 2011). All of these areas are designated as migration and spawning habitat. In the action area, 12.4 miles of the lower Sandy River and the mainstem Columbia River from the mouth to the base of Bonneville Dam (a distance of 143.2 miles) were designated as critical habitat. Dams and water diversions are major threats in the Columbia River where hydropower generation and flood control are major activities. Water temperatures during spawning are a concern as is the presence of chemical contaminants. Dredging is a low to moderate threat in the Columbia River.

Most projects completed under HIP 4 will have short-term adverse effects at the project scale. No in-water work will occur in spawning reaches during spawning. Construction-related project effects (e.g., increased turbidity) are unlikely to extend (either laterally in the Columbia River, or longitudinally in spawning rivers) to migration corridors using by eulachon. Thus, effects to critical habitat are highly unlikely to occur.

Conclusion
Based on the above analysis, NMFS concurs with the Action Agencies that the proposed action is not likely to adversely affect Southern DPS of eulachon and its designated critical habitat because all the effects of the proposed action are either discountable or insignificant.

3. Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

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 BPA and descriptions of EFH Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005), coastal pelagic species (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the 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 (Section 1.0) to this document. The action area includes areas designated as EFH for various life-history stages of Chinook salmon and coho salmon, groundfish and coastal pelagic species. In addition, the action area includes habitat areas of particular concern (HAPCs): HAPCs in the action area include the Columbia River estuary (see descriptions of salmon HAPCs in Appendix A to the Pacific Coast Salmon FMP).

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 as HAPCs in the Lower Columbia River.

1. Water Quality (spawning, rearing, and migration). Projects implemented under the HIP 4 program have the potential to cause short term habitat effects during project construction. These effects may include increased sediment, stormwater runoff, chemical contaminants, and increased dissolved oxygen demand. Proposed conservation measures such as erosion control measures, working in the dry, and the short duration of construction will minimize effects to water quality. Long-term beneficial effects includes the potential to improve riparian function, floodplain connectivity, and improved stormwater treatment.

2. Water Quantity (rearing and migration). Project implementation 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 temporarily impaired during project construction for those projects that require extensive in-water work. This is generally associated with work area isolation. Over the long term, NMFS expects improvements to fish passage at the local scale for projects that target fish passage restoration.

4. Substrate (migration and spawning). Substrate will have a short-term reduction in quality due to increased sedimentation. Restoration projects will result in a long-term improvement in substrate quality associated with projects that support habitat development, floodplain reconnections, and riparian improvements.

5. Forage (rearing and migration). Forage availability and quality will decline at the project level during construction activities. But restoration projects that improve habitat development will support improved forage availability over the long-term.

6. Cover/shelter (rearing and migration). Natural cover will have short-term decrease during construction of projects that involve riparian and channel disturbance. Restoration action will result in t a long-term increase because of improved habitat diversity and complexity a, improved riparian function and floodplain connectivity at the project scale.

7. Floodplain Connectivity (rearing and migration). Project construction for some actions will have a short-term decline in floodplain connectivity as a consequence of riparian disturbance. Restoration projects that target floodplain connectivity and riparian function will improve these functions at a reach scale. These include projects that set back levees, berms and dikes.

8. Estuarine EFH (rearing and migration). Restoration projects in the estuary are designed to improved rearing capacity in the estuary. Short-term negative effects are likely during project construction, but HIP 4 will result in improvements at the project scale.

3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, of designated EFH for Pacific Coast salmon.

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

1. Implement best management practices to minimize exposure of EFH to herbicides as described term and condition number 2 in the accompanying opinion.
2. Ensure completion of a monitoring and reporting program as described in term and condition number 3 in the accompanying opinion to verify the action is meeting its objective of restoring habitat at a project scale to support Pacific Coast salmon spawning, rearing and migration.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, BPA 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 approval of the action if the response is inconsistent with any of NMFS' 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, minimizing, mitigating, or otherwise 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

BPA 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 consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are BPA. Other interested users could include other organizations that implement restoration actions including both governmental and nongovernmental organizations. Individual copies of this opinion were provided to the BPA. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

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.

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Appendix A

Appendix A

The following is BPA's proposed action. Please be aware that the HIP 4 Handbook will be more current, and will incorporate the Reasonable and Prudent Measures (Terms and Conditions) from the HIP 4 biological opinion.

Categories of Action

The following are 8 categories of actions that are funded and proposed BPA considered in the biological opinion.

Category 1: Fish Passage Restoration (Profile Discontinuities)

a) Dams, Water Control, or Legacy Structure Removal
b) Consolidate or Replace Existing Irrigation Diversions
c) Headcut and Grade Stabilization
d) Low Flow Consolidation
e) Providing Fish Passage at an Existing Facility

Category 1: Fish Passage Restoration (Transportation Infrastructure)

f) Bridge and Culvert Removal or Replacement
g) Bridge and Culvert Maintenance
h) Installation of Fords

Category 2: River, Stream, Floodplain, and Wetland Restoration

a) Improve Secondary Channel and Floodplain Connectivity
b) Set-back or Removal of Existing, Berms, Dikes, and Levees
c) Protect Streambanks Using Bioengineering Methods
d) Install Habitat-Forming Instream Structures (Large Wood, Small Wood & Boulders)
e) Riparian Vegetation Planting
f) Channel Reconstruction
g) Install Habitat-Forming Materials (Sediment and Gravel)

Category 3: Invasive Plant Control

a) Manage Vegetation using Physical Control
b) Manage Vegetation using Herbicides (Riverine)
c) Manage Vegetation using Herbicides (Estuarine)
d) Juniper Removal
e) Prescribed Burning

Category 4: Piling Removal

Category 5: Road and Trail Erosion Control, Maintenance, and Decommissioning

a) Maintain Roads
b) Decommission Roads

Category 6: In-Channel Nutrient Enhancement

Category 7: Irrigation and Water Delivery/Management Actions

a) Convert Delivery System to Drip or Sprinkler Irrigation
b) Convert Water Conveyance from Open Ditch to Pipeline or Line Leaking Ditches or Canals
c) Convert from Instream Diversions to Groundwater Wells for Primary Water Sources
d) Install or Replace Return Flow Cooling Systems
e) Install Irrigation Water Siphon Beneath Waterway
f) Livestock Watering Facilities
g) Install New or Upgrade/Maintain Existing Fish Exclusion Devices and Bypass Systems

Category 8: Habitat, Hydrologic, and Geomorphologic Surveys

General Aquatic Conservation Measures Applicable to all Actions

These measures will be implemented on all projects covered under the HIP4 that involve in water or near water work.

Project Design and Site Preparation

Timing of in-water work

Formal recommendations published by state agencies such as the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Idaho Department of Fish and Game (IDFG), and Montana Fish Wildlife and Parks (MFWP), or informal recommendations from the appropriate state Fishery Biologist in regard to the timing of in-water work, will be followed.

1) **Bull trout –** In Bull Trout spawning and rearing areas, eggs, alevin, and fry are present nearly year round. In Bull Trout habitats designated as foraging, migration, and overwintering (FMO) habitats, juvenile and adult bull trout may be present seasonally. Some project locations may not have designated in-water work windows for bull trout, or if they do, they may differ from the in-water work windows for salmon and steelhead. If this is the case, the project sponsor will contact the appropriate USFWS field office to ensure that all reasonable implementation measures are considered and an appropriate in-water work window is used to minimize project effects.
2) **Lamprey –** To minimize disturbance to migrant adults, the project sponsor and/or their contractors will avoid working instream or river channels that contain Pacific lamprey from March 1 to July 1 in low- to mid-elevation reaches (<5,000 feet). In high-elevation reaches (>5,000 feet), the project sponsor will avoid working instream or river channels from March 1 to August 1. If either timeframe is incompatible with other objectives, the area will be surveyed for nests and lamprey presence, and avoided if possible. If lampreys are known to exist, the project sponsor will utilize best management practices (BMPs) for dewatering and salvage as outlined in USFWS 2010, or most recent guidance. Salvage should include salvage of larval lamprey from sediments. (See section "Conservation Measures for Salvage of Native Fish, Lamprey, and Mussels").
3) A **maximum of 1 week** past the recommended in-water work window shall be considered and approved by the EC lead, any other deviation from the IWWW shall considered and reviewed by the Services through the Variance Process.

Contaminants

The project sponsor will complete a site assessment with the following elements to identify the type, quantity, and extent of any potential contamination for any action that involves excavation of more than 20 cubic yards of material:

1) A review of available records, such as former site use, building plans, and records of any prior contamination events;
2) A site visit to inspect the areas used for various industrial processes and the condition of the property;

3) Interviews with knowledgeable people, such as site owners, operators, and occupants, neighbors, or local government officials; and
4) A summary, stored with the project file that includes an assessment of the likelihood that contaminants are present at the site, based on items 4(a) through 4(c).

Site layout and flagging

Prior to construction, the project area will be clearly flagged to identify the following:

1) Sensitive resource areas, such as areas below the ordinary high water (OHW), spawning areas, springs, and wetlands;
2) Equipment entry and exit points;
3) Road and stream crossing alignments;
4) Staging, storage, and stockpile areas; and
5) No-herbicide-application areas and buffers.

Temporary access roads and paths

1) Existing access roads and paths will be preferentially used whenever possible, and the number and length of temporary access roads and paths through riparian areas and floodplains will be minimized to lessen soil disturbance, soil compaction, and impacts to vegetation.
2) Vehicle use and human activities, including walking in areas occupied by terrestrial ESA-listed species, will be minimized.
3) Temporary access roads and paths will not be built on slopes where grade, soil, or other features suggest a likelihood of excessive erosion or failure. If slopes are steeper than 30%, the road will be designed by a civil engineer with experience in steep road design.
4) The removal of riparian vegetation during construction of temporary access roads will be minimized. When temporary vegetation removal is required, vegetation will be cut at ground level (not grubbed).
5) At project completion, all temporary access roads and paths will be decompacted and reshaped to match the original contour; and the soil will be stabilized and revegetated.
6) Helicopter flight patterns will be established in advance, and located to avoid terrestrial ESA-listed species, including their occupied habitat and appropriate buffers, during sensitive life stages (i.e. nesting and critical breeding periods).

Temporary stream crossings

1) Existing stream crossings, fords, or bedrock will be used whenever possible.
2) If an existing stream crossing is not accessible, temporary crossings will be installed. Treated wood shall not be used on temporary bridge crossings or in locations in contact with or over water.
3) For projects that require equipment and vehicles to cross in the wet:
    a) The location and number of all wet crossings must be approved by BPA and clearly indicated on design drawings.
    b) Vehicles and machinery will cross streams at right angles to the main channel wherever possible.
    c) No stream crossings will occur 300 feet upstream or 100-feet downstream of an existing redd or spawning fish.

d) After project completion, temporary stream crossings will be obliterated, and the banks restored.

Staging, storage, and stockpile areas

1) Staging areas (used for construction equipment storage, vehicle storage, fueling, servicing, and hazardous material storage) will be 150 feet or more from any natural waterbody or wetland, or on an adjacent established road area in a location and manner that will preclude erosion into, or contamination of, the stream or floodplain. Staging areas may be closer than 150 feet if the area is above (elevation) the 100-yr floodplain and spill prevention measures are approved by the EC Lead.
2) Natural materials used for implementation of aquatic restoration, such as large wood, gravel, and boulders, may be staged within 150 feet if clearly indicated in plans. Recommend referring to area as "Natural Material Stockpile Area" with a note that states vehicle storage, equipment storage, hazardous materials, fueling, and servicing not permitted in this area.
3) Any large wood, topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration at a specifically identified and flagged area.
4) Any material not used in restoration, and not native to the floodplain, will be removed to a location outside of the 100-year floodplain for disposal.

Equipment

Mechanized equipment and vehicles will be selected, operated, and maintained in a manner that minimizes adverse effects on the environment (e.g., minimally-sized, low pressure tires; minimal hard-turn paths for tracked vehicles; temporary mats or plates within wet areas or on sensitive soils). All vehicles and other mechanized equipment will be:

1) Stored, fueled, and maintained in a vehicle staging area located 150 feet or more from any natural water body or wetland, or on an adjacent, established road area;
2) Refueled in a vehicle staging area located 150 feet or more from a natural waterbody or wetland, or in an isolated hard zone, such as a paved parking lot or adjacent, established road (this measure applies only to gas or diesel-powered equipment with tanks larger than 5 gallons);
3) Biodegradable lubricants and fluids shall be used on equipment operating in the stream channel and live water.
4) Inspected daily for fluid leaks before leaving the vehicle staging area for operation within 150 feet of any natural water body or wetland; and
5) Thoroughly cleaned before operation below ordinary high water (OHW), and as often as necessary during operation, to remain free of grease.

Erosion control

Erosion control best management practices (BMPs) will be prepared and carried out, commensurate with the scope of the action that may include the following:

1) Temporary erosion control BMPs.
   a) Temporary erosion control BMPs shall be in place before any significant alteration of the action site, and shall be appropriately installed downslope of project activity within the riparian buffer area until site rehabilitation is complete.

b) If there is a potential for eroded sediment to enter the stream, sediment barriers will be installed and maintained for the duration of project implementation.
c) Temporary erosion control measures may include sedge mats, fiber wattles, silt fences, jute matting, wood fiber mulch with soil binder, or geotextiles and geosynthetic fabric. Biodegradable netting may be used so that they can decompose on site.
d) Soil stabilization utilizing wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are noxious-weed-free and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
e) Sediment will be removed from erosion control BMP once it has reached 1/3 of the exposed height of the BMP.
f) Once the site is stabilized following construction, temporary erosion control BMPs will be removed.

2) Emergency erosion control BMPs. The following materials for emergency erosion control will be available at the work site:
   a) A supply of sediment control materials; and
   b) An oil-absorbing floating boom whenever surface water is present.

Dust abatement

The project sponsor will determine the appropriate dust control measures by considering soil type, equipment usage, prevailing wind direction, and the effects caused by other erosion and sediment control measures. In addition, the following criteria will be followed:

1) Work will be sequenced and scheduled to reduce exposed bare soil subject to wind erosion.
2) Dust-abatement additives and stabilization chemicals (typically magnesium chloride, calcium chloride salts, or lignin sulfonate) will not be applied within 25 feet of a natural waterbody or wetland and will be applied so as to minimize the likelihood that they will enter streams. Applications of lignin sulfonate will be limited to a maximum rate of 0.5 gallons per square yard of road surface, assuming a 50:50 (lignin sulfonate to water) solution.
3) Application of dust abatement chemicals will be avoided during or just before wet weather and at stream crossings or other areas that could result in unfiltered delivery of the dust abatement chemicals to a waterbody (typically these would be areas within 25 feet of a natural waterbody or wetland; distances may be greater where vegetation is sparse or slopes are steep).
4) Spill containment equipment will be available during application of dust abatement chemicals.
5) Petroleum-based products will not be used for dust abatement.

Spill prevention, control, and counter measures

The following measures will be used to prevent accidental spills of fuel, lubricants, hydraulic fluid, or other contaminants into the riparian zone or directly into the water:

1) A description of hazardous materials that will be used, including inventory, storage, and handling procedures, will be available on-site.
2) Written procedures for notifying environmental response agencies will be posted at the work site.

3) Spill containment kits (including instructions for cleanup and disposal) adequate for the types and quantity of hazardous materials used at the site will be available at the work site.
4) Workers will be trained in spill containment procedures and will be informed of the location of spill containment kits.
5) Any waste liquids generated at the staging areas will be temporarily stored under an impervious cover, such as a tarpaulin, until they can be properly transported to, and disposed of, at a facility that is approved for receipt of hazardous materials.
6) Pumps used adjacent to water shall use spill containment systems.

