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

Refer to NMFS No.:
2007/03996

January 10, 2008

James M. Kehoe
Manager, Policy & Strategic Planning
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

Re: Endangered Species Act Section 7 Formal Programmatic Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Implementation of the Bonneville Power Administration Habitat Improvement Program in Oregon, Washington, and Idaho, CY2007-CY2012 (HIP II).

Dear Mr. Kehoe:

The enclosed document contains a programmatic biological opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) on the effects of the Bonneville Power Administration (BPA) implementing their Habitat Improvement Program in Oregon, Washington, and Idaho (HIP II). This program is carried out according to the BPA's authority under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501) throughout the Columbia River basin to mitigate for the effects of the Federal Columbia River Power System on fish, wildlife, and their habitat. In this Opinion, NMFS concludes that the programmatic action, as proposed, is not likely to jeopardize the continued existence of 13 species of salmon and steelhead listed under the ESA or result in the destruction or adverse modification of designated critical habitat for these species.

As required by section 7 of the ESA, NMFS provides an incidental take statement with the Opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that must be complied 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 take prohibition.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes 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, the BPA must explain why the recommendations will not be followed. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

If you have questions regarding this consultation, please contact Eric Murray, fish biologist in the Eastern Oregon Habitat Branch of the Oregon State Habitat Office, at 541.975.1835, ext. 222.

Sincerely,

for D. Robert Lohn
Regional Administrator

cc: Nancy Weintraub, BPA

Endangered Species Act – Section 7 Programmatic Consultation Biological Opinion

&

Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Habitat Improvement Program
Oregon, Washington, and Idaho, CY2007-CY2012
(HIP II)

Lead Action Agency:	Bonneville Power Administration
Consultation Conducted By:	National Marine Fisheries Service Northwest Region
Date Issued:	January 10, 2008
Issued by:	for D. Robert Lohn Regional Administrator
NMFS No.:	**2007/03996**

TABLE OF CONTENTS

INTRODUCTION 1
Background and Consultation History 1
Summary of Changes from the Previous HIP Opinion 2
Proposed Action 3
Geographic Scope 5
Implementation Process 7
Description of the Proposed Activity Categories 8
Planning and Habitat Protection Actions 13
Small-Scale Instream Habitat Actions 17
Livestock Impact Reduction 22
Control of Soil Erosion from Upland Farming 24
Irrigation and Water Delivery/Management Actions 26
Native Plant Community Establishment and Protection 30
Road Actions 43
Special Actions 48
Action Area 48

ENDANGERED SPECIES ACT 50
Biological Opinion 50
Status of the Species and Critical Habitat 50
Environmental Baseline 72
Effects of the Action 75
Effects on Listed Species 104
Effects on Critical Habitat 106
Cumulative Effects 109
Conclusion 110
Conservation Recommendations 111
Reinitiation of Consultation 111
Incidental Take Statement 112
Amount or Extent of Take 112
Reasonable and Prudent Measures 114
Terms and Conditions 116

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT 120
EFH Conservation Recommendations 121
Statutory Response Requirement 121
Supplemental Consultation 122

DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW 124

LITERATURE CITED 125

INTRODUCTION

The biological opinion (Opinion) and incidental take statement portions of this document were prepared by the National Marine Fisheries Service in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 USC 1531, *et seq*.), and implementing regulations at 50 CFR 402. With respect to designated critical habitat, the following analysis relied only on the statutory provisions of the ESA, and not on the regulatory definition of "destruction or adverse modification" at 50 CFR 402.02.

The essential fish habitat (EFH) portion of this document was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 USC 1801, *et seq*.) and implementing regulations at 50 CFR 600. The docket for this consultation is on file at the Oregon State Habitat Office in Portland, Oregon.

Background and Consultation History

On August 1, 2003, NOAA's National Marine Fisheries Service (NMFS) issued a programmatic Opinion and EFH consultation for the Bonneville Power Administration's (BPA) Habitat Improvement Program (HIP). This program is carried out according to the BPA's authority under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501) throughout the Columbia River basin to mitigate for the effects of the Federal Columbia River Power System on fish, wildlife, and their habitat.

In 2005, NMFS re-designated critical habitat for 11 salmon and steelhead species in the Columbia River basin. The original critical habitat designations for these species were withdrawn in response to a lawsuit settled in 2002. The HIP programmatic Opinion did not consider critical habitat for these species. In response to this new designation of critical habitat, the BPA began discussions with NMFS on reinitiation of consultation. Rather than issue a new programmatic Opinion immediately, the BPA and NMFS decided to consider new information such as: (1) Information developed during critical habitat designations; (2) recently completed subbasin plans; (3) preliminary recovery planning products developed for Columbia Basin salmon and steelhead; (4) implementation monitoring reports from 2003 to 2006 for the HIP consultation; (5) new scientific information regarding restoration and protection of anadromous fish habitat; and (6) new research on the effects of herbicide application. The BPA's biological assessment and this programmatic Opinion considered this new information during their development.

On June 21, 2007, the BPA submitted a new biological assessment (BA) and formal consultation was initiated on the second iteration of their Habitat Improvement Program (HIP II). On July 16, 2007, the BPA submitted additional information clarifying the proposed action for the Livestock Impact Reduction category to indicate that the maximum internal pipe diameter for off-channel water developments was 4 inches. On August 9, 2007, the BPA further clarified the proposed action to indicate that only those dams with a maximum total head measurement equal to or less than 3 feet are covered under this consultation. To protect endangered Snake River (SR) sockeye salmon (*Oncorhynchus nerka*), the BPA proposed to restrict any in-water work in migration

areas for this species to times when the fish are not present. This programmatic Opinion covers the proposed action from the signature date through the end of calendar year 2012.

Summary of Changes from the Previous HIP Opinion

After considering the newly available information, NMFS and the BPA decided to add new activity subcategories, remove certain activities from this programmatic consultation, and update the activity descriptions and minimization measures. The following summarizes the changes:

1. Reporting for this programmatic consultation will occur via the new NMFS Public Consultation Tracking System (PCTS)-Consultation Initiation and Reporting System (CIRS) as soon as that system is available and BPA staff have been adequately trained.
2. In the Small-Scale Instream Habitat Actions Activity Category, the following changes were made:
    a. The activity description and impact minimization measures for the installation of large woody debris (LWD) and boulders were updated.
    b. The augmentation of spawning gravel is now an activity covered by this Opinion.
    c. In the Improve Fish Passage subcategory, removal of natural log jams is no longer allowed.
    d. The proposed action was modified to clarify that tide gate removal is covered by this consultation, but replacement and construction of tide gates is not.
    e. The review process with NMFS Hydropower Division for projects that involve fish passage was refined and better described.
    f. A subcategory was added for the supplementation of streams with nutrients such as salmon carcasses and carcass analogs.
3. In the Livestock Impact Reduction Category, the following changes were made:
    a. Fencing of riparian areas is required to be carried out in conjunction with a riparian easement. Grazing within the riparian area is not allowed unless an individual consultation is completed.
    b. The maximum width of a hardened ford for livestock crossing is 20 feet.
4. In the Irrigation and Water Delivery/Management activity category, the following changes were made:
    a. Replacement of irrigation diversion structures and consolidation of diversions which involve construction of a new instream structure (concrete structure, rock structure, weir, infiltration gallery, and dam) are no longer covered by this consultation. Information from monitoring of these types of projects indicates that this type of activity can result in unintended effects to fish and stream habitat and are best addressed in individual consultations that consider site-specific information.
    b. Fish screens and diversions must be sized for the landowner's state water right or their historic use, whichever is less.
    c. A new activity subcategory, Install Siphon Under Waterway, was added.
5. In the Native Plant Community Establishment and Protection activity category, the following changes were made:
    a. Chaining of riparian vegetation (attaching chains between two vehicles and driving through an area to remove vegetation) was removed from the Manage

Vegetation Using Physical Control activity category because of the degree of disturbance created by this action.

b. The factors considered when determining whether to use chemical herbicides or other treatment methods were clarified.
c. The Manage Vegetation Using Herbicide subcategory was updated to include new low toxicity herbicides such as imazapyr, imazapic, and sethoxydim.
d. The proposed action was clarified to indicate that only the Banvel formulation of dicamba is proposed for use.
e. Herbicide mixtures were limited to three herbicides.
f. A buffer was added for the use of the adjuvant R-11.
g. A new requirement was added to develop a revegetation plan for any areas greater than ¼ acre that are treated with non-selective herbicides.

6. In the Road Actions activity category, the following changes were made:
   a. The proposed action was clarified to indicate that widening of existing roads is not allowed.
   b. Petroleum-based products are not proposed for dust abatement.
   c. Additional minimization measures were added for water drafting.
   d. Additional minimization measures were added for snow plowing.
   e. Vehicle fords will only be allowed in intermittent streams with no anadromous fish spawning.
   f. Baffled culverts and fishways will not be covered by this consultation.
   g. Decommissioning of roads will only occur in dry field conditions and vegetation will be disturbed as little as possible.

Proposed Action

For purposes of this consultation, the proposed action is to implement activities under the following nine categories, and subcategories:

- Surveying, Construction, Operation, and Maintenance Activities
- Planning and Habitat Protection Actions
  - Survey Stream Channels, Floodplains, and Uplands; Install Stream Monitoring Devices such as Steamflow and Temperature Monitors
  - Acquire Fee-Title Easement, Enter into Cooperative Agreements, and/or Lease Land and/or Water
  - Protect Streambanks Using Bioengineering Methods
- Small-Scale Instream Habitat Actions
  - Install Habitat-Forming Natural Materials Instream Structures (Large Wood, Boulders, and Gravel)
  - Improve Secondary Channel Habitats
  - Create Rehabilitate, and Enhance Riparian and Wetland Habitat
  - Improve Fish Passage
  - Supplement In-Channel Nutirents
- Livestock Impact Reduction
  - Construct Fencing for Grazing Control
  - Install Off-Channel Watering Facilities

    - Harden Fords for Livestock Crossing of Streams
- Control of Soil Erosion from Upland Farming
    - Create Upland Conservation Buffers
    - Implement Conservation Cropping Systems
    - Stabilize Soils via Planting and Seeding
    - Implement Erosion Control Practices
- Irrigation and Water Delivery/Management Actions
    - Convert Delivery System to Drip or Sprinkler Irrigation
    - Convert Water Conveyance from Open Ditch to Pipeline or Line Leaking Ditches and Canals
    - Convert from Instream Diversions to Groundwater Wells for Primary Water Sources
    - Install or Upgrade/Maintain Existing Fish Screens
    - Consolidate Diversions, or Replace Existing Irrigation Diversion with Pump Station, or Remove Unneeded Diversion Structures
    - Install or Replace Return Flow Cooling Systems
    - Install Irrigation Water Siphon Beneath Waterway
- Native Plant Community Establishment and Protection
    - Plant Vegetation
    - Manage Vegetation Using Physical Controls
    - Manage Vegetation Using Herbicides
- Road Actions
    - Maintain Roads
    - Maintain, Remove, and Replace Bridges, Culverts, and Fords
    - Decommission Roads
- Special Actions
    - Install/Develop Wildlife Structures

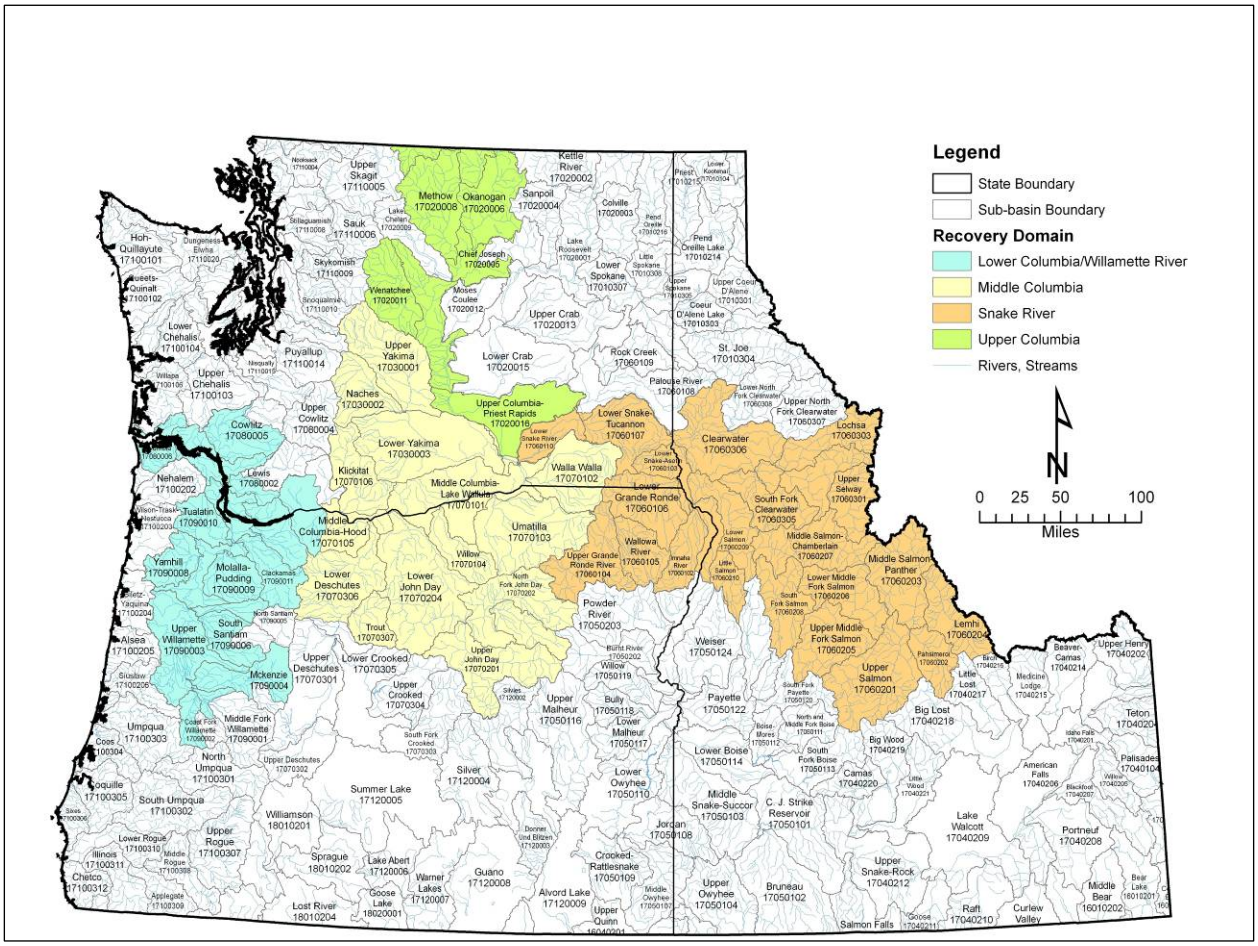
The activities selected for this programmatic consultation are a subset of the habitat improvement actions funded by the BPA. For an activity category to covered by this consultation, its effects must be predictable regardless of where it is carried out within the Columbia River basin. NMFS and the BPA selected activity categories with minor, predictable adverse effects and long-term beneficial effects for inclusion in this consultation. The BPA will continue to initiate individual consultations on actions with site-specific effects on listed anadromous fish and their critical habitat.

A typical project funded by the BPA will make use of several activity categories and subcategories. For this reason, the BPA did not make separate effect determinations for the each of the activity categories. The BPA determined that implementation of their habitat program as a whole was “likely to adversely affect” 13 species of salmon and steelhead listed under the ESA and their critical habitat. The BPA also determined that implementation of this program would adversely affect EFH for various salmon species. The proposed subcategories and associated minimization measures are fully described in the following sections.

Geographic Scope

This programmatic consultation covers areas of the Columbia River basin where ESA-listed anadromous salmon and steelhead are present. The downstream extent of this coverage includes the Columbia River estuary and the upstream extent ends at artificial or natural fish passage barriers that block migration of anadromous fish (see Figure 1).

Figure 1. Geographic coverage* of the HIP II consultation by subbasin and Columbia Basin salmon and steelhead species.



*Shaded subbasins are covered by this programmatic consultation.

Major artificial barriers that define the upstream extend of this area include: (1) Hells Canyon Dam on the Snake River; (2) Chief Joseph Dam on the Upper Columbia River; and (3) Dworshak Dam on the Clearwater River.

Major river basins covered by this consultation include: (1) The Lower Columbia River and its tributaries, (2) Willamatte, (3) Hood River, (4) Klickitat River, (5) Deschutes River, (6) John Day River, (7) Yakima River, (8) Walla Walla River, (9) Umatilla River, (10) Tucannon River,

(11) Grande Ronde River, (12) Imnaha River, (13) Clearwater River, (14) Salmon River, (15) Methow River, (16) Wenatchee River, and (17) Okananogon River. The recovery domain, subbasins, and United States Geological Survey hydrologic unit codes (HUCs) covered by this consultation can be found in Table 1.

Table 1. Recovery Domain, Subbasins, and HUCs covered by the HIP II Consultation

Recovery Domain	Subbasin Name	Hydrologic Unit Code
Lower Columbia/Willamette River	Lower Columbia	17080006
Lower Columbia/Willamette River	Lower Columbia-Clatskanie	17080003
Lower Columbia/Willamette River	Lower Willamette	17090012
Lower Columbia/Willamette River	Lewis	17080002
Lower Columbia/Willamette River	Cowlitz	17080005
Lower Columbia/Willamette River	Lower Columbia-Sandy	17080001
Lower Columbia/Willamette River	Tualatin	17090010
Lower Columbia/Willamette River	Yamhill	17090008
Lower Columbia/Willamette River	Middle Willamette	17090007
Lower Columbia/Willamette River	Molalla-Pudding	17090009
Lower Columbia/Willamette River	Clackamas	17090011
Lower Columbia/Willamette River	Lower Willamette	17090012
Lower Columbia/Willamette River	South Santiam	17090006
Lower Columbia/Willamette River	Mckenzie	17090004
Lower Columbia/Willamette River	Upper Willamette	17090003
Lower Columbia/Willamette River	Coast Fork Willamette	17090002
Lower Columbia/Willamette River	Middle Columbia-Hood	17070105
Interior Columbia	Klickitat	17070106
Interior Columbia	Lower Deschutes	17070306
Interior Columbia	Trout	17070307
Interior Columbia	Lower Yakima	17030003
Interior Columbia	Upper Yakima	17030001
Interior Columbia	Naches	17030002
Interior Columbia	Lower John Day	17070204
Interior Columbia	Upper John day	17070201
Interior Columbia	Middle Fork John Day	17070203
Interior Columbia	North Fork John Day	17070202
Interior Columbia	Middle Columbia-Lake Wallula	17070101
Interior Columbia	Umatilla	17070103
Interior Columbia	Walla Walla	17070102
Interior Columbia	Lower Snake River	17060110
Interior Columbia	Lower Snake-Tucannon	17060107
Interior Columbia	Lower Snake-Asotin	17060103
Interior Columbia	Lower Grande Ronde	17060106
Interior Columbia	Wallowa	17060105
Interior Columbia	Upper Grande Ronde	17060104
Interior Columbia	Imnaha	17060102
Interior Columbia	Hells Canyon	17060101
Interior Columbia	Clearwater	17060306
Interior Columbia	South Fork Clearwater	17060305
Interior Columbia	Lochsa	17060303
Interior Columbia	Upper Selway	17060301
Interior Columbia	Lower Selway	17060302
Interior Columbia	Lower Salmon	17060209

Recovery Domain	Subbasin Name	Hydrologic Unit Code
Interior Columbia	Little Salmon	17060210
Interior Columbia	South Fork Salmon	17060208
Interior Columbia	Middle Salmon-Chamberlin	17060207
Interior Columbia	Lower Middle Fork Salmon	17060206
Interior Columbia	Upper Middle Fork Salmon	17060205
Interior Columbia	Upper Salmon	17060201
Interior Columbia	Pahsimeroi	17060202
Interior Columbia	Lemhi	17060204
Interior Columbia	Middle Salmon-Panther	17060203
Interior Columbia	Upper Columbia-Priest Rapids	17020018
Interior Columbia	Wenatchee	17020011
Interior Columbia	Methow	17020008
Interior Columbia	Okanogan	17020006
Interior Columbia	Chief Joseph	17020005
Interior Columbia	Upper Columbia-Entiat	17020010

Implementation Process

The BPA determines which habitat improvement projects it will fund and contracts with various project sponsors (*e.g.*, state fish and wildlife agencies, Native American tribes, soil and water conservation districts, irrigation districts, and other Federal agencies and non-profit entities) to implement the projects. If ESA section 7 consultation is required, BPA staff will determine if the proposed project can be covered under this programmatic consultation. If any part of the proposed project is inconsistent with any provision of the HIP II consultation, an individual consultation will be initiated.

To ensure compliance with the HIP II consultation for each site-specific action, BPA staff will individually review each action through information submitted by the project sponsor. Prior to implementing the project, the BPA will submit a project notification report to NMFS. The BPA proposes to use the Public Consultation Tracking System (PCTS) Consultation Initiation and Reporting System (CIRS) to track implementation of the programmatic consultation when this system becomes available. The report will contain the following information:

1. A detailed description of the proposed project (what, where, when, how, intended result, *etc.*).
2. A map of the site location (using the CIRS GIS mapping tool when available), with the following information:
   a. Which species and critical habitats are potentially present at the site;
   b. sixth-field HUC and name; and
   c. latitude/longitude.
3. Identification of which habitat improvement activity(ies) addressed in the HIP II Opinion are included in the project.
4. A summary of the applicable terms and conditions from the HIP II Opinion for the particular actions of the project.
5. Determination of whether the project activities can be implemented according to the applicable terms and conditions.

This report may be submitted either directly from the BPA or from the project sponsor. If the report is submitted by the project sponsor, BPA staff will review and approve the report prior to final submission to NMFS.

Any requests for minor project-specific variances from the activities addressed or the Terms and Conditions of the HIP II Opinion will be documented in a "Variance Request" submitted to NMFS. NMFS will review and respond to the variance prior to work proceeding. BPA will submit variance requests in the provided field of the CIRS Project Notification Report when the system is available. Similarly, NMFS will provide an electronic response to the variance request in CIRS when it becomes available. NMFS will generally grant variances if the minor changes to the proposed action fall within the effects considered in this Opinion. Variances will not be granted for proposed changes that cause effects beyond those considered. If at any time there are uncertainties in interpreting the reasonable and prudent measures and terms and conditions of the HIP II Opinion, or doubts about the consistency with the HIP Opinion, the project sponsor, in conjunction with BPA staff, will coordinate with NMFS to address these concerns and resolve any outstanding issues.

BPA will work with each project sponsor to submit a Project Completion report to NMFS within 120 days of project completion. The BPA proposes to use the CIRS system to submit these reports when the system becomes available. The BPA will continue to provide paper reports using forms included in the Appendix of the BA submitted for this consultation. The report will include:

1. Date(s) of project completion.
2. A narrative assessment of the success of the project.
3. Fish salvage (take) reporting.
4. Herbicide use reporting.

Information from the reports will be reviewed in an annual meeting between BPA and NMFS staff to determine whether reinitiation of consultation is required.

In addition, all activities that require a site rehabilitation plan per the terms and conditions of the HIP II Opinion will be monitored for a period of up to 5 years after completion of the activity to ensure that the performance standards of the plan are being met. Documentation of the monitoring and any corrective actions will be maintained by the project sponsor.

Description of the Proposed Activity Categories

Surveying, Construction, Operation, and Maintenance Activities. The BPA proposes to fund various surveying, construction, and maintenance activities at restoration project sites, or lands owned or leased by the BPA. While actions carried out under this activity category do not directly result in habitat improvement, many of the subsequent activity categories require these activities to be carried out before ground disturbance begins.

Description

Many of the proposed projects to be covered under HIP II are likely to involve one or more of the following activities: (1) Onsite activities before site alteration may include surveying, minor vegetation clearing, placement of stakes and flagging guides, minor movements of machines and personnel over the action area; (2) construction of access roads, depending on the scope of the action, may entail subgrade stabilization, base course construction, aggregate production, and other activities listed; (3) establishment of construction staging area occurs when actions require heavy equipment; that equipment is delivered to the site, fueled, maintained and stored in temporary facilities when not in use; (4) materials storage applies to soil, rocks or other materials that may be hauled to and stored at the action site; (5) site preparation involves removal of surface vegetation and major root system, construction can also involve the discharge of water for actions such as concrete washout, pumping for work area isolation, and washing vehicles; (6) earthwork means use of heavy machinery to move natural soils from one location to another by excavating, filling, or compacting; (7) site restoration and cleanup involves protection of bare earth by seeding, planting, mulching, and fertilizing; (8) ongoing operation and maintenance of facilities is required for most projects.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity category:

1. Minimum Area. Construction impacts will be confined to the minimum area necessary to complete the project and boundaries of clearing limits associated with site access and construction will be marked to avoid or minimize disturbance of riparian vegetation, wetlands and other sensitive sites.
2. Timing of In-water Work. Work below the bankfull elevation[1] will be completed during the appropriate state preferred in-water work period[2] as appropriate for the project area, unless otherwise approved in writing by NMFS.
3. Cessation of Work. Project operations will cease under high flow conditions that may result in inundation of the project area, except for efforts to avoid or minimize resource damage.

---

[1] "Bankfull elevation" means the bank height inundated by a 1.5- to 2-year average recurrence interval and may be estimated by morphological features such average bank height, scour lines and vegetation limits.

[2] Sources for in-water work periods include:

• Oregon Department of Fish and Wildlife, *Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources*, 12 pp (June 2000) (http://www.dfw.state.or.us/lands/inwater/inwater_guide.pdf);

• U.S. Army Corps of Engineers, Seattle District, Approved Work Windows for Fish Protection (Version: 13 October 2000) http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=work_windows

• In-water work windows for work in the Snake River are set on a case by case basis by the Regulatory Branch of the Corps, Walla Walla District, based on input from the regional offices of Idaho Dept of Fish and Game (IDFG) and NMFS. They are typically July 1 to August 15 (Brad Daly, Chief of Regulatory Branch, the Corps, Walla Walla District, personal communication with Mark Pedersen, Shapiro and Associates, Inc., Seattle, WA and Bill Horton, October 11, 2002).. Any deviation from this work window will require approval from IDFG Anadromous Fish Coordinator. **(**IDFG, personal communication with Mark Pedersen, Shapiro and Associates, Inc. Seattle, WA).

4. Fish Screens. All water intakes used for a project, including pumps used to isolate an in-water work area, will have a fish screen installed, operated, and maintained according to NMFS fish screen criteria.
5. Fish Passage. Passage will be provided for any adult or juvenile salmonid species present in the project area during construction, unless otherwise approved in writing by NMFS, and will be maintained after construction for the life of the project. Upstream passage is not required during construction if it did not previously exist.
6. Pollution and Erosion Control Plan. A Pollution and Erosion Control Plan will be prepared and implemented to prevent pollution caused by survey, construction, operation, and maintenance activities. The Plan will be available for inspection upon request by BPA or NMFS and contain the following: (A) The name and address of the party or parties responsible for accomplishment of the Pollution and Erosion Control Plan; (B) practices to prevent erosion and sedimentation associated with access roads, stream crossings, drilling sites, construction sites, borrow pit operations, haul roads, equipment and material storage sites, fueling operations and staging areas; (C) practices to confine, remove, and dispose of excess concrete, cement and other mortars or bonding agents, including measures for washout facilities; (D) a description of any regulated or hazardous products or materials that will be used for the project, including procedures for inventory, storage, handling, and monitoring; (E) a spill containment and control plan with notification procedures, specific cleanup and disposal instructions for different products, quick response containment and cleanup measures that will be available on the site, proposed methods for disposal of spilled materials, and employee training for spill containment; (F) practices to prevent construction debris from dropping into any stream or waterbody, and to remove any material that does drop with a minimum disturbance to the streambed and water quality.
7. Inspection of erosion controls. During construction, monitor instream turbidity and inspect all erosion controls daily during the rainy season and weekly during the dry season, or more often if necessary, to ensure they are working adequately.[3] If monitoring or inspection shows that the erosion controls are ineffective, mobilize work crews immediately to make repairs, install replacements, or install additional controls as necessary. Remove sediment from erosion controls once it has reached one-third of the exposed height of the control.
8. Construction Discharge Water. All discharge water created by construction (*e.g.*, concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids) will be treated as follows: (A) Design, build, and maintain facilities to collect and treat all construction discharge water using the best available technology applicable to site conditions. Provide treatment to remove debris, nutrients, sediment, petroleum hydrocarbons, metals and other pollutants likely to be present; (B) If construction discharge water is released using an outfall or diffuser port, velocities will not exceed 4 feet per second, and the maximum flow of any aperture will not exceed 4 cubic feet per second; (C) do not release construction discharge water within 300 feet upstream of spawning areas or areas with submerged estuarine vegetation; (D) do not allow pollutants including green concrete, contaminated water, silt, welding slag, or sandblasting abrasive

[3] "Working adequately" means no more than a 10% cumulative increase in natural stream turbidity will be allowed, as measured relative to a control point immediately upstream of the turbidity-causing activity.

to contact any wetland or the 2-year floodplain, except cement or grout when abandoning a drill boring or installing instrumentation in the boring.