Invasive species control
The following measures will be followed to avoid introduction of invasive plants and noxious weeds into project areas:

1) Prior to entering the site, all vehicles and equipment will be power-washed, allowed to dry fully, and inspected to make sure no plants, soil, or other organic material adheres to the surface.
2) Watercraft, waders, boots, and any other gear to be used in or near water will be inspected for aquatic invasive species. Wading boots with felt soles are not to be used due to their propensity for aiding in the transfer of invasive species unless decontamination procedures are used.

Work Area Isolation & Fish Salvage

Work Area Isolation
Any work area requiring excavation or mobilization of sediment within the wetted channel will be isolated from the active stream whenever ESA-listed fish are reasonably certain to be present, or if the work area is less than 300-feet upstream from known ESA-listed fish spawning habitats. If the work area isolation practices would cause greater impacts than it would prevent, is located in deep or swiftly flowing water, or if fish can be effectively excluded by nets or screens, then a variance to not isolate the work area may be pursued.

When work area isolation is required, design plans will include all isolation elements, fish release areas, a pump to be used to dewater the isolation area, and, when fish are present, a fish screen that meets NMFS's fish screen criteria (NMFS 2011, or most current). Wider mesh screens may be used after all fish have been removed from the isolated area. Work area isolation and fish capture activities take place during periods of the coolest air and water temperatures possible, normally early in the morning versus late in the day, and during conditions appropriate to minimize stress to fish species present.

A fish biologist will determine how to remove ESA-listed fish, with least harm to the fish, before in-water work begins. This will involve either passive movement of fish out of the project reach through slow dewatering, or actively removing the fish from the project reach. Should active removal be warranted, a fish biologist will clear the area of fish before the site is dewatered using one or more of a variety of methods including seining, dipping, or electrofishing, depending on specific site conditions. In areas occupied by larval lamprey, to the extent possible, salvage using guidance set forth in USFWS 2010 or most recent guidance.

Dependent upon site conditions, a fish biologist will conduct or supervise the following:

1) Slowly reduce water from the work area to allow some fish to leave the work area volitionally;
    a) If dewatered area contains large fine/ sandy sediment deposits, larval lamprey could be present, and potentially in large numbers. If so, consider electrofishing using lamprey electrofishing settings (which do not affect bony fish) prior to or during drawdown. See section further down on Lamprey Conservation Measures and Electrofishing guidelines.
2) Install block nets;
    a) Block nets will be installed at upstream and downstream locations and maintained in a secured position to exclude fish from entering the project area.
    b) Block nets will be secured to the stream channel bed and banks until fish capture and transport activities are complete. Block nets may be left in place for the duration of the project to exclude fish.
    c) If block nets remain in place more than one day, the nets will be monitored at least daily to ensure they are secured to the banks and free of organic accumulation. If the project is within bull trout spawning and rearing habitat, the block nets must be checked every 4 hours for fish impingement on the net. Less frequent intervals must be approved through a variance request.
    d) Nets will be monitored hourly anytime there is instream disturbance.
3) Capture fish through seining, and relocate to streams;
    a) While dewatering, any remaining fish will be collected by hand or dip nets.
    b) Seines with a mesh size to ensure capture of the residing ESA-listed fish will be used.
    c) Minnow traps may be left in place overnight and used in conjunction with seining.
4) Electrofish to capture and relocate fish not caught during seining, NMFS electrofishing guidelines shall be used. This step is to be used as a last resort; after all passive techniques have been exhausted.
5) Continue to slowly dewater the stream reach;
6) Collect any remaining fish in cold-water buckets and relocate to the stream;
    a) Limit the time fish would be in a transport bucket, and release them as quickly as possible;
    b) The number of fish within a bucket will be limited, and fish will be of relatively comparable size to minimize predation;
    c) Aerators for buckets will be used, or the bucket's water will be frequently changed with cold, clear, water at 15-minute, or more-frequent intervals.
    d) Buckets will be kept in shaded areas; or if in exposed areas, covered by a canopy;
    e) Dead fish will not be stored in transport buckets but will be left on the streambank to avoid mortality counting errors.

NMFS' Electrofishing Guidelines (NMFS 2000)

1) Initial Site Surveys and Equipment Settings

a) In order to avoid contact with spawning adults or active redds, researchers must conduct a careful visual survey of the area to be sampled before beginning electrofishing.
b) Prior to the start of sampling at a new location, water temperature and conductivity measurements shall be taken to evaluate electrofisher settings and adjustments.
c) No electrofishing should occur when water temperatures are above 18°C or are expected to rise above this temperature prior to concluding the electrofishing survey.
d) Whenever possible, a block net should be placed below the area being sampled to capture stunned fish that may drift downstream.
e) Equipment must be in good working condition and operators should go through the manufacturer's preseason checks, adhere to all provisions, and record major maintenance work in a logbook.
f) Each electrofishing session must start with all settings (voltage, pulse width, and pulse rate) set to the **minimums** needed to capture fish. These settings should be gradually increased only to the point where fish are immobilized and captured, and generally not allowed to exceed conductivity-based maxima (Table A.1). Only direct current (DC) or pulsed direct current (PDC) should be used.

Table A.1 Electrofishing Guidelines for ESA-listed Salmonids.

	Initial Settings		Maximum Settings
Voltage		Conductivity	Max Voltage
	100V	<100	1100 V
		100-300	800 V
		>300	400 V
Pulse Width	500 µS	5 mS	
Pulse Rate	30 Hz	70 Hz	

2) Electrofishing Technique
a) Sampling should begin using straight DC. The power needs to remain on until the fish is netted when using straight DC. If fish capture is unsuccessful with initial low voltage, gradually increase voltage settings with straight DC.
b) If fish capture is not successful with the use of straight DC, then set the electrofisher to lower voltages with PDC. If fish capture is unsuccessful with low voltages, increase pulse width, voltage, and pulse frequency (duration, amplitude, and frequency).
c) Electrofishing should be performed in a manner that minimizes harm to the fish. Stream segments should be sampled systematically, moving the anode continuously in a herringbone pattern (where feasible) through the water. Care should be taken when fishing in areas with high fish concentrations, structure (e.g., wood, undercut banks) and in shallow waters where most backpack electrofishing for juvenile salmonids occurs. Voltage gradients may be high when electrodes are in shallow water where boundary layers (water surface and substrate) tend to intensify the electrical field.
d) Do not electrofish in one location for an extended period (e.g., undercut banks) and regularly check block nets for immobilized fish.

e) Fish should not make contact with the anode. The zone of potential injury for fish is 0.5 m from the anode.
f) Electrofishing crews should be generally observant of the condition of the fish and change or terminate sampling when experiencing problems with fish recovery time, banding, injury, mortality, or other indications of fish stress.
g) Netters should not allow the fish to remain in the electrical field any longer than necessary by removing stunned fish from the water immediately after netting.

3) Sample Processing and Recordkeeping
a) Fish should be processed as soon as possible after capture to minimize stress. This may require a larger crew size.
b) All sampling procedures must have a protocol for protecting held fish. Samplers must be aware of the conditions in the containers holding fish; air pumps, water transfers, etc., should be used as necessary to maintain safe conditions. Also, large fish should be kept separate from smaller prey-sized fish to avoid predation during containment.
c) Fish should be observed for general condition and injuries (e.g., increased recovery time, dark bands, and visually observable spinal injuries). Each fish should be completely revived before releasing at the location of capture. A plan for achieving efficient return to appropriate habitat should be developed before each sampling session. Also, every attempt should be made to process and release ESA-listed specimens first.
d) Pertinent water quality (e.g., conductivity and temperature) and sampling notes (e.g., shocker settings, fish condition/injuries/mortalities) should be recorded in a logbook to improve technique and help train new operators. It is important to note that records of injuries or mortalities pertain to the entire electrofishing survey, including the fish sample work-up.
e) The anode will not intentionally contact fish.
f) Electrofishing should not be conducted when the water conditions are turbid and visibility is poor. For example, when the sampler cannot see the stream bottom in one foot of water.
g) If mortality or obvious injury (defined as dark bands on the body, spinal deformations, de-scaling of 25% or more of body, and torpidity or inability to maintain upright attitude after sufficient recovery time) occurs during electrofishing, operations will be immediately discontinued, machine settings, water temperature, and conductivity checked, and procedures adjusted or electrofishing postponed to reduce mortality.

Dewatering

Dewatering, when necessary, will be conducted over a sufficient period of time to allow species to naturally migrate out of the work area and will be limited to the shortest linear extent practicable.

1) Diversion around the construction site may be accomplished with a cofferdam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch. Where gravity feed is not possible, a pump may be used, but must be operated in such a way as to avoid repetitive dewatering and rewatering of the site. Impoundment behind the cofferdam must occur slowly through the transition, while constant flow is delivered to the downstream reaches.

2) All pumps will have fish screens to avoid juvenile fish impingement or entrainment, and will be operated in accordance with NMFS' current fish screen criteria (NMFS 2011, or most recent version). If the pumping rate exceeds 3 cubic feet per second (cfs), a NMFS Engineering review will be necessary. If the screen is in an isolated area with no fish (salmonids or larval lamprey), a larger mesh screen may be used.
3) Dissipation of flow energy at the bypass outflow will be provided to prevent damage to riparian vegetation and/or stream channel.
4) Seepage water will be pumped to a temporary storage and treatment site or into upland areas to allow water to percolate through soil or to filter through vegetation prior to reentering the stream channel.
5) In areas occupied by larval lamprey, to the extent possible, salvage using guidance described in above section "Conservation Measures for Salvage of Native Fish, Lamprey and Mussels" (which is based on USFWS 2010) or most recent guidance.
6) In areas occupied by native freshwater mussels, to the extent possible, salvage using guidance developed by the Xerces Society (Blevins et al. 2018, 2019).

Fish Salvage Notice

Monitoring and recording of fish presence, handling, and mortality must occur for the duration of the isolation, salvage, electrofishing, dewatering, and rewatering operations. Once operations are completed, a salvage report will document procedures used, any fish injuries or deaths (including numbers of fish affected), and causes of any deaths.

Construction and Post-Construction Conservation Measures

Fish passage

Fish passage will be provided for any adult or juvenile fish likely to be present in the project area during construction, unless passage did not exist before construction, or the stream is naturally impassable at the time of construction. If the provision of temporary fish passage during construction will increase negative effects on ESA-listed species or their habitat, a variance can be requested from the NMFS Branch Chief and the USFWS Field Office Supervisor. Pertinent information, such as the species affected, length of stream reach affected, proposed time for the passage barrier, and alternatives considered will be included in the variance request.

Construction and discharge water

1) Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate.
2) Diversions will not exceed 10% of the available flow.
3) All construction discharge water will be collected and treated using the best available technology suitable for site conditions.
4) Treatments to remove debris, nutrients, sediment, petroleum hydrocarbons, metals and other pollutants likely to be present will be provided.

Minimize time and extent of disturbance

Earthwork (including drilling, excavation, dredging, filling and compacting) in which mechanized equipment is used in stream channels, riparian areas, and wetlands will be completed as quickly as possible. Mechanized equipment will be used in streams only when project specialists believe that such actions are the only reasonable alternative for implementation, or would result in less sediment in the stream channel or damage (short- or long-term) to the overall aquatic and riparian ecosystem relative to other alternatives. To the extent feasible, mechanized equipment will work from the top of the bank, unless work from another location would result in less habitat disturbance.

Cessation of work

Project operations will cease under the following conditions:

1) High flow conditions that may result in inundation of the project area, except for efforts to avoid or minimize resource damage
2) When allowable water quality impacts, as defined by the state CWA section 401 water quality certification or HIP Turbidity Monitoring Protocol, have been exceeded

Site restoration

When construction is complete:

1) All streambanks, soils, and vegetation will be cleaned up and restored as necessary using stockpiled large wood, topsoil, and native channel material.
2) All project-related waste will be removed.
3) All temporary access roads, crossings, and staging areas will be decompacted and re-contoured. When necessary for revegetation and infiltration of water, compacted areas of soil will be loosened.
4) All disturbed areas will be rehabilitated in a manner that results in similar or improved conditions relative to pre-project conditions. This will be achieved through redistribution of stockpiled materials, seeding, and/or planting with local native seed mixes or plants.

Revegetation

Long-term soil stabilization of disturbed sites will be accomplished with reestablishment of native vegetation using the following criteria:

1) Planting and seeding will occur prior to or at the beginning of the first growing season after construction.
2) Use a mix of species, appropriate to the site that will achieve establishment, shade, and erosion control objectives. These would, preferably be forb, grass, shrub, or tree species native to the project area or region.
3) Vegetation, such as willow, sedge and rush mats, will be salvaged from disturbed or abandoned floodplains, stream channels, or wetlands, and replanted at the site in appropriate locations.
4) Invasive species will not be used.
5) Short-term stabilization measures may include the use of non-native sterile seed mix (when native seeds are not available), weed-free certified straw, jute matting, and other similar techniques.
6) Surface fertilizer will not be applied within 50 feet of any stream channel, waterbody, or wetland.
7) Fencing will be installed as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
8) Re-establishment of vegetation in disturbed areas will achieve at least 70% of pre-project conditions within 3 years.

9) Invasive plants will be removed or controlled until native plant species are well established (typically 3 years post-construction).

Site access
The project sponsor will retain the right of reasonable access to the site in order to monitor the success of the project over its life.

Implementation monitoring
Project sponsor staff or their designated representative will provide implementation monitoring by filling out the Project Completion Form (PCF) to ensure compliance with the applicable BiOp, demonstrating that:

1) General conservation measures are adequately followed.
2) Effects to listed species are not greater than predicted and incidental take limitations are not exceeded.
3) Turbidity monitoring is being conducted in accordance with the HIP turbidity monitoring protocol and recorded in the PCF.

CWA section 401 water quality certification
The project sponsor or designated representative will complete and record water quality observations to ensure that in-water work is not degrading water quality. During construction, CWA section 401 water quality certification provisions provided by the Oregon Department of Environmental Quality, Washington Department of Ecology, or Idaho Department of Environmental Quality will be followed.

Turbidity Monitoring Protocol
The Project Sponsor shall complete and record the following water quality observations on the HIP 4 Project Completion Form (PCF). If the geomorphology of the project area (e.g., silty or claylike materials) or the nature of the action (e.g., large amounts of bare earth exposure) shall preclude the successful compliance with these triggers, notify your EC Lead & the Services in advance of the likelihood of an exceedance and seek additional recommendations.

1) Take a background turbidity measurement approximately 100 feet upstream from the project area using a recently-calibrated turbidimeter. Record the observation, location, and time of the background measurement before monitoring at the downstream point, known as the **measurement compliance point**. If the background turbidity is less than 20 NTU, then use visual observations.
2) Take a second sample or observation, immediately after each **measurement compliance point**, approximately:
    a) 50 feet downstream for streams that are less than 30 feet wide;
    b) 100 feet downstream for streams between 30 and 100 feet wide;
    c) 200 feet downstream for streams greater than 100 feet wide; and
    d) 300 feet from the discharge point or nonpoint source for locations subject to tidal or coastal scour.
    e) Record the downstream observation, location, and time.
3) Turbidity shall be measured (steps 1-2) every **4 hours** while work is being implemented.