9. Treated Wood. Projects will not use treated wood[4] that may contact flowing water or that will be placed over water where it will be exposed to mechanical abrasion or where leachate may enter flowing water. The use of sodium silicate impregnated wood products is allowed. Projects that require removal of treated wood will use the following precautions: (A) Take care to ensure that no treated wood debris falls into the water. If treated wood debris does fall into the water, remove it immediately; (B) dispose of all treated wood debris removed during a project, including treated wood pilings, at an upland facility approved for hazardous materials of this classification. Do not leave treated wood pilings in the water or stacked on the streambank.

10. Preconstruction Activity. The following actions will be completed before significant[5] alteration of the project area: (A) Flag the boundaries of clearing limits associated with site access and construction to prevent ground disturbance of critical riparian vegetation, wetlands, and other sensitive sites beyond the flagged boundary; (B) ensure that the a supply of sediment control materials are on-site (*e.g.*, silt fence, straw bales[6]) and an oil-absorbing floating boom is available whenever surface water is present.

11. Temporary erosion controls. Ensure that all temporary erosion controls are in place and appropriately installed downslope of project activity within the riparian buffer area[7] until site rehabilitation is complete.

12. Temporary Access Roads. The following is required for temporary access roads: (A) Do not build temporary roads mid-slope or on slopes steeper than 30%; (B) walk low-impact, tracked drills to a survey site without the need for an access road. Minimize soil disturbance and compaction for other types of access whenever a new temporary road is necessary within 150 feet[8] of a stream, waterbody, or wetland by clearing vegetation to ground level and placing clean gravel over geotextile fabric, unless otherwise approved in writing by NMFS.

---

[4] "Treated wood" means lumber, pilings, and other wood products preserved with alkaline copper quaternary (ACQ), ammoniacal copper arsenate (ACA), ammoniacal copper zinc arsenate (ACZA), copper naphthenate, chromated copper arsenate (CCA), pentachlorophenol, or creosote.

[5] "Significant" means an effect can be meaningfully measured, detected or evaluated.

[6] When available, certified weed-free straw or hay bales will be used to prevent introduction of noxious weeds.

[7] For purposes of this Opinion only, "riparian buffer area" means land: (1) within 150 feet of any natural water occupied by listed salmonids during any part of the year or designated as critical habitat; (2) within 100 feet of any natural water within ¼ mile upstream of areas occupied by listed salmonids or designated as critical habitat and that is physically connected by an aboveground channel system such that water, sediment, or woody material delivered to such waters will eventually be delivered to water occupied by listed salmon or designated as critical habitat; and (3) within 50 feet of any natural water more than a ¼ mile upstream of areas occupied by listed salmonids or designated as critical habitat and that is physically connected by an aboveground channel system such that water, sediment, or woody material delivered to such waters will eventually be delivered to water occupied by listed salmon or designated as critical habitat. "Natural water" means all perennial or seasonal waters except water conveyance systems that are artificially constructed and actively maintained for irrigation.

[8] Distances from a stream or waterbody are measured horizontally from, and perpendicular to, the bankfull elevation, the edge of the channel migration zone, or the edge of any associated wetland, whichever is greater. "Channel migration zone" means the area defined by the lateral extent of likely movement along a stream reach as shown by evidence of active stream channel movement over the past 100 years, e.g., alluvial fans or floodplains formed where the channel gradient decreases, the valley abruptly widens, or at the confluence of larger streams.

13. Temporary stream crossings. The following are required for all stream crossings: (A) Do not allow equipment in the flowing water portion of the stream channel where equipment activity could release sediment downstream, except at designated stream crossings; (B) minimize the number of temporary stream crossings; (C) survey and map any potential spawning habitat within 300 feet downstream of a proposed crossing; (D) do not place stream crossings at known or suspected spawning areas, or within 300 feet upstream of such areas if spawning areas may be affected; (E) when the project is completed, obliterate all temporary access roads, stabilize the soil, and revegetate the site.
14. Heavy Equipment. Use of heavy equipment will be restricted as follows: (A) When heavy equipment will be used, the equipment selected must have the least adverse effect on the environment (*e.g.*, minimally sized, low ground pressure equipment); (B) ensure that only enough supplies and equipment to complete a specific job will be stored on site; (C) complete vehicle staging, cleaning, maintenance, refueling, and fuel storage, except for that needed to service boats, in a vehicle staging area placed 150 feet or more from any stream, waterbody or wetland, unless otherwise approved in writing by NMFS; (D) inspect all vehicles operated within 150 feet of any stream, waterbody, or wetland daily for fluid leaks before leaving the vehicle staging area. Repair any leaks detected in the vehicle staging area before the vehicle resumes operation. Document inspections in a record that is available for review upon request by BPA or NMFS; (E) before operations begin and as often as necessary during operation, steam clean all equipment that will be used below ordinary high water until all external oil, grease, mud, and other visible contaminates are removed. Complete all cleaning in the staging area; (F) diaper all stationary power equipment (*e.g.*, generators, cranes, stationary drilling equipment) operated within 150 feet of any stream, waterbody, or wetland to prevent leaks, unless suitable containment is provided to prevent potential spills from entering any stream or waterbody; (G) if site conditions prohibit meeting any of the above criteria, then submit a minor deviation form to NMFS for authorization to continue project activities.
15. Site Preparation. (A) Native materials, including large wood, native vegetation, weed-free topsoil, and native channel materials (gravel, cobble, and boulders), disturbed during site preparation must be saved on site for site restoration; (B) instream blasting is excluded from this consultation; however, instream rock splitting by chemical expansion or shot-shell powered rock splitting is included.
16. Work Area Isolation/Capture and Release. If adult or juvenile fish are reasonably certain to be present, or if the work area is less than 300 feet upstream of spawning habitats, the work area will be completely isolated from the active flowing stream and any captured fish will be released at a safe release site. Before and intermittently during pumping to isolate an in-water work area, staff will attempt to capture and release fish from the isolated area using trapping, seining, electro-fishing, or other methods that are prudent to minimize risk of injury. All fish capture and release must follow NMFS electrofishing guidelines (Available from NMFS Northwest Region Protected Resources Division, http://www.nwr.noaa.gov/Regional-Office/Protected-Resources/index.cfm)
17. Earthwork. Complete earthwork (including drilling, excavation, dredging, filling and compacting) as quickly as possible, implementing the following: (A) During excavation, stockpile native streambed material above the bankfull elevation, where it cannot reenter the stream, for later use. If culvert inlet/outlet protecting riprap is used, it will be class 350 metric or larger and topsoil will be placed over the rock and planted with native

woody vegetation; (B) if drilling, boring, or jacking is used, isolate drilling operations in wetted stream channels using a steel pile, sleeve or other appropriate isolation method to prevent drilling fluids from contacting water. If directional drilling is used, the drill, bore or jack hole will span the channel migration zone and any associated wetland.

18. Stormwater Management. For any project that will produce a new impervious surface or a land cover conversion that slows the entry of water into the soil, a stormwater management plan will be prepared and implemented. The plan will be available for inspection on request by BPA or NMFS. The goal is to avoid and minimize adverse effects due to the quantity and quality of stormwater runoff for the life of the project by maintaining pre-project conditions, or by restoring more natural conditions. The plan will meet the following criteria and contain the pertinent elements listed below, and meet requirements of all applicable laws and regulations. A system of management practices and, if necessary, structural facilities, designed to complete the following functions: (A) Minimize, disperse, and infiltrate stormwater runoff onsite using sheet flow across permeable vegetated areas to the maximum extent possible without causing flooding, erosion impacts, or long-term adverse effects to groundwater; (B) pretreat stormwater from pollution generating surfaces, including bridge decks, before infiltration or discharge into a freshwater system, as necessary to minimize any nonpoint source pollutant (*e.g.*, debris, sediment, nutrients, petroleum hydrocarbons, metals) likely to be present in the volume of runoff predicted from a 6-month, 24-hour storm; (C) use permeable pavements for load-bearing surfaces, including multiple-use trails, to the maximum extent feasible based on soil, slope, and traffic conditions; (D) install structural facilities outside wetlands or the riparian buffer area whenever feasible; otherwise, provide compensatory mitigation to offset any long-term adverse effects; (E) for projects west of the Cascade Mountain summit that require engineered flow control facilities to meet the stormwater management goal, use a continuous rainfall/runoff model to ensure that the duration of post-project discharge matches the pre-project duration from 50% of the 2-year peak flow up to the 50-year peak flow.

19. Site Rehabilitation. Any large wood, native vegetation, topsoil, and native channel materials displaced by construction will be stockpiled for use during site restoration. When construction is finished, all streambanks, soils, and vegetation will be cleaned up and restored as necessary to renew ecosystem processes that form and maintain productive fish habitats. Fencing will be installed as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

20. Project Completion Reporting. BPA will require the following of each project sponsor as a condition of project funding: Each project sponsor will submit a project completion report in NMFS' CIRS (when it is functional) within 120 days of project completion that describes the sponsor's success in meeting the minimization measures, reasonable and prudent measures, and associated terms and conditions of the HIP Opinion; fish handling and salvage; actual herbicide use; and other reports as outlined in CIRS.

Planning and Habitat Protection Actions

Survey Stream Channels, Floodplains, and Uplands; Install Stream Monitoring Devices such as Streamflow and Temperature Monitors. The BPA proposes to use the above methods to collect information about existing on-ground conditions relative to habitat type,

condition, and impairment; species presence, abundance, and habitat use; and conservation, protection, and rehabilitation opportunities or effects.

Description

The BPA proposes to fund habitat and animal inventories in uplands, floodplains, and streambeds and to install monitoring equipment. Electro-shocking of fish for research purposes is not included, as this work is covered through an ESA Section 10 research permit. Work covered under this activity category 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) manually installing rebar or other markers along transects or at reference points; (3) manually installing piezometers and staff gauges to assess hydrologic conditions; (4) manually installing recording devices for streamflow and temperature; (5) locating and measuring physical features associated with structures on watercourses, such as culverts, bridges, gauges, and dams; (6) visually locating and recording fish presence, redds, or carcasses in support of carrying out other restorations activities described in this Opinion(surveys carried out solely for research purposes will be addressed by an ESA section 10 permit issued from the NMFS Protected Resources Division); (7) conducting snorkel surveys to determine species of fish in streams and observing interactions of fish with their habitats in support of carrying out other restorations activities described in this Opinion(surveys carried out solely for research purposes will be addressed by an ESA section 10 permit issued from the NMFS Protected Resources Division); (8) conducting habitat evaluation procedures, making observations, and walking transects for wildlife habitat assessment; (9) visually locating, identifying, and recording plant presence, frequency, and condition; (10) excavating cultural resource test pits using hand shovel only; (11) inventorying roads for general condition, needed work, and sediment sources.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

21. Except for escapement (redd) surveys, no in-water work will occur within 300 feet of spawning areas during anadromous fish spawning and incubation times.
22. Hydraulic and topographic measurement within the wetted channel may be completed anytime except during the spawning period, unless a natural resource specialist with experience in fish handling verifies that no redds are occupied within 300 feet downstream from the measurement site.
23. Persons conducting redd surveys will be trained in redd identification, likely redd locations, and methods to minimize the likelihood of stepping on redds or delivering fine sediment to redds.
24. Workers will avoid redds and listed spawning fish while walking within or near stream channels to the extent possible. Avoidance will be accomplished by examining pool tailouts and low-gradient riffles for clean gravel and characteristic shapes and flows prior to walking or snorkeling through these areas.
25. If redds or listed spawning fish are observed at any time, workers will step out of the channel and walk around the habitat unit on the bank at a distance from the active channel.

26. Snorkel surveys will follow a statistically valid sampling design or rely on a single pass approach.
27. Surveyors will coordinate with other local agencies to prevent redundant surveys.
28. Excavated material from cultural resource test pits will be placed away from stream channels. All material will be replaced back into test pits when testing is completed.
29. Multiple stream sites will be used for field trips to minimize effects on any given stream or riparian buffer area.

Acquire Fee-Title or Easement, Enter into Cooperative Agreements, and/or Lease Land and/or Water. The BPA proposes to preserve existing habitat for fish and wildlife by preventing development or degradation; increasing connectivity by reconnecting patches of high quality habitat or extending habitat out from a core area; and/or increase tributary water flow to improve conditions in a Clean Water Act 303d water quality limited stream, improve fish spawning, rearing, and migration, restore riparian functions.

Description

The BPA proposes to fund the purchase or lease of, or implement cooperative agreements on, good quality upland, riparian, and aquatic habitat. This includes funding the acquisition of riparian buffers under the Conservation Reserve Program administered by the Natural Resources Conservation Service. For most transactions, management of the property or rights will be conducted by a land managing or water conservation entity. For land habitat acquisitions, a long-term management plan will be developed.

The acquisition of a water right for instream flow is an administrative process where water that otherwise would have legally been withdrawn from the stream will instead remain in the stream, thereby enhancing flow, improving water quality, and maintaining temperature for the benefit of fish and the riparian system as a whole. Management activities occurring subsequent to the acquisition, leasing, or agreement, such as fencing, revegetation, *etc*. are not included in this description of the fee-title or easement acquisition, cooperative agreements, and/or leasing of land and/or water activity, since many of these potential management activities are addressed elsewhere in this consultation.

In 2000, the BPA developed a Water Transaction Program. BPA invited state agencies, Indian tribes, water trusts, water districts, watershed councils, irrigation districts, and other interested individuals and parties to apply for consideration as either a regional entity or local entity. BPA selected the National Fish and Wildlife Foundation (NFWF), Pacific Northwest Regional Office, as the regional entity that will receive, evaluate, and facilitate implementation of water transactions submitted by local entities. The regional entity will receive policy-level guidance from a steering committee, which will assist the entity to establish region-wide priorities and criteria, address funding issues, and set the goals and objectives of the program. Local entities will propose to the regional entity innovative ways to increase tributary flows within the Columbia River basin (Washington, Oregon, and Idaho). BPA evaluates and prioritizes these actions for funding according to the criteria developed and approved by NMFS.

Protect Streambanks Using Bioengineering Methods. The BPA proposes to protect and repair eroding streambanks using bioengineering methods.

Description

All actions proposed for streambank protection must provide the greatest degree of natural stream and floodplain function achievable through application of an integrated, ecological approach. The following bank protection techniques are proposed for use either individually or in combination: (1) Woody plantings and variations (*e.g.*, live stakes, brush layering, facines, brush mattresses); (2) herbaceous cover, where analysis of available records (*e.g.*, historical accounts and photographs) shows that trees or shrubs did not exist on the site within historic times; primarily for use on small streams or adjacent wetlands; (3) deformable soil reinforcement, consisting of soil layers or lifts strengthened with fabric and vegetation that are mobile ("deformable") at approximately two- to five-year recurrence flows. Projects using deformable soil reinforcements must meet the following criteria must be bio-degradable, break down within 10-15 years, and penetrable by plant roots; (4) coir logs (long bundles of coconut fiber), straw bales and straw logs used individually or in stacks to trap sediment and provide a growth medium for riparian plants; (5) bank reshaping and slope grading, when used to reduce a bank slope angle without changing the location of its toe, to increase roughness and cross-section, and to provide more favorable planting surfaces; (6) tree and LWD rows, live siltation fences, brush traverses, brush rows and live brush sills in floodplains, used to reduce the likelihood of avulsion[9] in areas where natural floodplain roughness is poorly developed or has been removed (7) floodplain flow spreaders, consisting of one or more rows of trees and accumulated debris used to spread flow across the floodplain.

Minimization Measures

In addition to the general minimization measures and those for construction activities described above, BPA proposes the following specific methods to minimize adverse effects to fish and their habitats from measures for streambank erosion control activities:

30. Use of Large Wood and Rock. Whenever possible, large wood will be used as an integral component of all streambank protection treatments.[10] The use of rock, stone and similar materials will be avoided or minimized. 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 or partially under ground is not acceptable. If LWD is used primarily for bank stabilization, limit the total project length to 250 feet. Use cables sparingly and favor bioengineering techniques.

    Rock may be used instead of wood for the following purposes and structures. The rock will be class 350 metric (700 pounds), or larger, wherever feasible, but may not impair natural stream flows into or out of secondary channels or riparian wetlands. Rock will be used: (A) As ballast to anchor or stabilize LWD components of an approved bank

[9] "Avulsion" means a significant and abrupt change in channel alignment resulting in a river moving into a new channel across the floodplain. It is usually associated with large floods, and may be caused by either natural events or actions such as straightening or moving channels by building dikes or levees, or building deep, floodplain gravel pits too near the river.

[10] See, for example., WDFW/WDOT/WDOE, *Integrated Streambank Protection Guidelines*, Appendix I: Anchoring and placement of large woody debris (June 2002) http://www.wa.gov/wdfw/hab/ahg/ispgdoc.htm; or ODFW/ODF, *A Guide to Placing Large Wood in Streams*, May 1995 http://www.oregon.gov/ODF/PRIVATE_FORESTS/docs/fp/WoodPlacmntGuide1995.pdf

treatment; (B) to fill scour holes, as necessary to protect the integrity of the project, if the rock is limited to the depth of the scour hole and does not extend above the channel bed; (C) to construct a footing, facing, headwall, or other protection necessary to prevent scouring or downcutting of an existing flow control structure (*e.g.*, a culvert or bridge support).

Small-Scale Instream Habitat Actions

Install Habitat-Forming Natural Material Instream Structures (Large Wood, Boulders, and Gravel). The BPA proposes to fund placement of natural habitat forming structures to provide instream spawning, rearing and resting habitat for salmonids and other aquatic species; provide high flow refugia; increase interstitial spaces for benthic organisms and juvenile salmonids; increase instream structural complexity and diversity; promote natural vegetation composition and diversity; reduce embeddedness in spawning gravels; reduce siltation in pools; reduce the width/depth ratio of the stream; mimic natural input of LWD (*e.g.*, whole conifer and hardwood trees, logs, root wads) in aquatic systems that have been altered by channelization and land use practices; restore historic hydrologic regimes; decrease flow velocities; and deflect flows into adjoining floodplain areas.

Description

Large wood debris (LWD) and boulders will be placed in stream channels. All activities intended for installing habitat-forming instream structures will provide the greatest degree of natural stream and floodplain function achievable through application of an integrated, ecological approach. Instream structures capable of enhancing habitat forming processes and migratory corridors will be installed only within previously degraded stream reaches, where past disturbances have removed habitat elements such as LWD, boulders, or gravel. These structures include engineered log jams and other cover structures designed with LWD and/or boulder materials. Structures will be installed only in streambed gradients of 6% or less. Structure placement activities will be limited to areas where structures are, or would be, naturally present. Placement design may include structure types that are designed to lower a stream's width-to-depth ratio while providing habitat and migratory corridors capable of connecting existing habitats and promoting a naturally functioning channel. Large woody debris structures will be designed to minimize the need for anchoring. However, depending on site location and design criteria, some structures may be anchored. Key boulders (footings) or large wood can be buried into the streambank or channel but shall not constitute the dominant placement method of boulders and large wood. If anchored, a variety of methods may be used. These include buttressing the wood between riparian trees, cabling the structure to existing structures, and/or anchoring with boulders, concrete blocks or new log wedges. Biodegradable manila/sisal rope may be used to temporarily stabilize structures. Work may require the use of heavy equipment, excavator-type machinery, cable yarders, draft horses, helicopters, power tools, or hand tools.

LWD will be placed in channels that have an intact, well-vegetated riparian buffer area that is not mature enough to provide large wood, or in conjunction with riparian rehabilitation or management. Wood placement will also be limited to areas where survey data indicate that the absence of large wood has been a limiting factor for fish habitat.

LWD will be placed in a manner that most closely mimics natural accumulations of large wood for that particular stream type. Large woody debris may partially or completely span stream channels or be positioned along streambanks. If LWD is used primarily for bank stabilization, the total project length will be limited to 250 feet. Cable will be used sparingly and only when conditions do not exist to anchor large wood naturally between riparian trees or where stream power is great enough that wood meeting size criteria cannot be stabilized through natural anchoring or buried in banks. Bioengineering techniques will be favored.

The placement of large boulders will be restricted to streams where boulders naturally occur but are currently lacking. Boulder size and placement patterns will closely mimic that which would naturally occur for that particular stream type. Boulder placement projects will rely on the size of boulder for stability, not on any artificial cabling or other devices. No use of cables to anchor boulders is allowed under this programmatic consultation. The use of boulders to construct weirs or other channel-spanning structures is not included under this action (see Protect Streambanks using bioengineering methods, above) for activities included in this consultation where boulders may be used). The use of a series of boulders to armor streambanks is not allowed.

Some of the instream habitat improvement projects may involve pulling or felling trees into streams. Although trees would be sacrificed and maneuvered within the riparian zone and stream channel in these projects, no trees would be harvested or removed from riparian reserves. In addition, the projects will extend over substantial distances and stocking levels of remaining trees will remain high, so BPA does not believe that riparian indicators will be degraded. Gravel augmentation will occur only in areas where the natural supply has been eliminated or significantly reduced (below dams, weirs, *etc.*). Gravel will be placed immediately downstream of the obstruction, allowing the stream to naturally sort and distribute the material.

Installation of LWD will comply with the size requirements outlined in *A Guide to Placing Large Wood in Streams* (ODFW/ODF 1995) and placement guidance in the *Oregon Aquatic Habitat Restoration and Enhancement Guide* (ODFW/ODF 1999), or Appendix I of the *Integrated Streambank Protection Guidelines* (WDFW *et al.* 2003). When available, trees with rootwads attached should be a minimum length of 1.5 times the bankfull channel width, while logs without rootwads should be a minimum of 2.0 times the bankfull width (ODFW/ODF 1999).

Minimization Measures

The BPA proposes the following specific method to minimize installing habitat-forming natural material instream structures:

31. Gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible, gravel of the same lithology as found in the watershed will be used.

Improve Secondary Channel Habitats. The BPA proposes to fund improvement of secondary channel habitats to increase the area available for rearing habitat; improve access to rearing habitat; increase hydrologic capacity of side channels; increase channel diversity and

complexity; provide resting areas for fish and wildlife species at various levels of inundation; reduce flow velocities; and provide protective cover for fish and other aquatic species.

Description

Actions proposed for this activity category include removing or modifying sediment bars or terraces that block fish passage and removing channel and bank sediments to open the channel or increase the channel area. All activities intended for improving secondary channel habitats will provide the greatest degree of natural stream and floodplain function achievable through application of an integrated, ecological approach. Activities that will create new side channels or alcoves, or alter streambank or channel conditions are not included in this consultation except for the following: (1) Removal of trash and other artificial debris dams that block fish passage; (2) removal of sediment bars or terraces that block fish passage within 50 feet of a tributary mouth.

Work may entail use of heavy equipment, power tools, and/or hand tools.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

32. For removal of sediment bars or terraces, no more than 25 cubic yards (cy) of sediment may be removed.
33. Adequate precautions will be taken to prevent the creation of fish passage issues or post-construction stranding of juvenile or adult fish.

Create, Rehabilitate, and Enhance Riparian and Wetland Habitat. The BPA proposes to fund restoration of wetland habitat to reestablish a hydrologic regime that has been disrupted by human activities, including functions such as water depth, seasonal fluctuations, flooding periodicity, and connectivity.

Description

For purposes of this consultation, the riparian and wetland habitat creation, rehabilitation,[11] and enhancement activity is limited to the following list: (1) Remove levees, dikes, berms, weirs or other water control structures; (2) set back levees, dikes, and berms; (3) reshape streambanks as necessary to reestablish vegetation; (4) excavate and remove artificial fill materials from former wetlands; (5) reintroduce beavers in areas where they have been removed; (6) excavate pools and ponds to groundwater to create wetlands in uplands; (7) remove structural bank protections, and other engineered or created structures that do not meet the description and minimization measures under Streambank Protection Using Bioengineering Methods; (8) re-contour off-stream areas that have been leveled.

No other projects that would alter streambank or channel conditions are included in this proposed action. All activities intended for riparian and wetland habitat creation, rehabilitation, and enhancement will also provide the greatest degree of natural stream and floodplain function

[11] "Rehabilitation project" means a habitat rehabilitation activity whose primary purpose is to restore natural aquatic or riparian habitat process or conditions, which would not be undertaken but for its rehabilitation purpose.

achievable through application of an integrated, ecological approach. This work will involve careful design to retain or reclaim natural conditions and the functions of the natural, active floodplain. The design will consider data and results from current and historic aerial photos, maps, hydraulic models, original plans, local knowledge of historic conditions and recent literature. Projects will be designed to mimic natural conditions for gradient, width, sinuosity and other hydraulic parameters. Bioengineering methods will be employed to help stabilize the banks and floodplains as the new features perform minor self-adjustment during bankfull (and larger) flood events.

Common practices for riparian or wetland creation include the use of heavy equipment, such as excavators, backhoes, and graders. Power tools and crews with hand tools may also be used. Soil may be moved out of or brought onto a site, depending on the specific characteristics of the site. 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.

Minimization Measures
The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

34. Adequate precautions will be taken to prevent the creation of fish passage issues or stranding of juvenile or adult fish.

Improve Fish Passage. The BPA proposes to fund various activities to facilitate fish passage past obstacles in streams.

Description
The BPA proposes the following activities to improve fish passage: (1) Removal of trash and other artificial debris dams that block fish passage; (2) removal of permanent or intermittent dams, if fish cannot readily pass at any streamflow. Only those dams with a maximum total head measurement equal to or less than 3 feet are covered under this consultation. Total head will be measured from the forebay to tailwater. All other dam removal projects will be site- specific consultations; (3) removal of tide gates that block fish passage to estuarine habitat (replacement of existing tidal gates or installation of new tide gates is not covered by this consultation); (4) modification of a dam apron with shallow depth (less than 10 inches), or high flow velocity to provide depths and velocities passable to upstream migrants; (5) modification of a diffused or braided flow that impedes approach to the impediment; (6) re-engineering of improperly designed fish passage or fish collection facilities; (7) periodic maintenance of fish passage or fish collection facilities to ensure proper functioning, *e.g.*, cleaning debris buildup, replacement of parts; (8) installation of a fish ladder at an existing facility. The removal of natural blockages such as beaver dams and log jams is not allowed.

Minimization Measures
The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

35. Conceptual Design Review. Designs for upstream passage facilities will be developed in an interactive process with NMFS, in accordance with NMFS Anadromous Salmonid Passage Facility Design Guidelines (NMFS 2007). At the conceptual design stage (generally eight months to two years prior to construction) the project sponsor will contact NMFS Engineering (FERC Branch Chief) to be assigned to an engineer for technical assistance. The conceptual design will be discussed with the engineer. The engineer will provide immediate feedback to the project sponsor via email and within a week or less. The engineer may: (A) Give approval to move forward with the design; (B) remain engaged with the design process if the project is of sufficient scale to warrant this; or (C) waive engineering involvement (if a small-scale project).
36. Final Design Approval. If the engineer did not waive NMFS involvement in the design process, final designs will be submitted for review at least 90 days prior to construction (60 days for small projects requiring less than 2 weeks construction time). Final approval from the NMFS engineer will be obtained via email or letter prior to initiating construction.
37. Operation and maintenance of fish passage structures will be conducted in accordance with the operation and maintenance plan outlined in the project description section of the NMFS CIRS Project Notification Report.

Supplement In-Channel Nutrients. The BPA proposes to fund projects designed to improve biological productivity in a stream or river through the application and distribution of nutrients.

Description

Under this activity category, nutrients will be applied throughout a waterway corridor by: (1) Placement of salmon carcasses into waterways; (2) placement of carcass analogs (processed fish cakes) into waterways; (3) placement of inorganic fertilizers into waterways.

In Oregon, projects are permitted through Oregon Department of Environmental Quality (ODEQ). Carcasses from the treated watershed or those that are certified disease free by an ODFW pathologist will be used. In Washington, the Washington Department of Fish and Wildlife's (WDFW) *Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State, 2004*, will be followed.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

38. Targeted streams will have the capacity to capture and store placed carcasses.
39. 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.
40. Eutrophic or naturally oligotrophic systems will not be supplemented with nutrients.
41. Nutrients will be applied and distributed manually from bridges or streambanks, by boat, or by helicopter.

42. Each waterway will be individually assessed for available light, water quality, stream gradient and life history of the fish present, and adaptive management will be used to derive the maximum benefits of nutrient enhancement.

Livestock Impact Reduction

Construct Fencing for Grazing Control. The BPA proposes to fund construction of fences to eliminate or reduce livestock degradation of streams, streambanks, lakeshores, riparian/wetland vegetation, and unstable upland slopes; reduce soil compaction and erosion; and reduce fecal input to streams and wetlands, thereby improving riparian habitat function.

Description
Permanent or temporary livestock exclusion fences or cross-fences will be installed to assist in grazing management. Fenced riparian areas would be placed into a conservation easement for approximately 15 years with no grazing allowed. Individual fence posts will be pounded or dug using hand tools or augers on backhoes or similar equipment. Fence posts will be set in the holes, backfilled, and fence wire strung or wooden rails placed. Installation may involve the removal of native or non-native vegetation along the proposed fence line. Occasionally, rustic wood X-shaped fence that does not require setting posts will be used.

Minimization Measures
The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

43. No grazing will be allowed within riparian area fenced exclosures unless a separate, individual consultation on the grazing plan is completed.

Install Off-Channel Watering Facilities. The BPA proposes to fund development of off-channel watering facilities to preclude or limit the need for cattle to access a creek or wetland for drinking water, which would eliminate or reduce livestock degradation of streams and streambanks.

Description
The proposed 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. Placement of the pipes in the ground will typically involve minor trenching using a backhoe or similar equipment. All new wells or other stock watering sources installed under this activity will be permitted by the appropriate state agency.

Minimization Measures
The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

The BPA proposes the following minimization measures for installation of watering facilities:

44. Off-channel livestock watering facilities will be located to minimize compaction and/or damage to sensitive soils, slopes, vegetation, or fish spawning habitat due to congregating livestock.
45. Wherever feasible, new livestock water developments will be placed, and existing water developments moved, at least 0.5 mile away from riparian areas, unless livestock movement is otherwise limited by terrain.
46. Each watering development will have a float valve, fenced overflow area, return flow system, or other means, as necessary, to minimize water withdrawal and potential runoff and erosion.
47. All intake screening projects will be consistent with NMFS Screen Guidelines (NMFS 1996).

Harden Fords for Livestock Crossings of Streams. The BPA proposes to fund hardening of fords for livestock crossing to eliminate or reduce livestock degradation of streams and streambanks and to reduce soil compaction and erosion.

Description

Livestock stream crossings will be installed to allow access to pastures and watering sources where livestock and other farm animals access and cross a stream channel on a somewhat infrequent basis. Culverts or bridges will be installed for frequent crossing locations in accordance with the Maintain, Remove, and Replace Bridges, Culverts, and Fords activity category. Hardening stream crossings will involve the placement of river rock along the stream bottom. Work will entail the use of heavy equipment, power tools, and/or hand tools. Additional use of fences will reduce straying off fords or watering areas into spawning gravels or large rearing pools.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

48. The number of crossings will be minimized.
49. Crossings will be located to minimize compaction and/or damage to sensitive soils, slopes, or vegetation. Fords will be placed on bedrock or stable substrates whenever possible.
50. Crossings will not be placed in areas where ESA-listed salmon or steelhead spawn or are suspected of spawning, or within 300 feet upstream of such areas if spawning areas may be disturbed.
51. Essential crossings will be designed and constructed or improved to accommodate 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.
52. 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.

53. Livestock crossings in and of themselves will not create barriers to the passage of adult and juvenile fish.
54. Livestock will be managed to minimize time spent in the crossing or riparian area.
55. Livestock crossings will have a maximum width of 20 feet.

Control of Soil Erosion from Upland Farming

Create Upland Conservation Buffers. The BPA proposes to fund the creation of upland conservation buffers to reduce sediment and nutrient pollution from upland agricultural lands to streams.

Description
Under this activity category, borders of perennial vegetation, consisting of shrub and herbaceous cover, will be created along edges of fields. Close-growing groundcover species will be planted to encircle areas that may serve as a source of sediment, to prevent contamination of streams, rivers and lakes. Grassed waterways will be constructed with a swale cross-section to assure bank stability and retain vegetation, with vegetation suitable for conveyance of runoff. The BA states that the following Natural Resource Conservation Service (NRCS) conservation practice standards may be consulted for guidance: (1) 332 Contour Buffer Strip; (2) 380 Windbreak/Shelterbelt Establishment; (3) 386 Field Border; (4) Filter Strip; (5) Grassed Waterway; (6) Vegetative Barriers. These activities will be implemented in combination with a riparian forest buffer (NRCS measure 391) wherever trees and/or shrubs can grow, or a riparian herbaceous cover (NRCS measure 390) where analysis of available records (historical accounts and photographs) indicates that no trees or shrubs, including willow (*Salix* spp.), existed on the site within historic times.

Implement Conservation Cropping Systems. The BPA proposes to fund implementation of conservation cropping systems to reduce sediment and nutrient pollution from upland agricultural lands to streams.

Description
Conservation tillage and no-till direct seeding methods will be used to minimize tilling of agricultural fields. Crops will be arranged so that close-growing crops or grasses alternate with bands of clean-tilled crops. The contour of the land will be followed during all preparation, planting, and cultivation of crops. Slopes will be altered to create a stair-step or inclining ridge and swale appearance. Green manure crops and grasses and legumes will be planted in rotation to increase organic matter in the soil and reduce the need for synthetic fertilizers. The following NRCS Conservation Practice Standards may be consulted for guidance: (1) 329a Residue Management, No-Till and Strip Till; (2) 329b Residue Management – Mulch Till; (3) 328 Conservation Crop Rotation (4) 330 Contour Farming; (5) 585 Contour Stripcropping; (6) 590 Nutrient Management; (7) 777 Residue Management Direct Seed; (8) 585 Stripcropping.

Conservation tillage and residue management practices will be employed that leave 30% or more of the previous crop residue on the soil surface after planting, as feasible, to reduce erosion potential. Nutrient management practices will be employed to increase the efficiency of fertilizer inputs and decrease the transport of nutrients to ground and surface water. Nutrients will be

applied at an agronomic rate.[12] Pest management practices will be employed, including non-chemical pest control measures, that will reduce pollution due to pesticide contamination during transport, handling, and use, and that will reduce non-point pollution after use.[13] These activities will be implemented in combination with a riparian forest buffer (NRCS measure 391) wherever trees or shrubs can grow, or a riparian herbaceous cover (NRCS measure 390) where analysis of available records (historical accounts and photographs) indicates that no trees or shrubs, including willow (*Salix* spp.), existed on the site within historic times. Installation and management of the full range of field and landscape buffers will be encouraged by BPA as necessary to address small but unavoidable pollutant discharges associated with active agricultural operations, catastrophic pollution-associated episodic storm events, and other landscape level concerns.

Stabilize Soils via Planting and Seeding. The BPA proposes to fund stabilization of soils by planting and seeding to reduce sediment pollution from upland agricultural lands to streams.

Description

Pastures and rangelands will be planted or seeded with native or adapted perennial and biannual vegetation. The ground will be scarified as necessary to promote seed germination. In areas with severe erosion or high erosion potential, trees, shrubs, vines, grasses, and legumes will be planted to stabilize soils. Because noxious weeds, nonnative invasive plants, and aggressive, weedy species can take over disturbed lands and degrade range values, vegetation will be controlled through the use of herbicide applications, mechanical removal, hand pulling, and prescribed burning. Vegetation control activities will be conducted in accordance with the descriptions and minimization measures in the Native Plant Community Establishment and Protection activity category. Planting and seeding will be accomplished, as appropriate, in consultation with: (1) The applicable best management practices outlined in the NRCS Conservation Practice Standards in the two previous activity categories; (2) Sloping Agricultural Land Technology (SALT) to reduce erosion and soil loss on sloping lands. Nutrients will be applied at an agronomic rate.[14] Pest management practices will be employed, including non-chemical pest control measures, that will reduce pollution due to pesticide contamination during transport, handling, and use, and that will reduce non-point pollution after use.[15] These activities will be implemented in combination with a riparian forest buffer (NRCS measure 391) wherever trees or shrubs can grow, or a riparian herbaceous cover (NRCS measure 390) where analysis of

[12] "Agronomic rate" means a quantity and timing of total nutrient application that does not exceed the requirements of the crop production and harvest or grazing system, as opposed to a nutrient application rate based on production goals that are difficult to define and variable. Calculation of the agronomic rate should take into account the total nitrogen or phosphorus resources for plant nutrition, and any retention of phosphorus in the soil and losses of nitrogen through dentrification and ammonia volatilization.

[13] Take of ESA-listed species caused by any aspect of pesticide use not otherwise covered in this HIP II consultation must be evaluated in an individual consultation if it is funded by BPA.

[14] "Agronomic rate" means a quantity and timing of total nutrient application that does not exceed the requirements of the crop production and harvest or grazing system, as opposed to a nutrient application rate based on production goals that are difficult to define and variable. Calculation of the agronomic rate should take into account the total nitrogen or phosphorus resources for plant nutrition, and any retention of phosphorus in the soil and losses of nitrogen through dentrification and ammonia volatilization.

[15] Take of ESA-listed species caused by any aspect of pesticide use not otherwise covered in this HIP II consultation must be evaluated in an individual consultation if it is funded by BPA.

available records (historical accounts and photographs) indicates that no trees or shrubs, including willow (*Salix* spp.), existed on the site within historic times.

Implement Erosion Control Practices. The BPA proposes to fund implementation of erosion control measures to trap and contain water and sediment from uplands prior to it entering streams; to prevent sediment from entering fish-bearing streams and retain runoff for release during low streamflow periods in late summer and fall.

Description

Small impoundments with water retention and release capabilities will be created in natural swales in uplands. Water will be released from the top of the water column so that sediment is retained. This practice will be applied where physical conditions or land ownership preclude treatment of a sediment source by the installation of erosion-control measures to keep soil and other material in place, or where a sediment basin offers the most practical solution to the problem. The criteria, plans and specifications, and operation and maintenance protocols of the following NRCS conservation practice standards (or the most recent versions of them) may be consulted for guidance: (1) 342 Critical Area Planting; (2) 350 Sediment Basin (3) 362 Diversion; (4) 410 Grade Stabilization Structure; (5) 638 Water and Sediment Control Basins.

These activities will be implemented in combination with a riparian forest buffer (NRCS measure 391) wherever trees or shrubs can grow, or a riparian herbaceous cover (NRCS measure 390) where analysis of available records (historical accounts and photographs) indicates that no trees or shrubs, including willow (*Salix* spp.), existed on the site within historic times. Installation and management of the full range of field and landscape buffers will be encouraged by BPA as necessary to address small but unavoidable pollutant discharges associated with active agricultural operations, catastrophic pollution-associated episodic storm events, and other landscape level concerns.

Irrigation and Water Delivery/Management Actions

Convert Delivery System to Drip or Sprinkler Irrigation. The BPA proposes to fund conversion of water delivery system from flood irrigation to drip or sprinkler irrigation to increase the amount of instream flow for fish and to increase riparian functions.

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. The criteria, plans and specifications, and operation and maintenance protocols of the NRCS conservation practice standards for Irrigation System, Sprinkler may be consulted for guidance.

Convert Water Conveyance from Open Ditch to Pipeline or Line Leaking Ditches and Canals. The BPA proposes to fund conversion of water conveyance from open ditch to pipeline or line leaking ditches and canals to increase the amount of instream flow for fish and to increase riparian functions.

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, bentonite, or appropriate lining materials. The criteria, plans and specifications, and operation and maintenance protocols of the NRCS conservation practice standards for irrigation water conveyance may be consulted for guidance. This guidance might include publications dealing with galvanized steel ditch and canal lining; flexible membrane ditch and canal lining; non-reinforced concrete ditch and canal lining; aluminum tubing pipeline; asbestos-cement pipeline; and high-pressure, underground, plastic pipeline. The most recent versions of NRCS guidance will be used.

Convert from Instream Diversions to Groundwater Wells for Primary Water Source. The BPA proposes to fund conversion of instream water diversion to groundwater wells to increase the amount of instream flow for fish and to increase riparian functions.

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 and designed to facilitate fish passage, if feasible. If an instream diversion is downsized, it will be covered under this programmatic consultation only by following all criteria outlined in the Consolidate Diversions, or Replace Existing Irrigation Diversions with Pump Stations, or Remove Unneeded Diversion Structures Activity Category. The criteria, plans and specifications, and operation and maintenance protocols of the NRCS conservation practice standards for water well code (NRCS 1999c) may be consulted for guidance. All new wells or other stock watering sources installed under this activity will obtain applicable permits from the appropriate state agency.

Minimization Measures
The BPA proposes the following specific method to minimize adverse effects on fish and their habitat for this activity:

56. Conversion of instream diversions to groundwater wells will only be used in circumstances where there is an agreement to ensure that any surface water made available for instream flows is protected from surface withdrawal by another water-user.

Install New or Upgrade/Maintain Existing Fish Screens. The BPA proposes to fund installation of new fish screens or upgrade or maintain existing fish screens.

Description
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 into the irrigation system. Intake pipes or discharges will be screened with mesh sizes small enough to prevent access to the withdrawal and outlet structures. Designs will prevent fish and other aquatic organisms from becoming trapped against the screen by excessive water velocities or entrained or impinged by improperly designed screens. Periodic maintenance of fish screens will be

conducted to ensure their proper functioning. Maintenance includes activities such as cleaning debris buildup and replacement of parts, and may require temporary removal of the screen.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

57. All fish screening projects will be consistent with NMFS Juvenile Fish Screen Criteria (NMFS 1995b), and all pump intake screening projects will be consistent with NMFS Fisheries' Pump Intake Screen Guidelines (NMFS 1996).
58. Conceptual Design Review. Designs for fish screens and upstream passage facilities will be developed in an interactive process with NMFS, in accordance with NMFS Anadromous Salmonid Passage Facility Design Guidelines (NMFS 2007). At the conceptual design stage (generally eight months to two years prior to construction) the project sponsor will contact NMFS Engineering (FERC Branch Chief) to be assigned to an engineer for technical assistance. The conceptual design will be discussed with the engineer. The engineer will provide immediate feedback to the project sponsor via email and within a week or less. The engineer may: (A) Give approval to move forward with the design; (B) remain engaged with the design process if the project is of sufficient scale to warrant this; or (C) waive engineering involvement (if a small scale project).
59. Final Design Approval. If the engineer did not waive NMFS involvement in the design process, final designs will be submitted for review at least 90 days prior to construction (60 days for small projects requiring less than two weeks construction time). Obtain final approval from the engineer via email or by letter prior to initiating construction.
60. All fish screens will be sized to match the irrigator's state water right or estimated historic water use, whichever is less.
61. Operation and maintenance of fish passage structures will be conducted in accordance with the operation and maintenance plan outlined in the project description of the NMFS CIRS Project Notification document.

Consolidate Diversions, or Replace Existing Irrigation Diversions with Pump Stations, or Remove Unneeded Diversion Structures. The BPA proposes to fund consolidation of, or replacement of existing diversions with pump stations, or removal of unneeded irrigation diversion structures. This action will reduce the number of diversions on streams and thereby conserve water and improve habitat for fish, improve the design of diversions to allow for fish passage and adequate screening, or reduce the annual instream construction of push-up dams and instream structures.

Description

Push-up dams, concrete structures, or other instream irrigation diversion structures will be replaced with pumping stations to improve fish passage and habitat. Small instream rock structures that facilitate proper pump station operations are allowed when designed in association with the pump station. Multiple existing diversions may be consolidated into one diversion as long as there is no new instream construction or structures, and if the consolidated diversion is located at the most downstream existing diversion point. Unneeded or abandoned irrigation diversion structures will be removed where they are barriers to fish passage, have created

unacceptable habitat modifications, or are causing sediment concerns through deposition behind the structure or downstream scour. Projects will be supported by watershed-based analyses with the involvement of multiple owners and users. Coordination with appropriate local governments, irrigation districts, and state and Federal agencies will be required. Periodic maintenance of irrigation diversions will be conducted to ensure their proper functioning, *i.e.*, cleaning debris buildup, and replacement of parts. Work will entail use of heavy equipment, power tools or crews with hand tools.

New instream construction and diversion structures including dams, rock structures, weirs, infiltration galleries, or concrete structures are not covered by this programmatic consultation. If existing diversion structures require modifications, coverage is not included under this consultation. If consolidation of multiple diversions results in a new diversion location, coverage is not included under this consultation.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

62. Diversion structures will be designed and screened to meet NMFS Anadromous Salmonid Passage Facility Design Guidelines (NMFS 2007). The design of the proposed irrigation diversion installation will enable the irrigators to comply with all appropriate state water right agency rules and regulations.
63. Multiple existing diversions may be consolidated into one diversion as long as there is no new instream construction or structures, and if the consolidated diversion is located at the most downstream existing diversion point.
64. Diversions will be designed so that diverted water withdrawal is equal to or less than the irrigator's state water right, or equal to the current rate of diversion, whichever is less.
65. Project design will include the installation of a totalizing flow meter device 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.
66. Operation and maintenance of irrigation diversion structures will be conducted in accordance with the operation and maintenance plan provided with the HIP II Form 1 (Found in Appendix A of the BA).

Install or Replace Return Flow Cooling Systems. The BPA proposes to fund installation or replacement of irrigation return flow cooling systems to reduce the temperatures of return flows from irrigation systems and possibly to reduce instream temperatures in localized areas.

Description

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.

Install Irrigation Water Siphon Beneath Waterway. The BPA proposes to fund installation of siphons under streams or rivers to keep water in irrigation ditches from mixing with natural stream flow. The purpose of this activity category is to prevent irrigation water from entering and commingling with stream water and prevent stream flows from being captured and redirected into the irrigation ditch system and to restore natural stream bedload transport.

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.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

67. Directional drilling to create siphon pathway will be employed whenever possible.
68. Trenching will occur in dry stream beds only; work area isolation will be employed in perennial streams.
69. Stream widths will be maintained at bankfull width or greater.
70. No part of the siphon structure will block fish passage.
71. No concrete will be placed within the bankfull width.
72. Siphon surface structures will be set back from the top of the streambank at least 10 feet.
73. Minimum cover over a siphon structure within the streambed shall be 3 feet of natural substrate.
74. Waterway will be reconstructed to a natural streambed configuration upon completion.

Native Plant Community Establishment and Protection

Plant Vegetation. The BPA proposes to fund vegetation planting to recover watershed processes and functions associated with native plant communities.

Description

Under this activity category, project proponents would plant trees, shrubs, herbaceous plants, and aquatic macrophytes to help stabilize soils. Large trees such as cottonwoods and conifers will be planted in areas where they historically occurred but are currently either scarce or absent. Plants and seeds will be obtained from local sources to ensure plants are adapted to local climate and soil chemistry. Native Plant species will be required for these activities.

The BPA will include vegetation management strategies 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. The BPA will only certified noxious weed-free seed (99.9%), hay, straw, mulch, or other vegetation material for site stability and revegetation projects.

Manage Vegetation Using Physical Controls. The BPA proposes to fund management of vegetation using physical controls to control or eliminate non-native, invasive plant species that compete with or displace native plant communities.

Description

The following two mechanisms will be used for vegetation management by physical control: (1) 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; (2) 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).

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

75. For mechanical control that will disturb the soil, an untreated or modified treatment area will be maintained within the immediate riparian buffer area to prevent any potential adverse effects to stream channel or water quality conditions. The width of the untreated riparian buffer area will vary depending on site-specific conditions and type of treatment.
76. 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.
77. When possible, manual control (*e.g.*, hand pulling, grubbing, cutting) will be used in sensitive areas to avoid adverse effects to listed species or water quality.
78. 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.

Manage Vegetation Using Herbicides. The BPA proposes to fund management of vegetation using chemical herbicides to recover watershed processes and functions associated with native plant communities.

Description

Herbicides will be applied in liquid or granular form using wand or boom sprayers mounted on or towed by trucks, backpack equipment containing a pressurized container with an agitation device, injection, hand wicking cut surfaces, and ground application of granular formulas. Herbicides will be mixed with water as a carrier (no petroleum-based carriers will be used) and may also contain a variety of additives (see adjuvant paragraph below) to promote saturation and adherence, to stabilize, or to enhance chemical reactions. Aerial treatment is not proposed to be covered under this consultation, nor is treatment of aquatic weeds except for knotweed (*Polygonum cuspidatum*).

BPA proposes the use of the following herbicides for vegetation management:

- 2,4-D Amine Formulations.
- Aminopyralid
- Chlorsulfuron
- Clethodim
- Clopyralid
- Dicamba **(**Banvel formulation only)
- Glyphosate (For the purpose of this document glyphosate is being proposed and analyzed as two distinct factory-formulated types. The first type (I) is glyphosate factory-formulated without an identified surfactant. The second type (II) is glyphosate factory-formulated with an identified or implied surfactant. The reason for this is due to the increased aquatic toxicity resulting from the surfactant formulation. See BA Appendix D for a listing of Glyphosate product brands, selective characteristics, and types.)
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr (Only Triclopyr TEA, or the acid formulation labeled as Garlon 3A/Tahoe 3A, is being proposed in this consultation.)
- Herbicide Mixes (Combinations of herbicides may be used where several species of noxious weeds occur together, where the herbicides affect weeds differently, or where herbicide resistance is occurring. Chemical treatment can also be used in conjunction with, or preceeding, non-chemical weed control treatments, depending on weed species composition, infestation level, and environmental setting. No more than three herbicides will be used in a mixture.)

The BPA proposes the use of various adjuvants in conjunction with chemical herbicides. Spray additives can be included in formulated herbicides, or can be added to the spray mixture to improve the effectiveness of the spray solution. Adjuvants are classified by their uses rather than their chemistry, although chemical properties determine their suitability for use with different herbicides. Adjuvants include surfactants, antifoaming agents, compatibility agents, crop oil or crop oil concentrates, activators, drift retardants, and marker colorants/dyes. Adjuvants BPA proposes to use in this consultation are listed in Table 2.

Dyes will be added to herbicides to identify areas that have been sprayed, to warn the general public, to regulate application rates, reduce drift, and reduce risk of spraying non-target species. The dyes proposed for use with herbicides are water-soluble, break down in sunlight and wash away easily with water.

Surfactants are specialized additives, formulated to improve the emulsifying, spreading, sticking, and absorbing properties of herbicides to aid in uptake by the target plant. The type of surfactant used depends on the target plant, the selected herbicide, and environmental condition. Drift is primarily a function of droplet size and wind. Droplets with diameters of 100 microns (0.1 mm)

or less contribute the bulk of the drift off site from the treated fields. Drift control adjuvants increase the viscosity and the tensile strength of water and decrease the proportion of smaller drops in a spray system. They will also increase the average drop size, resulting in fewer drops per square inch of leaf surface, but the rate of deposit of pesticide in pounds per acre remains the same.

Liquid or granular forms of herbicides would be applied either with machinery or by hand. Mechanized application would be done with vehicle-mounted (pick-up, 4-wheeler, or tractor) fixed-booms, or spray guns. Hand application methods to be used are: (1) Spot-spraying with hand-held spray nozzles attached to either a tank-mounted on a vehicle or a backpack system; (2) hand-spreading granular formulations; and (3) wicking, wiping, dripping, painting, or injecting target weeds.

Table 2. Adjuvants to chemical herbicides proposed for use by BPA.

Adjuvant Type	Trade Name	Labeled Mixing Rates per Gallon of Application Mix	General Geographic Application Areas	Aquatic Level of Concern
Colorants	Dynamark™ U.V. (red)	0.1 fl oz	Riparian	Low (Food Grade)
	Dynamark™ U.V. (yel)	0.1 fl oz	Riparian	Low (Food Grade)
	Dynamark™ U.V. (blu)	0.5 fl oz	Upland	Moderate (Non-Crop Use)
	Hi-Light® (blu)	0.5 fl oz	UpLand	Moderate (Non-Crop Use)
Surfactants	Activator 90®	0.16 – 0.64 fl oz	Upland	Moderate
	Agri-Dex®	0.16 – 0.48 fl oz	Riparian	Low
	Entry II®	0.16 – 0.64 fl oz	Upland	High
	Hasten®	0.16 – 0.48 fl oz	Riparian	Low
	LI 700®	0.16 – 0.48 fl oz	Riparian	Moderate
	R-11®	0.16 – 1.28 fl oz	Riparian	Moderate
	Super Spread MSO®	0.16 – 0.32 fl oz	Riparian	Low
	Syl-Tac®	0.16 – 0.48 fl oz	Upland	Moderate
	Generic POEA	Pre-formulated	Upland	High
Drift Retardants	41-A®	0.03 – 0.06 fl oz	Riparian	Low
	Valid®	0.16 fl oz	Upland	Moderate

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

79. General Herbicide Conservations Measures. The measures listed below are for terrestrial application of chemicals only, and are designed to prevent chemicals from entering any surface waters. Applicators will only use the herbicides and adjuvants as proposed in this document as follows:

a. BPA will use the following factors to determine whether to use herbicides instead of or in combination with other types of vegetation control method(s), and when and how often they will be applied: (1) Toxicity of the herbicide(s), (2) physical growth characteristics of target weeds (rhizomatous vs. tap-rooted, *etc.*), (3) seed longevity and germination, (4) infestation size, (5) relationship of the site to other infestations, (6) relationship of the site to listed and/or proposed species, (7) distance to surface water, (8) accessibility to site for equipment, (9) type and amount of use of the area by people, (10) effectiveness of treatment on the target weed, and (11) cost.

b. In riparian zones, a site vegetation rehabilitation plan must be prepared if areas larger than ¼ acre (10,890 sq. ft.) are treated with a non-selective herbicide per year per project area.

c. In riparian zones, broadcast application of non-selective herbicides (glyphosate 1 and imazapyr) is limited to 5 acres (217,800 sq. ft.) per year per project area.

d. Product label directions will be followed as required by the Federal Insecticide, Fungicide, and Rodenticide Act, including "mandatory" statements (such as registered uses, maximum use rates, application restrictions, worker safety standards, restricted entry intervals, environmental hazards, weather restrictions, and equipment cleaning).

e. The most recent product label "precautionary" statements such as environmental hazards, physical or chemical hazards, soil and climate application restrictions, wildlife warnings, and threatened and endangered species warnings will be followed.

f. Herbicides will be applied only by a licensed applicator (valid for the state where the work is located) and only in accordance with EPA labeling or the restrictions identified in the HIP consultation, whichever are more restrictive. Applicators will use the herbicide specifically targeted for a particular weed species that will cause the least impact to non-target vegetation.

g. Applicators will keep records of each application, the active ingredient, formulation, application rate, date, time, location, etc. Records will be available to state and Federal inspectors, and will be supplied to applicable regulatory agencies and land managers as requested.

h. Applicators will also supply application information to BPA for the annual NMFS reporting and monitoring requirements described in the Reporting, Monitoring, Evaluation, and Adaptive Management portion of this section.

i. Applicators will never leave herbicides or equipment unattended in unrestricted access.

j. Only the minimum area necessary for the control of noxious weeds will be treated.

k. Before application, applicators will thoroughly review the site to identify and mark, if necessary, the buffer requirements.

l. Applicators will observe restricted entry intervals specified by the herbicide label.

m. No 2,4-D ester formulations of any kind will be used.

n. Only glyphosate that is factory-formulated without a surfactant will be used within 100 feet of any surface waters.

o. Tank mixing of surfactants or other additives to glyphosate without factory-formulated surfactants for use within 100 feet of any surface waters will be in strict accordance with all requirements in this activity category.

p. Only triclopyr TEA (acid) (Garlon 3A/Tahoe 3A) formulations of triclopyr will be used. No triclopyr BEE (ester) (Garlon 4) formulations of any kind will be used.

q. Only surfactants listed in Table 2 will be used for any project within the buffer specified in the following minimization measures, only surfactants registered and approved for aquatic use as shown on Table 2 will used within 15 feet of any surface waters.

r. No carrier other than water will be used for tank mixing.

s. No application to submerged aquatic vegetation with any herbicide is included in this consultation.

t. No aquatic application of chemicals is covered by this consultation except for treating emergent knotweed as follows:

   i. The only application methods for emergent knotweed are stem injection, wicking or wiping, and hand-held spray bottle application of glyphosate.

   ii. Applicators will be familiar with proper glyphosate stem injection methodology prior to treatment.

   iii. Only aquatic labeled glyphosate formulations will be used. The formulation can be up to 100% concentration for the stem injection method. The formulation will be diluted to 50% or less active ingredient when applied directly to fresh stem cuts using wicking or wiping, and up to the percentage allowed by label instructions when applied to foliage using low pressure hand-held spot spray applicators.

   iv. Larger emergent knotweed can be treated with glyphosate by stem injection, and smaller emergent knotweed by wicking/wiping and spot spray with hand-held sprayers. Wicking or wiping and hand-held spray bottle application of glyphosate is allowed to emergent knotweed plants less than 4 to 5 feet tall, and usually smaller.

   v. Emergent plants with actively growing stems greater than 0.75 inches in diameter will be treated by stem injection.

   vi. Most knotweed patches are expected to have overland access. However, some sites may be reached only by water travel, either by wading or inflatable raft (or kayak). The following measures will be used to reduce the risk of a spill during water transport:

      (1) No more than 2.5 gallons of glyphosate will be transported per person or raft, and typically it will be one gallon or less.

      (2) 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.