4) An exceedance occurs whenever the both of the following conditions are exceeded: a) Downstream turbidity exceeds 40 NTU**,** b) Downstream turbidity exceeds 10% above background
5) If an exceedance occurs then adjustments or corrective measures must be taken in order to reduce turbidity. The NMFS staff biologists of the area can provide technical assistance.
6) If exceedances occur for more than **two consecutive monitoring intervals** (after 8 hours), the activity must stop until the turbidity level returns to background, and the EC lead must be notified immediately after the project is concluded. The EC lead shall document the reasons for the exceedances and **corrective measures** taken.
7) If at any time, monitoring, inspections, or observations/samples show that the turbidity controls are ineffective, immediately mobilize work crews to repair, replace, or reinforce controls as necessary. Document those occurrences in the PCF.

Activity-Specific Conservation Measures

Category 1: Fish Passage Restoration

Profile Discontinuities

BPA proposes to review and fund fish passage projects for ESA-listed salmon, steelhead, and bull trout ("salmonids"). The objective of fish passage restoration is to allow all life stages of salmonids access to historical habitat from which they have been excluded and focuses on restoring safe upstream and downstream fish passage to stream reaches that have become isolated by obstructions, non-functioning structures, or instream profile discontinuities resulting from insufficient depth, or excessive jump heights and velocities. These projects should also incorporate Pacific lamprey passage in the design and implementation, where appropriate.

Although passage actions are generally viewed as positive actions for native fish restoration, there may be occasions where restoring passage exposes native fish (isolated above or below a barrier) to negative influences (predation, competition, hybridization) from non-native species such as brook trout, brown trout, and lake trout.

Proposed passage projects that may increase connectivity between bull trout and non-native species must be approved by the appropriate USFWS Field Office Supervisor.

BPA has grouped passage projects according to the effects and review requirements in the following subcategories: **Profile Discontinuities** and **Transportation Infrastructure**. These subcategories represent a logical break between transportation-related effects (transportation infrastructure) and effects due to physical fish barriers, classified by water velocity, water depth, and barrier height (profile discontinuities).

BPA proposes the following activities to improve fish passage; (a) Dam, Water Control or Legacy Structure Removal; (b) Consolidation, or Replacement of Existing Irrigation Diversions; (c) Headcut and Grade Stabilization; (d) Low Flow Consolidation; and (e) Fish passage provision at an existing facility.

Category 1a) Dams, Water Control Structures, or Legacy Structures Removal

Description. BPA proposes to fund and review fish passage projects, and restore more natural channel and flow conditions by removing small dams, channel-spanning weirs, earthen embankments, subsurface drainage features, spillway systems, tide gates, outfalls, pipes, instream flow redirection structures (e.g., drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels.

"Small dams" include instream structures (1) up to 15 feet in height (as measured at the maximum difference between water surface elevations upstream and downstream of the dam during low flow) for streams with a slope less than 4% downstream, or (2) up to 16.4 feet in height for streams with a slope greater than 4%.

If the structure being removed contains material (i.e. large wood, boulders, etc.) that is typically found within the stream or floodplain at that site, the material can be reused to implement habitat improvements. Any such project must follow the design criteria outlined in the "**Install Habitat-Forming Natural Material Instream Structures (Large Wood, Small Wood & Boulders)"** activity category 2d).

<u>*Guidelines for Review*</u>

Low Risk: Removal of instream structures such as subsurface drainage features, tide gates, outfalls, pipes, small dams with total head measurement < 3 feet.

Medium Risk: Removal of instream structures that will not result in significant hydrological and geomorphic impacts > 3 feet will require both BPA and NMFS Engineering Review.

High Risk: Removal of small dams > 3 feet and <15 feet in height for streams with an active channel width of < 75 feet and a slope <4%, or >3 feet and < 16.4 feet in height with a slope greater than 4% and an active channel width of <75 feet will require both BPA and NMFS Engineering Review.

All medium to high risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

<u>*Conservation Measures*</u>

1) In the design plans, the profile of the stream channel thalweg shall be shown to provide enough information to clearly demonstrate project impacts to the stream channel and the potential for channel degradation, for a minimum of 10 upstream and 10 downstream channel widths of the downstream and upstream boundaries of the project.
2) Surveys must be taken of any downstream spawning areas that may be affected by sediment released by removal of the water control structure or dam.
3) Sediment characterization must demonstrate the proportion of coarse sediment (>2mm) in the reservoir area. 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.
4) Restore all structure bank lines and fill in all holes with native materials to restore contours of streambank and floodplain. Compact the fill material adequately to prevent washing out of the soil during over-bank flooding. Do not mine material from the stream channel to fill in "key" holes. When removal of buried (keyed) structures could result in significant disruption to riparian vegetation and/or the floodplain, consider leaving the buried structure sections within the streambank.
5) If the legacy structures (log, rock, or gabion weirs) were placed to provide grade control, evaluate the site for potential headcutting and incision due to structure removal by using the appropriate guidance. If headcutting and channel incision are likely to occur due to structure removal, additional measures must be taken to reduce

these impacts. See grade control options described under **Headcut and Grade Stabilization** activity category 1c.

6) If the structure is being removed because it has caused an over-widening of the channel, consider implementing other HIP 4 restoration categories to decrease the width-to-depth ratio of the stream at that location to a level similar to the natural and representative upstream and downstream sections of the stream, within the same channel type.
7) Tide gates can only be removed, but not modified or replaced, under this activity category.

Category 1b) Consolidate, or Replace Existing Irrigation Diversions

Description. BPA proposes to fund and review the consolidation or replacement of existing diversion check structures with pump stations or engineered riffles (including cross vanes, "W" weirs, or "A" frame weirs) to reduce the number of diversions on streams and thereby conserve water and improve habitat for fish; improve the design of diversions (with adequate fish-screening) to allow for fish passage; or reduce the annual instream construction of push-up dams and instream structures.

The HIP 4 will only cover irrigation efficiency actions within this activity category that use state-approved regulatory mechanisms (e.g., Oregon ORS 537.455-.500, Washington RCW 90.42) for ensuring that water savings will be protected as instream water rights, or in cases where project implementers identify how the water conserved will remain instream to benefit fish without any significant loss of the instream flows to downstream diversions.

Unneeded or abandoned irrigation diversion structures will be removed where they are barriers to fish passage; have created wide, shallow, channels or simplified habitat; or are causing sediment concerns through downstream scour or deposition behind the structure according to **Dams, Water Control Structures, or Legacy Structures Removal** section (Category 1a).

Lay-flat stanchions are not covered under HIP.

Guidelines for Review

Low Risk: Removal or replacement of irrigation diversion structures less than 3 feet in height.

Medium Risk: Removal or replacement of irrigation diversion structures greater than 3 feet in height will require both BPA and NMFS Engineering Review.

All medium risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

Conservation Measures

1) For removal of channel spanning diversion structures greater than 3 feet in height, the profile of the stream channel thalweg in the design plan shall be shown to provide enough information to clearly demonstrate project impacts to the stream channel, and the

potential for channel degradation for a minimum for (10) upstream and (10) downstream channel widths of the upstream and downstream boundaries of the project.

2) Diversion structures shall be designed to meet NMFS Anadromous Salmonid Passage Facility Design Guidelines (NMFS 2011 or more recent version) and, where appropriate, *Guidelines for incorporating adult Pacific lamprey passage at fishways (PLTW 2017)*.
3) In order to reduce entrainment of larval lamprey, the use of wire cloth for screening should be avoided; perforated plate, vertical bar or interlocking bar screens should be used instead (Rose and Mesa 2012).
4) Placement of rock structures or engineered riffles shall follow criteria outlined in the Headcut and Grade Stabilization activity category 1c.
5) Project design shall include the installation of a totalizing flow meter on all diversions for which installation of this device is possible. A staff gauge or other device capable of measuring instantaneous flow will be utilized on all other diversions.
6) Multiple existing diversions may be consolidated into one diversion if the consolidated diversion is located at the most downstream existing diversion point unless sufficient water is available to support unimpeded passage at low flows. The design will clearly identify the low flow conditions within the stream reach relative to the cumulative diverted water right. If instream flow conditions are proven favorable for fish passage and habitat use, then diversion consolidation may occur upstream of the lowest original structure.
7) Diversions will be designed to incorporate Point of Diversion (POD) flow restrictions to limit the diverted flow to satisfy the irrigator's water right at the 95% exceedance stream flow stage. Diversion flow restriction may be accomplished by any practical means available but must be supported by hydraulic calculations and a stage rating curve. POD flow restriction may be accomplished by:
8) Incorporation of a restricted orifice plate or screen at the POD that provides at a maximum, the required area to pass the irrigators water right;
9) Mechanically restricting the opening of a variable head gate to the maximum area required to pass the irrigator's water right; or
10) Any other method that will satisfy the intent of the diversion flow governance requirement that can be justified by the design documents.
11) Treated wood and copper- or zinc-plated hardware shall not be used in the construction of irrigation diversions. Concrete must be sufficiently cured or dried (48-72 hours depending on temperature) before coming into contact with stream flow.
12) Irrigation diversion intake and return points will be designed or replaced to prevent fish and other aquatic organisms of all life stages from swimming or being entrained in the irrigation system. Fish screens for surface water that is diverted by gravity or by pumping at a rate that exceeds 3 cfs will be submitted to NMFS for review and approval.
13) Diversions equipped with a fish screen that utilizes an automated cleaning device will have a minimum effective surface area of 2.5 square feet per cfs, and a nominal maximum approach velocity of 0.4 feet per second (fps).
14) Diversions with no automated cleaning device shall have a minimum effective surface area of 5 square foot per cfs, and a nominal maximum approach rate of 0.2 fps; and a round or square screen mesh that is no larger than 2.38 mm (0.094 inch) in the narrow dimension, or any other shape that is no larger than 1.75 mm (0.069 inch) in the narrow dimension.

Category 1c) Headcut and Grade Stabilization

*Description***.** BPA proposes to review and fund the restoration of fish passage and grade control (i.e. headcut stabilization) with geomorphically-appropriate structures constructed from rock or large wood (LW). Boulder weirs and roughened channels may be installed for grade control at culverts to mitigate headcuts, and to provide passage at small dams or other channel obstructions that cannot otherwise be removed. For wood-dominated systems, grade control engineered log jams (ELJs) should be considered as an alternative.

Grade control ELJs are designed to arrest channel downcutting or incision, retain sediment, lower stream energy, and increase water elevations to reconnect floodplain habitat and diffuse downstream flood peaks. Grade control ELJs also serve to protect infrastructure that is exposed by channel incision and to stabilize over-steepened banks. Unlike hard weirs or rock grade control structures, a grade control ELJ is a complex broad-crested structure that dissipates energy more gradually.

If geomorphic conditions are appropriate, consideration should be given towards use of a roughened channel or constructed riffle to minimize the potential for future development of a passage (jump height) barrier.

Guidelines for Review

Low Risk: Boulder weirs and other grade control structures that address headcuts less than 18 inches in height (18 inches refers to height of the headcut, rather that the height of individual weirs or other grade-control structures intended to address the headcut) with drawings that demonstrate the incorporation of applicable conservation measures.

Medium Risk: Boulder weirs and other grade control structures that are constructed to address headcuts greater than 18 inches in height (elevation differential across headcut from streambed) will require both BPA and NMFS Engineering Review. Roughened channels or constructed riffles are considered medium-risk.

All medium to high risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

Conservation Measures

1) For boulder weirs and other grade control structures that are greater than 18 inches in height (elevation differential across headcut from streambed), the profile of the stream channel thalweg in the design plan shall provide enough information to clearly demonstrate project impacts to the stream channel and the potential for channel degradation, for a minimum for (10) upstream and (10) downstream channel widths of the downstream and upstream boundaries of the project.
2) All structures will be designed to the design benchmarks set forth in NMFS 2011 or most recent version).
3) **Boulder weirs** shall incorporate the following design features:
    a) Install boulder weirs low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.5-year flow event).

b) Boulder weirs are to be placed diagonally across the channel or in upstream pointing “V” or “U” configurations (with the apex oriented upstream). The apex should be lower in elevation than the structure wings to support low flow consolidation.
c) Boulder weirs are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. This can be accomplished by providing plunges no greater than 6 inches in height, allowing for juvenile fish passage at all flows.
d) Key the weirs into the streambed (preferably at least 2.5 times their exposure height)) to minimize structure undermining due to scour. The weir should also be keyed into both banks in a manner that prevents water from cutting around the structure.
e) Include fine material in the weir material mix to help seal the weir/channel bed, thereby preventing subsurface flow. Geotextile material can be used as an alternative approach to prevent subsurface flow.
f) Rock for boulder weirs shall be durable and of suitable quality to ensure permanence in the climate in which it is to be used.
g) Full spanning boulder weir placement shall be coupled with measures to improve habitat complexity (e.g., LW placement, etc.) and protection of riparian areas.
h) The use of gabions, cable, or other means to prevent the movement of individual boulders in a boulder weir is not allowed.

4) **Headcut stabilization** shall incorporate the following design features:
   a) Armor the head-cut with sufficiently-sized and amounts of material to prevent continued up-stream movement. Materials can include both rock and organic materials which are native to the area.
   b) Focus stabilization efforts in the plunge pool, the head cut, as well as in a short distance of stream above the headcut.
   c) Minimize lateral migration of the channel around the head cut (“flanking”) by placing rocks and organic material at a lower elevation in the center of the channel cross section to direct flows to the middle of channel.
   d) Provide fish passage over a stabilized head-cut through a series of log or rock weir structures or a roughened channel.
   e) Headcut stabilization structures will be constructed utilizing stream simulation bed material, which will be pressure-washed into place until surface flow is apparent and minimal subsurface material to ensure fish passage immediately following construction (if natural flows are sufficient). Successful washing will be determined by minimizing voids within placed matrix such that ponding occurs with little to no percolation losses.

Category 1d) Low Flow Consolidation

Description. BPA proposes to fund and review projects that: (a) modify diffused or braided flow conditions that impede fish passage; (b) modify dam aprons with shallow depth (less than 10 inches); or (c) utilize temporary placement of sandbags, straw bales, and ecology blocks to provide depths and velocities passable to upstream migrants.

Guidelines for Review
*Medium or High Risk***:** All of the sub-activities under the Low Flow Consolidation activity category will require both BPA and NMFS Engineering Review.

All medium to high risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

Conservation Measures

1) *Fish Passage will be designed to the design benchmarks set forth in NMFS 2011 (or* most recent version) and, where appropriate, guidelines set forth in Pacific Lamprey Technical Workgroup 2017.
2) All temporary material placed in the stream to aid low-flow fish passage will be removed when stream flow increases, prior to anticipated high flows that could wash consolidation measures away or cause flow to go around them.

Category 1e) Provide Fish Passage at an Existing Facility

*Description***.** BPA proposes to fund and review projects that: (a) re-engineer fish passage or fish collection facilities that are improperly designed; (b) periodic maintenance of fish passage or fish collection facilities to ensure proper functioning (e.g., cleaning debris buildup, replacement of parts); and (c) installation of a fish ladder at an existing facility.

Guidelines for Review

Low Risk: Periodic Maintenance of Fish passage or Fish Collection Facilities.

Medium or High Risk: Re-engineering improperly-designed fish passage or fish collection facilities, installation of a fish ladder at an existing facility, or other activities that are not considered maintenance. These require both BPA and NMFS Engineering Review.

All medium to high risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

Conservation Measures

1) Fish Passage will be designed to the design benchmarks set forth in NMFS 2011 (or most recent version).
2) Design consideration should be given for Pacific lamprey passage, as described in guidelines set forth in Pacific Lamprey Technical Workgroup 2017. Briefly fish ladders that are primarily designed for salmonids are usually impediments to lamprey passage as they do not have continuous, adequate surfaces for attachment, velocities are often too high, and there are inadequate places for resting. Providing rounded corners, smooth continuous floor for attachment, resting areas, or providing a natural stream channel (stream simulation) or wetted ramp for passage over the impediment have been effective in facilitating lamprey passage.
3) Treated wood and copper- or zinc-plated hardware shall not be used in the construction of fish ladders. Concrete must be sufficiently cured or dried before coming into contact with stream flow.