80. Drift and Leach Reduction Minimization measures.
    a. Applicators will use drift reduction agents, as appropriate and as identified in this document, to reduce the drift hazard when applying herbicides as broadcast or localized foliar treatments.
    b. Colorants will be used to the extent practicable to ensure proper coverage and targeting.
    c. Herbicides/adjuvants with a groundwater or surface water label advisory will not be used within 100 feet of any surface water.
    d. For basal bark/stem and stump applications, applicators will directly spray the root collar area, sides of the stump, and/or the outer portion of the cut surface, including the cambium, until thoroughly wet, but not to the point of runoff, in order to avoid or minimize deposition to surrounding surfaces. A marker colorant/dye is recommended to establish coverage and prevent plant runoff.
    e. Treatment will be delayed if precipitation is forecasted to occur within 24 hours, except for pellet application.
    f. Table 5 identifies minimization measures the BPA's weather and wind speed restrictions (to be used in the absence of more stringent label instructions and restrictions). During application, applicators will monitor weather conditions hourly at sites where spray methods are being used.
81. Herbicide Mixing Minimization measures.
    a. Applicators will prepare spray mixtures in accordance with the label's instructions and will not exceed the amount of herbicide per acre specified on the label.
    b. Applicators will perform mixing at suitable locations with respect to buffer zones and recommended buffer widths.
    c. Except as indicated by Tables 3, 4, and 5, applicators will mix and load herbicides at least 100 feet from any surface waters and only in locations where accidental spills cannot flow into waters or contaminate groundwater.
    d. No more than three different herbicides may be mixed for any one application.
82. Spills and Misapplication Minimization measures.
    a. Applicators will conduct regular testing on field calibration and calculations to prevent gross application errors.
    b. The applicator will develop a Spill Containment and Control Plan (SCCP) prior to herbicide application. The plan will contain notification procedures, specific clean up and disposal instructions for different products, quick response containment and clean up measures that will be available on site, proposed methods for disposal of spilled materials, and employee training for spill containment. All individuals involved, including any contracted applicators, will be instructed on the plan.
    c. In addition to an applicator's SCCP, applicators will report spills and misapplications to EPA in accordance with the BPA's Government Agency Plan (GAP) (See Appendix E of BA). Applicators will report spills and misapplications and will clean up according to Federal and applicable state laws and regulations. At a minimum, applicators will:
        i. Notify BPA within 24 hours of any spill or misapplication.
        ii. Contain the spill or leak, or halt misapplication.
        iii. Isolate the area and request help as appropriate.

iv. As soon as possible, notify the owner of the land and any other potentially affected parties.
v. Clean up the spill.
vi. Clean up equipment and vehicles.
vii. Dispose of cleanup materials properly.
viii. Follow up with appropriate cleanup documentation.

d. Upon notification of a spill or misapplication by an applicator, BPA will immediately notify the nearest NMFS field office and provide copies of all subsequent relevant information generated from the event.

83. Herbicide Handling Minimization measures.

a. During transportation, applicators will secure herbicide containers to prevent movement within the vehicle or loss from the vehicle during the operation of the vehicle.
b. When spray equipment is not being used, applicators will ensure that all valves and tank covers are closed during any movement of the vehicle.
c. Applicators will firmly secure any portable tanks used for herbicide application to the frame of the vehicles.

84. Storage of Herbicides, Containers, and Equipment Minimization measures.

a. Applicators will follow label requirements for storage.
b. Storage of herbicides will be in strict compliance with the relevant regulations of the state in which the herbicides are being stored.
c. Applicators will inspect storage areas frequently for leakage and clean up spill areas immediately.
d. Applicators will store only minimum amounts of chemicals at field and temporary locations, and will order out no more chemicals than necessary.
e. Applicators will dispose of unwanted or unusable products promptly and correctly.
f. In temporary storage locations, such as the field, applicators will store all chemicals in buildings or vehicles that can be locked and no closer than 300 feet from any surface water.

85. Herbicide Disposal Minimization measures.

a. Applicators will use water-soluble packaging (WSP) when available, to eliminate the need for container disposal.
b. Applicators will not burn paper and carton-type containers unless stated as permissible on the label.
c. Applicators will dispose of containers or cartons in one of three ways:
i. Triple rinse containers of liquid herbicides before disposal. The rinse solution will be poured into the mix-tank and used for treatment. Each rinse solution will be equal to at least 10% of the container volume. Dispose of the empty containers as non-contaminated waste, at any legal landfill dump.
ii. Use a rinsing nozzle (instead of triple rinsing). A rinsing nozzle has a sharp point that can puncture a plastic or metal empty herbicide container and flush the container's contents into the mix tank.
iii. Recycle returnable "mini-bulk" type containers to the distributor for refill.

d. Applicators will observe the applicable buffers when washing or rinsing spray tanks near waters.

e. Applicators will dispose of unwanted or unusable herbicide products as contaminated waste at an approved waste facility.

f. Applicators will dispose of contaminated materials (including contaminated soil) resulting from cleanup procedures according to EPA directives.

g. Applicators will place any contaminated materials to be transported in watertight containers.

86. Herbicide Reporting.

a. Herbicide use will follow the same approval process as other activities under the HIP BO, with the submittal of the Proposed Herbicide Use Table (Appendix A in the BA) to BPA or entering it into the NMFS CIRS once that system is functional. BPA environmental staff will review the table and send the project sponsor an approval letter. If herbicide use is the only activity proposed under the HIP BO, submittal of a Form 1, found in Appendix A of the BA, is not required, but some form of entry into the NMFS CIRS will be required once it is available.

b. Actual herbicide use will be reported by the project sponsors with the submittal of the Actual Herbicide Use Table (Appendix A in the BA) to BPA or entering it into the NMFS CIRS once the system is available. If herbicide use is the only activity proposed under the HIP BO, submittal of a 120-day implementation report is not required, but some form of entry into the NOAA database will be required once it is functional.

87. Herbicide Adaptive Management.

a. The BPA habitat improvement program is a long-term endeavor that includes control of noxious weeds, removal of unwanted vegetation, and revegetation where and when practicable. However, because there are areas of scientific and management uncertainty, management actions may require refinement or change over time as data from specific effectiveness monitoring is analyzed. With the likely development of new control methods and technology, changes in existing treatments or use of new noxious weed treatments and/or vegetation restoration methods may be authorized and warranted. Any changes to the proposed action, as described in the BA, would be analyzed for impacts to listed/proposed species and critical habitat, and consultation would be reinitiated as appropriate.

The BPA proposes the following buffers be used for all herbicide applications:

Table 3. Herbicide Buffers to Minimize Impacts on Non-Target Resources

Activity	**Minimum Buffers for Non-Target Resources Needing Protection**						
	Aquatic Species Spawning Seasons/Rearing Areas	**Soils**		**Agricultural Resources**			**Other T&E Species not Covered in this BA**
		Slopes >10% <20%	Slopes >20%	Food/Feed Crops	Grazing	Irrigation	
Chemical Application including mixing/ loading/cleaning	300 feet/Instream Timing Guidelines[a] (whichever is greater). Herbicides will be mixed at least 150 feet from streams, standing water, and other drainage features such as road ditches unless more restrictive distances are required by the label	NA	Do not apply any herbicide with a groundwater/surface water advisory. Do not apply any granulated herbicide.	Apply only chemicals in this document labeled for crop use.	Observe all labeled grazing restrictions.	Do not apply unless dry and allowed by the label.	Requires NMFS/USFWS consultation.
Motorized Activities	300 feet/Instream Timing Guidelines[a] (whichever is greater)	Do not enter within 35 feet of any surface water	Do not enter within 300 feet of any surface water	NA	NA	NA	Requires NMFS/USFWS consultation.
Manual Activities	100 feet/Instream Timing Guidelines[a] (whichever is greater)	NA	NA	NA	NA	NA	Requires NMFS/USFWS consultation.

Activity	Minimum Buffers for Non-Target Resources Needing Protection						
	Water Resources			Weather			
	Domestic/Public/Wildlife Drinking Water Well	Domestic/Public/Wildlife Drinking Water Intake/Spring	Sole Source Aquifers	Rain	Wind	Temperature[b] at >30% Humidity	
						Air	Soil
Chemical Application including mixing/loading/cleaning	50m (164 ft.) radius for any herbicide having a ground/ surface water advisory[c] 15m (50 ft.) radius for any other herbicide	For slopes <10% 50-m (164- ft.) radius for any herbicide having a ground/ surface water advisory[4] 15-m (50-ft.) radius for any other herbicide For slopes >10% <30% 150-m (492-ft.) radius for any herbicide having a ground/surface water advisory[4] 50-m (164-ft.) radius for any other herbicide For slopes >30% 300-m (984-ft.) radius for any herbicide having a ground/surface water advisory[4] 100-m (328-ft.) radius for any other herbicide	As per local aquifer management plan	Do not apply if rain is likely within 24 hours (does not apply to granular herbicides)	See Tables 4 and 5	<85ºF, >50ºF	>32ºF, <85ºF

a Contact appropriate State or Federal agency for timing restrictions based on location.
b. Represents optimum range when label lacks specific instructions.
c As stated on the label.

Table 4. Herbicide Buffer Widths to Minimize Impacts on Non-Target Resources

Herbicide	Broadcast Application[1]		Backpack Sprayer/Bottle Spot Spray Foliar/Basal[2]		Hand Application Wicking/Wiping/Injection[3]
	Minimum buffer from high water mark (ft)[6]	Maximum/ Minimum wind speed (mph)[4,5]	Minimum buffer from high water mark (ft)[6]	Maximum/ Minimum wind speed (mph)[4,5]	Minimum buffer from high water mark (wind speed not a factor)
2,4-D (amine)	100	10/2	50	5/2	15 feet for aquatic labeled formulations.
Aminopyralid	100	10/2	15	5/2	Up to high water mark.
Chlorsulfuron	100	10/2	15	5/2	Up to high water mark
Clethodim			50	5/2	Do not use within 50 feet of any surface water.
Clopyralid	100	10/2	15	5/2	Up to high water mark.
Dicamba (Banvel formulation only)	100	10/2	15	5/2	Up to high water mark.
Glyphosate 1	100	10/2	15 See knotweed General Herbicide Minimization measures for emergent application restrictions.	5/2	Up to water's edge for aquatic labeled formulations. See knotweed General Herbicide Minimization measures for emergent application restrictions.
Glyphosate 2	100	10/2	100	5/2	100 feet
Imazapic	100	10/2	15	5/2	Up to high water mark
Imazapyr	100	10/2	15	5/2	Up to water's edge for aquatic labeled formulations; otherwise, up to the high water mark.
Metsulfuron	100	10/2	15	5/2	Up to high water mark.
Picloram	100	8/2	100	5/2	Do not use within 100 feet of any surface water.
Sethoxydim	100	10/2	50	5/2	Do not use within 50 feet of any surface water.
Sulfometuron	100	10/2	15	5/2	Up to high water mark.
Triclopyr (TEA) (acid)	100	10/2	50	5/2	Up to high water mark for cut-stump application of aquatic labeled formulations; 15 feet for other applications.
Herbicide Mixtures	100	Most conservative of listed herbicides.	15	Most conservative of listed herbicides.	Most conservative of listed herbicides.

[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. This technique implies that herbicides do not touch the soil during the application process.
[4] Unless more conservative wind speed restrictions are required by the product label.
[5] The maximum and minimum wind speeds are designed to reduce the likelihood of spray/dust drift. Winds of 2 mph or less are indicative of air inversions. The applicator must confirm (using smoke or equivalent) the absence of an inversion before proceeding with the application whenever the wind speed is 2 mph or less.
[6] Bankfull or mean high tide mark.

Table 5. Herbicide Adjuvant Buffer Widths to Minimize Impacts on Non-Target Resources

Adjuvant	Broadcast Application[1]		Backpack Sprayer/Bottle Spot Spray Foliar/Basal[2]		Hand Application Wicking/Wiping/Injection[3]
	Minimum buffer (ft)	Maximum/Minimum wind speed (mph)[4,5]	Minimum buffer (ft)	Maximum/Minimum wind speed (mph) [4,5]	Minimum buffer (ft) (wind speed not a factor)
Dynamark (red)	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge when using herbicides labeled for aquatic uses.
Dynamark (yel)	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge when using herbicides labeled for aquatic uses.
Dynamark (blu)	100	Herbicide dependent from Table 4	>50 <50 Do not use	Herbicide dependent from Table 4	>50 Herbicide dependent from Table 4. <50 Do not use.
Hi-Light (blu)	100	Herbicide dependent from Table 4	>50 <50 Do not use	Herbicide dependent from Table 4	>50 Herbicide dependent from Table 4. <50 Do not use.
Activator 90®	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge for aquatic labeled formulations.
Agri-Dex	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge for aquatic labeled formulations.
Entry II	100	Herbicide dependent from Table 4	<100 Do not use	Herbicide dependent from Table 4	<100 Do not use.
Hasten	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge for aquatic labeled formulations.
LI 700	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge for aquatic labeled formulations.
R-11	100	Herbicide dependent from Table 4	>50 <50 Do not use	Herbicide dependent from Table 4	>50 Herbicide dependent from Table 4. <50 Do not use.
Super Spread MSO	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge for aquatic labeled formulations.
Syl-Tac	100	Herbicide dependent from Table 4	<50	Do not use.	<50 Do not use.
Unspecified POEA	100	Herbicide dependent from Table 4	<100	Do not use.	<100 Do not use.
41-A	100	Herbicide dependent from Table 4	15	Herbicide dependent from Table 4	Up to water's edge when using herbicides labeled for aquatic uses.
Valid	100	Herbicide dependent from Table 4	50	Herbicide dependent from Table 4	<50 Do not use.

[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 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. This technique implies that herbicides do not touch the soil during the application process.
[4] Unless more conservative wind speed restrictions are required by the product label.
[5] The maximum and minimum wind speeds are designed to reduce the likelihood of spray/dust drift. Winds of 2 mph or less are indicative of air inversions. The applicator must confirm (using smoke or equivalent) the absence of an inversion before proceeding with the application whenever the wind speed is 2 mph or less.

Road Actions

Maintain Roads. The BPA proposes to fund road maintenance at project sites or on lands they own or lease to eliminate or reduce erosion and mass-wasting hazards and thereby the sedimentation potential to down slope habitats.

Description

In general, road maintenance will involve minor construction efforts, typically using a small work crew equipped with one or two vehicles. This activity category also addresses road maintenance activities using heavy equipment, including: (1) Creating barriers to human access: gates, fences, boulders, logs, tank traps, vegetative buffers, and signs; (2) surface maintenance, such as building and compacting the road prism, grading, and spreading rock or surfacing material; (3) drainage maintenance and repair of inboard ditch lines, waterbars, sediment traps; (4) removing and hauling or stabilizing pre-existing cut and fill material or slide material; (5) snowplowing; (6) dust abatement; (7) relocating portions of roads and trails to less sensitive areas outside of riparian buffer areas.

Widening of roads is not allowed under this activity category. This activity category does not include new construction or relocation of any permanent road inside a riparian buffer area except for a bridge approach in accordance with the Maintain, Remove, and Replace Bridges, Culverts, and Fords activity category. This activity category also does not include a new bridge pier or abutment below the bankfull elevation, a new bridge approach within the Federal Emergency Management Agency (FEMA) designated floodway that will require embankment fills that significantly impair floodplain function, or a baffled culvert or fishway. Extensive asphalt resurfacing also is not included.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

88. Road maintenance will comply with ODOT (1999) practices or the most current version of the Regional Road Maintenance Endangered Species Act Program Guidelines[16].
89. All fill-associated wood will be removed during sidecast removal.
90. Waste material generated from road maintenance activities and slides will be disposed of in stable, non-floodplain sites approved by a geotechnical engineer or other qualified personnel.
91. Soil-disturbing maintenance activities will be conducted during dry conditions to the greatest extent practical. Road maintenance work in riparian areas will follow the appropriate state agency In-Water Work Timing guidelines, where relevant, except where the potential for greater damage to water quality and fish habitat exists if the emergency road maintenance is not performed as soon as possible.

[16] Oregon Department of Transportation, *Routine Road Maintenance: Water Quality and Habitat Guide, Best Management Practices*, 21 pp. + appendices (July 1999) (providing guidance on routine road maintenance activity only) (http://www.odot.state.or.us/eshtm/images/4dman.pdf); or see Regional Road Maintenance Endangered Species Act Program Guidelines (March 2002) (http://www.metrokc.gov/roadcon/bmp/pdfguide.htm)

92. Disturbance of existing vegetation in ditches and at stream crossings will be minimized to the greatest extent possible.
93. Ditches and culverts will be promptly cleaned of materials resulting from slides or other debris.
94. 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. Application will be avoided during or just before wet weather and at stream crossings or other locations that could result in direct delivery to a waterbody, typically within 25 feet of a waterbody or stream channel. Spill containment equipment will be available during chemical dust abatement application. Petroleum-based products will not be used for dust abatement.
95. 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.
96. Roads will be graded and shaped to conserve existing surface material. 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.
97. Ditch back slopes will not be undercut, to avoid slope destabilization and erosion acceleration.
98. 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. Slides and rock failures including fine material of more than approximately ½ 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 300 feet of perennial or 100 feet of intermittent streams.
99. Road grading material will not be sidecast along roads within ¼ mile of perennial streams and from roads onto fill slopes having a slope greater than 45%.
100. Road maintenance will not be attempted when surface material is saturated with water and erosion problems could result.
101. Large woody debris (LWD >9 m in length and >50 cm in diameter) present on roads will be moved intact to downslope 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.
102. Unsurfaced roads that can directly contribute sediment to streams will be identified and closed during the wet season.
103. Water drafting/pumping (for dust suppression or other needs) will be done in accordance with the following criteria: (A) Non-stream sources will be used prior to the use of stream sources whenever feasible; (B) when non-stream sources are unavailable, streams with the greatest flow will be used whenever feasible; (C) water withdrawal will not reduce stream flow by more than $1/10^{th}$ (stream flow may be estimated visually). For pumps with adjustable pump rates, pumping rates will be adjusted to avoid drafting more than 1/10th of the current stream flow; (D) streams with less than 5 cfs are used for

drafting, no more than 18,000 gallons will be removed in one day; (E) if streams with less than 5 cfs are used for drafting, no more than one pump will operate at one time at any one drafting site; (F) no water will be drafted from sites where adult salmonids are visibly present, to prevent interference with spawning activities; (G) no dams or channel alterations will be made for pumping in streams occupied by listed fish species.

104. Snowplowing will be preformed in accordance with the following criteria: (A) No chemical additives such as salt or de-icing chemicals will be used in conjunction with snowplowing; (B) drainage holes will be placed in snow berms to provide drainage; (C) a minimum of two inches of snow will be left on gravel roads during plowing; paved roads may be scraped to the surface; (D) no gravel or surfacing material will be bladed off the road (E) no deliberate sidecasting of snow into or over drainage structures will be permitted; (F) plowing will not be allowed on gravel roads during thaw periods when the road is wet.

Maintain, Remove, and Replace Bridges, Culverts, and Fords. The BPA proposes to 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.

Description

The BPA proposes the following bridge, culvert, and ford activities: (1) Remove culverts, where possible, and reestablish natural channel cross sections; (2) replace undersized culverts that present a barrier to fish movement with appropriately sized culverts or bridges; (3) lower perched culverts to meet the natural bed of the stream; (4) excavate and realign misaligned culverts; (5) modify culverts by, for example, installing step-and-pool weirs at culvert outlets, trash and debris racks, or erosion protection structures at culvert outlets or inlets where replacement or lowering is not feasible; (6) redesign stream crossings determined to be inappropriate for culvert installations to steel or concrete reinforced bridge installations, or vehicle fords; (7) remove or lower artificial structures that impede fish passage; (8) repair, upgrade or replace bridges and culverts. Bridge replacements will be full spanning only, *i.e.*, no bents, piers, or other support structures below bankfull elevation.

Replacement culverts and bridges will be designed using an interdisciplinary stream simulation approach involving team members with expertise in engineering, fluvial geomorphology, and fish biology. Culverts and bridges will be designed to mimic the natural stream processes and allow for fish passage, sediment transport, and flood and debris conveyance. Culvert installations will be designed to avoid upstream headcutting.

Vehicle fords will be constructed only in intermittent streams that have no anadromous fish spawning habitat.

These proposed activities will entail use of heavy equipment, power tools, and/or crews with hand tools. Restoring fish passage at existing culvert crossing sites implies that road access is available and that the need for new road construction and the associated impacts can be largely avoided. In the case of large fills, or depending on the engineered solution, some constructed road access may be required to gain access to the culvert structure itself.

The following types of culvert, bridge, and ford maintenance, removal, and replacement are not included under this programmatic consultation: (1) Culverts with widths less than bankfull width; (2) culverts with widths less than 6 feet in fish-bearing streams; (3) embedded culverts in a slope greater than 8%; (4) modifying existing culverts in place; (5) a baffled culverts or fishways; (6) new or replacement bridge piers or abutments below the bankfull elevation,[17] or in an active channel migration zone[18]; (7) new bridge approachs within the Federal Emergency Management Agency (FEMA) designated floodway that will require embankment fills that significantly impair floodplain function; (8) fords used for vehicle traffic which cross perennial streams; (9) vehicle fords crossing intermittent streams that support anadromous fish spawning habitat.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

105. Permanent stream crossings[19] will be designed in the following priority:
106. Nothing – realign road to avoid crossing the stream.
107. Bridge – new bridges will span the stream to allow for long-term dynamic channel stability, *i.e.*, no bents, piers or other support structures below bankfull elevation.
108. Streambed simulation – bottomless arch, embedded culvert, or vehicle fords crossing only intermittent streams that do not support anadromous fish spawning habitat.
109. No-slope design culvert[20] – limit new culverts to 0% slopes.
110. New culvert widths will meet or exceed bankfull width.
111. To provide for upstream passage of juvenile salmonids, the maximum average water velocity[21] will not exceed 1 foot per second.
112. Include suitable grade controls to prevent culvert failure caused by changes in stream elevation.
113. An explanation of why a particular design was chosen will be provided.
114. The Conceptual Design Review process with NMFS Hydropower Division will be implemented. Designs for upstream passage facilities will be developed in an interactive process with NMFS, in accordance with NMFS Anadromous Salmonid Passage Facility

[17] "Bankfull elevation" means the bank height inundated by an approximately 1.2 to 1.5 year (maximum) average recurrence interval and may be estimated by morphological features such as the following: (1) A topographic break from vertical bank to flat floodplain; (2) a topographic break from steep slope to gentle slope; (3) a change in vegetation from bare to grass, moss to grass, grass to sage, grass to trees, or from no trees to trees; (4) a textural change of depositional sediment; (5) the elevation below which no fine debris (*e.g.*, needles, leaves, cones, seeds) occurs; and (6) a textural change of matrix material between cobbles or rocks.

[18] "Channel migration zone" means the area defined by the lateral extent of likely movement along a stream reach where there is evidence of active stream channel movement over the past 100 years, e.g., alluvial fans or floodplains formed where the channel gradient decreases, the valley abruptly widens, or at the confluence of larger streams.

[19] For a discussion of crossing design types, see National Marine Fisheries Service, Southwest Region, *Guidelines for Salmonid Passage at Stream Crossings* (September 2001) (http://swr.nmfs.noaa.gov/hcd/NMFSSCG.pdf) and Washington Department of Fish and Wildlife, *Fish Passage Design at Road Culverts: A Design Manual for Fish Passage at Road Crossings* (March 3, 1999) (http://www.wa.gov/wdfw/hab/engineer/cm/toc.htm).

[20] "No-slope design culvert" means a culvert that is sufficiently large and installed flat to allow the natural movement of bedload to form a stable bed inside the culvert.

[21] "Maximum average water velocity" means the average of water velocity within the barrel of the culvert calculated using the 10% annual exceedance of the daily average flow.

Design Guidelines (NMFS 2007). At the conceptual design stage (generally eight months to two years prior to construction) the project sponsor will contact NMFS Engineering (FERC Branch Chief) to be assigned to an engineer for technical assistance. The conceptual design will be discussed with the engineer. The engineer will provide immediate feedback to the project sponsor via email, within a week or less. The engineer may: (A) give approval to move forward with the design; (B) remain engaged with the design process if the project is of sufficient scale to warrant this or; (C) waive engineering involvement (if a small-scale project). The Final Design Approval process will be implemented. If the engineer did not waive NMFS involvement in the design process, submit final designs for review at least 90 days prior to construction (60 days for small projects requiring less than two weeks construction time). Final approval will be obtained from the engineer via email or letter prior to initiating construction.

115. If the crossing will occur near an active spawning area, only full span bridges or streambed simulation will be used.
116. Fill width will be limited to the minimum necessary to complete the crossing, and existing stream width will not be reduced.
117. 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.
118. Place all large wood, cobbles, and gravels recovered during cleaning downstream of the culvert.
119. Do all routine work in the dry, using work area isolation if necessary.
120. Culverts or bridge abutments will not be filled with vegetation, debris, or mud. Abutments will be properly protected (*e.g.*, rock armored) to prevent future scouring actions and erosion hazards.
121. Maintenance schedules will be developed for culvert installations to ensure the culverts remain in proper functioning condition.

Decommission Roads. The BPA proposes to fund decommissioning of roads to eliminate or reduce erosion and mass-wasting hazards and thereby their sedimentation hazards to downslope habitats, to reduce the impact of roads on the hydrology of watersheds, and to eliminate or reduce human access associated impacts.

Description

The BPA proposes to decommission and obliterate roads that are no longer needed. Water bars will be installed, road surfaces will be insloped or outsloped, asphalt and gravel will be removed from road surfaces. Culverts and bridges will be altered or removed and streambanks will be recontoured at stream crossings. Cross drains will be installed, fill or sidecast will be removed, road prism will be reshaped, and sediment catch basins will be created. All surfaces will be revegetated to reduce surface erosion of bare soils, surface drainage patterns will be recreated, and dissipaters, chutes or rock will be placed at remaining culvert outlets.

Minimization Measures

The BPA proposes the following specific methods to minimize adverse effects on fish and their habitat for this activity:

122. All fill-associated wood will be removed during sidecast removal.
123. A natural resource specialist or hydrologist will be involved in the design and implementation of each road decommissioning project.
124. Activities will be conducted during dry-field conditions: low to moderate soil moisture levels.
125. Slide and waste material will be disposed of in stable, non-floodplain sites. Disposal of slide and waste material within the existing road prism or on adjacent hillslopes will be allowed to restore natural or near-natural contours, if approved by a geotechnical engineer or other qualified expert.
126. Disturbance of existing vegetation in ditches and at stream crossings will be minimized to the extent necessary to restore hydrologic functions.
127. Culvert removal will be designed to restore the natural drainage pattern.
128. Existing vegetation in ditches and at stream crossings will be disturbed as little as possible.

Special Actions

Install/Develop Wildlife Structures. The BPA proposes to fund installation or development of wildlife structures to enhance terrestrial habitats until native plant communities are established or help other natural habitat features become established.

Description
This activity involves the installation or development of a variety of structures that mimic natural features and provide support for wildlife foraging, breeding, and or resting. These can include bat roosting/breeding structures, avian nest boxes, hardwood snags, brush/cover piles, coarse woody debris, and raptor perches. Work may entail use of power tools and crews with hand tools.

Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For purposes of this consultation, the overall action area consists of the combined action areas of each project authorized under this Opinion. This includes riparian and aquatic areas affected by project implementation in the area described in the *Geographic Scope* section of this Opinion. Individual action areas also cover up to 500 feet downstream from the project area where aquatic habitat conditions may be temporarily degraded by increased turbidity and fine sediments in stream substrates. All projects authorized by this Opinion will occur within both of the following areas: (1) Private lands, state-owned, or Federal lands in the Columbia River basin; and (2) the range of ESA-listed salmon or steelhead, designated critical habitat, or EFH designated under the MSA.

The BPA has concluded that the proposed action for this consultation is "likely to adversely affect" Lower Columbia River (LCR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) fall-run Chinook salmon, SR spring/summer-run Chinook salmon, Upper Willamette River spring-run (UWR) Chinook salmon, Columbia River (CR) chum salmon, SR sockeye salmon, LCR coho salmon, LCR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, Snake River Basin (SRB) steelhead, UWR steelhead and critical habitat designated for these species. The action areas provide spawning, rearing, and migration habitat for these species and many action areas will be within designated critical habitat for these species.

Action areas involved in this consultation are also designated as EFH for Pacific Coast groundfish (PFMC 1998a), coastal pelagic species (PFMC 1998b), and/or Pacific Coast salmon (PFMC 1999), or are in areas where environmental effects of the proposed project may adversely affect designated EFH for those species.

The BPA has provided information regarding the number of projects they covered with the previous HIP consultation. From 2003 to 2006, the BPA covered 217 projects under the HIP consultation in Oregon, Washington, and Idaho. In 2003, BPA covered 18 projects, 13 of which were strictly vegetation control with chemical herbicides and 2 which involved in-water construction. In 2004, 51 projects were covered, 33 of which were strictly vegetation control with chemical herbicides and 16 of which involved in-water construction. In 2005, 69 projects were covered, 41 of which were strictly vegetation control with chemical herbicides, and 21 of which involved in-water work. In 2006, 79 projects were covered 47 of which were strictly vegetation control with chemical herbicides, and 31 of which involved in-water work. For the vegetation control projects with chemical herbicides, 198 riparian acres were treated in 2003, 1456 riparian acres were treated in 2004, 1157 riparian acres were treated in 2005, and 1993 riparian acres were treated in 2006.