Transportation Infrastructure

Description. BPA proposes to review and fund maintenance, removal, or replacement of bridges, culverts, and fords to improve fish passage; prevent streambank and roadbed erosion; facilitate natural sediment and wood movement; and eliminate or reduce excess sediment loading.

BPA proposes the following activities to improve fish passage:

1) Bridge and Culvert Removal or Replacement;
2) Bridge and Culvert Maintenance; and
3) Installation of Fords.

Category 1f) Bridge and Culvert Removal or Replacement

Description. When replacing an existing culvert with a new crossing, the preferred methods of replacement are (in decreasing order of preference):

1) Bridge
2) Open bottom culvert (designed by the streambed simulation design method)
3) Closed bottom culvert (designed by the streambed simulation design method or the no-slope method)

New culverts can only be built when an existing crossing was present, unless there are an overall reduction in the amount of stream crossings.

Guidelines for Review

Medium Risk: Culverts and bridges will require BPA Engineering Review.

All medium to high risk projects shall address the **Basis of Design Requirements.**

Conservation Measures

Bridges and open bottom culverts must be designed so they are wide enough to maintain a clear, unobstructed opening during events that approximate a two-year recurrence interval.

1) A single span bridge or stream simulation culvert must maintain a clear and unobstructed opening 1.5 times the bankfull width or greater.
2) A multiple span bridge must maintain a total clear and unobstructed opening 2.2 times the bankfull width or greater.
3) For bridge structures across steep canyons or tidal sloughs, entrenchment ratios (ER) may be used in order to calculate appropriate span.

Category 1g) Bridge and Culvert Maintenance

Description. BPA proposes to fund the redress, or return, of a bridge or culvert to its as-built conditions.

Guidelines for Review

Low Risk: Culverts and bridge maintenance is a low-risk activity and requires no review.

Conservation Measures

1) Culverts will be cleaned by working from the top of the bank, unless culvert access using work area isolation would result in less habitat disturbance. Only the minimum amount of wood, sediment and other natural debris necessary to maintain culvert function will be removed; spawning gravel will not be disturbed.
2) All large wood, cobbles, and gravels recovered during cleaning will be placed downstream of the culvert.
3) Do all routine work in the dry. If this is not possible, follow work area isolation criteria outlined in the Work Area Isolation & Fish Salvage Requirements.

Category 1h) Installation of Fords

Description. Fords will be installed to allow improved stream crossing conditions only. New fords shall not be installed when there was not a previously existing stream crossing. For the purposes of this proposed action, fords are defined as crossings for vehicles, off-highway vehicles (OHVs), bikes, pack animals, and livestock.

Guidelines for Review

Low Risk: Fords that meet all conservation measures.

Medium Risk: Fords that do not meet all conservation measures.

All medium to high risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

Conservation Measures

1) The ford will not create barriers to the passage of adult and juvenile fish. This includes upstream passage of Pacific lamprey, so any corners should be rounded to allow their passage.
2) Ford stream crossings will require the placement of river rock along the stream bottom. The rock shall be of proper-sized gradation for that stream and, if possible, non-angular.
3) Existing access roads, trails, and stream crossings will be used whenever possible, unless new construction would result in less habitat disturbance and the old crossing is retired.
4) The ford will not be located in an area that will result in disturbance or damage to a properly functioning riparian area.
5) Fords will be placed on bedrock or stable substrates whenever possible.
6) Fords will not be placed in areas where ESA-listed salmonids (salmon, steelhead, bull trout) spawn or are suspected of spawning; or within 300 feet of such areas if spawning areas may be disturbed. Sufficient information detailing locations of ESA-listed salmonid spawning areas within the reach shall be provided to demonstrate adherence to this conservation measure.
7) Bank cuts, if any, will be stabilized with vegetation; and approaches and crossings will be protected with river rock (not crushed rock) when necessary to prevent erosion.

8) Fords will have a maximum width of 15 feet (downstream-upstream) to minimize the time that livestock spends in the crossing or riparian area.
9) Fences will be installed (if not already existing and functioning) along with all new and replaced fords to limit access of livestock to riparian areas. Fenced-off riparian areas will be maximized in size and planted with native vegetation. Fences will not inhibit upstream or downstream movement of fish or significantly impede bedload movement. Where appropriate, construct fences at fords to allow passage of large wood and other natural debris.
10) Vehicle fords will only be allowed in streams with no salmonid fish spawning.
11) Designs must demonstrate that the ford accommodates reasonably foreseeable flood risks, including associated bedload and debris, and to prevent the diversion of streamflow out of the channel and down the trail if the crossing fails.

Category 2: River, Stream, Floodplain, and Wetland Restoration

BPA proposes to review and fund river, stream, floodplain, and wetland restoration actions with the objective of providing appropriate habitat conditions required for foraging, rearing, and migrating ESA-listed fish.

Projects utilizing habitat restoration actions outlined within this activity category shall be related to limiting factors identified within the applicable sub-basin plan for the watershed, a recovery plan for ESA-listed species, or shall be prioritized by recommended restoration activities identified within a localized region by a technical oversight and steering committee (e.g., the Columbia River Estuary). Individual projects may utilize a combination of the activities listed in the **River, Stream, Floodplain, and Wetland Restoration** activity category.

BPA proposes the following activities to improve fish habitat: (a) improve secondary channel and wetland habitats; (b) set-back or removal of existing berms, dikes, and levees; (c) protect streambanks using bioengineering methods; (d) install habitat-forming natural material instream structures (e.g., large wood, boulders, and spawning gravel); (e) riparian vegetation planting; and (f) channel reconstruction.

<u>*Category 2a) Improve Secondary Channel and Floodplain Connectivity*</u>

Description. BPA proposes to review and fund projects that reconnect historical stream channels within floodplains; restore or modify hydrologic and other essential habitat features of historical river floodplain swales, abandoned side channels, spring-flow channels, wetlands, and historical floodplain channels; and create new self-sustaining side channel habitats, which are maintained through natural processes.

<u>*Guidelines for Review*</u>

Medium or High Risk: All of the sub-activities under the **Improve Secondary Channel and Wetland Habitats** projects subcategory will require BPA review.

All medium to high-risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

<u>*Conservation Measures*</u>

1) Designs must demonstrate that the project will be self-sustaining over time or promote the recovery of natural habitat-forming processes. Self-sustaining means the restored or created habitat would not require major or periodic maintenance, but function naturally within the processes of the floodplain. Promotion of natural habitat-forming processes means an early step in the restoration of a process that may take decades or multiple steps to restore.
2) Proposed new side channel construction must be within the historic floodplain (e.g., 5-year recurrence interval), current channel meander migration zone, and require limited excavation for construction. Reconnection of historical fragmented habitats is preferred.

3) Perennial side channels will be constructed to prevent fish stranding by providing a continual positive **overall** grade, or, if the gradient is lower than the main channel then by providing a year-round water connection.
4) Intermittent side channels activated only at flood stage should be designed with sufficient roughness and gradient to create shallow, slow-moving water that will not attract fish.
5) Excavated material removed from off- or side-channel habitat shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity. Hydric soils may be salvaged to provide appropriate substrate and/or seed source for hydrophytic plant community development. Hydric soils will only be obtained from wetland salvage sites.
6) Excavation depth will never exceed the maximum thalweg depth of the main channel.
7) All side channel and pool habitat work will occur in isolation from waters occupied by ESA-listed salmonid species until project completion. During project completion, a reconnection may be made by either excavation to waters occupied by ESA-listed salmonids or re-watering of these channel units.
8) Adequate precautions will be taken to prevent the creation of fish passage issues or stranding of juvenile or adult fish. Stranding must be avoided by incorporating floodplain or channel features that create shallow, slow-moving, water during flood stage that will not attract fish.
9) **Re-watering stream channels**. For stream channels which have been isolated and dewatered during project construction:
    a) Reconstructed stream channels will be "pre-washed" into a reach equipped with sediment capture devices, prior to reintroduction of stream flow.
    b) Stream channels will be re-watered slowly to minimize a sudden increase in turbidity (use **Staged Rewatering Plan** when appropriate).

Category 2b) Set-back or Removal of Existing Berms, Dikes, and Levees

Description. This action category includes the removal of fill (e.g., dredge spoils) from past channelization projects, roads, trails, railroad beds, dikes, berms, and levees in order to restore natural estuary and freshwater floodplain functions. Tide gates may be setback with berms, dikes, and levees. However, tide gates must not degrade baseline conditions (fish passage and habitat). Placement of new gates where none previously existed is not covered in this consultation.

Actions in freshwater, estuarine, and marine areas include: 1) full and partial removal of levees, dikes, berms, and jetties; 2) breaching of levees, dikes, and berms; 3) lowering of levees, dikes, and berms; 4) setback of levees, dikes, and berms; and 5) removal of spoils piles from the floodplain.

Guidelines for Review

Medium or High Risk: All of the sub-activities under the **Set-back or Removal of Existing Berms, Dikes, and Levees** projects subcategory will require BPA Engineering review. Tide gates will require NMFS engineering review.

All medium to high risk projects shall address the **Basis of Design Requirements.**

Conservation Measures

1) To the greatest degree possible, non-native fill material, originating from outside the floodplain of the action area, will be removed from the floodplain and disposed of at an upland site.
2) Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events.
3) 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 that flows will naturally recede back into the main channel, minimizing fish entrapment.
4) When necessary, loosen compacted soils once overburden material is removed.
5) Overburden or fill material that is native to the project area may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that this does not impede floodplain function.
6) When a setback is required, setback locations should be prioritized to the outside of either the meander belt width or the channel meander zone margins.

Category 2c) Protect Streambanks Using Bioengineering Methods

The HIP will not cover stand-alone bank stabilization projects.

Description. BPA proposes to review and fund projects that restore eroding streambanks through bank shaping; installation of soil reinforcements (e.g., coir logs, large wood, etc.) and other bioengineering techniques, as necessary, to support development of riparian vegetation; and/or planting of trees, shrubs, and herbaceous cover, as necessary, to restore ecological functions in riparian and floodplain habitats.

As actions that are covered by this programmatic consultation need to have the purpose of restoring floodplain and estuary functions or to enhance fish habitat, streambank stabilization shall only be proposed when there are additional interrelated and interdependent habitat restoration actions.

The primary structural streambank protection action proposed is the installation of large wood and riparian vegetation configured to increase bank strength and resistance to erosion. This is considered to be an ecological approach to managing streambank erosion (i.e. bioengineering).

Guidelines for Review

Medium or High Risk: Streambank projects will require BPA Engineering review.

All medium to high risk projects shall address the **Basis of Design Requirements** and require **BPA Engineering Review**.

Conservation Measures

1) Without changing the location of the bank toe, damaged streambanks will be restored to a slope, pattern, and profile suitable for establishment of permanent woody vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated cohesive soils. The purpose of

bank shaping is to provide a more stable platform for the establishment of riparian vegetation, while also reducing the depth to the water table, therefore promoting better plant survival.

2) Projects should ideally use plantings and soil bioengineering for bank stabilization, and use large wood for stabilization as a last resort. The goal of bioengineering projects should be long term stabilization by vegetation.
3) Large wood will be added to create habitat complexity and interstitial habitats through use of various large wood sizes and configurations of the placements when feasible.
4) Structural placement of large wood should focus on providing channel boundary roughness for energy dissipation versus flow re-direction that may affect the stability of the opposite streambank.
5) Large wood will be intact, hard, and undecayed to partly decaying with untrimmed root wads to provide functional refugia habitat for fish. Use of decayed or fragmented wood found lying on the ground may be used for additional roughness and to add complexity to large wood placements but will not constitute the primary structural components.
6) Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream.
7) Large wood anchoring will not utilize cable or chain. Manila, sisal or other biodegradable ropes may be used for lashing connections. If hydraulic conditions warrant use of structural connections, then rebar pinning or bolting may be used. The utilization of structural connections should be used minimally and only to ensure structural longevity in highly energetic systems (high gradient systems with lateral confinement and a limited floodplain). The need for structural anchorage shall be demonstrated in the design documentation.
8) Rock will not be used for streambank stabilization, except as ballast to stabilize large wood unless it is necessary to prevent scouring or downcutting of an existing flow control structure (e.g., a culvert, bridge support, headwall, utility lines, or building). In this case, rock may be used as the primary structural component for construction of vegetated riprap with large wood. Scour holes may be filled with rock to prevent damage to structural foundations but will not extend above the adjacent bed of the river. This does not include scour protection for bridge approach fills.
9) The rock may not impair natural stream flows into or out of secondary channels or riparian wetlands.
10) Fencing will be installed as necessary to prevent access and grazing damage to revegetated sites and riparian buffer strips.
11) Riparian buffer strips associated with streambank protection shall extend from the bankfull elevation towards the floodplain a minimum distance of 35 feet.

Category 2d) Install Habitat-Forming Instream Structures (Large Wood, Small Wood & Boulders)

Description. BPA proposes to review and fund projects that include placement of in stream structures comprised of natural habitat-forming materials to provide instream complexity and to support spawning, rearing, and resting habitat for salmonids and other aquatic species. Anthropogenic activities that have altered riparian habitats, such as splash damming and the removal of large wood, logjams, and boulders have reduced instream habitat complexity in many rivers and have eliminated or reduced features like pools, cover, and bed complexity that Salmonids need for rearing, feeding, and migrating. To offset these impacts, in-stream structures consisting of large wood, small wood and boulders will be placed in stream channels either individually or in combination.

Projects utilizing structures shall increase instream structural complexity and diversity, shall mimic the processes and functions of natural input of large wood (e.g., whole conifer and hardwood trees, logs, root wads, etc.); boulders and complex bedforms, create rearing habitat and pool formation; promote spawning gravel deposition; reduce siltation in pools; reduce the width/depth ratio of the stream; decrease flow velocities; deflect flows into adjoining floodplain areas to increase channel and floodplain function, promote natural vegetation composition and diversity on the floodplain and provide high-flow refugia.

The term "structure" refers to any intentionally placed object in the stream or floodplain. Structures that come in contact with water obstruct streamflow and force it to run over, around, and/or under the structure. This redirection, concentration, or expansion of flow influences the form, structure, hydraulics, and consequently, the function of the stream. As a result, instream structures are prone to having unintended consequences; caution must be exercised when using this approach.

All structures placed in a channel have the potential to affect channel hydraulics, sediment scour and deposition patterns, and the processes of wood and sediment transport. The degree to which these effects achieve the desired results or place nearby habitat, infrastructure, property, and public safety at risk depends on a number of important variables that affect the way in which a structure functions in the stream. The following parameters should be considered in structure design.

- Channel constriction caused by the structure
- Location of the structure within the channel cross-section and its height relative to the depth of flow
- Structure spacing
- Structure configuration and position in the channel
- Sediment supply and substrate composition
- Wood loading, transport and supply
- Channel confinement
- Channel slope
- Hydrology
- Fish life histories and limiting factors
- Time

Large Wood Placements. Large wood placements are defined herein as projects or structures that use trees that are greater 1 foot in diameter as measured at diameter at breast height, (DBH), (measured 4.5 feet from the end of the rootwad or cut end) and 15 feet or greater in length as the primary pieces within the placement or structure. This criterion does not preclude the use of materials with dimensions less than this size class for racking, woven, or slash that may be incorporated into the structure.

Placement of large woody debris (wood) and other structures in streams is one of the most widespread and common techniques to improve riverine fish habitat. Techniques for wood placement range from simply falling, pushing, or hauling trees from the riparian zone into the active stream channel to construction of highly engineered structures such as log weirs or engineered logjams (Roni et al. 2014).

Large wood will be placed to increase coarse sediment storage, increase habitat diversity and complexity, retain gravel for spawning habitat, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macroinvertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refugia for fish during high flows. Structure design criteria should be focused on balancing biological benefit, structural resiliency, and enhancing complementing watershed driven and reach scale processes. Increasing the system-wide placement and longitudinal extent of process forming friction elements may be more effective in many reaches than individual, large scale structures. This process allows for longitudinal moderation of applied energy along a longer reach of the river system vs. a few large structures that must with stand the applied forces of the simplified watershed and stream network. The placement of large wood should be viewed as an interim solution - a short-term improvement providing habitat as natural rates of woody debris recruitment are restored through riparian forest regeneration.

Habitat created by structures may be critical at specific times of year or ranges of discharge. Therefore, it may be appropriate to establish design discharges that relate to specific fish and wildlife benefits, in addition to those that dictate structural failure. For instance, the limiting factor for fish may be cover during summer low flow or shelter during high flow events. Under these circumstances structures will need to be designed to function during this critical time, at a minimum, in order to optimize their effects. Timing and discharge requirements may be specific to the stream and target species and age class (e.g., fish passage requirements for adult chum salmon will differ from that for juvenile coho salmon).

Small Wood Placements. Small wood placements are defined herein as projects or structures that use trees that are less than 1 foot in diameter as measured at diameter at breast height, (DBH), (measured 4.5 feet from the end of the rootwad or cut end) and 15 feet or less in length.

This activity includes the installation of small wood in-channel structures that mimic the processes and functions of beaver dams including flattening of local stream gradients, increasing interactions between the stream and floodplain, increasing bank storage, capturing of relatively fine sediment in the channel, pool formation, and hyporheic exchange. Structures consist of porous channel-spanning or partial spanning structures comprised of small diameter woody debris (including whole trees) riparian cuttings and other inert materials that are structurally reinforced with small diameter driven posts. Structures include spaces between posts that allow water, sediment, fish, and other aquatic organisms to move through the structure.

Variation of this restoration treatment may include small, whole tree placement, beaver dam analogues, post assisted log structures, post lines only, post lines with wicker weaves, construction of starter dams, reinforcement of existing active beaver dams, and reinforcement of abandoned beaver dams as described by Pollock et al. (2012). The structure (either alone or in combination with debris that it traps) causes a significant reduction in channel cross-sectional area or in series will collectively increase the hydraulic roughness of the channel, thereby reducing velocities, increasing flow depth and creating backwater. The effects of large-scale backwatering can include increased flood levels and frequency of floodplain inundation, potential change in riparian species composition and distribution in response to changing inundation patterns and water table elevations, and reduced reach transport of sediment and woody debris.

Boulder Placements. Boulder placements may be used to restore habitat diversity to plane bed streams from which boulders have been removed, as an enhancement technique to increase habitat diversity in new channels, naturally plane bed stream reaches, and altered plane bed channels that were historically dominated by wood. Boulder placements increase habitat diversity and complexity, improve flow heterogeneity, provide substrate for aquatic vertebrates, moderate flow disturbances, and provide refuge for fish during high flows.

The placement of individual large boulders and boulder clusters to increase structural diversity is important to provide holding and rearing habitat for ESA-listed salmonids and create a diversity of water depth, substrate, and velocity, thereby increasing habitat diversity of an otherwise plane bed stream. Increased diversity is evident immediately after boulder placement and improves over time as substrate is scoured and sorted during high flow events. Boulder clusters should only be applied where a biologic or geomorphic need has been identified.

Guidelines for Review:

Low Risk: Installation of habitat forming structures with drawings that demonstrate the incorporation of all conservation measures and require no ballast, boulders, excavation or structural connections and include no risk to downstream infrastructure or property.

Medium or High Risk: Installation of habitat forming structures that require ballast, excavation, or structural connections. Risk level of habitat forming structures also depends on scope and scale of proposal.

Both Large Wood and Small Wood projects shall address the **Basis of Design Requirements** and require initial **BPA Engineering Review**.

Conservation Measures (Large Wood)

1) Large wood placements must be designed to mimic the process and function of natural accumulations of large wood in the channel, estuary, or marine environment and address defined limiting factors.
2) Large wood placements for other purposes than habitat restoration or enhancement are excluded from this consultation.
3) Large wood must be intact, hard, and undecayed to partly decaying and should include untrimmed root wads to provide functional refugia habitat for fish. Large wood includes whole trees with rootwad and limbs attached, pieces of trees with or without rootwads and limbs, and cut logs. Use of decayed or fragmented wood found

lying on the ground or partially sunken in the ground is not acceptable for key pieces but may be incorporated to add habitat complexity.

4) Large wood anchoring will not utilize cable or chain. Manila, sisal or other biodegradable ropes may be used for lashing connections. If hydraulic conditions warrant use of structural connections then rebar pinning or bolting may be used. The utilization of structural connections should be used minimally and only to ensure structural longevity in highly energetic systems (high gradient systems with lateral confinement and limited floodplain). Rationale for structural anchorage shall be justified and demonstrated in the Basis of Design Report and will be evaluated as a component of the HIP Technical Review.
5) If 100 year flood design criteria is applied to specific structures then stability requirements must be considered for the primary LWD elements including base, key and anchorage members (logs larger than 15 feet long and greater than one foot in diameter). These pieces are assumed to comprise ~ 50% of the overall structure. Woven, racking, matrix, and recruited material are expected to be transient and dynamically interact with the fluvial system. If specific stability evaluation of a structure result in criteria more conservative than that presented above, then a risk – benefit analyses is expected to ascertain the appropriateness of the subject structure. This assessment will be used to determine the benefits to fish habitat and may result in forgoing or modification of the project element.
6) Rock may be used for ballast but should be limited to what is needed to anchor the large wood.
7) Piling shall consist of wood piles; steel piles are not to be used under any circumstance. Drive each piling as follows to minimize the use of force and resulting sound pressure:
    a) Use a vibratory head to drive the piles; an impact hammer shall not be used.
    b) Select areas with soft substrate rather than rocky hard substrate; avoid bedrock.
    c) Isolate the work area if possible to minimize acoustic disturbance.

Conservation Measures (Small Wood)

1) Small wood placements shall be constructed for floodplain reconnection in stream systems less than 4% stream gradient.
2) Structures that are overtopped shall have crest elevations that extend no more than 3 feet above the stream bed. Vertical posts (if utilized) shall be cut flush and not extend above the proposed crest elevation.
3) For incised channels, an adaptive management approach using lower elevation structures that trap sediment and aggrade the channel, with future and subsequent project phases is preferred over tall structures with excessive drop and increased risk of failure.
4) Vertical posts (if utilized) must be driven to a depth at least 1.5 times the expected scour depth of the waterway or a ratio of 1:2 for exposed – embedded length whichever is more conservative. A minimum 1.5 foot clear space is required between posts.
5) All in-stream construction associated with small wood structures shall be completed by hand or small machinery not to exceed 15,000lbs operating weight.

6) All primary materials used in small wood placements must consist of non-treated wood (e.g. fence posts) and must be constructed from a materials source collected outside the riparian area.
7) Structures cannot unreasonably interfere with use of the waterway for navigation, fishing or recreation.
8) Placement of inorganic material is limited to the minimum quantity necessary to prevent under-scour of structure and manage pore flow sufficient to ensure adequate over-topping flow and side flow to facilitate fish passage where required.
9) In addition to any other design parameters necessary to meet fish passage requirements, structures must be porous, must provide for a water surface differential of no more than one-foot at low flows, or otherwise provide a clear path for fish passage over, through or around the structure during low flows.
10) No cabling, wire, mortar or other materials that serve to affix the structure to the bed, banks or upland is allowed.
11) Additional potential effects of these structures may include channel aggradation and associated channel widening, bank erosion, increased channel meandering, and decreased channel depth. The Basis of Design Report must demonstrate how these potential impacts have been addressed.
12) At project completion, all disturbed areas, including staging and access areas, will need to be graded smooth, seeded, and planted to repair damage and restore the riparian zone.

Conservation Measures (Boulder Placement)

1) Boulder placements for purposes other than habitat restoration or enhancement are not covered under this activity of HIP 4.
2) Boulder placements will be limited to reaches with a streambed that consists predominantly of coarse gravel or larger sediments and will address identified limiting factors.
3) The cross-sectional area of boulder placements may not exceed 25% of the cross-sectional area of the low-flow channel.
4) Boulder placements may not be installed with the purpose of shifting the stream flow to a single flow pattern in the middle or to the side of the stream.
5) Boulders will be machine-placed (no end dumping allowed) and will rely on the size of boulder, rather than anchoring, for stability.
6) Boulders will be installed in a low position in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 2-year flow event).
7) Permanent anchoring, including rebar or cabling, may not be used.
8) At project completion, all disturbed areas, including staging and access areas, will need to be graded smooth, seeded, and planted to repair damage and restore the riparian zone.

Category 2e) Riparian and Wetland Vegetation Planting

Description. BPA proposes to fund vegetation planting to recover watershed processes and functions associated with native plant communities and that will help restore natural plant species composition and structure. Under this activity category, the project sponsors would plant trees, shrubs, herbaceous plants, and aquatic macrophytes to help stabilize soils or restore riparian plant communities. Large trees such as cottonwoods and conifers will be planted in areas where they historically occurred but are currently either scarce or absent. Native plant species and seeds will be obtained from local sources to ensure plants are adapted to local climate and soil chemistry.

Vegetation management strategies will be utilized that are consistent with local native succession and disturbance regimes and specify seed/plant source, seed/plant mixes, and soil preparation. Planting will address the abiotic factors contributing to the sites' succession (i.e. weather and disturbance patterns, nutrient cycling, and hydrologic condition). Only certified noxious weed-free seed (99.9%), straw, mulch or other vegetation material for site stability and revegetation projects will be utilized.

Guidelines for Review

Low Risk: Riparian vegetation planting is considered low-risk and requires no BPA review.

Conservation Measures

1) An experienced silviculturist, botanist, ecologist, or associated technician shall be involved in designing vegetation treatments.
2) Species to be planted must be of the same species that naturally occur in the project area.
3) Tree and shrub species as well as sedge and rush mats to be used as transplant material shall come from outside the bankfull width, typically in abandoned floodplains, and where such plants are abundant, or be salvaged from areas where excavation is planned.
4) Sedge and rush mats should be sized and anchored to prevent their movement during high flow events.
5) Species distribution shall mimic natural distribution in the riparian and floodplain areas.

Category 2f) Channel Reconstruction

Description. BPA proposes to review and fund channel reconstruction projects to improve aquatic and riparian habitat diversity and complexity, reconnect stream channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, provide long-term nutrient storage, provide substrate for macroinvertebrates, moderate flow disturbance, increase retention of organic material, and provide refuge for fish and other aquatic species. All this will be accomplished by reconstructing stream channels and floodplains that are compatible within the appropriate watershed context and geomorphic setting.

The reconstructed stream system shall be composed of a naturally sustainable and dynamic planform, cross-section, and longitudinal profile which incorporates unimpeded passage and temporary storage of water, sediment, organic material, and species. Stream channel adjustment over time is to be expected in naturally dynamic systems and is a necessary component to restore a wide array of stream functions. It is expected that for most projects there will be a primary channel with secondary channels that are activated at various flow levels to increase floodplain connectivity and to improve aquatic habitat through a range of flows. This proposed action is not intended to artificially stabilize streams into a single location or into a single channel for the purposes of protecting infrastructure or property.

Channel reconstruction consists of re-meandering or movement of the primary active channel and may include structural elements such as streambed simulation materials, streambank restoration, and hydraulic roughness elements. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder weirs shall be preferentially used in step-pool and cascade stream types. Material selection (large wood, rock, gravel) shall also mimic natural stream system materials.

Guidelines for Review

Medium Risk: Channel Reconstruction that restores historical alignment with minimal excavation shall require BPA HIP Review.

High Risk: Channel Reconstruction that creates entirely new channel meanders through significant excavation shall require BPA Engineering and Interagency Review.

All medium to high risk projects shall address the **Basis of Design Report Requirements.**

Channel Reconstruction also requires a **Staged Rewatering Plan** and a **Monitoring and Adaptive Management Plan.**

Conservation Measures

1) Detailed construction drawings must be provided.
2) Designs must demonstrate that channel reconstruction will identify, correct (to the extent possible), and account for (in the project development process), the conditions that lead to the degraded condition.
3) Designs must demonstrate that the proposed action will mimic natural conditions for gradient, width, sinuosity and other hydraulic parameters.
4) Designs must demonstrate that structural elements shall fit within the geomorphic context of the stream system.
5) Designs must demonstrate sufficient hydrology and that the project will be self-sustaining over time. Self-sustaining means the restored or created habitat would not require major or periodic maintenance but function naturally within the processes of the floodplain.
6) Designs must demonstrate that the proposed action will not result in the creation of fish passage issues or post-construction stranding of juvenile or adult fish.

Category 2g) Install Habitat-Forming Materials (sediment and spawning gravel)

Description. In areas where natural gravel and sediment supplies are low (e.g., immediately below reservoirs), gravel and sediment placement can be used to improve spawning habitat.

Sediment supply is limited in the estuary due to the presence of numerous dams in the Columbia basin that trap sediments and prevent them from depositing downriver. The Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (NMFS 2011) identifies sediment as a limiting factor for salmonid recovery: "The transport of sediment is fundamental to habitat-forming processes in the estuary through sediment deposition and erosion (Fresh et al. 2005). Since the late nineteenth century, sediment transport from the interior basin to the Columbia River estuary has decreased about 60% and total sediment transport has decreased about 70% (Jay and Kukulka 2003). This reduction in the amount of sediment transport in the Columbia River has affected habitat-forming processes in the estuary (Bottom et al. 2005). It is presumed to be a limiting factor for salmon and steelhead because it limits the accretion of sediment and thus the formation of shallow-water habitats." Shallow-water habitats are of particular importance to out-migrating juvenile salmonids, in particular young-of-the-year Chinook and chum, which are highly shoreline dependent.

NMFS 2001 states further, "Although the consequences of the reduced transport of sediment through the estuary and plume are not fully understood, the magnitude of change is very large compared to historical benchmarks (Fresh et al. 2005). Sediment also provides important nutrients that support food production in the estuary and plume. Microdetrital food particles adhere to sediment suspended in the water column, making different food sources available to different species than was the case historically. Currently, organic matter associated with fine sediments supplies the majority of estuarine secondary productivity in the food web (Simenstad et al. 1984 as cited in Northwest Power and Conservation Council 2004)."

Sediment will be placed along shorelines to create shallow-water habitat to compensate for loss of natural sediment and concurrent diminishment of migratory habitat and food-web support. This treatment will be used only in areas when fine sediment and/or shallow-water habitat have been identified as a limiting factor in a sub-basin report.

Guidelines for Review

Low - Medium Risk: All structures shall require a NMFS Engineering review and initial HIP review. The HIP review will confirm conservation measures are met and determine if a low-risk rating is appropriate.

Medium-risk projects shall address the **Basis of Design Requirements**. In addition, all structures shall require a NMFS Biologist Review.