Implementation of projects under this consultation increased steadily through 2006 as project proponents and BPA staff became more familiar with its use. The BPA expects to allocate similar or slightly higher funding for restoration projects falling under this consultation for the next several years, so NMFS will assume for the purposes of this consultation that habitat improvement projects will continue to occur at a level similar or slightly higher than in the recent past. For our analysis, we will assume that approximately 100 projects per year will be implemented under this consultation. This may slightly overestimate the number of habitat improvement projects that may occur, but to provide maximum coverage to the BPA for habitat improvement projects, the analysis will be completed on this level of activity.

ENDANGERED SPECIES ACT

The ESA establishes a national program to conserve threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with U.S. Fish and Wildlife Service and NMFS to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitats. Section 7(b)(4) requires the provision of an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

Biological Opinion

This Programmatic Opinion presents NMFS' review of the status of each listed species[22] of Pacific salmon and steelhead considered in this consultation, the condition of designated critical habitat, the environmental baseline for the action area, all the effects of the action as proposed, and cumulative effects (50 CFR 402.14(g)). For the jeopardy analysis, NMFS analyzes those combined factors to conclude whether the proposed action is likely to appreciably reduce the likelihood of both the survival and recovery of the affected listed species.

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for listed species by examining any change in the conservation value of the essential features of that critical habitat. The regulatory definition of "destruction or adverse modification" at 50 CFR 402.02 is not used in this analysis. Instead, the analysis relies on statutory provisions of the ESA, including those in section 3 that define "critical habitat" and "conservation," in section 4 that describe the designation process, and in section 7 that sets forth the substantive protections and procedural aspects of consultation, and on agency guidance[23] for application of the "destruction or adverse modification" standard.

Status of the Species and Critical Habitat

This section defines the biological requirements of each listed species affected by the proposed action, and the status of each designated critical habitat relative to those requirements. Listed species facing a high risk of extinction and critical habitats with degraded conservation value are more vulnerable to the aggregation of effects considered under the environmental baseline, the effects of the proposed action, and cumulative effects.

Status of the Species. The NMFS reviews the condition of the listed species affected by the proposed action using criteria that describe a 'viable salmonid population' (VSP) (McElhany *et al*. 2000). Attributes associated with a VSP include abundance, productivity, spatial structure, and genetic diversity that maintain its capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival,

---

[22] An 'evolutionarily significant unit' (ESU) of Pacific salmon (Waples 1991) and a 'distinct population segment' (DPS) of steelhead (1/05/06; 71 FR 834) are considered to be 'species,' as defined in section 3 of the ESA.

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

behavior, and experiences throughout the entire life cycle, characteristics that are influenced, in turn, by habitat and other environmental conditions.

The species addressed by this consultation include the following:

1. LCR Chinook salmon
2. UCR spring-run Chinook salmon
3. SR fall-run Chinook salmon
4. SR spring/summer run Chinook salmon
5. UWR Chinook salmon
6. CR chum salmon
7. SR sockeye salmon
8. LCR coho salmon
9. LCR steelhead
10. MCR steelhead
11. UCR steelhead
12. SRB steelhead
13. UWR steelhead

Table 6 lists Federal Register notices for final rules that list threatened and endangered species, designate critical habitats, or apply protective regulations to listed species considered in this consultation.

Table 6. Federal Register notices for final rules that list threatened and endangered species, designate critical habitats, or apply protective regulations to listed species considered in this consultation. (Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered).

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River spring-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Chum salmon *(O. keta*)			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon (*O. kisutch*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	Not applicable	6/28/05; 70 FR 37160
Sockeye salmon (*O. nerka*)			
Snake River	E 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	E 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Snake River Basin	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

Lower Columbia River (LCR) Chinook Salmon. The status of LCR Chinook was initially reviewed by NMFS in 1998 (Myers *et al.* 1998) and updated by the biological review team (BRT) in that same year (NMFS 1998). In the 1998 update, the BRT noted several concerns for this listed species. The BRT was concerned that there were very few naturally self-sustaining populations of native Chinook salmon remaining in the LCR. A majority of the previous (1998) BRT concluded that the LCR Chinook salmon were likely to become endangered in the foreseeable future. A minority felt that LCR Chinook salmon were not presently in danger of extinction, nor were they likely to become so in the foreseeable future.

New data acquired for the Good *et al.* (2005) report includes spawner abundance estimates through 2001, new estimates of the fraction of hatchery spawners and harvest estimates. In addition, estimates of historical abundance have been provided by the WDFW. Information on recent hatchery releases was also obtained. New analyses include the designation of relatively demographically independent populations, recalculation of previous BRT metrics with additional years data, estimates of median annual growth rate under different assumptions about the reproductive success of hatchery fish, and estimates of current and historically available kilometers of stream.

A majority (71%) of the BRT votes for LCR Chinook salmon fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories. Moderately high concerns for all VSP elements are indicated by estimates of moderate to moderately high risk for abundance and diversity. All of the risk factors identified in previous reviews were still considered important by the BRT. The Willamette/Lower Columbia River Technical Review Team has estimated that 8 to 10 historic populations have been extirpated, most of them spring-run populations. Near loss of that important life history type remains an important BRT concern. Although some natural production currently occurs in 20 or so populations, only one exceeds 1,000 spawners. High hatchery production continues to pose genetic and ecological risks to natural populations and to mask their performance. Most LCR Chinook salmon populations have not seen increases in recent years as pronounced as those that have occurred in many other geographic areas.

The Willamette-Lower Columbia Technical Recovery Team (WLCTRT) identified 32 historical populations of LCR Chinook salmon – seven in the coastal subregion, six in the Columbia Gorge, and nine in the western Cascades. The construction of large impassable or partially passable barriers in the western Cascades led to the likely extirpation or amalgamation of several historical populations, thus complicating this reconstruction. Moreover, historical life history and abundance information on specific historical populations generally is limited, with the exception of those populations that were associated with hatcheries or major fisheries. Within the Columbia Gorge, habitat degradation, especially the construction of Condit Dam on the White Salmon River and the flooding of tributaries upstream of Bonneville Dam, extirpated at least one population and severely reduced the abundance of naturally produced fish in the remaining historical populations. Hatchery programs also have resulted in the introgression of non-local Chinook salmon populations.

Limiting factors identified for this species include: (1) Reduced access to spawning/rearing habitat in tributaries, (2) loss of habitat diversity, (3) altered channel morphology and stability,

(4) excessive fine sediment, (5) high water temperature, (6) reduced access to spawning/rearing areas, and (7) harvest impacts (NMFS 2006).

Upper Willamette River Spring-Run (UWR) Chinook Salmon. The status of UWR Chinook salmon was initially reviewed by NMFS' BRT in 1998 (Myers *et al.* 1998) and updated in that same year (NMFS 1998). In the 1998 update, the BRT was concerned about the few remaining populations of UWR spring Chinook salmon, and the high proportion of hatchery fish in the remaining runs.

Another BRT document (Good *et al.* 2005) covered additional viability parameters, including: data regarding spawner abundance through 2002 in the Clackamas River, 2001 in the McKenzie River, and 2001 at Willamette Falls; updated redd surveys in the basin; new estimates of the fraction of hatchery-origin spawners in the McKenzie and North Santiam Rivers; the first estimate of hatchery fraction in the Clackamas River (2002 data); and information on recent hatchery releases. This update also included data on the designation of relatively demographically independent populations, recalculation of previous BRT metrics in the McKenzie River with additional years of data, estimates of current and historically available kilometers of stream, and updates on current hatchery releases.

The updated information provided in the BRT report (Good *et al.* 2005), the information contained in previous UWR Chinook status reviews, and preliminary analysis by the WLCTRT indicate that most natural spring Chinook populations are likely extirpated or nearly so. The only population considered potentially self-sustaining is the McKenzie River population. However, abundance in this population has been relatively low (low thousands) with a substantial number of these fish being of hatchery origin. The population increased substantially in 2000-2003, probably due to increased survival in the ocean. Future survival rates in the ocean are unpredictable, and the likelihood of long-term sustainability for this population has not been determined.

A majority (70%) of the BRT votes for this species fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories. The BRT found moderately high risks in all VSP elements, with risk estimates ranging from moderate for growth rate/productivity to moderately high for spatial structure.

The WLCTRT has not yet evaluated viability of UWR Chinook salmon. All seven historical populations of UWR Chinook salmon identified by the WLCTRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range.

Limiting factors identified for this species include: (1) Reduced access to spawning/rearing habitat in tributaries, (2) degraded water quality, (3) altered water quality and temperature in tributaries, (4) reduced stream flow, (5) high water temperature, and (6) lost/degraded floodplain connectivity and lowland stream habitat (NMFS 2006).

Upper Columbia River (UCR) Spring-Run Chinook Salmon. The NMFS listed UCR Spring-run Chinook salmon as an endangered species on March 24, 1999 (64 FR 14308) and

their endangered status was reaffirmed on June 28, 2005 (70 FR 37160). This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington (excluding the Okanogan River), the Columbia River upstream to Chief Joseph Dam, as well as six artificial propagation programs: the Twisp River, Chewuch River, Methow Composite, Winthrop National Fish Hatchery, Chiwawa River, and White River Spring-run Chinook hatchery programs.

The Interior Columbia Basin Technical Recovery Team (ICBTRT) has identified three populations in one major population group (Eastern Cascades) for this species. A historic population in the Okanogan River has been extirpated (ICBTRT 2005). Spatial structure and genetic diversity of this species are not at levels that support viability.

The UCR spring-run Chinook salmon exhibit classic stream-type life-history strategies: emigrating from freshwater as yearling smolts in the spring and undertaking extensive offshore ocean migrations. The majority of these fish mature at 4 years of age and return to the Columbia River from March through mid-May. Spawning occurs in tributaries in August through September.

In July 2005, the ICBTRT defined minimum abundance thresholds for Interior Columbia Basin stream type Chinook populations. These numbers are indicators of the number and productivity of naturally produced spawners that may be needed for recovery, in the context of whatever take or mortality is occurring. They should not be considered in isolation, as they represent the numbers that, taken together, may be needed for the population to be self-sustaining in its natural ecosystem. For UCR spring-run Chinook salmon, the minimum abundance thresholds are 2,000 spawners in the Wenatchee River, 2,000 spawners in the Methow River, and 500 spawners in the Entiat River. Current and recent escapement numbers are below this target.

All three of the existing UCR spring-run Chinook salmon populations have exhibited similar trends and patterns in abundance over the past 40 years. The 1998 status review (Myers *et al.* 1998) reported that long-term trends in abundance were generally negative. Analyses of the data series, updated to include 1996-2001 returns, indicate that those trends have continued. Based on redd count data series, spawning escapements for the Wenatchee, Entiat, and Methow rivers have declined an average of 5.6%, 4.8%, and 6.3% per year, respectively, since 1958. In the most recent 5-year geometric mean (1997-2001), spawning escapements were 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population, only 8% to 15% of the minimum abundance thresholds, although escapement increased substantially in 2000 and 2001 in all three river systems. Based on 1980-2000 returns, the average annual growth rate for this species is estimated as 0.85 (meaning the population is not replacing itself). Assuming that population growth rates were to continue at 1980-2000 levels, UCR spring-run Chinook salmon populations are projected to have very high probabilities of decline within 50 years (87% to 100%). Based on productivity and abundance trends, the species is likely to go extinct (ICBTRT 2003).

Limiting factors identified for this species include: (1) Hydropower system mortality, (2) riparian degradation and loss of in-river wood, (3) altered floodplain and channel morphology, (4) reduced stream flow, (5) harvest impacts, and (6) impaired passage (NMFS 2006).

Snake River (SR) Spring/Summer Run Chinook Salmon. This species occupies the Snake River basin, which drains portions of southeastern Washington, northeastern Oregon, and north/central Idaho. Environmental conditions are generally drier and warmer in these areas than in areas occupied by other Chinook species. Chinook-producing drainages occupied by the SR spring/summer run Chinook salmon include the Grande Ronde, Imnaha, Salmon, and Tucannon river systems.

SR spring/summer run Chinook salmon exhibit a stream-type life history. Juvenile fish mature in fresh water for one year before they migrate to the ocean in the spring of their second year. Adults re-enter the Columbia River in late February and early March after 2 or 3 years in the ocean. In high elevation areas, mature fish hold in cool, deep pools until late summer and early fall, when they return to their native streams to begin spawning. Eggs incubate through the fall and winter and emergence begins in the late winter and early spring. Juveniles migrate through the action area starting in early May through the middle of June.

Although direct estimates of historical annual SR spring/summer run Chinook returns are not available, returns may have declined by as much as 97% between the late 1800s and 2000. According to Matthews and Waples (1991), total annual SR spring/summer run Chinook salmon production may have exceeded 1.5 million adult fish in the late 1800s. Total (natural + hatchery origin) returns fell to roughly 100,000 spawners by the late 1960s (Fulton 1968) and were below 10,000 by 1980. Between 1981 and 2000, total returns fluctuated between extremes of 1,800 and 44,000 fish. The 2001 and 2002 total returns increased to over 185,000 and 97,184 adults, respectively. However, it is important to note that over 80% of the 2001 return and over 60% of the 2002 return originated in hatcheries (Good *et al.* 2005).

The ICBTRT has identified 32 populations in 5 major population groups (Upper Salmon River, South Fork Salmon River, Middle Fork Salmon River, Grande Ronde/Imnaha, Lower Snake Mainstem Tributaries) for this species. Historic populations above Hells Canyon Dam are considered extinct (ICBTRT 2003).

Thus, despite the recent increases in total spring/summer-run Chinook salmon returns to the basin, natural origin abundance and productivity are still below their targets. The BRT has noted that SR spring/summer run Chinook salmon remains likely to become endangered (Good *et al.*, 2005).

Limiting factors identified for this species include: (1) Hydrosystem mortality, (2) reduced stream flow, (3) altered channel morphology and floodplain, (4) excessive fine sediment, (5) degraded water quality (NMFS 2006).

Snake River (SR) Fall-Run Chinook Salmon. SR fall-run Chinook salmon spawn above Lower Granite Dam in the mainstem Snake River and in the lower reaches of the larger tributaries. Adult SR fall-run Chinook salmon enter the Columbia River in July and August.

Spawning occurs from October through November. Juveniles emerge from the gravels in March and April of the following year, moving downstream from natal spawning and early rearing areas from June through early fall.

The NMFS BRT recently completed a status review of SR fall-run Chinook salmon and concluded that the species is "likely to become endangered" (Good *et al.* 2005). The BRT found moderate risk to the species for productivity and moderately high risks for abundance, spatial structure, and diversity. The paragraphs below summarize information from BRT, ICBTRT, and other sources on the status of SR fall-run Chinook salmon in terms of those four viability components.

The estimated annual return for the period 1938-1949 was 72,000 fish; and by the 1950s, numbers had declined to an annual average of 29,000 fish. Numbers of SR fall-run Chinook salmon continued to decline during the 1960s and 1970s as approximately 80% of their historic habitat was eliminated or severely degraded by the construction of the Hells Canyon complex (1958–1967) and the lower Snake River dams (1961–1975). Counts of natural-origin adult SR fall-run Chinook salmon at Lower Granite Dam were 1000 fish in 1975, and ranged from 78 to 905 fish (with an average of 489 fish) over the ensuing 25-year period through 2000 (Good *et al.* 2005). Numbers of natural-origin SR fall-run Chinook salmon have increased over the last few years, with estimates at Lower Granite dam of 2,652 fish in 2001 (Good *et al.* 2005), 2,095 fish in 2002, and 3,895 fish in 2003. There have been notable and steady increases in the number of redds since 2000, with a count of 1,303 redds in 2001, 1,854 redds in 2002, 2,241 redds in 2003, and 2,562 redds in 2004 (Garcia *et al.* 2005, p.16).

The ICBTRT has defined only one extant population for the SR fall-run Chinook salmon, the Lower Snake River mainstem population. This population occupies the Snake River from its confluence with the Columbia River to Hells Canyon Dam, and the lower reaches of the Clearwater, Imnaha, Grande Ronde, Salmon, and Tucannon Rivers (ICBTRT 2003).

The BRT concluded that, although SR fall-run Chinook salmon numbers have been increasing in recent years, there remains a moderately high risk of extinction due to insufficient abundance (Good *et al.* 2005). Sustained abundance of natural origin fish at current levels or higher will decrease long-term risks to the species.

Limiting factors identified for Snake River fall-run Chinook salmon include: (1) Hydrosystem mortality, (2) degraded water quality, (3) reduced spawning and rearing habitat, and (4) harvest impacts (NMFS 2006).

Columbia River (CR) Chum Salmon. The NMFS provided an updated status report on CR chum in 1999 (NMFS 1999). As documented in the 1999 report, the BRT was concerned about the dramatic declines in abundance and contraction in distribution from historical levels. The BRT was also concerned about the low productivity of the extant populations, as evidenced by flat trend lines at low population sizes. A majority of the BRT concluded that the CR chum salmon species was likely to become endangered in the foreseeable future and a minority concluded that the species was currently in danger of extinction.

New data includes spawner abundance through 2000, with a preliminary estimate in 2002, new information on the hatchery program, and new genetic data describing the current relationship of spawning groups. New analyses include designation of relatively demographically independent populations, recalculation of previous BRT metrics with additional years data, estimates of median annual growth rate, and estimates of current and historically available kilometers of stream.

Updated information provided in the Good *et al.* (2005), the information contained in previous Lower Columbia River status reviews, and preliminary analyses by the WLCTRT suggest that 14 of the 17 historical populations (88%) are extinct or nearly so. The two extant populations have been at low abundance for the last 50 years in the range where stochastic processes could lead to extinction. Encouragingly, there has been a substantial increase in the abundance of these two populations. In addition there are the new (or newly discovered) Washougal River mainstem spawning groups. However, it is not known if the increase will continue and the abundance is still substantially below the historical levels.

The WLCTRT identified 17 historical populations of CR chum salmon and aggregated these into four strata. Of those, seven populations, all fall runs, were attributed to the Coastal subregion. Eight populations, seven fall runs and one summer run, were attributed to the western Cascade subregion. Fall and summer populations in the Cowlitz River were considered distinct based on run timing and spawning habitat because summer chum salmon appear to have migrated farther upstream in the Cowlitz River than fall chum salmon. In the Columbia Gorge subregion, two fall-run populations were identified. Chum salmon exhibiting additional run times may have been historically present, but were either extirpated or currently are at very low numbers. The WLCTRT has not yet evaluated viability of CR chum salmon.

Nearly all of the likelihood votes for this species fell in the “likely to become endangered” (63%) or “danger of extinction” (34%) categories. The BRT had substantial concerns about every VSP element, as indicated risk estimates scores that ranged from moderately high for growth rate/productivity to high to very high for spatial structure. Most or all of the risk factors identified previously by the BRT remain important concerns. The Willamette/Lower Columbia Technical Review Team has estimated that close to 90% of the historical populations in the species are extinct or nearly so, resulting in loss of much diversity and connectivity between populations. The populations that remain are small, and overall abundance for the species is low. This species has showed low productivity for many decades, even though the remaining populations are at low abundance and density dependent compensation might be expected. The BRT was encouraged that unofficial reports for 2002 suggest a large increase in abundance in some (perhaps many) locations. Whether this large increase is due to any recent management actions or simply reflects unusually good conditions in the marine environment is not known at this time, but the result is encouraging, particularly if it were to be sustained for a number of years.

Limiting factors identified for CR chum salmon include: (1) Altered channel morphology and stability, (2) excessive sediment, (3) reduced stream flow (4) loss of habitat diversity, and (5) harassment of spawners (NMFS 2006).

Lower Columbia River (LCR) Coho Salmon. The status of LCR coho salmon was initially reviewed by NMFS in 1996 and the most recent review occurred in 2001. In the 2001 review, the BRT was very concerned that the vast majority (over 90%) of the historical populations of LCR coho salmon appear to be either extirpated or nearly so. The two populations with any significant production (Sandy and Clackamas) were at appreciable risk because of low abundance, declining trends, and failure to respond after a dramatic reduction in harvest. The large number of hatchery coho salmon in the ESU was also considered an important risk factor. The majority of the 2001 BRT votes were for "at risk of extinction" with a substantial minority in "likely to become endangered."

Since the status of the LCR coho salmon was reviewed by the BRT, relatively little new information was available for the 2003 review. A majority (68%) of the 2003 likelihood votes for LCR coho salmon fell in the "danger of extinction" category, with the remainder falling in the "likely to become endangered" category. As indicated by the risk matrix totals, the BRT had major concerns for this species in all VSP risk categories (risk estimates ranged from high risk for spatial structure/connectivity and growth rate/productivity to very high for diversity). The most serious overall concern was the scarcity of naturally-produced spawners, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally-produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short- and long-term trends are negative and productivity (as gauged by pre-harvest recruits) is down sharply from recent (1980s) levels.

The WLCTRT identified 24 historical populations of LCR coho salmon and divided these into two strata based on major run timing: early and late. These included seven populations in the Coast Range that would have included late-timed runs. In the western Cascades, 14 populations were thought to have existed. Many of these popultions would have contained both early- and late-run coho salmon. In the Gorge subregion, three historical populations were identified. The majority of coho salmon in these populations likely would have exhibited an early-run life history. The major limiting factors have not yet been specifically identified by NMFS for this species although degraded floodplain condition and stream channel structure, reduced access to spawning/rearing habitat, excessive sediment and elevated water temperatures in tributaries, and hatchery impacts were all identified as factors for the decline of this species.

Snake River (SR) Sockeye Salmon. SR sockeye salmon are unique. Anadromous sockeye salmon returning to Redfish Lake in Idaho's Stanley Basin travel a greater distance from the sea (approximately 900 miles) to a higher elevation (6,500 feet) than any other sockeye salmon population and are the southern-most population of sockeye salmon in the world (Bjornn *et al.* 1968; Foerster 1968). Stanley Basin sockeye salmon are separated by 700 or more river miles from two other extant upper Columbia River populations in the Wenatchee River and Okanogan River drainages. These latter populations return to lakes at substantially lower elevations (Wenatchee at 1870 feet, Okanagon at 912 feet) and occupy different ecoregions.

The only extant sockeye salmon population in the Snake River basin at the time of listing was that in Redfish Lake, in the Stanley Basin (upper Salmon River drainage) of Idaho. Other lakes in the Snake River basin historically supported sockeye salmon populations, including Wallowa Lake (Grande Ronde River drainage, Oregon), Payette Lake (Payette River drainage, Idaho) and

Warm Lake (South Fork Salmon River drainage, Idaho) (Waples *et al.* 1997). These populations are now considered extinct. Although kokanee, a resident form of *Oncorhynchus nerka*, occur in numerous lakes in the Snake River basin, other lakes in the Stanley Basin and sympatrically with sockeye in Redfish Lake, resident *O. nerka* were not considered part of the species at the time of listing (1991). Subsequent to the 1991 listing a residual form of sockeye residing in Redfish Lake was identified. The residuals are non-anadromous, completing their entire life cycle in freshwater, but spawn at the same time and in the same location as anadromous sockeye salmon. In 1993, NMFS determined that residual sockeye salmon in Redfish Lake were part of the Snake River sockeye salmon. Also, artificially propagated sockeye salmon from the Redfish Lake Captive Propagation program are considered part of this species (70 FR 37160; June 28, 2005). NMFS has determined that this artificially propagated stock is genetically no more than moderately divergent from the natural population (NMFS 2005).

Five lakes in the Stanley Basin historically contained sockeye salmon: Alturas, Pettit, Redfish, Stanley and Yellowbelly (Bjornn *et al.* 1968). It is generally believed that adults were prevented from returning to the Sawtooth Valley from 1910 to 1934 by Sunbeam Dam. Sunbeam Dam was constructed on the Salmon River approximately 20 miles downstream of Redfish Lake. Whether or not Sunbeam Dam was a complete barrier to adult migration remains unknown. It has been hypothesized that some passage occurred while the dam was in place, allowing the Stanley Basin population or populations to persist (see Bjornn *et al.* 1968, Waples *et al.* 1991). Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (Bjornn *et al*. 1968). Sockeye salmon in Alturas Lake were extirpated in the early 1900s as a result of irrigation diversions, although residual sockeye may still exist in the lake (Chapman and Witty 1993). From 1955-1965, the Idaho Department of Fish and Game eradicated sockeye salmon from Pettit, Stanley, and Yellowbelly lakes, and built permanent structures on each of the lake outlets that prevented re-entry of anadromous sockeye salmon (Chapman and Witty 1993). In 1985, 1986 and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir (Good *et al.* 2005). Only 18 natural origin sockeye salmon have returned to the Stanley Basin since 1987. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, a total of 345 captive brood program adults that had migrated to the ocean returned to the Stanley Basin.

Recent annual abundances of natural origin sockeye salmon in the Stanley Basin have been extremely low. No natural origin anadromous adults have returned since 1998 and the abundance of residual sockeye salmon in Redfish Lake is unknown. This species is entirely supported by adults produced through the captive propagation program at the present time. Current smolt-to-adult survival of sockeye originating from the Stanley Basin lakes is rarely greater than 0.3% (Hebdon *et al.* 2004). The current average productivity likely is substantially less than the productivity required for any population to be at low (1-5%) extinction risk at the minimum abundance threshold. The BRT determined that the SR sockeye salmon remains in danger of extinction (Good *et al.* 2005). The ICBTRT has identified only one extant population for this species.

Limiting factors identified for SR sockeye include: (1) Reduced stream flow, (2) impaired passage, and (3) altered channel morphology and floodplain, (4) hydropower system mortality (NMFS 2006).

Lower Columbia River (LCR) Steelhead. The status of LCR steelhead was initially reviewed by NMFS in 1996 (Busby *et al*. 1996), and the most recent review occurred in 1998. In the 1998 review, the BRT noted several concerns for this species, including the low abundance relative to historical levels, the universal and often drastic declines observed since the mid-1980s, and the widespread occurrence of hatchery fish in naturally spawning steelhead populations. Analysis also suggested that introduced summer steelhead may negatively affect native winter steelhead in some populations. A majority of the 1998 BRT concluded that LCR steelhead were at risk of becoming endangered in the foreseeable future.

A large majority (over 79%) of the BRT votes for this species fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction" and "not likely to become endangered" categories. The BRT found moderate risks in all the VSP categories, with mean risk matrix scores ranging from moderately low for spatial structure to moderately high for both abundance and growth rate/productivity. All of the major risk factors identified by previous BRTs still remain. Most populations are at relatively low abundance, and those with adequate data for modeling are estimated to have a relatively high extinction probability.

The WLCTRT identified 23 historical populations of LCR steelhead, none of which occurred in the Coast Range. The west Cascade subregion included 18 populations, divided into summer and winter strata and corresponding to distinct life history strategies shown by this species. Within this subregion, the Cowlitz River basin historically was a major center of abundance and diversity, containing seven of the 14 winter steelhead. The Gorge subregion included five populations, also divided into summer and winter strata. The Columbia Gorge tributaries historically contained three winter and two summer steelhead populations, also divided into summer and winter strata. The WLCTRT has not completed a viability assessment of this species.

Limiting factors identified for LCR steelhead include: (1) Altered channel morphology and floodplain, (2) reduced access to spawning/rearing habitat, (3) reduced stream flow, (4) excessive sediment, (5) high water temperatures, and (6) lost/degraded floodplain connectivity and lowland stream habitat (NMFS 2006).

Upper Willamette River (UWR) Steelhead. The status of UWR steelhead was reviewed in Busby *et al*. (1996) and updated in NMFS (1999). In the 1999 review, the BRT noted several concerns for this species, including the relatively low abundance and steep declines since 1988. The BRT was also concerned about the potential negative interaction between non-native summer steelhead and wild winter steelhead. The BRT considered the loss of access to historical spawning grounds because of dams to be a major risk factor. The 1999 BRT reached a unanimous decision that the UWR steelhead was at risk of becoming endangered in the foreseeable future.

New data considered in BRT (Good *et al.* 2005) for UWR steelhead include redd counts and dam/weir counts through 2000, 2001, or 2002, and estimates of hatchery fraction and harvest rates through 2000. New analyses for this update include the designation of demographically independent populations, and estimates of current and historically available kilometers of stream.

Based on the updated information provided in the BRT report (Good *et al.* 2005), the information contained in previous UWR steelhead species status reviews, and preliminary analyses by the WLCTRT, a single population that is self-sustaining could not be conclusively identified. All populations are relatively small, with the recent mean abundance of the entire species at less than 6,000. Over the period of the available time series, most of the populations are in decline. The recent elimination of the winter-run hatchery production will allow estimation of the natural productivity of the populations in the future, but the available time series are confounded by the presence of hatchery-origin spawners.

The majority (more than 76%) of the BRT votes for this species fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction" and "not likely to become endangered" categories. The BRT did not identify any extreme risks for this species but found moderate risks in all the VSP categories, ranging from moderately low for diversity to moderate spatial structure and growth rate/productivity. On a positive note, after a decade in which overall abundance (Willamette Falls count) hovered around the lowest levels on record, adult returns for 2001 and 2002, were up significantly, on par with levels seen in the 1980s. Still, the total abundance is low, and while recent increases are encouraging, it is uncertain whether they can be sustained. The BRT considered it a positive sign that releases of the *early* winter-run hatchery population have been discontinued, but remained concerned that releases of non-native summer-run steelhead continue.

The WLCTRT identified four historical populations of UWR steelhead, all with winter-run timing. Only winter steelhead historically existed in this area because flow conditions over Willamette Falls allowed only late winter steelhead to ascend the falls until a fish ladder was constructed in the early 1900s and summer steelhead were introduced. Summer steelhead have become established in the McKenzie River where historically no steelhead existed, although these fish were not considered in the identification of historical populations. The WLCTRT has not completed a viability assessment of this species.

Limiting factors identified for UWR steelhead include: (1) Lost/degraded floodplain connectivity and lowland stream habitat, (2) degraded water quality, (3) reduced stream flow, (4) high water temperature, and (5) reduced access to spawning/rearing habitat (NMFS 2006).

Middle Columbia River (MCR) Steelhead. MCR steelhead include all naturally-spawned populations of steelhead in streams within the Columbia River basin from above the Wind River in Washington and the Hood River in Oregon (exclusive), upstream to, and including, the Yakima River in Washington, excluding steelhead from the Snake River basin (64 FR 14517, March 25, 1999). The major tributaries occupied by this species are the Deschutes, John Day, Klickitat, Umatilla, Walla Walla, and Yakima river systems. The John Day River represents the largest naturally spawning, native stock of steelhead in the region. MCR steelhead do not include resident forms of *O. mykiss* (rainbow trout) co-occurring with these steelhead.

The ICBTRT (2003) identified 15 populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, the Walla Walla and Umatilla rivers, and the Yakima River) and one unaffiliated independent population (Rock Creek) in this species. There are two extinct populations in the Cascades Eastern Slope major population group (MPG), the

White Salmon River and Deschutes River above Pelton Dam. The only population currently rated viable by the ICBTRT is the North Fork John Day.

MCR steelhead remain well-distributed in the majority of occupied subbasins. However, natural returns to the Yakima River, once a major historical production center for the species, continue to be less than 20% of the interim recovery abundance target for the subbasin (Good *et al.* 2005). The presence of substantial numbers of out-of-basin (and largely out-of-species) natural spawners in the Deschutes River raised substantial concern within the NMFS BRT regarding the genetic integrity and productivity of the native Deschutes population.

The five-year average return (geometric mean) of natural MCR steelhead for 1997-2001 was up from previous years' basin estimates (Good *et al.* 2005). Returns to the Yakima River, the Deschutes River and sections of the John Day River system were substantially higher compared to 1992-1997 (Good *et al.* 2005). Yakima River returns are still substantially below interim target levels and estimated historical return levels, with the majority of spawning occurring in one tributary, Satus Creek (Berg 2001). Recent 5-year geometric mean annual returns to the John Day basin are generally below the corresponding mean returns reported in previous status reviews. However, each major production area in the John Day system has shown upward trends since the 1999 return year (Good *et al.* 2005).

Thus, despite recent increases in MCR steelhead returns, the BRT believes that the species remains at moderate risk for all four VSP parameters. Consequently the BRT has determined that MCR steelhead remain likely to become endangered (Good *et al.* 2005).

Liming factors identified for MCR steelhead include: (1) Hydropower system mortality, (2) reduced stream flow, (3) impaired passage, (4) excessive sediment (5) degraded water quality, and (6) altered channel morphology and floodplain (NMFS 2006).

Upper Columbia River (UCR) Steelhead. The UCR steelhead was listed as endangered on August 18, 1997 (62 FR 43937). This species includes all naturally -spawned anadromous steelhead populations below natural and artificial impassable barriers in streams in the Columbia River basin upstream from the Yakima River, Washington, to the U.S.-Canada border.

The ICBTRT has identified five populations within this species: Wenatchee River, Entiat River, Methow River, Okanogan Basin, and Crab Creek (ICBTRT 2005).

UCR steelhead continue to have problems including genetic homogenization from hatchery supplementation (reducing genetic variations from levels that support viability), high harvest rates on steelhead smolts in rainbow trout fisheries (reducing abundance), and the degradation of freshwater habitats within the region (negatively affecting spatial structure and productivity), especially the effects of grazing, irrigation diversions, and hydroelectric dams (Good *et al.* 2005).

In July 2005, the ICBTRT defined minimum abundance thresholds for Interior Columbia Basin steelhead populations. These numbers are indicators of the number and productivity of naturally produced spawners that may be needed for recovery, in the context of whatever take or mortality

is occurring. They should not be considered in isolation, as they represent the numbers that, taken together, may be needed for the population to be self-sustaining in its natural ecosystem. For UCR steelhead, the minimum abundance thresholds are 1,500 spawners in the Wenatchee River, 1,500 spawners in the Methow River, 1,000 spawners in the Okanogan River, and 500 spawners in the Entiat River. Recent trends in productivity and abundance have fallen short of these target numbers.

Returns of both hatchery and naturally-produced steelhead to the Upper Columbia River have increased in recent years. The average 1997-2001 return counted through the Priest Rapids fish ladder was approximately 12,900 fish. The average for the previous 5 years (1992-1996) was 7,800 fish. Abundance estimates of returning naturally produced UCR steelhead have been based on extrapolations from mainstem dam counts and associated sampling information (*e.g.*, hatchery/wild fraction, age composition). The natural component of the annual steelhead run over Priest Rapids Dam increased from an average of 1,040 (1992-1996), representing about 10% of the total adult count, to 2,200 (1997-2001), representing about 17% of the adult count during this period of time (ICBTRT 2003).

In terms of natural production, recent population abundances for both the Wenatchee and Entiat aggregate population and the Methow population remain well below the minimum abundance thresholds developed for these populations (ICBTRT 2005). A 5-year geometric mean (1997-2001) of approximately 900 naturally produced steelhead returned to the Wenatchee and Entiat rivers (combined) compared to a combined abundance target of 2,000 fish. Although this is well below the minimum abundance thresholds, it represents an improvement over the past (an increasing trend of 3.4% per year). However, the average percentage of natural fish for the recent 5-year period dropped from 35% to 29%, compared to the previous status review. For the Methow population, the 5-year geometric mean of natural returns over Wells Dam was 358. Although this is well below the minimum abundance thresholds, it is an improvement over the recent past (an increasing trend of 5.9% per year). In addition, the 2001 return (1,380 naturally-produced spawners) was the highest single annual return in the 25-year data series. However, the average percentage of wild origin spawners dropped from 19% for the period prior to the 1998 status review to 9% for the 1997 to 2001 returns. This species is failing to meet viability criteria in all four categories: productivity, abundance, spatial structure, and genetic diversity.

Liming factors identified for the UCR steelhead include: (1) Hydropower system mortality; (2) reduced stream flow; (3) tributary riparian degradation and loss of in-river wood; (4) altered floodplain and channel morphology, (5) excessive sediment, (6) degraded water quality, (7) harvest impacts, and (8) hatchery impacts (NMFS 2006).

Snake River Basin (SRB) Steelhead. The SRB steelhead species includes all naturally-spawned populations of steelhead (and their progeny) in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho (62 FR 43937; August 18, 1997). SRB steelhead do not include resident forms of *O. mykiss* (rainbow trout) co-occurring with these steelhead.

The ICBTRT (2003) identified 23 populations in the following six major population groups (MPGs) in this species: Clearwater River, Grande Ronde River, Hells Canyon, Imnaha River,

Lower Snake River, and Salmon River. The BRT noted that SRB steelhead remain spatially well-distributed in each of the six major geographic areas in the Snake River basin (Good *et al.* 2005). Environmental conditions are generally drier and warmer in these areas than in areas occupied by other steelhead species in the Pacific Northwest. SRB steelhead were blocked from portions of the upper Snake River beginning in the late 1800s and culminating with the construction of Hells Canyon Dam in the 1960s. The SRB steelhead "B run" population levels remain particularly depressed. The ICBTRT has not completed it viability assessment for SRB steelhead.

The paucity of information on adult spawning escapement for specific tributary production areas for SRB steelhead made a quantitative assessment of viability difficult. Annual return estimates are limited to counts of the aggregate return over Lower Granite Dam, and spawner estimates for the Tucannon, Grande Ronde, and Imnaha Rivers. The 2001 return over Lower Granite Dam was substantially higher relative to the low levels seen in the 1990s; the recent 5-year mean abundance (14,768 natural returns) was approximately 28% of the interim recovery target level. The abundance surveyed in sections of the Grande Ronde, Imnaha and Tucannon Rivers improved in 2001. However, recent 5-year abundance and productivity trends (through 2001) were mixed. Five of the nine available data series exhibit positive long- and short-term trends in abundance. The majority of long-term population growth rate estimates for the nine available series were below replacement. The majority of short-term population growth rates (through 2001) were marginally above replacement or well below replacement, depending upon the assumption made regarding the effectiveness of hatchery fish in contributing to natural production.

Cooney (2004) reported continuing high returns of natural-origin SRB steelhead (both A- and B-run fish) during 2002 and 2003 compared to those observed during much of the 1990s. In their preliminary report, Fisher and Hinrichsen (2004) estimated that the geometric mean of the natural-origin run was 37,784 during 2001-2003, a 253% increase over the 1996-2000 period (10,694 steelhead). The slope of the population trend increased 9.3% (from 1.00 to 1.10) when the counts for 2001-2003 were added to the 1990-2000 data series. These data indicate that, at least in the short term, the natural-origin run has been increasing. Despite the recent increases in SRB steelhead returns, the BRT believes that the species remains at moderate risk for abundance, productivity, and diversity. Consequently, the BRT has determined that SRB steelhead remains likely to become endangered (Good *et al.* 2005).

Limiting factors identified for SRB steelhead include: (1) Hydrosystem mortality, (2) reduced stream flow, (3) altered channel morphology and floodplain, (4) excessive sediment, (5) degraded water quality, (6) harvest impacts, and (7) hatchery impacts (NMFS 2006).

Status of Critical Habitat. The ESA requires the federal government to designate critical habitat for any species it lists under the ESA; in this case, salmon and steelhead. Critical habitat is defined as: (1) Specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and whether those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

The species addressed by this consultation have had critical habitat designated between 1993 and 2005. One species, LCR coho salmon, does not have designated critical habitat.

To assist in the designation of critical habitat in 2005, NMFS convened several Critical Habitat Analytical Review Teams (CHARTs) organized by major geographic areas that roughly correspond to salmon recovery planning domains. The CHARTs consisted of Federal biologists and habitat specialists from NMFS, the U.S. Fish and Wildlife Service, FS, and BLM, with demonstrated expertise regarding salmonid habitat and related protective efforts within the domain.

The CHARTs were tasked with assessing biological information pertaining to areas under consideration for designation as critical habitat.[24] Specifically, CHARTs: (1) Determined if occupied areas contained primary constituent elements (PCEs) essential for conservation; (2) determined whether there were any unoccupied areas within the historical range of the listed salmon and steelhead that may be essential for conservation; (3) scored each habitat area based on several factors related to the quantity and quality of the physical and biological features; (4) rated each habitat area as having a 'high," "medium," or "low" conservation value; and (5) identified management actions that could affect salmonid habitat in given areas.

The ESA gives the Secretary of Commerce discretion to exclude areas from designation if he determines that the benefits of exclusion outweigh the benefits of designation. Considering economic factors and information from CHARTs, NMFS excluded areas in the following categories during its 2005 critical habitat designations.[25]

1. Military areas. All military areas were excluded because of the current national priority on military readiness, and in recognition of conservation activities covered by military integrated natural resource management plans.
2. Tribal lands. Native American lands were excluded because of the unique trust relationship between tribes and the federal government, the federal emphasis on respect for tribal sovereignty and self governance, and the importance of tribal participation in numerous activities aimed at conserving salmon.
3. Habitat Conservation Plans. Some lands covered by habitat conservation plans were excluded because NMFS had evidence that exclusion would benefit our relationship with the landowner, the protections secured through these plans outweigh the protections that are likely through critical habitat designation, and exclusion of these lands may provide an incentive for other landowners to seek similar voluntary conservation plans.
4. Economic Impacts. NMFS excluded areas where the conservation benefit to the species is relatively low compared to the economic impacts.

In its 2005 designation of critical habitat for 12 species of ESA-listed salmon and steelhead in Oregon, Washington, and Idaho, NMFS used the watershed or 5th field hydrologic unit code

[24] CHART reports are available at: http://www.nwr.noaa.gov/Salmon-Habitat/Critical-Habitat/2005-Biological-Teams-Report.cfm

[25] More detailed information on the 2005 critical habitat designations, including exclusions, is available at: http://www.nwr.noaa.gov/Publications/FR-Notices/2005/upload/70FR52630Pre.pdf

(HUC) to organize critical habitat information systematically and at a scale that is applicable to the spatial distribution of salmon. Organizing information at this scale is especially relevant to salmonids, since their innate homing ability allows them to return to the watersheds where they were born. Such site fidelity results in spatial aggregations of salmonid populations that generally correspond to the area encompassed by 5th field watersheds (Kostow, 1995; McElhany *et al.*, 2000). For prior critical habitat designations, spatial data for 5th field watersheds was widely not available, and NMFS used the subbasin or 4th field HUC to organize critical habitat information. Critical habitat for SR sockeye, SR fall-run Chinook salmon, and SR spring/summer run Chinook salmon was designated at the 4th field subbasin scale.

The NMFS reviews the status of designated critical habitat affected by the proposed action by examining the condition and trends of PCEs throughout the designated area. PCEs consist of the physical and biological features identified as essential to the conservation of the listed species in the documents that designate critical habitat (Tables 7 and 8).

Table 7. Types of sites and essential physical and biological features named as PCEs in all salmon and steelhead critical habitat designations, except Snake River spring/ summer run Chinook salmon, Snake River fall-run Chinook salmon, and Snake River sockeye salmon (Table 8).

Site	Essential Physical and Biological Features	Species Life Stage
Freshwater spawning	Water quality, water quantity, and substrate	Spawning, incubation, and larval development
Freshwater rearing	Water quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile development
	Natural cover [a]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover[a]	Juvenile and adult mobility and survival
Estuarine areas	Free of obstruction, water quality and quantity, and salinity	Juvenile and adult physiological transitions between salt and freshwater
	Natural cover,[a] forage,[b] and water quantity	Growth and maturation
Nearshore marine areas	Free of obstruction, water quality and quantity, natural cover,[a] and forage [b]	Growth and maturation, survival
Offshore marine areas	Water quality and forage [b]	Growth and maturation

[a] Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
[b] Forage includes aquatic invertebrate and fish species that support growth and maturation.

Table 8. Types of sites and essential physical and biological features designated as PCEs, for Snake River spring/summer run Chinook salmon, Snake River fall-run Chinook salmon, and Snake River sockeye salmon.

Habitat Component	Spring/Summer run Chinook salmon	Fall-run Chinook salmon	Sockeye salmon
Spawning and juvenile rearing areas	Spawning gravel Water quality Water quantity Cover/shelter Food Riparian vegetation Space	Same as Spring/summer run Chinook	Spawning gravel Water quality Water quantity Water temperature Food Riparian vegetation Access
Juvenile migration corridors	Substrate Water quality Water quantity Water temperature Water velocity Cover/shelter Food Riparian vegetation Space Safe passage	Same as Spring/summer run Chinook	Same as Spring/summer run Chinook
Areas for growth and development to adulthood	Ocean areas – not identified	Same as Spring/ summer run Chinook	Same as Spring/ summer run Chinook
Adult migration corridors	Substrate Water quality Water quantity Water temperature Water velocity Cover/shelter Riparian vegetation Space Safe passage	Same as Spring/ summer run Chinook	Same as Spring/ summer run Chinook

Status of Critical Habitat in the Lower Columbia and Willamette River Basins. Critical habitat has been designated in the Lower Columbia and Willamette River basins for UWR Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, and CR chum salmon.

The Willamette River, once a highly-braided river system, has been simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin has blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Water quality is also affected by development and other economic activities. Agricultural and urban land uses on the valley floor and timber harvesting in the Cascade and Coast Ranges contribute to increased erosion and sediment load in Willamette River basin streams and rivers. Municipal and industrial pollution has been present in the Lower Willamette River since the 1920s. Gravel mining has effects on substrate quantity and quality in the Upper Willamette River.

The mainstem Willamette River has been altered by historical channelization and large wood removal. Agricultural and urban development reduced the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). Gregory *et al.* (2002b) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to RM 120) has incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Overall, the length of channel types did not change while the area declined. The greatest changes were in the upper reach, from Albany to Eugene (RM 187). In this reach, approximately 40% of both channel length and channel area were lost, as well as 21% primary channel, 41% side channel, 74% alcoves, and 80% island areas.

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

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

Gregory *et al.* (2002c) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion represents a loss of recruitment of LWD, which functions as a component of channel complexity, much as the morphology of the streambed does, to reduce velocity and provide habitat for invertebrates that support the salmonid prey food base. Declining extent and quality of riparian forests have also reduced rearing and refugia habitat provided by large wood, shading by riparian vegetation which can cool water temperatures, and the availability of leaf litter and the macroinvertebrates that feed on it.

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

Several hydropower projects including the Bonneville Dam on the mainstem Columbia River adversely affect habitat along the Lower Columbia River. The series of dams along the Columbia River blocked an estimated 12 million cy of debris and sediment that would otherwise naturally flow down the Columbia, replenishing the shorelines along the Washington and Oregon coasts.

Industrial harbor and port development have been significant along the mainstem Columbia River. One hundred miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River have been dredged as a navigation channel by the Army Corps of Engineers since 1878. Originally dredged to a 20-foot minimum depth in 1878, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet.

The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. These ports primarily focus on the transport of timber and agricultural commodities. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, several sediment chemical exceedances, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial activities.

The most extensive urban development in the Lower Columbia River watershed occurs in the Vancouver/Camas area. Outside of this major urban area, the majority of residential development relies on septic systems. Common water contaminants associated with urban development and residential septic systems include excessive water temperatures, lowered dissolved oxygen levels, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

In addition to the hydropower development in the Columbia River, complex freshwater and estuarine habitats needed to maintain diverse wild populations and life histories have been lost and fragmented, increasing the risk of extinction for salmon stocks in the Columbia River basin. Freshwater rearing sites and migration corridors for juvenile salmonids are PCEs of critical habitat. Not only have rearing habitats been removed or altered within the Lower Columbia River, but the connections among habitats needed to support tidal and seasonal movements of

juvenile salmon have been severed. The most significant habitat changes in the Columbia River estuary have been the loss of tidal marsh and tidal swamp habitat that are critical to juvenile salmonids, particularly small or ocean-type salmonids (Johnson *et al.* 2003, Thomas 1983, USACE 2001). The edges of marsh areas provide sheltered habitats for juvenile salmon where food in the form of amphipods or other small invertebrates which feed on marsh detritus is plentiful and larger predatory fish is avoided (Seaman 1977).

Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon access to a wide expanse of low-velocity marshland and tidal channel habitats (Bottom *et al.* 2001). In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming salmonid habitat during flooding river discharges or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Altered channel morphology and stability, and reduced floodplain connectivity are significant limiting factors in the Willamette and Lower Columbia rivers and their tributaries. Other major factors affecting critical habitat PCEs are loss of habitat diversity, excessive sediment, degraded water quality and increased stream temperatures. Reduced stream flows and fish passage blockages have reduced access to spawning and rearing areas (NMFS 2006).

Status of Critical Habitat in the Interior Columbia Basin. Critical habitat has been designated in the Interior Columbia Basin (including the Snake River basin) for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead. Major tributary river basins in the Interior Columbia basin include the Klickitat, Deschutes, Yakima, John Day, Umatilla, Walla Walla, Methow, Entiat, Wenatchee, Grande Ronde, Tucannon, Imnaha, Clearwater, and Salmon.

Migratory habitat quality in this area has been impacted by the development and operation of the Federal Columbia River Power System dams in the mainstem Columbia River and privately owned dams in the Snake and Upper Columbia River basins. Hydroelectric development has modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmonids, and delayed migration time for both adult and juvenile salmonids. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good *et al.* 2005). Grande Coulee and Chief Joseph Dams on the Upper Columbia completely block anadromous fish passage on the upper mainstem Columbia River.

In addition to the development and operation of the dams in the mainstem rivers, development and operation of irrigation systems and hydroelectric dams for water withdrawal and storage in tributaries have altered hydrological cycles, causing a variety of adverse impacts to salmon and steelhead spawning and rearing habitat. Condit Dam on the White Salmon River has extirpated a population of MCR steelhead from the Cascades Eastern Slope MPG. In the Umatilla River subbasin, the Bureau of Reclamation developed the Umatilla Project in 1906, effectively eliminating over 108 miles of historically highly productive tributary habitat for MCR steelhead in upper McKay Creek due to construction of the McKay Dam and Reservoir in 1927. Construction of Lewiston Dam, completed in 1927, eliminated access for Snake River basin steelhead and salmon to a major portion of the Clearwater basin.

Habitat quality in tributary streams in the Interior Columbia basin varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Overton *et al.* 1995; Wissmar *et al.* 1994; and McIntosh *et al.* 1994). Lack of summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas. Critical habitat throughout the Interior Columbia River basin has been degraded by several management activities, including agriculture, alteration of stream morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, timber harvest, mining, and urbanization (Lee *et al.* 1997). Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common symptoms of ecosystem decline in areas of critical habitat.

Large-scale habitat assessments in the Interior Columbia basin indicate that in watersheds managed for natural resources extraction, the number of large pools has decreased from 20 to 87% (McIntosh *et al.* 1994).

Areas where habitat is still largely functioning appropriately include: the Wenaha, Minam, Selway, Upper Imnaha, and Middle Fork Salmon rivers in the Snake River basin and the South Fork Walla Walla, portions of the Deschutes, and portions of the North Fork John Day River in the Middle Columbia River basin. Most of these areas are in designated wilderness or roadless areas.

Many stream reaches designated as critical habitat in the Interior Columbia basin are over-allocated under state water law, with more allocated water rights than existing streamflow conditions can support. Irrigated agriculture is common throughout this region and withdrawal of water increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence *et al.* 1996). Continued operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have disrupted riverine ecosystems. Reduced tributary stream flow has been identified as a limiting factor for all listed salmon and steelhead species in this area except SR fall-run Chinook salmon (NMFS 2006).

Impaired water quality is a problem in many tributaries of the Columbia and Snake rivers. Summer stream temperature is the primary water quality problem for this area, with many stream reaches designated as critical habitat listed on the Clean Water Act (CWA) 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now

unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevate stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

Environmental Baseline

The 'environmental baseline' includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). An environmental baseline that does not meet the biological requirements of a listed species may increase the likelihood that adverse effects of the proposed action will result in jeopardy to a listed species or in destruction or adverse modification of a designated critical habitat.

The NMFS describes the environmental baseline in terms of the habitat features and processes necessary to support all life stages of each listed species that occurs within the action area. Each listed species considered in this Opinion resides in or migrates through the action area. Thus, for this action area, the biological requirements for salmon and steelhead are the habitat characteristics that support successful completion of spawning, rearing, freshwater migration, and transition to saltwater.

The biological requirements of salmon and steelhead vary depending on the life history stage and the natural range of variation present within aquatic systems (Groot and Margolis 1991, NRC 1996, Spence *et al*. 1996). During spawning migrations, adult salmon and steelhead require clean water with cool temperatures and access to thermal refugia, dissolved oxygen near 100% saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (*e.g.*, gravel size, porosity, permeability, oxygen concentrations), substrate stability during high flows, and, for most species, water temperatures of 13°C or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration of juveniles to rearing areas, whether the ocean, lakes, or other stream reaches, requires access to these habitats. Physical, chemical, and thermal conditions may impede movements of adult or juvenile fish.

The condition of aquatic habitats on private, state, and Federal lands where BPA may fund habitat improvement projects varies from excellent in wilderness, roadless, and undeveloped areas to poor in areas heavily impacted by development and natural resources extraction (FEMAT 1993, McIntosh *et* al. 1994, Wissmar *et al.* 1994, Lee *et al.* 1997). The BPA's proposed habitat improvement actions that are the subject of this programmatic Opinion would typically be carried out in areas degraded by one or more human activity or natural events. In

some cases, the BPA would lease or aquire high quality aquatic habitat to protect it from degedation or development.

West of the Cascade Mountains in Oregon and Washington, stream habitats and riparian areas have been adversely affected by road construction, timber harvest, splash damming, urbanization, agricultural activities, mining, flood control, filling of estuaries, and construction of dams (Sedell *et al.* 1991; FEMAT 1993; NMFS 1996). Road construction has increased the drainage network of watersheds, created fish passage barriers at road/stream crossings, and increased delivery of fine sediments. Timber harvest has removed shade-providing trees, decreased recruitment of LWD, and increased delivery of fine sediments to streams. Splash damming to move logs altered steam channels by removing habitat elements such as boulders and LWD and increasing stream width-to-depth ratios. Mining of gravel and precious metals removed natural stream substrates, created tailing piles in riparian areas, and altered stream channels. Flood control projects straightened stream channels. Construction of dams has blocked fish passage, altered natural hydrologic cycles, and interrupted bedload movement. Non-native invasive plants have colonized riparian areas, is some cases to the exclusion of native plants. In urban centers, high road densities and large amounts of impervious surface have altered natural hydrologic cycles and increased runoff of contaminated water.

East of the Cascade Mountains in Oregon, Washington, and Idaho, aquatic habitats have been impacted by road building, timber harvest, splash damming, livestock grazing, water withdrawal, agricultural activities, mining, urbanization, and construction of reservoirs and dams (USDA and USDI 1995, McIntosh *et al*. 1994, Wissmar *et al.* 1994, Lee *et al*. 1997). As with areas west of the Cascades, road construction has increased the drainage network of watersheds, created fish passage barriers at road-stream crossings, and increased delivery of fine sediments. Timber harvest has removed shade-providing trees, decreased recruitment of LWD, and increased delivery of fine sediments to streams. Splash-damming altered stream channels by removing habitat elements such as boulders and LWD and increasing stream width-to-depth ratios. Unmanaged livestock grazing has led to incised stream channels, removal of riparian vegetation, alterations of riparian vegetation communities, increased stream width-to-depth rations, and trampled streambanks. Water withdrawal reduces base flows in streams in montane environments where natural base flows are already low. Water diversion structures can block fish passage and unscreened diversions can entrain fish into canals where they become trapped and die. Streams have been straightened and diked to accommodate transportation infrastructure and agriculture. Mining of precious metals has left large mine tailing piles in riparian areas and added fine sediment to streams. In some areas, stream channels have been completely destroyed by dredge mining. Some abandoned mines leach contaminated water into streams. Construction of dams and reservoirs has blocked fish passage, altered natural hydrologic cycles, and interrupted bedload movement. Invasive non-native plants are a significant problem in some riparian areas.

The environmental baseline also includes the anticipated impacts of all Federal projects in the action area that have already undergone formal consultation. From 2003 to 2006, the BPA covered 218 projects under the HIP consulation. Most projects involved use of multiple HIP activity categories with improvement of fish passage and treatment of non-native plants with herbicides as the most common actions. During the same time period, BPA completed 28

individual formal consultations on habitat improvement actions that were not covered by the HIP consultation. Channel reconstruction, complex fish passage improvement projects, and streambank stabilization were the most common activity types.

Other Federal Projects that have undergone consultation in the action area include various transportation, natural resource management, and water management projects. The Army Corps of Engineers and Federal Highway Administration have consulted on numerous transportation projects, primarily bridge and culvert replacement projects. These actions typically improve fish passage at road-stream crossings and reduce the hydraulic effects of culverts and bridges by replacing them with larger structures. The Army Corps of Engineers has consulted on projects permitted under the section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. These actions include installation or improvement of docks and bulkheads, streambank stabilization, and improvements to other navigational and transportation infrastructure. Some stream restoration projects are also permitted under this authorities.

The USDA Forest Service and USDI Bureau of Land Management have consulted on restoration and natural resource management projects throughout Oregon, Washington, and Idaho. These projects include stream restoration actions, commercial timber harvest, authorization of livestock grazing, and issuance of special use permits. These actions, as implemented in conjunction with these agencies' aquatic conservation strategies, are designed to avoid or minimize effects on listed salmon, steelhead, and their habitat. The restoration actions are designed to restore natural stream habitat forming processes.

The Bureau of Reclamation has completed consultation on a few large tributary water management projects such as the Umatilla Project and Deschutes Project. These projects are operated in manner consistent with the recovery of listed salmon and steelhead. As more information on the recovery needs of salmon and steelhead becomes available, operation of these projects can be adjusted accordingly.

It is very likely that a small number of action areas for some of these previously consulted upon actions will overlap with action areas for restoration projects covered under this new iteration of the HIP consultation. Impacts to the environmental baseline from these previous projects vary from short-term adverse effects to long-term beneficial effects. When considered as whole, these actions are likely to have a small beneficial effect on the environmental baseline over time.