Conservation Measures

1) Beaver Dam Analogs shall be constructed with the goal and intent of restoring beaver habitat and supporting recolonization. Areas where beaver reintroduction is unlikely shall use habitat structure methods outlined in Activity Category 2d.
2) All construction associated with BDAs shall be completed by hand and hand power tools (e.g., pneumatic post-driver).
3) Dams shall consist of porous channel-spanning structures comprised of biodegradable vertical posts at a height intended to act as the crest elevation of an active beaver dam. Variation of this restoration treatment may include post lines only, post lines with wicker weaves, reinforcement of existing active beaver dams, and reinforcement of abandoned beaver dams. Gaps are between structures and any infrastructure, water

diversion or drainage systems or other property improvements within the area expected to be affected by the reach, quantity or duration of water flow.

4) Materials used must be inert and biodegradable, or be similar to materials currently or historically found naturally in the project area.
5) The project must include a riparian area planting or vegetation management plan considering current vegetation conditions, land uses, the expected reach of water, likelihood of volunteer native plant recruitment, planting prescriptions, and the potential for spread of invasive species within the project area. The plan must describe protection measures for planted or naturally occurring native woody vegetation within the project area.
6) If livestock grazing will occur within the project area, the plan must include and describe the grazing practices to be used.
7) Structures cannot unreasonably interfere with use of the waterway for navigation, fishing or recreation.
8) Placement of inorganic material is limited to the minimum quantity necessary to prevent under-scour of structure and manage pore flow sufficient to ensure adequate over-topping flow and side flow to facilitate fish passage where required.
9) In addition to any other design parameters necessary to meet fish passage requirements, structures must provide for a water surface differential of no more than one-foot at low flows, or otherwise provide a clear path for fish passage over, through, or around the structure via side channels during low flows.
10) No cabling, wire, mortar, or other materials that serve to affix the structure to the bed, banks or upland is allowed.

Category 3: Invasive Plant Control.

Category 3a) Manage Vegetation Using Physical Control

Description. BPA proposes to use two mechanisms for vegetation management by physical control in fluvial and estuarine systems: (a) Manual control includes hand pulling and grubbing with hand tools; bagging plant residue for burning or other proper disposal; mulching with organic materials; shading or covering unwanted vegetation; controlling brush and pruning using hand and power tools such as chain saws and machetes; using grazing goats. (b) Mechanical control includes techniques such as mowing, tilling, disking, or plowing. Mechanical control may be carried out over large areas or be confined to smaller areas (known as scalping).

Conservation Measures

1) Ground-disturbing mechanical activity will be restricted in established buffer zones adjacent to streams, lakes, ponds, wetlands and other identified sensitive habitats based on percent slope. For slopes less than 20%, a buffer width of 35 feet will be used. For slopes over 20%, no ground-disturbing mechanical equipment will be used.
2) When possible, manual control (e.g., hand pulling, grubbing, and cutting) will be used in sensitive areas to avoid adverse effects to listed species or water quality.
3) All noxious weed material will be disposed of in a manner that will prevent its spread. Noxious weeds that have developed seeds will be bagged and burned.

Category 3b) Manage Vegetation Using Herbicides (River Systems)

Description. BPA proposes to fund management of vegetation using chemical herbicides to recover watershed processes and functions associated with native plant communities in fluvial systems. The primary goal of these conservation measures is to limit exposure of herbicides and their adjuvants to surface waters.

Herbicides will be applied in liquid or granular form using wand or boom sprayers mounted on or towed by trucks, ATVs, UTVs, backpack equipment containing a pressurized container with an agitation device, injection, hand wicking cut surfaces, and ground application of granular formulas.

Aerial treatment is not proposed to be covered under this consultation.

Conservation Measures

1) **Herbicide applicator qualifications.** Herbicides will be applied only by an appropriately licensed applicator using an herbicide specifically targeted for a particular plant species that will cause the least impact to non-target species. The applicator will be responsible for preparing and carrying out the herbicide transportation and safety plan shown below.
2) **Herbicide transportation and safety plan.** The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or misapplication, take remedial actions in the event of spills, and fully report the event. At a minimum, the plan will:
    a) Address spill prevention and containment;

b) Estimate and limit the daily quantity of herbicides to be transported to treatment sites;
c) Require that impervious material be placed beneath mixing areas in such a manner as to contain small spills associated with mixing/refilling;
d) Require a spill cleanup kit be readily available for herbicide transportation, storage and application;
e) Outline reporting procedures, including reporting spills to the appropriate regulatory agency;
f) Require that equipment used in herbicide storage, transportation, and handling are maintained in a leak proof condition;
g) Address transportation routes so that hazardous conditions are avoided to the extent possible;
h) Specify mixing and loading locations away from waterbodies so that accidental spills do not contaminate surface waters;
i) Require that spray tanks be mixed or washed further than 150 feet of surface water;
j) Ensure safe disposal of herbicide containers;
k) Identify sites that may only be reached by water travel and limit the amount of herbicide that may be transported by watercraft; and
l) Instruct all individuals involved, including any contracted applicators, on the plan.

3) **Herbicides.** BPA proposes to use the herbicides in Table A.2 in the typical application rates for invasive plant control.

Table A.2 Allowable herbicides under HIP4.

Active Ingredient	Typical Products	Maximum Label Application Rate (ai/ac)
2,4-D (amine)	Amine® 4 Weedar® 64 Riverdale® AM-40	4.0 lb.
Aminopyralid	Milestone®	0.375 lb.
Chlorsulfuron	Telar XP®	3.0 oz.
Clethodim	Select®	0.50 lb.
Clopyralid	Transline®	0.5 lb.
Dicamba	Banvel® Vanquish®	8.0 lb.
Glyphosate	Rodeo® Glypro®	3.75 lb.

Active Ingredient	Typical Products	Maximum Label Application Rate (ai/ac)
	Accord® Aquamaste® Aquaneat® Foresters®	
Imazapic	Plateau®	0.189 lb.
Imazapyr	Habitat® Arsenal®	1.5 lb.
	Chopper®	
Metsulfuron methyl	Escort XP®	4.0 oz.
Picloram	Tordon® 22K Tordon® K	1 lb.
Sethoxydim	Poast® Vantage®	0.375 lb.
Sulfometuron methyl	Oust XP®	2.25 oz.
Triclopyr (TEA)	Garlon 3A® Tahoe 3A® Triclopyr 3A® Triclopyr 3SL®	9.0 lb.
Fluroxypyr (upland only)	Vista®	20 oz. (upland only)
Fluazifop-P-butyl (upland only)	Fusilade®	Label recommendation (upland only)
Oryzalin (upland only)	Surflan®	Label recommendation (upland only)
Diquat dibromide (upland only)	Reward®	Label recommendation (upland only)

****upland is defined as 300 feet from bankful width.**

4) **2,4-D.** As a result of the national consultation on herbicides, this herbicide shall comply with all relevant reasonable and prudent alternatives from the 2011 Biological Opinion (NMFS 2011a):
    a) Do not apply when wind speeds are below 2 mph or exceed 10 mph, except when winds in excess of 10 mph will carry drift away from salmonid-bearing waters.
    b) Do not apply when a precipitation event, likely to produce direct runoff to salmonid bearing waters from the treated area, is forecasted by NOAA/NWS (National Weather Service) or other similar forecasting service within 48 hours following application.
    c) Control of invasive plants within the riparian habitat shall be by individual plant treatments for woody species, and spot treatment of less than 1/10 acre for herbaceous species per project per year.
5) **Adjuvants.** BPA proposes to use the adjuvants in Table A.3 in the typical application rates for invasive plant control.

Table A.3 Allowable Adjuvants under HIP4.

Adjuvant Type	Trade Name
Colorants	Dynamark™ U.V. (red)
	Aquamark™ Blue
	Dynamark™ U.V. (blu)
	Hi-Light® (blu)
Surfactants	Activator 90®
	Agri-Dex®
	Bond®
	Competitor®
	Entry II®
	Hasten®
	LI 700®
	Liberate®
	R-11®
	Super Spread MSO®
	Syl-Tac®
Drift Retardants	41-A®
	Valid®
	Compadre®

6) Polyethoxylated tallow amine (POEA) surfactant and herbicides that contain POEA (e.g., Roundup™) are not allowed for use.
7) **Herbicide carriers.** Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil.
8) **Herbicide mixing.** Herbicides will be mixed more than 150 feet from any natural waterbody to minimize the risk of an accidental discharge and no more than three different herbicides may be mixed for any one application.
9) **Herbicide application methods.** Liquid or granular forms of herbicides to be applied by a licensed applicator as follows:
10) Broadcast spraying – hand held nozzles attached to back pack tanks or vehicles, or vehicle-mounted booms;
11) Spot spraying – hand-held nozzles attached to backpack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants;
12) Hand/selective – wicking and wiping, basal bark, fill ("hack and squirt"), stem injection, and cut-stump.
13) **Emergent Knotweed Application.** Only aquatic labeled glyphosate formulations will be used. The only application methods for emergent knotweed are stem injection (formulation up to 100% for emergent stems greater than 0.75 inches in diameter), wicking or wiping (diluted to 50% formulation), and hand-held spray bottle application of glyphosate (up to the percentage allowed by label instructions when applied to foliage using low-pressure hand-held spot spray applicators).
14) **Water Transportation.** The following measures will be used to reduce the risk of a spill during water transport:
    a) No more than 2.5 gallons of glyphosate will be transported per person or raft, and typically, it will be 1 gallon or less.
    b) Glyphosate will be carried in 1 gallon or smaller plastic containers. The containers will be wrapped in plastic bags and then sealed in a dry-bag. If transported by raft, the dry-bag will be secured to the watercraft.
15) **Minimization of herbicide drift and leaching.** Herbicide drift and leaching will be minimized as follows:
    a) Do not spray when wind speeds exceed 10 mph or are less than 2 mph;
    b) Do not spray when wind direction will carry herbicide directly to surface water.
    c) Keep boom or spray as low as possible to reduce wind effects;
    d) 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;
    e) Do not apply herbicides during temperature inversions, or when ground temperatures exceed 80 degrees Fahrenheit;
    f) Do not spray when rain, fog or other precipitation is falling or is imminent. Wind and other weather data will be monitored and reported for all broadcast applications. Table A.4 identifies BPA's proposed minimum weather and wind speed restrictions (to be used in the absence of more stringent label instructions and restrictions).

g) During application, applicators will monitor weather conditions hourly at sites where spray methods are being used.

Table A.4 Required Herbicide Buffer Widths and Maximum/Minimum Wind Speeds (mph)

Active Ingredient	Broadcast Application[1]		Backpack Sprayer/Bottle[2] Spot Spray Foliar/Basal		Hand Application[3] Wicking/ Wiping/ Injection
	Min buffer (ft.)	Max/ Min wind speed (mph)	Min buffer (ft.)	Max/ Min wind speed (mph)	Min buffer (ft.)
2,4 D (amine)	100	10/2	50	5/2	15
Aminopyralid	100	10/2	15	5/2	0
Chlorsulfuron	100	10/2	15	5/2	0
Clethodim	**Not Allowed**	**Not Allowed**	50	5/2	50
Clopyralid	100	10/2	15	5/2	0
Dicamba	100	10/2	15	5/2	0
Glyphosate (aquatic)	100	10/2	15	5/2	0
Glyphosate	100	10/2	100	5/2	100
Imazapic	100	10/2	15	5/2	0
Imazapyr	100	10/2	15	5/2	0
Metsulfuron	100	10/2	15	5/2	0
Picloram	100	8/2	100	5/2	100
Sethoxydim	100	10/2	50	5/2	50
Sulfometuron	100	10/2	15	5/2	0
Triclopyr (TEA)	**Not Allowed**	**Not Allowed**	50	5/2	0 for cut-stump application; 15 feet for other applications
Fluroxypyr	300	10/2	300	5/2	300

[1] Ground-based only broadcast application methods via truck/ATV with motorized low-pressure, high-volume sprayers using spray guns, broadcast nozzles, or booms.
[2] Spot and localized foliar and basal/stump applications using a hand-pump backpack sprayer or field-mixed or pre-mixed hand-operated spray bottle.
[3] Hand applications to a specific portion of the target plant using wicking, wiping, or injection techniques; herbicides do not touch the soil during the application process.

Active Ingredient	Broadcast Application[1]		Backpack Sprayer/Bottle[2] Spot Spray Foliar/Basal		Hand Application[3] Wicking/ Wiping/ Injection
(upland only)					
Fluazifop P butyl (upland only)	300	10/2	300	5/2	300
Oryzalin (upland only)	300	10/2	300	5/2	300
Diquat dibromide (upland only)	300	10/2	300	5/2	300
Herbicide Mixtures	Most conservative of listed herbicides	Most conservative of listed herbicides	Most conservative of listed herbicides	Most conservative of listed herbicides	Most conservative of listed herbicides

****Buffer Distances are from Bankful Width**

16) **ESA-Listed Terrestrial Species.** On sites where ESA-listed **terrestrial wildlife** may occur (within 1 mile of habitat where ESA-listed terrestrial wildlife occur), herbicide applications will be avoided or minimized to the extent practicable while still achieving project goals. Staff will avoid any potential for direct spraying of wildlife, or immediate habitat in use by wildlife for breeding, feeding, or sheltering. Herbicide use will be limited to the chemicals and application rates as shown in Table A.5. Additional herbicide restrictions may apply in suitable or occupied habitats. See species-specific conservation measures for additional detail.

Table A.5 Maximum Application Rates within 1 Mile of Habitat where ESA-listed Terrestrial Species Occur (lb./ac).[4]

Active Ingredient	Plants	Mammals	Birds	Invertebrates
2,4 D	**Not Allowed**	**Not Allowed**	**Not Allowed**	**Not Allowed**
Aminopyralid	**0.11**	**0.11**	**0.11**	**Not Allowed**
Chlorsulfuron (Hand Application only)	**0.188**	**0.188**	**0.188**	**Not Allowed**
Clethodim	**<1.0**	**<1.0**	**<1.0**	**<1.0**

[4] Additional restrictions for herbicide may apply in suitable or occupied habitats of ESA-listed species. See species-specific conservation measures.

Active Ingredient	Plants	Mammals	Birds	Invertebrates
Clopyralid	**0.5**	**0.5**	**0.5**	**0.5**
Dicamba	**<1.0**	**<1.0**	**<1.0**	**<1.0**
Glyphosate	**2.0**	**2.0**	**2.0**	**2.0**
Imazapic[5]	**0.189**	**0.189**	**0.189**	**Not Allowed**
Imazapyr	**1.0**	**1.0**	**1.0**	**Not Allowed**
Metsulfuron[6]	**0.15**	**0.15**	**0.15**	**Not Allowed**
Picloram	**Not Allowed**	**Not Allowed**	**Not Allowed**	**Not Allowed**
Sethoxydim[7]	**0.3**	**0.3**	**0.3**	**0.3**
Sulfometuron	**Not Allowed**	**Not Allowed**	**Not Allowed**	**Not Allowed**
Triclopyr (TEA)	**Not Allowed**	**Not Allowed**	**Not Allowed**	**Not Allowed**
Fluroxypyr	**Not Allowed**	**Not Allowed**	**Not Allowed**	**Not Allowed**
Fluazifop P butyl	0.188	0.188	0.188	0.188
Oryzalin (Hand application only)	2	2	**2**	**2**
Diquat dibromide	**Not Allowed**	**Not Allowed**	**Not Allowed**	**Not Allowed**

[5] Highly soluble in water, degrades slowly in soil, is persistent, and has a highly leaching potential which may contaminate groundwater. Cannot be use on sandy soil or sandy loamy soils and/or where distance to groundwater is <10ft.

[6] Highly soluble in water and has a highly leaching potential which may contaminate groundwater. Cannot be use on sandy soil or sandy loamy soils and/or where distance to groundwater is <10 ft.