Recently-completed subbasin plans[26] provide additonal environmental baseline information at a finer scale. Each plan contains a detailed habitat assesment that characterizes the condition of anadromous fish-bearing streams and ongoing impacts of land management, fish harvest, and hatcheries. The plans also contain lists of identified restoration actions. The actions are prioritzed by expected benefit. When funding projects coverd by this consultation, BPA considers this information.

Under the current environmental baseline, the biological needs of salmon and steelhead are generally not being met on lands in Oregon, Washington, and Idaho where the BPA would fund projects covered by this consultation. The purpose of the actions proposed in this consultation is

[26] Subbasin plans are available at: http://www.nwcouncil.org/fw/subbasinplanning/Default.htm

to improve degraded habitat conditions. In areas with high qaulity habitat, the BPA proposes to protect this habitat through land aqcuisition or lease and conservation easements. Because the HIP program is intended to correct or ameliorate existing habitat problems, rather than enhancing habitats that are not impaired, program activities would generally occur in areas where the environmental baseline is degraded to the extent that the biological needs are not met.

In the following effects section, the analysis is based on the assumption that the various activities will occur in areas with degraded salmonid habitats.

Effects of the Action

'Effects of the action' means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). The habitat improvement actions addressed by this programmatic Opinion will all have long-term beneficial effects to salmon, steelhead, 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 condition of that habitat at the site and watershed scale.

The actions selected for this programmatic consultation all have predictable effects regardless of where in Oregon, Washington, and Idaho they are carried out. The NMFS has conducted several individual consultations on each activity type over the past 10 years. The knowledge gained from these individual consultations has been applied by NMFS and the BPA to compose the activity design criteria and minimization measures for this consultation. Restoration activities with unpredictable effects (*e.g.*, irrigation diversion replacements) or aspects of included activity categories that introduced uncertainty into our effects analysis (*e.g.*, tide gate replacement) are not included in the proposed action.

The implementation of many activities will also have some minor, unavoidable, short-term adverse effects such as increased stream turbidity and riparian disturbance, in order to gain more permanent habitat improvements. The NMFS worked closely with the BPA to incorporate minimization measures into the proposed action to reduce these adverse effects. However, short-term effects are not completely avoidable and some are still reasonably certain to occur. Most short-term adverse effects of the proposed activities result from near- and instream construction or application of chemical herbicides. The analysis begins with an evaluation of the short-term effects common to proposed activities that involve significant construction or excavation in streams or riparian areas. The analysis then moves to a habitat-based assessment of other, non-construction effects. The analysis continues with an evaluation of how these habitat effects impact individual fish and salmonid population VSP and concludes with an assessment of effects on critical habitat.

Effects of Near and Instream Construction. Many of the activity categories including, but not limited to, installation of large wood, boulder, and gravel, protecting streambanks using

bioengineering methods, culvert and bridge projects require the operation of heavy equipment in the riparian areas and active stream channel. The surveying, construction, operation, and maintenance activity category, while not strictly a habitat improvement action in itself almost always involves in-water or near-water construction. Unavoidable short-term adverse effects resulting from these activities include disturbance of riparian vegetation, exposure of bare soil, increased stream turbidity, increased fine sediments in stream substrates, and increased risk of chemical contamination from fuel and lubricants. If work area isolation is required, listed fish will be captured and relocated.

Access to construction sites typically requires removal of riparian vegetation and creation of temporary access paths. Operation of heavy equipment, including excavators, dumps trucks, and bulldozers, in or near streams can compact soil, thus reducing soil permeability and infiltration. Any work that occurs along the streambanks can destroy or damage shade- and cover- providing vegetation and damage the streambank itself. Excavation of streambanks to place large wood or other structures will expose bare soil and release some fine sediment into streams. Release of fine sediments into streams causes elevated turbidity and increased fine sediment in downstream substrates.

The literature reports that suspended sediment and turbidity influences on fish range from beneficial to detrimental. Elevated total suspended solids (TSS) have been reported to enhance cover conditions, reduce piscivorus fish/bird predation rates, and improve survival, but elevated TSS have also been reported to cause physiological stress, reduce growth, and adversely affect survival. Although fish that remain in turbid waters experience a reduction in predation from piscivorus fish and birds (Gregory and Levings 1998), chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Redding *et al.* 1987, Lloyd *et al.* 1987, Servizi and Martens 1991). Of key importance in considering the detrimental effects of TSS on fish are the frequency and the duration of the exposure, as well as the TSS concentration. Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, unless the fish traverse these streams along migration routes (Lloyd *et al.* 1987). Construction activities addressed by this consultation are likely to last two weeks at a maximum. During that time, juvenile salmonids may experience decreased feeding, stress, or be unable to use the action area, depending on the severity of the turbidity. Although this represents a significant behavioral change, the temporal and spatial scale of the impact is too small to cause any population level effects.

As suspended fine sediment settles out downstream from the construction areas, minor increases in stream substrate embeddedness occurs. Suttle *et al.* (2004) report that increases in fine sediments in stream substrates can decrease productivity and habitat quality for juvenile salmonids. Waters (1995) describes how elevated fine sediment levels in streams impair physical and biological processes. Significant increases in fine sediment levels reduce interstitial spaces between substrate particles, leads to shifts in invertebrate community structure, fills pools, and can entomb redds. In such cases, eggs are smothered, prey available for rearing juveniles is reduced, and habitat features are lost.

When heavy equipment is operating in the riparian areas or stream, there is always the potential for fuel or other contaminant spills. Operation of bulldozers, excavators, and other equipment

requires the use of fuel and lubricants which, if spilled into the channel of a waterbody or into the adjacent riparian zone, can injure or kill aquatic organisms. Petroleum-based contaminants (such as fuel, oil, and some hydraulic fluids) contain polycyclic aromatic hydrocarbons (PAHs), which can be acutely toxic to salmonids at high levels of exposure and can cause acute and chronic sublethal effects on aquatic organisms (Neff 1985).

Direct effects on juvenile salmonids from work area isolation and fish relocation include mechanical injury during capture, holding, or release, and potential horizontal transmission of disease and pathogens and stress-related phenomena. Stress approaching or exceeding the physiological tolerance limits of individual fish can impair reproductive success, growth, resistance to infectious diseases, and survival (Wedemeyer *et al.* 1990). If electrofishing is used to salvage fish, it will particularly increase stress loads. Harmful effects of electrofishing are detailed by Snyder (2003) and include internal and external hemorrhage, fractured spines, and death. Although some listed salmonids will die from electroshocking, fish will only be exposed to the stress caused by work area isolation activities once and the fish relocation is only expected to last a few hours. If construction took place without work area isolation, more fish would be injured or killed.

This analysis was completed with the assumption that not more than 100 projects per year will be implemented under this consultation. A typical project would affect several hundred feet of stream channel while large projects covered under this consultation may effect several miles of stream. The actual number of projects implemented will likely be somewhat less than this ceiling. The maximum number of projects is used in this analysis so that it captures the upper limit of possible program effects. Any actual lesser number of projects implemented under this consultation will have lesser effects. At most, half of these projects may involve instream construction and work area isolation. Information provided by the BPA indicates that during a typical isolation and fish relocation, less than 10 salmonids will be captured and relocated. In some cases, as many as 100 fish have been encountered. At a maximum, NMFS anticipates that each year, up to 5,000 listed salmon and steelhead will be captured during work areas isolation.

The number of fish encountered during work area isolation for projects the BPA funds is usually lower than the number of fish encountered during work area isolation for projects carried out by other Federal agencies such as the Forest Service and BLM. This is because projects funded by the BPA typically occur in degraded habitat on private, state, and tribal lands located at relatively lower elevations. Instream construction takes place during preferred in-water work periods, usually during the summer low-flow period when water temperatures are high. In contrast, Forest Service and BLM projects typically occur in better quality habitat at higher elevations where flow and water temperature conditions are typically more suitable for salmonids during the summer.

The BPA proposes a suite of minimization measures intended to reduce the short-term effects caused by near and instream construction. Limiting instream construction to low flow periods and using sediment control measures greatly reduce the amount of fine sediment and turbidity created by the restoration actions. Refueling and servicing equipment outside the riparian area reduces the chance of spilling toxic fuels and lubricants. Development and implementation of a pollution and erosion control plan limit any potential adverse effects of a toxic material spill by

ensuring that spill response materials are on site during all construction activities. Ensuring that all heavy equipment that will operate instream is cleaned and free of leaks will also reduce the introduction of contaminants into the aquatic environment. The BPA proposes several minimization measures to limit stress and mortality during work area isolation and fish relocation. Limiting in-water construction activities to preferred in-water work periods will greatly reduces the chance of affecting adult fish, as these periods are designated to avoid times when adult salmonids are present.

Other Activity-Specific Effects.

Protect Streambanks Using Bioengineering Methods. The BPA proposes to stabilize eroding streambanks using bioengineering methods. This requires instream construction with short-term effects as described above.

The use of large rock groins, weirs, rock toes, and riprap have been excluded from this consultation by the BPA to avoid the potential negative effects of using hard structures to stabilize streambanks. Bio-engineered structures accelerate the stabilization of eroding banks without interfering with long-term channel-forming processes. Long-term beneficial effects of stabilizing eroding streambanks include reductions in fine sediment inputs. Eliminating a sediment source will help to increase the diversity and densities of aquatic macroinvertebrates used as a food source by covered fish species. It will also maintain or increase the amount of interstitial cover available to juveniles and juvenile emergence success. Suffocation of fry and entombment caused by excessive siltation of spawning gravels will also be reduced or eliminated. Light penetration, which, in turn, affects the feeding abilities of salmonids growth rates, will improve. By limiting bank restoration to bioengineering methods such as placement of LWD and riparian plantings, overhead cover for fish will be increased and streambank stability will improve.

Install Habitat-Forming Natural Material Instream Structures (LWD, Boulders, and Gravel). Placement of LWD, boulders, and gravel will result in unavoidable short-term, construction-related effects as described above but will increase stream habitat complexity, increase overhead cover, and help re-establish natural hydraulic processes in streams over time. Numerous authors have highlighted the importance of LWD to lotic ecosystems (Bilby 1984, Keller *et al.* 1985, Spence *et al*. 1996, Lassettre and Harris 2001). Large woody debris influences channel morphology, traps and retains spawning gravels, and provides food for aquatic invertebrates that in turn provide food for juvenile salmonids. Large woody debris, boulders, and other structures provide hydraulic complexity and pool habitats that serve as resting and feeding stations for salmonids as they rear or migrate upstream to spawn (Spence *et al.* 1996).

Land management actions such as logging, road building, stream clearing, and splash damming carried out over the last 150 years have greatly reduced the amount of LWD and boulders in streams in Oregon, Washington, and Idaho (Murphy 1995, McIntosh *et al.*1994). The BPA proposes this activity category to return these important elements to stream ecosytems. Addition of LWD is a common and effective restoration technique used throughout the Pacific Northwest (Asbridge 2004). Roni and Quinn (2001a) found that LWD placement can lead to higher

densities of juvenile coho salmon during summer and winter and higher densities of steelhead and cutthroat trout in the winter. These authors also found that addition of LWD to streams with low levels of wood can lead to greater fish growth and less frequent and shorter fish movements (Roni and Quinn 2001b).

As with LWD, addition of boulders and properly-designed rock structures can help restore natural stream processes and provide cover for rearing salmonids. Roni *et al.* (2006) found that placement of boulder weirs in highly disturbed streams of Western Oregon led to increased pool area and increased abundance of trout and coho salmon. Addition of gravel in areas where it is lacking, such as below impoundments, will increase spawning substrate available to salmon and steelhead. Although little research has been conducted on the effectiveness of gravel augmentation in improving salmonid spawning, Merz and Chan (2005) found that gravel augmentation can result in increased macroinvertebrate densities and biomass, thus leading to more food for juvenile salmonids.

The proposed design criteria and minimization measures ensure that the BPA will fund projects that place woody debris and boulders and gravel in a natural manner to avoid unintended negative consequences. This activity category will result in numerous long-term beneficial effects including increased cover and resting areas for rearing and migrating fish and restoration of natural stream processes. Most importantly, the proposed criteria ensure that structure placement will not be used to augment habitat, but instead, used to replace natural features that have been lost. This approach has a low probability of causing the baseline to become worse, and a moderate to high probability of improving the baseline.

Improve Secondary Channel Habitats. Side channels and alcoves serve as important rearing habitat for juvenile salmonids. Many side channels and alcoves have been blocked from mainstream channels for flood control or other land management activities. The BPA will fund removal of debris from, or reconnection of, these important habitat areas. Because the creation of new side channels or alcoves can entail a considerable risk of channel collapse, the BPA proposes only to fund reconnection of existing side channel and alcove habitat in this consultation.

This activity requires in-water and near-water construction and will have the short-term, construction-related adverse effects described above. However, once completed, reconnection of side channel and alcove habitat increases the available amount of this important habitat type and provides refugia for juvenile fish during high flows. This is especially important for coho salmon, which require this type of habitat for over-wintering (NRC 1996).

Create, Rehabilitate, and Enhance Riparian and Wetland Habitat. The BPA proposes to contribute to the restoration of wetland and estuary function by removing tide gates, breaching or removing dikes, setting back dikes, removing fill in wetland, and excavating pools and ponds in upland areas. The BPA also proposes to introduce beavers in an effort to more passively restore wetland function.

The types of active wetland restoration proposed by the BPA often require the operation of heavy equipment. Salmonids that are present in the area during construction may experience

increased turbidity, but turbidity is often naturally high in these areas. Nevertheless, fish will generally leave the area as construction begins. Over time, restored wetland and estuary areas will be open to freshwater and tidal influence and will be colonized by hydrophilic plants.

Wetland areas associated with river systems provide key functions such as water storage, water filtering, and development of healthy riparian vegetation. Estuaries are key areas for the completion of salmon and steelhead life histories. The transition between fresh and saltwater occurs in estuaries and ocean-type Chinook salmon spend much of their adult life in or near estuary areas (Groot and Margolis 1991). Beneficial effects of wetland and estuary restoration include increased vegetative cover for rearing juvenile fish and increased prey. Wetlands can also attenuate flood pulses, retaining water and releasing it slowly over time.

Breaching or removing dikes is proposed by the BPA and is a common practice along the West Coast (Frenkel and Morlan 1991). It is also among the easiest of wetland restoration methods. Once a dike is breached, allowing freshwater and tidal exchange, native plants will begin to recolonize. Areas of an estuary that have been filled should readily transform back to a more natural state. In areas with significant artificial fill, the BPA proposes to remove the fill and recontour off-stream areas that have been leveled. As with dike breaching, the area should be allowed to recolonize through natural recruitment. This method requires a substantial amount of time to fully develop, but it will have a high rate of success. Maintaining a wetland area through time requires a hydrologic interaction with the landscape (Bedford 1996). Surface elevation controls the hydrology of the site and thus the plant community (Frenkel and Morlan 1991).

Improve Fish Passage. Under this activity subcategory, artificial obstructions that block fish passage will be removed. Structures removed could include temporary or intermittent dams, artificial debris, and tide gates. The beneficial effects of removal include improved fish passage, restoration of natural bedload movement in streams, and restoration of tidal influence in estuarine areas. Removal of these structures requires instream construction with effects as described earlier.

Other actions covered by this subcategory include modification of dam aprons to improve fish passage, installation of a fish ladder at an existing facilities, redesigning of fish collection facilities, and periodic maintenance of fish passage or collection facilities. All of these actions require review and approval by fish passage engineers from the NMFS Hydropower Division. The primary beneficial effect of these actions is improvement of juvenile and adult fish passage.

Maintain Roads. Improperly maintained roads can transport fine sediment to streams. The BPA proposes to maintain existing roads on lands they acquire or lease for conservation purposes and maintain roads that are essential for reaching other restoration project sites. Maintenance activities will include road blading, rocking of roads, snowplowing, and dust abatement.

This activity category is intended to reduce the potential effects of any existing roads on fish and their habitat. Carrying out road maintenance will reduce the amount of fine sediment reaching streams, but the maintenance itself is likely to have some minor adverse effects on listed salmonids and their habitat. Blading is often done on the inside road shoulder to maintain

drainage ditches, and on the outside shoulder to maintain road width or recover gravels pushed toward the edge by vehicular use. In the absence of ditch maintenance, chronic erosion of road surfaces is likely to occur from surface runoff that carves rills and gullies in the road. Ditch maintenance can substantially reduce the amount of surface erosion on unpaved roads by controlling the runoff. Ditch maintenance generally removes vegetation from drainage ditches and often excavates some portion of the cutslope. The disturbed surfaces are easily eroded during the first few rain events, and a spike of sediment delivery is common during this period. After the first few rain events, the ditches and cutslopes become more resistant to erosion. When roads are immediately adjacent to streams, improper blading can push materials over the road shoulder, which introduces sediment directly into the stream channel or cause streambanks to become over-steppened as soils and gravels accumulate. Over-steepened banks eventually fail from rilling or mass erosion. Adverse effects of road maintenance are avoided or minimized by the minimization measures proposed by the BPA such as not side-casting while blading roads, closing native surface roads during the wet season, and not conducting maintenance when road surfaces are saturated.

Water drafting for road maintenance activities from streams during the low flow periods of summer and fall can result in adverse effects to rearing juvenile salmonids and spawning adult salmonids. Short-term reductions in flow may cause fish to relocate to areas of greater water depth or strand fish in residual pool. In streams where multiple draftings occur in a day, temperature increases may result from reduced flows. However, the BPA proposes numerous water drafting minimization measures to avoid the potential adverse effects of this activity. The amount of water that can be removed from small streams is strictly limited. Screens on pumps used for water drafting will prevent juvenile fish from being entrained during water withdrawal. No drafting is allowed in areas where listed salmonids are actively spawning.

Road maintenance activities include the use of dust abatement chemicals (magnesium chloride and lignin sulfonate products) that can have negative effects on water quality when used near streams. Heffner (1996) concluded that although the overall risk to aquatic life from using dust abatement compounds is low, in certain circumstances, their use may cause some adverse effects. Salmonids have been shown to be able to withstand chloride level of approximately 400 parts per million (ppm) (Heffner 1996). However, chloride levels in waterbodies receiving runoff from application areas would probably drop to 70 ppm where a 3 to 50 foot buffer between the application site and the water exists (Schwendman 1981). Plant life in the direct vicinity of the application site are at the more risk, as application of dust abatement compounds can cause necrosis of plant tissues (Heffner 1996).

Lignon sulfonate and similar dust abatement chemicals have to present in relatively high levels to cause mortality in rainbow trout (the lethal concentration required to kill 50% of individuals in 48 hours (LC_{50}) has been calculated to be between 5,200 and 7,500 ppm), but it does have some adverse sublethal effects at much lower concentrations (Heffner 1996). A retarding effect on growth was observed at concentrations as low as 160 ppm because lignon sulfonate seems to impair the activity of several digestive enzymes. It can be expected however, that any sublethal effects would be short lived, as lignon sulfonate is water soluble, does not bioaccumulate, and is usually only present during short periods when runoff transports it to streams. Lignon sulfonate can also raise biological oxygen demand (BOD) in receiving waterbodies although this seems to

be more of a concern when the exposure is chronic as in the case of streams receiving pulp mill effluent.

Bolander and Yamada (1999) and Heffner (1996) concluded that a vegetative buffer of 25 feet or greater reduced the influences from using dust abatement chemical. The BPA proposes to only use dust abatement chemicals in areas where a 25-foot buffer of vegetation exists between any streams and the road being treated. No petroleum products are allowed for dust abatement. Some vegetation, particularly western red cedar (*Thuja plicata),* is sensitive to salt-based dust abatement chemicals. If these chemicals area applied to areas where western red cedar is present close to the road, these trees can be killed.[27] This can lead to a reduction in stream shade and LWD recruitment,

If not carried out with the proper minimization measures, snowplowing of roads near streams can have adverse effects on salmonids and their habitat. If an unpaved road is plowed to its bare surface, fine sediment and rocks can be deposited at road-stream crossing. If large amounts of snow are deposited at road/stream crossings, temporary blockages of the stream can form, flooding the road and causing subsequent deposition of fine sediment in the stream. Roadside vegetation can be disturbed if the plow wanders off the road. The BPA proposed minimization measures such as leaving at least 2 inches of snow on unpaved roads, not allowing side casting into drainage structures, and not plowing unpaved roads when they are wet to avoid these potential adverse effects.

Maintain, Remove, and Replace Bridges, Culverts, and Fords. The BPA proposes to fund replacement or removal of fish passage barriers caused by improperly sized or improperly functioning culverts and bridges. Correcting these problems will increase the amount of habitat available to listed fish to varying degrees, depending on the locations of the structures within the watersheds. This activity could potentially restore or improve access to hundreds of miles of habitat each year. This activity requires significant instream construction, isolation of the work area from flowing water, and relocation of fish. The construction related effects described above will occur at all culvert and bridge project sites. The BPA proposes to replace culverts using the stream simulation method, in which natural stream substrates will be placed in the bottom of these structures.

Long-term beneficial effects of culvert and bridge replacement or removal projects include restoration of fish passage and restoration of natural stream channel processes through removal of channel constricting structures. Fish passage impediments are common throughout Oregon, Washington, and Idaho, and restoration planning efforts have highlighted the need to restore fish passage, particularly when the blockage occurs low in a watershed.

Minimization measures and design criteria proposed by the BPA ensure that new culverts and bridges do not constrain stream channel during flows reaching ordinary high water level. Fish

[27] Personal communication with Bob Ries, NMFS, on 9/6/07 regarding an incident when nearly all the mature cedar trees along the Selway River in Idaho were killed in 7 mile stretch when the Nez Perce National Forest applied magnesium chloride . Nez Perce National Forest personnel attributed the deaths to a combination of drought stress, and ripping the top 3 inches of the road to mix-in the chemical.

passage engineers from NMFS will be reviewing all proposed culvert and bridge replacements covered by this Opinion. Culverts are restricted to an 8% gradient due to the difficulties of maintaining natural stream substrates in culverts placed at high gradients. Baffled and other non-typical culverts requiring special circumstances are not covered by this Opinion. The use of riprap is limited to protection of the outlets and inlets of culverts and for protection of bridge abutments.

Decommission Roads. The BPA proposes to fund decommissioning of unneeded roads. Over the past century, roads have been constructed throughout Federal, state and private lands in Oregon, Washington, and Idaho to access timber and mines, facilitate fire suppression, and access recreation areas. The effects of road building and maintenance on fish habitat and watershed function are summarized in Furniss *et al.* (1991). Roads and associated ditch systems increase watershed drainage networks, intercept overland flow, and shift timing of peak flows. Improperly constructed road-stream crossings, particularly culverts, can impede fish passage. During precipitation events, fine sediments can be washed from the road surface into streams. This is especially true for poorly maintained roads. Roads constructed in close proximity to streams constrain the stream channel and eliminate the stream's access to its floodplain. Decommissioning roads reduces these adverse effects.

Road obliterations near streams will have short-term construction related effects as described earlier in this section. In the long term, road obliteration helps restore instream habitats dependant on more natural patterns of surface runoff and sediment delivery, eliminates channel alterations caused by road crossings, and it helps restore growth of riparian vegetation inhibited by soil compaction. Obliterating roads within a stream's floodplain will decrease channel constriction and allow reestablishment of riparian functions.

Install Off-Channel Watering Facilities. Under this activity subcategory, water troughs and pipes would be installed at streams or springs to preclude the need for livestock to enter the stream or spring itself to drink. Ponds, may be created in upland areas and, in some cases, water may come from ground water wells. Installation of these systems requires some near water construction, primarily excavation of a small trench to bury the water delivery pipes.

Trough systems typically include a water delivery and overflow systems so that water is constantly flowing through the trough. The maximum size of a pipe delivering water from a stream is 4 inches and the water returns to the stream in a relatively short amount of time. Although there is some risk that juvenile salmon and steelhead can be entrained during water withdrawal, the BPA will require that intakes be screened to NMFS criteria.

The beneficial effects of installing off-channel watering facilities come from decreased livestock activity near streams. Improvements in streambank stability and an increase in the vigor of riparian vegetation are indirect beneficial effects expected from this activity subcategory.

Harden Fords for Livestock Crossings of Streams. The BPA proposes to fund creation or hardening of fords for livestock crossing of streams. This activity is typically done in conjunction with riparian fencing.

Concentration of livestock at fords can result in streambank damage and addition of fine sediment to stream substrates. Livestock crossing streams at established fords can startle rearing juvenile salmonids and cause them to leave the areas. In areas where fords are used regularly, a maximum of approximately 20 feet of stream may become unusable by salmonids.

The addition of river rock to the stream bottom and ford approaches reduces the amount of fine sediment that is mobilized by use of the ford. Although concentration of livestock use at the fords may result in adverse effects to listed salmonids and stream habitat, the reduction of wide-spread access to the stream will result in beneficial effects such as reduced streambank alteration and reduced consumption of riparian vegetation.

The BPA proposes several minimization measures to reduce the potential for these types of adverse effects from occurring. Crossing widths are limited to 20 feet and areas of sensitive soils and vegetation will be avoided. Fords will not be created or hardened in areas where anadromous fish spawning occurs so spawning fish and redds will not be at risk. Although these measures will reduce the potential for adverse effects, some minor streambank damage is likely to occur in these small areas.

Install Irrigation Water Siphon Beneath Waterway. To prevent irrigation water from commingling with stream water, to keep irrigation ditches from intercepting streams, and to restore natural bedload transport, the BPA proposes to fund installation of siphons to take the irrigation water underground where it can bypass the stream. Water siphons are concrete and metal structures that take irrigation water in ditches subsurface and below streams at stream/ditch crossings. At many stream/ditch crossings, a barrier is placed at the downstream end, effectively intercepting the stream into the ditch and blocking fish passage. This activity subcategory requires in-water construction with adverse effects as describe earlier.

The BPA proposes several minimization measures to ensure that the installation of siphons does not interfere with natural stream process. Stream widths must be maintained at bankfull width or greater and no concrete will be placed in the bankfull width. This will avoid the creation of stream flow constriction points at the siphon which could cause scour or other stream morphology problems. Siphon surface structures must be at least 10 feet from the top of the streambank and no portion of the siphon can block fish passage, so impacts to normal fish movements will occur. To reduce the short-term impacts, the BPA proposes to use directional drilling whenever possible. If trenching is required, it will occur only in dry streambeds and work area isolation will be employed in perennial streams.

The beneficial effects of siphon installation result from stopping the mixing of natural stream water and irrigation water, restoring fish passage, and restoring natural bedload transport. Anadromous fish rely heavily on their olfactory systems when completing migrations to natal spawning areas (Groot and Margolis 1991). Adult salmonid detect specific tributary “odors” to help them return to streams where they were born. When ditches intercept tributary streams and return their water to mainstem rivers at alternate locations, fish homing ability can be compromised. By allowing irrigation ditches to pass under streams, these problems can be avoided.

Survey Stream Channels, Floodplains, and Uplands; Install Stream Monitoring Devices such as Stream flow and Temperature Monitors. Under this activity subcategory, information will be collected about current conditions at sites where habitat improvement may occur or are scheduled to occur. The actions included in this subcategory vary from actual instream biological surveys, to installing of monitoring equipment, to excavation of cultural resources test pits. As such, the effects of this subcategory vary from harassment of fish from instream surveys to minor disturbance of riparian areas.

During snorkel and redd surveys, salmonids are sometimes flushed from hiding cover or otherwise disturbed from normal daily activities. Fish forced from cover are more susceptible to avian and piscivorous predation and occupy suboptimal feeding locations. However, exposure to stress caused by these human activities only lasts a few minutes to hours and fish are likely to return to their previous locations within the same day.

Any excavation or construction that would occur in riparian areas would be minor and occur by the use of hand tools. Some exposure of bare soil and minor disturbance of riparian vegetation would result. Many other actions proposed under this activity subcategory such as wildlife habitat assessments and inventorying roads will not have any effect on listed salmonids or stream habitat. The BPA proposes minimization measures to minimize any result from implementation of this subcategory.

Install/Develop Wildlife Structures. The BPA proposes to fund installation or development of a variety of structures that mimic natural features such as bat roosting and breeding structures, avian nest boxes, hardwood snags, brush cover piles, coarse woody debris, and raptor perches. Installation of structures in uplands will have no effect on listed salmonids or their habitat. Installation of structures next to streams will have negligible effects on riparian function due to the small amount of area affected by these types of structures. While installing the structures, people may startle salmon and steelhead from cover or cause them to leave the work area for a period of a few hours. Temporary disturbances of this nature are common natural occurrence. Generally, disturbances that alarm fish do not have an appreciable effect unless the disturbances occur at a frequency that precludes fish from engaging in behaviors essential to their growth, survival, or reproduction. Infrequent disturbances caused by installation of wildlife structures are unlikely to cause any adverse effects to fish that would differ from natural disturbances encountered by fish on a daily basis.

Acquire Fee-Title or Easement, Enter into Cooperative Agreements, and/or Lease Land and/or Water. The BPA proposes to acquire or lease lands important for conservation of listed anadromous fish. This land is then managed with a focus on improving or protecting anadromous fish habitat. The BPA also proposes to lease water that would otherwise be diverted from streams for irrigation. No adverse effects are expected to result from this activity category.