[7] Sethoxydim is considered acutely toxic to bees (USEPA 2015). Whenever possible, but especially when the application method is "broadcast," sethoxydim should not be applied when native plants are blooming and may attract bees to the area.

Category 3c) Manage Vegetation Using Herbicides (Estuarine Systems)

Guidelines for Review

Low Risk: All applications of herbicides in the uplands (>300 feet) that adhere to all listed conservation measures.

Medium Risk: All applications of herbicides in the Estuary that deviate from the criteria.
High Risk: All applications of herbicides within low marsh or high marsh in the Estuary (CR below Bonneville Dam, including CR tributaries).

All medium to high risk Estuarine Herbicide projects shall require NMFS branch chief or workgroup approval. To facilitate this evaluation, a Herbicide Application Memo shall be drafted that contains the following information:

1) Application methodology
2) Application Timing
3) Deviations from HIP4 conservation measures
4) Application areas in high, low marsh, tidal flats
5) Lidar and tidal/ water surface elevation inundation maps

This memo shall be evaluated to confirm if the proposal is within the range of effects described in the HIP4 Biological Opinion, if not, additional conservation measures or restrictions may be prescribed that contain the action within the programmatic, or a formal individual consultation may be pursued. After the first year of implementation and with satisfactory process implementation, and upon approval of NMFS, Herbicide Application Memos shall not be needed for subsequent years.

Description. Invasive plant treatments in tidally influenced areas are proposed within tidal wetlands and areas below the Ordinary High Water (OHW). Treatment areas below the OHW have been subdivided into High Marsh, Low Marsh, and Tidal Flat as each area has differing inundation levels and therefore delivery routes to surface waters (Figure A.1). High Marsh tidal areas are subject to seasonal inundation, mainly in winter and are often dry during the summer months. Low Marsh areas are below mean high water and are subject to daily to semi-daily tidal influence. Within the Tidal Flats, emergent vegetation such as knotweed and aquatic bed species such as yellow flag iris may be present in permanently inundated areas.

The various treatment methodologies, proposed herbicides, timing, and acreage limit are illustrated above. In High Marsh Areas, there are a larger amount of proposed herbicides and a larger acreage limit. However herbicide application shall be limited to be between July-October. If application must occur between November-July only glyphosate and imazapyr shall be used with a minimum dry time of 4 hours for imazapyr and glyphosate prior to tidal inundation.

In the Low Marsh only glyphosate and imazapyr shall be used with a minimum dry time of 4 hours prior to tidal inundation. Episodic flow events shall be monitored and avoided. In tidal flats/ aquatic beds, no application of herbicides over standing waters is proposed (Table A.6). However treatment of emergent vegetation using hand application or mechanical treatments shall occur.

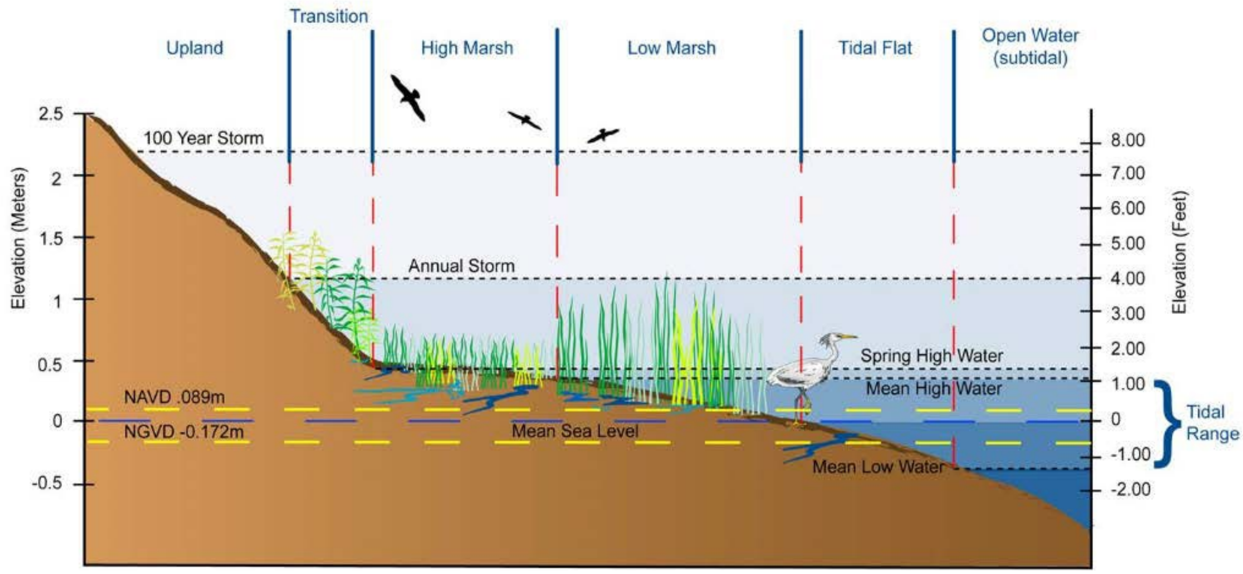

Figure A.1 Estuarine Herbicide Treatment Areas (Titus and Wang 2008).

Table A.6 Herbicide Treatment and Methodology by Treatment Area.

	High Marsh	Low Marsh	Tidal Flat/ Aquatic Bed
Methodology	Broadcast Application[8] or Backpack Sprayer/Bottle[9]	Broadcast Application or Backpack Sprayer/Bottle	Hand Application[10] Wicking/Wiping/Injection
Herbicides	Glyphosate (Aquatic) Imazapyr (Aquatic) Imazapic (Aquatic) Triclopyr (TEA)	Glyphosate (Aquatic) Imazapyr (Aquatic)	Glyphosate (Aquatic) Imazapyr (Aquatic)
Limit (per project per year)	200 acres	40 acres	<2 acres
Timing	Summer months	Low tidal cycle	Extreme low tide within the in-water work window

Conservation measures

1) Only Hasten and Agri-dex surfactants shall be allowed.
2) Only aquatic formulations of herbicides are allowed.
3) Tidal elevations are project-specific and shall be confirmed at the project level.

[8] Ground-based only broadcast application methods via truck/ATV with motorized low-pressure, high-volume sprayers using spray guns, broadcast nozzles, or booms.
[9] Spot and localized foliar and basal/stump applications using a hand-pump backpack sprayer or field-mixed or pre-mixed hand-operated spray bottle.
[10] Hand applications to a specific portion of the target plant using wicking, wiping or injection techniques. This technique implies that herbicides do not touch the soil during the application process.

4) Time herbicide application to coincide with the lowest low tide sequence of the month (occurring during daylight hours) in order to allow for maximum drying time prior to inundation.
5) For ATV mounted herbicide application, a) Use boom heights < 4 feet where possible and < 6 feet if needed to treat tall vegetation. b) Observe buffer widths of 15' from standing waterc) Use drift-reducing nozzles that do not exceed 45 psi sprayer pressure with 200-800 μm droplet size.
6) Treatment may be combined with mechanical control.
7) Apply herbicide to allow for a minimum 4-hour dry time for glyphosate and Imazapyr.
8) During hand application (such as wicking, wiping, and stem injection), herbicides must not come into contact with soil or water.
9) If appropriate for the plant species prioritize mechanical removal of aquatic bed vegetation over herbicide application in inundated areas.
10) Follow-up monitoring and invasive plant treatments shall occur for a minimum of three years after initiating invasive species control or large scale restoration.
11) Use marker dye in mixes to track where herbicide has been sprayed and reduce herbicide use.
12) Increase spray droplet size (>200um) by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and/or thickening agents.
13) Wind and other weather data will be monitored and reported for all broadcast applications.
14) Do not apply herbicides if a precipitation event is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application.
15) Do not spray when wind speeds exceed 10 miles per hour, or are less than 2 miles per hour. Avoid spraying when wind is blowing towards the water.
16) In Low Marshes use equipment like amphibious tractors as the platform to treat large, infested areas and minimize disturbance by minimizing ingress/egress points. The equipment has less ground pressure than a person.
17) When using mechanical control methods ensure that site drainage is maintained and depressions are not created that could potentially trap fish.
18) ESA-Listed Terrestrial Species. On sites where ESA-listed terrestrial wildlife may occur (within 1 mile of habitat where ESA-listed terrestrial wildlife occur), applicators will avoid any potential for direct spraying of wildlife, or immediate habitat in use by wildlife for breeding, feeding, or sheltering. Herbicide use will be limited to the chemicals and application rates as shown in Table A.7.
19) If the wind is blowing towards surface water, a 50-foot buffer should be observed around waters so that the herbicide droplets don’t drift into the water
20) If standing water is present in ditches, you must walk along their edges and backpack spray, if standing water is not present in ditches, broadcast spray with a 4-wheeler is allowed.

Table A.7 Maximum Application Rates within 1 Mile of Habitat where ESA-listed Terrestrial Species Occur in the Estuary (lb./ac).

	Mammals	Birds	Invertebrates
Glyphosate	**2.0**	**2.0**	**2.0**
Imazapic	**0.189**	**0.189**	**Not Allowed**
Imazapyr	**1.0**	**1.0**	**1.0**
Triclopyr (TEA)	**Not Allowed**	**Not Allowed**	**Not Allowed**

Category 3d) Juniper Removal

Description. This restoration action will be conducted in riparian areas and adjoining uplands to help restore plant species composition and structure that would occur under natural fire regimes. Juniper removal will occur in those areas where juniper have encroached into riparian areas as a result of fire exclusion, thereby replacing more desired riparian plant species such as willow, cottonwood (*Populus* spp.), aspen (*Populus tremuloides*), alder (*Alnus* spp.), sedge, and rush.

Conservation measures

1) Remove juniper to natural stocking levels where juniper trees are expanding into neighboring plant communities to the detriment of other native riparian vegetation, soils, or streamflow.
2) Do not cut old-growth juniper, which typically has several of the following features: sparse limbs, dead limbed or spiked tops, deeply furrowed and fibrous bark, branches covered with bright-green arboreal lichens, noticeable decay of cambium layer at base of tree, and limited terminal leader growth in upper branches.
3) Felled trees may be left in place, lower limbs may be cut and scattered, or material may be piled and burned.
4) Where appropriate, juniper may be cut or removed with rootwads intact and placed into stream channels and floodplains to provide aquatic benefits. Removal with rootwads should utilize appropriate soil stabilization techniques and not cause increased sedimentation or erosion into adjacent waters.
5) On steep or south-facing slopes, where ground vegetation is sparse, leave felled juniper in sufficient quantities to promote reestablishment of vegetation and prevent erosion.
6) If seeding is a part of the action, consider whether seeding will be most appropriate before or after juniper treatment.
7) When using heavy equipment, operate equipment in a manner that minimizes soil compaction and disturbance to soils and native vegetation to the extent possible. Equipment exclusion areas (buffer area along stream channels) shall be maintained.

Category 3e) Prescribed burning

Description. Prescribed burning is the measured application of fire to control invasive woody plants. The technique involves the hand application of fire via drip torches or similar equipment.

Conservation measures

1) A 15 m (50 feet) vegetative buffer will be maintained adjacent to any fish-bearing stream.
2) A burn plan, with burn prescription is required, although it may vary by management objectives and site conditions. The prescription will address the following elements:
    a) Time of year and time of day
    b) Relative humidity range
    c) Allowable maximum wind speed and direction
    d) Temperature range
    e) Soil moisture minimums
    f) Firing methods
    g) Fire escape contingency plan
3) Firebreaks will be used to prevent fire from spreading outside of the planned burn area. Fire retardant chemicals will be used sparingly and will not be used within 37 m (120 feet) of surface waters.
4) An area 3 to 6 m (10 to 20 feet) wide may also be mowed around the outside boundary of the burn area to help ensure fire control.
5) Fire management vehicles will not be allowed to drive wherever is convenient when fire is burning under prescription. Travel is restricted to area with non-native or resilient vegetation except during an emergency, and then for only the duration of the emergency.
6) Slash pile burning shall occur when wildfire risk is low (usually winter or spring when soils are frozen or saturated).
7) *Timing or Season:* Treatment may be conducted at any time of year when conditions are suitable with the following caveats:
    a) March 1 – June 30: delay implementation until 2 hours after sunrise to avoid disturbing sage-grouse breeding activities,
    b) May 15 – July 15: avoid conducting treatments during the primary bird nesting season; if impractical to avoid, minimize impacts by beginning treatments prior to start of nesting season and continue daily activity to discourage bird nesting in treatment area and avoid cutting trees with observed nests until after nesting season.c) June 1 – July 15; prescribed burning will not occur in known or suitable fawning habitat of Columbian white-tailed deer.

Category 4: Piling Removal

Description. BPA proposes to remove creosote-treated wooden pilings from waterways in the Columbia River Basin.

<u>*Conservation measures*</u>

1) 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 the piles above the waterline.
    c) Complete all work during low water and low current conditions.
    d) Dislodge pilings with a vibratory hammer whenever feasible; never intentionally break a pile by twisting or bending.
    e) Slowly lift the pile from the sediment and slowly lift it through the water column.
    f) 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 straw bales or another support structure to contain all sediment. Return flow may be directed back to the waterway.
    g) Fill the holes left by each piling with clean, native sediments.
    h) Dispose of all removed piles, floating surface debris, sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.
2) If a pile breaks above the surface of uncontaminated sediment, or less than 2 feet below the surface, every attempt short of excavation will be made to remove it entirely.
    a) If the pile cannot be removed without excavation, the stump will be sawn off at the surface of the sediment.
    b) If a pile breaks above contaminated sediment, the stump will be sawn off at the sediment line.
    c) If a pile breaks within contaminated sediment, no further effort will be made to remove it. The hole will be covered with a cap of clean substrate appropriate for the site.
    d) If dredging is likely in the area of piling removal, global positioning system (GPS) device will be used to note the location of all broken piles for future use in site debris characterization.

Category 5: Road and Trail Maintenance and Decommissioning

Category 5a) Road Maintenance

Description. BPA proposes to fund road maintenance activities, including:

1) Creating barriers to human access, e.g., gates, fences, boulders, logs, tank traps, vegetative buffers, and signs
2) Surface maintenance, e.g., building and compacting the road prism, grading, and spreading rock or surfacing material
3) Drainage maintenance and repair of inboard ditch lines, water bars, and sediment traps
4) Removing and hauling or stabilizing pre-existing cut and fill material or slide material
5) Relocating portions of roads and trails to less sensitive areas outside of riparian buffer areas

The proposed activity does not include asphalt resurfacing, widening roads, or new construction/relocation of any permanent road inside a riparian area except for a bridge approach, in accordance with the section on **Transportation Infrastructure.**

Road grading and shaping will maintain, not destroy, the designed drainage of the road, unless modification is necessary to improve drainage problems that were not anticipated during the design phase. Road maintenance will not be attempted when surface material is saturated with water and erosion problems could result.

Conservation Measures

1) Dust-abatement additives and stabilization chemicals (typically magnesium chloride or calcium chloride salts) will not be applied within 25 feet of water or a stream channel and will be applied so as to minimize the likelihood that they will enter streams.
2) Spill containment equipment will be available during chemical dust abatement application.
3) No petroleum-based products will be used for dust abatement.
4) Dust abatement applications will be avoided during or just before wet weather and at stream crossings or other locations that could result in direct delivery to a water body (typically within 25 feet of a water body or stream channel).
5) Waste material generated from road maintenance activities and slides will be disposed of on stable non-floodplain sites approved by a geotechnical engineer or other qualified personnel.
6) Disturbance of existing vegetation in ditches and at stream crossings will be minimized to the greatest extent possible.
7) Ditches and culverts will be promptly cleaned of materials resulting from slides or other debris.
8) Berms will not be left along the outside edge of roads, unless an outside berm was specifically designed to be a part of the road, and low-energy drainage is provided.
9) Ditch back-slopes will not be undercut to avoid slope destabilization and erosion acceleration.
10) When blading and shaping roads, excess material will not be sidecast onto the fill. All excess material that cannot be bladed into the surface will be hauled to an appropriate

site. Haul and prohibition of sidecasting will not be required for organic material like trees, needles, branches, and clean sod; however, fine organics like sod and grass will not be cast into water.

11) Slides and rock failures, including fine material of more than approximately 1⁄2 yard at one site, will be hauled to disposal sites. Fine materials (1-inch or smaller) from slides, ditch maintenance, or blading may be worked into the road. Scattered clean rocks (1-inch or larger) may be raked or bladed off the road except within either 300 feet of perennial or 100 feet of intermittent streams.
12) Road grading material will not be sidecast along roads within 1⁄4 mile of perennial streams and from roads onto fill slopes having a slope greater than 45%.
13) Road maintenance will not be conducted when surface material is saturated with water and erosion problems could result.
14) Large wood, >9 m in length and >50 cm in diameter, present on roads will be moved intact down-slope of the road, subject to site-specific considerations. Movement down-slope will be subject to the guidance of a natural resource specialist with experience in fish biology.
15) Snowplowing will be performed in accordance with the following criteria:
16) No chemical additives such as salt or de-icing chemicals will be used in conjunction with snowplowing.
17) Drainage holes will be placed in snow berms to provide drainage.
18) A minimum of 2 inches of snow will be left on gravel roads during plowing. Paved roads may be scraped to the surface.
19) No gravel or surfacing material will be bladed off the road.
20) No deliberate sidecasting of snow into or over drainage structures will be permitted.
21) Plowing will not be allowed on gravel roads during thaw periods when the road is wet.

Category 5b) Road Decommissioning

Description. BPA proposes to decommission and obliterate (decompact, recontour, or reshape) roads that are no longer needed (e.g., old or temporary logging roads). Water bars will be installed, road surfaces will be in-sloped or out-sloped, asphalt and gravel will be removed from road surfaces, culverts and bridges will be altered or removed, streambanks will be recontoured at stream crossings, cross drains will be installed, fill or sidecast materials will be removed, the road prism will be reshaped, and sediment catch basins will be created.

Conservation Measures

1) All bare-soil surfaces will be revegetated to reduce surface erosion.
2) Recontour the affected area to mimic natural floodplain contours and gradient to the extent possible.
3) Surface drainage patterns will be recreated, and dissipaters, chutes, or rock will be placed at remaining culvert outlets.
4) Conduct activities during dry field conditions, generally May 15 – October 15, when the soil is more resistant to compaction and when soil moisture is low.
5) Slide and waste material will be disposed of in stable non-floodplain sites unless materials are intended to restore natural or near-natural contours and approved by a geotechnical engineer or other qualified personnel.

Category 6: In-Channel Nutrient Enhancement

Description. BPA proposes to fund the application of nutrients throughout a waterway corridor by placement of salmon carcasses into waterways, placement of carcass analogs (processed fish cakes) into waterways, or placement of inorganic fertilizers into waterways.

Conservation Measures

1) In Oregon, projects are permitted through the Oregon Department of Environmental Quality. Carcasses from the treated watershed or those that are certified disease-free by an ODFW pathologist will be used.
2) In Washington, the WDFW publication, entitled "Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State" (WDFW 2004), will be followed.
3) Carcasses will be of species native to the watershed and placed during the normal migration and spawning times, as would naturally occur in the watershed.
4) Eutrophic or naturally oligotrophic systems will not be supplemented with nutrients.
5) Each waterway will be individually assessed for available light, water quality, stream gradient, and life history of the fish present. Adaptive management will be used to derive the maximum benefits of nutrient enhancement.

Category 7: Irrigation and Water Delivery/Management Actions

Description. The intent of these activity categories is to increase instream flow and improve habitat for ESA-listed species.

The HIP 4 will only cover irrigation efficiency actions within this activity category that use state-approved regulatory mechanisms (e.g., Oregon ORS 537.455-.500 and Washington RCW 90.42) for ensuring that water savings will be protected as instream water rights, or in cases for which project sponsors identify how the water conserved will remain instream to benefit fish without any significant loss of the instream flows to downstream diversions.

Category 7a) Convert Delivery System to Drip or Sprinkler Irrigation

Description. Flood or other inefficient irrigation systems will be converted to drip or sprinkler irrigation. Education will be provided to irrigators on ways to make their systems more efficient. This proposed activity will involve the installation of pipe, possibly trenched and buried into the ground, and possibly pumps to pressurize the system.

Guidelines for Review

Low - Medium Risk: Shall require an initial HIP review. The HIP review will confirm that that designs are adequate, objectives are clearly stated, agreements for water diversion and bypass flows are enforceable, and a monitoring protocol will be employed to ensure that expected flow improvements are realized.

Conservation Measures

The designs must identify the approximate downstream extent of the flow benefit and must demonstrate that consumptive use of water will not appreciably increase, how surface water withdraws will be reduced, and how instream flow will be increased.

Category 7b) Convert Water Conveyance from Open Ditch to Pipeline

Description. Open ditch irrigation water conveyance systems will be replaced with pipelines to reduce evaporation and transpiration losses. Leaking irrigation ditches and canals will be converted to pipeline or lined with concrete, betonite or other appropriate lining materials.

Guidelines for Review

Low - Medium Risk: Shall require an initial HIP review. The HIP review will confirm that that designs are adequate, objectives are clearly stated, agreements for water diversion and bypass flows are enforceable, and a monitoring protocol will be employed to ensure that expected flow improvements are realized.

Conservation Measures

The designs must demonstrate how there is a net instream benefit by reducing surface water withdrawals during all periods when the diversion is active.

Category 7c) Convert from Instream Diversions to Groundwater Wells

Description. Wells will be drilled as an alternative water source to surface water withdrawals. Water from the wells will be pumped into ponds or troughs for livestock or used to irrigate agricultural fields. Instream diversion infrastructure will be removed or downsized, if feasible. If an instream diversion is downsized, it will only be covered under the HIP 4 by following all criteria outlined in the Consolidate or Replace Existing Irrigation Diversions section.

Guidelines for Review

Low Risk: Shall not require HIP Review.

Conservation Measures

New wells will be located more than 1⁄4 mile from the stream and will not be hydrologically connected to the stream.

Category 7d) Install or Replace Return Flow Cooling Systems

Above-ground pipes and open ditches that return tailwater from flood-irrigated fields back to the river will be replaced. Return flow cooling systems will be constructed by trenching and burying a network of perforated PVC pipes that will collect irrigation tailwater below ground, eliminating pools of standing water in the fields and exposure of the water to direct solar heating. No instream work is involved, except for installing the drain pipe outfall. Most work will be in uplands or in riparian buffer areas that are already plowed or grazed.

Guidelines for Review

Low Risk: Shall not require HIP Review.

Category 7e) Install Irrigation Water Siphons

Description. Siphons transporting irrigation water will be installed beneath waterways, where irrigation ditch water currently enters a stream and commingles with stream water, with subsequent withdrawal of irrigation water back into an irrigation ditch system downstream. Periodic maintenance of the siphon will be conducted. Work may entail use of heavy equipment, power tools, and/or hand tools.

Guidelines for Review

Low Risk: Siphons that meet all conservation measures.

*Medium Risk: Siphon*s that do not meet all conservation measures and require significant in-channel work shall require a review by BPA Engineering.

Conservation Measures

1) Directional drilling to create siphon pathway will be employed whenever possible.
2) Trenching will occur in dry stream beds only.
3) Work area isolation will be employed in perennial streams.
4) Stream widths will be maintained at bankfull width or greater.
5) No part of the siphon structure will block fish passage.
6) No concrete will be placed below the bankfull elevation.

7) Siphon surface structures will be set back from the bankfull elevation at least 10 feet.
8) Minimum cover over a siphon structure within the streambed shall be 3 feet of natural substrate.
9) Waterways will be reconstructed to a natural streambed configuration upon completion.
10) The criteria, plans and specifications, and operation and maintenance protocols of this activity category shall use the most recent versions of Natural Resource Conservation Service (NRCS) guidance.

Category 7f) Livestock watering facilities

Description. Watering facilities will consist of various low-volume pumping or gravity-feed systems to move the water to a trough or pond at an upland site. Either above-ground or underground piping will be installed between the troughs or ponds and the water source. Water sources may include springs and seeps, streams, or groundwater wells. Pipes will generally range from 0.5 to 4 inches but may exceed 4 inches in diameter. Placement of the pipes in the ground will typically involve minor trenching using a backhoe or similar equipment.

Conservation measures

1) avoid steep slopes
2) ensure that each livestock water development has a float valve or similar device limiting use to demand
3) include a return flow system
4) include a fenced overflow area or similar means to minimize water withdrawal and minimize potential runoff and erosion
5) All pumping and gravity-feed systems within habitat occupied by ESA-listed salmonids will have fish screens to avoid juvenile fish entrainment and will be operated in accordance with NMFS's current fish screen criteria (NMFS 2011 or most recent version).
6) If pumping rate exceeds 3 cfs, a NMFS Engineering Review will be necessary.
7) In areas where larval lamprey could be entrained, screening should use perforated plate, vertical bar or interlocking bar screens and avoid the use of wire cloth.

Category 7g) Install, upgrade, or maintain fish exclusion devices and bypass

Description. This category includes installing, replacing, upgrading, removing, or maintaining fish exclusion screens and associated fish bypass systems to prevent fish entrapment in irrigation canals or other surface-water diversions for existing legal water diversions. This category does not cover screen installations for new water diversions.

BPA proposes to provide funding for certain State sponsored Fish Screen Programs. These programs provides immediate and long-term protection for anadromous and resident fish species in by ensuring proper operation and maintenance of protection and passage devices on diversions and dam structures. Proper operation and maintenance is critical to fish survival, and will ensure that fish protection is adequate as per NMFS Criteria. These facilities reduce or eliminate fish loss associated with water withdrawals and passage barriers.

Currently the ODFW Fish Screen Program is the largest and consists of 3 screen shops located at the Dalles, Enterprise, and John Day. This fish screen program is the largest because it includes O&M of fish screens with numerous private landowners. Fish screen programs in other states (IDFG and WDFW) are typically engaged with federal partners and will have much less fish screen maintenance, although the actions themselves may be larger and involve construction.

The ODFW Fish Screen Program has nearly 1,400 locations where O&M actions may be necessary across the Hood River, Deschutes, Grande Ronde, Imnaha, John Day, Umatilla, and Walla Walla, Willamette River, and other Columbia River subbasins. Each year approximately 700 fish screens and fishways are maintained. The Type of activity is segmented into Operations and Maintenance and New Construction. Because these fish screens and fishways need year around maintenance, these activities may occur outside the in-water work window, however in most cases work occurs in the dry. New Construction will require greater in-stream work and will result in the potential effects to ESA-listed species and habitat addressed in the general construction section.

Operations and Maintenance
Fish screen operation and maintenance actions are typically minor in nature and may include:

1) Lubricate moving parts
2) Manually clean screen material, bypass pipes, and trash racks
3) Maintain bypass outfalls to ensure a safe landing area for fish and maintain entrance areas to minimize false attraction flows.
4) Remove material from bypass pipe to maintain safe fish return to waterway
5) Inspect and replace screen seal material
6) Adjust weir boards and/or bypass orifice to maintain proper water levels for screen's submergence and debris removal
7) Replace screen material, bypass pipe, gear boxes, u-joints, bearings, and other worn-out parts
8) Adjust cleaning arms, carriages, cable, pulleys, and brushes to maintain good contact with screen for debris removal
9) Remove accumulated sediment and debris by hand
10) Mechanical removal of vegetation that prevents fish screens from operating properly
11) Replace batteries and other components of solar power systems
12) Repair paddlewheels and other components of paddlewheel driven power systems
13) Remove sediment and debris and/or adjust fish passage conditions in fishways by hand
14) Annual installation or removal of fish screen and components
15) Screen adjustments
16) Install water measuring devices behind fish screens (dewatered)
17) Inspect, maintain, or repair headgates at the start of diversions (dewatered)
18) Inspect, maintain, or repair return flow outlets

Guidelines for Review
Operation and maintenance actions require little to no in-water work. These activities may occur outside the in-water work window without a variance and do not require turbidity monitoring, or NMFS Engineering Review.

The sponsor may submit one PNF form to BPA for all anticipated low-risk fish screen actions for each field season. The PNF shall include a list of proposed activities and locations (latitude/longitude in decimal degrees), where these operation and maintenance activities will take place. At the end of the field season, the PCF shall contain actual locations where work took place and any activities that occurred beyond what was originally proposed (i.e. the operation and maintenance actions list above).

New Construction

This involves new structures or expansion of existing structures with construction that requires ground disturbance or in-water work. Installation of a fish screen typically involves excavation, installation of bedding material, construction of forms for pouring concrete, installation of the screen and cleaning system, and backfilling of bedding and other material.
Examples include but are not limited to:

1) Install/replace/modify/remove fish bypass
2) Install/replace/modify/remove fish screens and associated pipes on gravity or pump intakes 3-71
3) Install/replace/modify/remove fishway
4) Remove accumulated sediment and debris with heavy machinery
5) Assess and repair concrete or steel support structures
6) Repair or replace screen due to damage from extreme weather event
7) Install/replace/modify/remove headgates at the start of diversions
8) Install, replace, or modify structures with the intent to improve fish passage and/or flow, typically by removing or modifying a full or partial instream barrier
9) Install/replace/modify/remove fish exclusion barriers on ditch return flow outlets

Guidelines for Review

If these activities can occur entirely isolated from the stream (e.g. behind a closed headgate), with no fish present, then they may occur outside the in-water work window without a variance.

Project sponsors may submit one PNF to BPA for all fish screen construction projects. This PNF shall contain anticipated project locations (latitude/longitude at a minimum), specific activities, and at a minimum general descriptions for each activity that may occur at multiple locations. At the end of the field season, the PCF shall contain locations where fish screen projects occurred, specific activities undertaken, incidental take reporting, turbidity monitoring, and any details on in-water work done outside recommended in-water work windows.

Fish screen construction projects require reporting of incidental take (capture/injury/kill) of ESA-listed salmonids and monitoring turbidity according to HIP 4 guidance.

If there is in-water work, these activities shall occur during the recommended in-water work window. If this is not possible, either a variance and a rationale provided by a state biologist in regard to the deviation shall be required.

Category 8: Habitat, Hydrologic, and Geomorphologic Surveys

Description. BPA proposes to fund the collection of information in uplands, wetlands, floodplains, and streambeds regarding existing on-the-ground conditions relative to: habitat type, condition, and impairment; species presence, abundance, and habitat use; and conservation, protection, and rehabilitation opportunities or effects.

Electro-shocking and fish handling for research purposes is not included, as this work must have an ESA Section 10 research permit.

Work may entail use of trucks, survey equipment, and crews using hand tools, and includes the following activities:

1) Measuring/assessing and recording physical measurements by visual estimates or with survey instruments
2) Installing rebar or other markers along transects or at reference points
3) Installing piezometers and staff gauges to assess hydrologic conditions
4) Installing recording devices for stream flow and temperature
5) Conducting snorkel surveys to determine species of fish in streams and observing interactions of fish with their habitats
6) Excavating cultural resource test pits
7) Installing PIT detector arrays