Numerous beneficial effects would result from the cessation of land management activities that may have adverse effects on salmonids and their habitat such as development, agriculture, and timber harvest. Improvements in streambank stability, overhead cover, shade, and stream substrate embeddedness will occur over time as natural processes are restored. Increases in

instream flow would increase the wetted width of stream, decrease stream temperatures, and improve fish passage.

Construct Fencing for Grazing Control. The BPA proposes to fund construction of fences to exclude livestock from streams and riparian areas. This activity will be used only where grazing is an existing practice, and it will not be used to enable new grazing activities to occur. Fencing is proposed in conjunction with conservation easements (*i.e.,* CREP) and no grazing will be allowed in the riparian exclosures. Exclusion of cattle from riparian areas is likely to eliminate bank trampling and enable natural plant succession to reach mid- or late-seral stages that would occur in the absence of grazing. No adverse effects are expected to occur from constructing fences in places where cattle grazing in riparian areas has been an on-going activity. However, if livestock are allowed to enter riparian exclosures, streambank damage and heavy consumption of riparian vegetation may occur as the animals are confined in a relatively small area. Leonard *et al.* (1997) point out that it only takes a few weeks of unauthorized use or overgrazing to set back years of progress in improving riparian systems. The BPA proposes to minimize the occurrence of this situation by requiring individual consultations for any instances when they plan to authorize livestock grazing in a riparian exclosure they have funded.

Fencing sensitive riparian areas is a very effective way of protecting riparian resources, fish habitat and fish populations. Platts (1991) found that in 20 of 21 studies identified, stream and riparian habitats were degraded by livestock grazing, and habitats improved when grazing was prohibited in the riparian zone. Storch (1979) reported that in Oregon, in a reach of Camp Creek passing through grazed areas, game fish (trout) made up 77% of the population in a fenced exclosure, but only 24% of the population outside the exclosure. Line *et al.* (2000) found that excluding livestock through fencing and planting trees in the excluded area significantly reduced nutrient inputs to streams. Beneficial effects on fish and their habitat from fencing include reduced streambank damage, decreased consumption of riparian vegetation, and decreased fish-livestock interactions.

Create Upland Conservation Buffers and Implement Conservation Cropping Systems. The BPA proposes to fund these two activities on private agricultural lands where existing activities typically involve annual tilling. Both activities increase infiltration of water into soils, and reduce erosion. These changes in agricultural practices generally take place in upstream locations, away from streams. These activities must be implemented in conjunction with a riparian forest or riparian herbaceous buffer so that tilling and other soil disturbing agricultural practices are not occurring within riparian areas. The effects of these activities are wholly beneficial; they reduce the amount of fine sediment reaching streams.

Implement Conservation Cropping Systems. The BPA proposes to fund conservation cropping systems such as no-till seeding to improve water quality of streams that flow through agricultural lands. These cropping systems generally require less soil disturbance, reducing the amount of erosion carrying fine sediment and other pollutants to streams. These practices must be done in conjunction with the establishment of riparian forest buffer (wherever trees can grow) or herbaceous buffer (NRCS practices 391 and 390, respectively). Required buffer widths would be approximately 35 feet. Although a buffer of this width is not fully capable of stopping all sediment reaching streams, the total sediment and other pollutants reaching streams will be

reduced. The establishment of riparian buffer will also allow for development of riparian plant community which can provide stream shade and overhanging cover.

Stabilize Soils via Planting and Seeding. The BPA proposes to fund this upland activity category to reduce the amount of fine sediment created by agricultural activities that reaches streams. This activity subcategory will have the wholly beneficial effect of reducing the amount of fine sediment generated by upland agricultural activities reaching streams.

Implement Erosion Control Practices. The BPA proposes to fund upland erosion control measures such as critical area planting and development of sediment basins and grade stabilization structures. These upland activities have no direct effect on streams or riparian areas. These activities do reduce the amount of upland erosion and fine sediments that may reach streams.

Convert Delivery System to Drip or Sprinkler Irrigation. The BPA proposes to fund conversion of flood irrigation to drip or sprinkler systems. Installation of these more efficient systems should reduce the need for water withdrawal from streams. This activity subcategory can involve minor amount of near water construction with effects as described earlier. The beneficial effects of this activity subcategory result from increased instream flow and include improved fish passage, improved riparian function and greater wetted habitat available for salmonids.

Convert Water Conveyance from Open Ditch to Pipeline or Line Leaking Ditches and Canals. This activity subcategory is similar to the previous; it is intend to convert inefficient open ditches to pipe or line leaking ditches that lose less water. In some cases, this will require in-water or water construction with effects as described earlier. The beneficial effects of this subcategory result from the decreasing the amount of water withdrawn from streams for irrigation.

Convert from Instream Diversions to Groundwater Wells for Primary Water Source. The BPA proposes this activity subcategory to reduce the demand for surface water diversion. All activities associated with this subcategory would occur away from streams except the removal of unneeded diversion structures which would be covered under another activity subcategory. The beneficial effects of this activity subcategory result from increased instream flow and include improved fish passage, improved riparian function and greater wetted habitat available for salmonids.

Install New or Upgrade/Maintain Existing Fish Screens. The BPA proposes to install, upgrade, or replace off-channel fish screens on existing water diversion structures. These activities will require near or instream construction, so that related effects (as described above) will occur. Installation of screens will occur only on existing diversion, and no additional water withdrawals points will be established. Additionally, no greater rates of water withdrawal will be authorized.

Unscreened or improperly screened irrigation diversion structures can entrain fish into canals where they become trapped and die. If approach velocities are too fast, fish can also be

impinged against the screen surface. To avoid any effects from improperly designed screens, all proposed screen installations or replacements will meet NMFS fish passage criteria (NMFS 2007).

The primary long-term beneficial effect of properly screening diversions is decreased salmonid mortality. Although it is well accepted that screens prevent fish from dying, NMFS cannot predict exactly how many fish would be saved by installing screens on lands in Oregon, Washington, and Idaho. Despite millions of dollars spent on fish screening of water diversions in the Pacific Northwest and California, there have been few quantitative studies conducted on how screening actually affects fish populations (Moyle and Israel 2005). Even though the effects of screening have not been well studied, NMFS recognizes the value of screening and supports the BPA's precautionary approach to screen diversions that may affect listed salmon and steelhead. Any action involving effects to listed salmon, steelhead, or their habitat caused by lack of stream flow is not covered by this consultation.

Consolidate Diversions, or Replace Existing Irrigation Diversions with Pump Stations, or Remove Unneeded Diversion Structures. Under this activity subcategory, the BPA will fund replacement of instream irrigation diversion structures with screened pump stations or remove unneeded irrigation diversion structures. This activity category requires significant in-water construction, so effects as described earlier will occur.

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

Pump stations created under this subcategory must be screened to NMFS fish passage and screening criteria (NMFS 2007). This will prevent juvenile fish from being entrained into the irrigation system. Actions involving effects to listed salmon, steelhead, or their habitat caused by lack of stream flow are not covered by this consultation.

Install or Replace Return Flow Cooling Systems. The BPA proposes to fund installation of a network of perforated PVC pipes in agricultural fields and pastures to collect irrigation tailwater and return it to a stream. These systems keep irrigation water from pooling on the surface of fields and heating from solar radiation. By keeping these return flows subsurface, the temperature of the water returning to streams should lower. Although these systems have not been studied in detail, reducing the temperature of irrigation return flows will result in minor beneficial effects to stream temperature.

This activity subcategory requires a minor amount of near water construction. Short-term adverse effects to salmonids and their habitat include minor inputs of fine sediment, exposure of bare soils, and removal of a small amount of riparian vegetation.

Plant Vegetation. The BPA proposes to fund planting of riparian vegetation that would naturally occur in the project area. This may occur as a stand alone action, or as an action to stabilize areas disturbed by other activities covered by this programmatic Opinion. Many authors have discussed the importance of riparian vegetation to stream ecosystems (Murphy and Meehan 1991; Swanston 1991, Hicks *et al.* 1991, Spence *et al.* 1996). Streambanks covered with well-rooted, woody vegetation have an average critical sheer stress three times that of streambanks that are weakly vegetated or covered with grass (Millar and Quick 1998). This is one of the most important actions that can be taken to restore natural processes to stream ecosystems.

Planting in riparian areas may result in very minor fine sediment delivery to streams. It could also temporarily flush fish from hiding cover but it is not expected to result in significant behavior modification of listed salmon and steelhead. In the long term, planting of riparian vegetation will increase shade, hiding cover, woody debris, and streambank stability. As plantings mature, width-to-depth ratios of disturbed channels and fine sediment delivery will decrease.

Supplement In-Channel Nutrients. Many streams throughout the Pacific Northwest that once had large returns of salmon and steelhead are now lacking the nutrients that decomposing fish carcasses provided. This is especially true for trace marine nutrients (Compton 2006, Murota 2003, Thomas *et al.* 2003). The BPA proposes to fund addition salmon carcasses, carcass analogs, or inorganic fertilizers to replace missing nutrients.

The addition of nutrients can increase primary productivity and result in more food for juvenile salmonids (summarized in Reeves *et al.* 1991). The organisms in the base of the food chain that rely on those inputs are ultimately the food base that juvenile salmonids consume when rearing and migrating to the ocean. Studies conducted in British Columbia have shown that addition of inorganic fertilizers can increase salmonid production in oligotrophic streams (Slaney and Ward 2003, Ward *et al.* 2003, Wilson *et al.* 2003).

Because the effects of these nutrient additions, particularly carcass additions, have not been studied in detail (Compton 2006), the BPA proposes minimization measures in conjunction with this activity type. In Oregon, fish carcasses will be certified as disease free by an ODFW fish pathologist and in Washington, placement of carcasses will follow *Washington Department of Fish and Wildlife Habitat Technical Assistance: Nutrient Supplementation* (2004).[28] Following these steps will minimize the chance of introducing disease causing pathogens through carcass supplementation. The BPA will not place carcasses in naturally oligotrophic systems where nutrient levels would be naturally low, and they will not add nutrients to eutrophic systems where nutrient levels are unnaturally elevated. Carcass additions will occur during normal spawning periods, so some spawning activities could be temporarily interrupted by the addition activities. These interruptions will last for a maximum of a few hours, will only happen once, and are not likely to cause a measurable decrease in spawning success.

Vegetation Management Using Physical and Chemical Methods. The BPA proposes to control non-native plants in riparian areas by manual, mechanical, and herbicidal methods. The

[28] Available at: http://wdfw.wa.gov/hab/ahg/shrg/index.htm

following analysis considers the effects of these plant removal methods. Although NMFS recognizes the need to control non-native plants and restore native plant communities to riparian areas, the use of herbicides close to streams exposes aquatic vegetation, aquatic invertebrates, and salmonids to toxic chemicals. The BPA has proposed minimization measures that minimize the amount of herbicides and associated chemicals that will enter aquatic systems. The following section details the thorough analysis conducted to determine what effects invasive plant treatment will have on listed salmon, steelhead, and their habitat. This will be the most commonly used activity categories under the proposed action, and NMFS has included in this programmatic Opinion a comprehensive analysis of its effects on listed salmonids and their habitat.

Disturbance

Manual and herbicide treatment activities occurring within occupied stream channels are likely to disturb juvenile and adult listed fish, and disturb redds. This disturbance is caused by the physical presence of people traveling through streams to complete either manual or chemical treatments. These effects will cause some juveniles and adults to seek alternative habitat, which is likely to contain suboptimal cover and juvenile forage. Fish that seek suboptimal forage and cover will have increased behavioral stress (avoidance, displacement), and sub-lethal responses (increased respiration, reduced feeding success, reduced growth rates). Instream treatment activities are likely to cause some physical injury or death to eggs present in redds or to juvenile fish that do not leave the activity area.

Sediment and Turbidity

Manual, mechanical, or herbicide treatments that are extensive, intensive, and immediately adjacent to a stream course may cause instream fine sediment delivery, resulting in localized sediment deposition or stream turbidity increases.

Hand pulling of emergent vegetation, tilling, discing, and plowing are likely to result in localized turbidity increases and mobilization of fine sediments. The degree of effect will be in proportion to the extent of the infestation treated, type of substrate in which the plants are rooted, rooting depth, and other factors. Treatment of knotweed and other streamside invasive species with herbicides is likely to result in significant short-term increases in localized fine sediment deposition or turbidity only when treatment of locally extensive streamside monocultures occurs. Localized turbidity increases are likely to cause some juveniles and adults to seek alternative habitat, which is likely to contain suboptimal cover and juvenile forage. Fish that seek suboptimal forage and cover will have increased behavioral stress (avoidance, displacement), and sub-lethal responses (increased respiration, reduced feeding success, reduced growth rates). Other effects of increased turbidity were discussed as a general matter at the beginning of this analysis and are relevant here as well.

Other manual, mechanical, and herbicide (cut-stump, and wicking and wiping) treatment methods are unlikely to cause fine sediment or turbidity increases. Seed clipping, stabbing, girdling, and cutting typically do not involve ground disturbance or result in bare ground. Shading and covering may result in bare ground, but are typically small in scale, treating less than 0.1 acres at a time at individual sites.

Water Temperature

Most manual, mechanical, and herbicide treatments of invasive plant species in riparian areas are not likely to decrease shading of streams. However, in some situations decreased shading will likely result in increasing the amount of incident solar radiation reaching the stream and resulting in increased water temperatures. Sustained high stream temperatures are harmful to salmon because these species are adapted to the specific, natural temperature ranges of their natal streams. Laboratory studies concluded that changes in stream temperature ranges can alter salmon development, growth, survival, and the timing of life history phenomena (Beschta *et al.* 1987). Based on the conclusions of these laboratory studies, increased temperatures beyond those meeting the biological requirements of salmon could cause juvenile salmon to seek other rearing areas or decrease their rates of growth. Furthermore, Berman and Quinn (1991) reported that fecundity and the variability of spring Chinook salmon eggs were adversely affected by greatly elevated water temperatures above those meeting the biological requirements of Chinook. Severely high temperatures can inhibit the upstream migration of adult salmon and increase the incidence of disease throughout a salmon population. Finally, a study in coastal Oregon found that as stream temperatures increase, competition between rearing salmon and warm water fish species can increase, potentially extirpating salmon populations through competitive pressure (Reeves *et al.*, 1987).

Shade loss that significantly affects water temperature will be very rare, perhaps caused by treating streamside knotweed and blackberry monocultures, and possibly from cutting streamside woody species (tree of heaven, scotch broom, *etc.*). 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.

Chemical Methods

Two application scenarios were identified that have the potential to expose listed fish to herbicides: (1) Runoff from riparian application, and (2) application within perennial streams.

Each exposure scenario was analyzed to determine the level of acute exposure risk. The risk of chronic exposure from riparian application of the 14 herbicides included in this activity category was analyzed. That analysis is summarized below, and the original analysis has been saved in the project file.

The chronic effects analysis concluded that an insufficient amount of the proposed herbicides would be applied in the 10 acre/small stream scenario[29] to result in exposure of fish and aquatic invertebrates to chronic effects threshold concentrations for the standard durations (90 days for fish, 21 days for aquatic invertebrates). The analysis also concluded that chronic effects to algae (21 days) from herbicides other than dicamba and sulfometuron are not possible in this activity description. Chronic effects to aquatic macrophytes (21 days) from aminopyralid, clopyralid, clethodim, dicamba, glyphosate, picloram, sethoxydim, and triclopyr were determined not to be possible, not likely to occur for 2,4-D, imazapyr, metsulfuron, and sulfometuron, and likely to

[29] As used in the SERA (Syracuse Env. Research Associates) risk assessment, available at: www.fs.fed.us/foresthealth/pesticide/risk.shtml.

occur for chlorsulfuron under some conditions. The chronic exposure analysis determined that adverse effects to aquatic macrophytes are likely for chlorsulfuron when 10 or more streamside acres are treated at application rates greater than about 0.08 pounds active ingredient (a.i.)/acre (0.056 pounds a.i./acre is the typical rate, and 0.25 pounds a.i./acre is the maximum rate).

The risk of adverse effects to listed salmonids and their habitat was evaluated in terms of hazard quotient (HQ) values. Hazard quotient values are calculated by dividing the expected environmental concentration (expected exposure) by the effects threshold concentration (identified threshold). For fish, the effects threshold was the measured or estimated sub-lethal no-observed-effect level (NOEC) value. When the HQ value is >1, adverse effects to fish in the form of acute sub-lethal effects are likely to occur since ambient toxicant concentrations would then exceed the effect threshold. .

The lowest acute or chronic fish sub-lethal NOEC value reported for an herbicide in the literature was used as the measured NOEC value. The estimated sub-lethal NOEC value, defined as $1/20^{th}$ of the LC_{50} value, was used when it was lower than the measured NOEC value or no measured NOEC was available. This process for selecting effect threshold values for short-term exposure is designed to compensate for some of the lack of information regarding the effects of sub-lethal exposure. The NOEC values used as effect thresholds are listed in Table 9.

Hazard quotient values were also calculated for aquatic invertebrates, algae, and aquatic macrophytes. Threshold concentrations at which herbicides are likely to adversely affect aquatic invertebrates, algae, and aquatic macrophytes were considered to be equal to LC_{50} and EC_{50} concentrations. The LC_{50} values were used for aquatic invertebrates and some algal species, and EC_{50} values were used for the remaining algal species and aquatic macrophytes.

The LC_{50} and EC_{50} values for invertebrates, algae, and aquatic macrophytes were obtained from the SERA risk assessments or Pesticide Action Network (PAN) database. The values recommended in the risk assessments for “sensitive” species within each species group were used. The LC_{50} and EC_{50} values were frequently those for which toxicity data was required for EPA registration of the herbicide. If an HQ value exceeded 1.0 for algae or aquatic macrophytes an adverse effect to habitat was considered to occur. When an HQ value exceeds 1.0, the ambient toxicant concentration exceeds the effect threshold concentration.

Table 9. Summary of NOEC values used in HQ calculations.

Herbicide	Duration	Endpoint	Effect Threshold	Species	Source
2,4 – D amine	Acute	LC_{50}	[1] 0.05 mg/L	Rainbow trout	[2] PAN database
Aminopyralid	Chronic	Mortality	1.36 mg/L	Fathead minnow	[3] EPA 2005
Chlorsulfuron	Acute	LC_{50}	[1] 2 mg/L	Brown trout	[4] SERA risk assessment
Clopyralid	Acute	LC_{50}	[1] 5 mg/L	Rainbow trout	SERA risk assessment
Clethodim	Acute	LC_{50}	[1] 0.95 mg/L	Rainbow trout	PAN database
Dicamba	Acute	LC_{50}	[1] 1.4 mg/L	Rainbow trout	SERA risk assessment
Glyphosate (no surfactant)	Acute	Olfaction	0.1 mg/L	Coho salmon	Tierney *et al*. 2006
Imazapic	Acute	LC_{50}	[1] 100 mg/L	Rainbow trout	SERA risk assessment
Imazapyr	Acute	LC_{50}	[1] 5 mg/L	Rainbow trout	SERA risk assessment
Metsulfuron methyl	Chronic	Standard length	4.5 mg/L	Rainbow trout	SERA risk assessment
Picloram	Chronic	Not stated	0.04 mg/L	Cutthroat trout	SERA risk assessment
Sethoxydim	Acute	LC_{50}	[1] 0.06 mg/L	Rainbow trout	SERA risk assessment
Sulfometuron methyl	Chronic	Hatch, survival, and growth	1.17 mg/L	Fathead minnow	SERA risk assessment
Triclopyr acid	Acute	LC_{50}	[1] 0.26 mg/L	Chum salmon	Wan *et al.* 1989

[1] Listed value is 1/20th of LC_{50}
[2] Pesticide Action Network Database - http://www.pesticideinfo.org/Index.html
[3] EPA aminopyralid fact sheet - http://www.epa.gov/opprd001/factsheets/aminopyralid.pdf
[4] Various sourced cited in SERA risk assessments - http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Runoff and Percolation from Riparian Application

This section addresses exposure risks to listed fish in both small streams and the margins of larger streams from runoff and percolation resulting from herbicide application in riparian areas. The analysis is based on the small stream scenario used in the SERA risk assessments, and provides a higher risk exposure scenario. The exposure scenario is for a 10-acre herbicide application adjacent to a small stream (base flow of 1.8 cfs). The water contamination rate (WCR) values for annual rainfall rates of 15, 50, 100, and 150 were selected to represent the range of climates occurring across the action area. The peak WCR values predicted for each rainfall level by soil type (clay, loam, and sand), and the typical and maximum herbicide application rates, were used to calculate the range of HQ values likely to occur. The WCR values for all herbicides, except clethodim, are those listed in the SERA risk assessments. The

WCR values for sethoxydim were used as an estimate of WCR values likely to occur for clethodim. The K_{oc} and soil half-life of clethodim (116 and 3 days, respectively) are similar to those for sethoxydim (100 and 5 days). A sensitivity analysis for the GLEAMS model conducted by Cryer and Havens (1999) found K_{oc} and soil half-life to be the most sensitive of the pesticide properties tested.

Since several relevant parameters of the margins of larger streams are analogous to the modeled small stream scenario, the small stream analysis results are extended to stream margin habitat. Stream margins often provide shallow, low flow habitat, may have a slow mixing rate with mainstem waters, and may also be the site at which subsurface runoff is introduced.

Early stage juvenile salmonids, particularly recently emerged fry, often utilize low flow areas along stream margins (Groot and Marcolis 1991; Johnson et al. 1992; Quinn 2005). As juveniles grow, they migrate away from margins, occupying habitats of progressively higher velocity (Lister and Genoe 1970, Everest and Chapman 1972). Weber and Fausch (2004) found that wild Chinook salmon reared near the river margin until reaching about 60 mm in length. Stream margins are utilized by salmonids for a variety of reasons, including nocturnal resting (Roussel and Bardonnet 1999, Polacek and James 2003), summer and winter thermal refuge, predator avoidance (Roussel and Bardonnet 1999), and flow refuge (Roussel and Bardonnet 1999).

Exposure resulting from riparian applications occurs when rainfall mobilizes herbicides and associated compounds through dissolution and into surface or subsurface runoff, and ultimately into stream channels. Soil erosion can also deliver herbicides from riparian applications.

The peak WCR values predicted by soil type were used to calculate the likely range of HQ values at typical and maximum herbicide application rates for all four rainfall levels (15, 50, 100, and 150 inches/year). The data from the SERA risk assessments shows that modeled peak WCR values generally increased with higher application and rainfall rates. Numerous environmental factors exist that can result in variation of actual WCR values from those predicted are known to exist (USFS 2005, Berg 2005). However, the SERA risk assessments represent the best available information, and WCR-based HQ values greater than 1 are considered to represent an adverse effect in this Opinion.

Table 10 summarizes the results of the small stream exposure analysis. Table 10 shows that at typical application rates, HQ values greater than 1 for glyphosate, picloram, sethoxydim and triclopyr occurred primarily at rainfall rates of 100 inches/year or greater. At typical and maximum application rates 2,4-D, glyphosate, picloram, sethoxydim, and triclopyr exhibited HQ values greater than 1. As displayed in Table 10, under the riparian application scenario no HQ values greater than 1 occurred for fish from aminopyralid, chlorsulfuron, clethodim, clopyralid, dicamba, imazapic, imazapyr, metsulfuron, or sulfometuron at any application rate or soil type.

If riparian applications occur in irrigation ditches, exposure levels are likely to be substantially higher than those displayed in Table 10, and much more likely to adversely affect algae and aquatic macrophytes (which are typically more sensitive to herbicides). Irrigation ditches provide an efficient conduit for herbicide delivery to adjacent occupied streams. However, exposure duration from ditch application is likely to be shorter.

An exposure analysis similar to that displayed in Table 10 was conducted for algae and aquatic macrophytes, and determined that adverse effects to salmonid habitat, in the form of adverse effects to algae and aquatic macrophytes, are likely to occur for 2,4-D amine, chlorsulfuron, and metsulfuron.

The HQ values exceeding 1, indicating likely adverse effects for listed salmonids or their habitat, are discussed below by herbicide.

Table 10. Summary of exposure concentrations from riparian applications to small streams and stream margins, and salmonid HQ values based on typical and maximum herbicide application rates under the standard SERA risk assessment scenario.

		Riparian Application											
		Typical Application Rate						Maximum Application Rate					
		Clay		Loam		Sand		Clay		Loam		Sand	
Herbicide	Rainfall (inch/yr)	Exposure (mg/l)	HQ Value	Exposure (mg/l)	HQ Value	Exposure (mg/l)	HQ Value	Exposure (mg/l)	HQ Value	Exposure (mg/l)	HQ Value	Exposure (mg/l)	HQ Value
2,4-D amine	15	0.09	1.8	0.000	0.000	0.000	0.000	0.4	7	0.000	0.000	0.000	0.000
	50	0.4	8	0.000	0.005	0.000	0.001	1.5	30	0.001	0.02	0.000	0.005
	100	0.4	9	0.005	0.1	0.004	0.08	1.8	35	0.02	0.4	0.02	0.3
	150	0.4	8	0.004	0.07	0.01	0.2	1.5	31	0.01	0.3	0.04	0.9
Aminopyralid	15	0.005	0.004	0.002	0.001	0.01	0.01	0.007	0.005	0.002	0.002	0.02	0.01
	50	0.006	0.004	0.008	0.006	0.02	0.01	0.008	0.006	0.01	0.008	0.03	0.02
	100	0.003	0.002	0.008	0.006	0.02	0.01	0.005	0.003	0.01	0.008	0.02	0.02
	150	0.003	0.002	0.007	0.005	0.02	0.01	0.004	0.003	0.009	0.007	0.02	0.02
Chlorsulfuron	15	0.0007	0.0003	0.00000	0.0000	0.00000	0.0000	0.003	0.002	0.00000	0.0000	0.00000	0.0000
	50	0.006	0.003	0.00002	0.0000	0.003	0.0004	0.03	0.01	0.0001	0.0001	0.003	0.002
	100	0.01	0.006	0.0001	0.0001	0.00000	0.001	0.05	0.02	0.0007	0.0003	0.009	0.004
	150	0.01	0.006	0.0002	0.0001	0.01	0.001	0.05	0.03	0.001	0.0005	0.01	0.006
Clethodim	15	0.005	0.000	0.001	0.0001	0.02	0.002	0.005	0.0006	0.001	0.0002	0.02	0.003
	50	0.05	0.005	0.1	0.01	0.1	0.009	0.05	0.007	0.1	0.02	0.1	0.01
	100	0.1	0.01	0.3	0.03	0.2	0.02	0.1	0.02	0.3	0.04	0.2	0.02
	150	0.2	0.02	0.4	0.04	0.2	0.02	0.2	0.03	0.4	0.05	0.2	0.03
Clopyralid	15	0.002	0.0003	0.00000	0.0000	0.00000	0.0000	0.002	0.0005	0.00000	0.0000	0.00000	0.0000
	50	0.004	0.0007	0.002	0.0005	0.006	0.001	0.005	0.001	0.004	0.0007	0.009	0.002
	100	0.004	0.0007	0.007	0.001	0.02	0.003	0.005	0.001	0.01	0.002	0.02	0.004
	150	0.004	0.0007	0.009	0.002	0.02	0.004	0.005	0.001	0.01	0.003	0.03	0.006
Dicamba	15	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.000	0.000
	50	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0002	0.0001	0.0000	0.000	0.000
	100	0.000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0004	0.0003	0.0002	0.0001	0.001	0.000
	150	0.000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0004	0.0003	0.0003	0.0002	0.001	0.001
Glyphosate	15	0.002	0.02	0.005	0.05	0.01	0.1	0.009	0.09	0.02	0.2	0.05	0.5
	50	0.04	0.4	0.06	0.6	0.1	1.1	0.1	1.4	0.2	2.2	0.5	4.5
	100	0.1	1.1	0.2	1.5	0.3	2.8	0.4	4.2	0.6	6.2	1.1	11
	150	0.2	1.8	0.3	2.6	0.5	4.5	0.7	7.4	1.1	11	1.8	18
Imazapic	15	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000
	50	0.00005	0.0000	0.00000	0.0000	0.00001	0.0000	0.00009	0.0000	0.00000	0.0000	0.00002	0.0000
	100	0.0001	0.0000	0.00001	0.0000	0.00002	0.0000	0.0002	0.0000	0.00002	0.0000	0.00004	0.0000
	150	0.0001	0.0000	0.00001	0.0000	0.00003	0.0000	0.0003	0.0001	0.00002	0.0000	0.00005	0.0000
Imazapyr	15	0.00002	0.0000	0.00000	0.0000	0.00000	0.0000	0.00008	0.0000	0.00000	0.0000	0.00000	0.0000
	50	0.0003	0.0001	0.00000	0.0000	0.00007	0.0000	0.0009	0.0002	0.00000	0.0000	0.0002	0.0000
	100	0.0006	0.0001	0.00004	0.0000	0.0001	0.0000	0.002	0.0004	0.0001	0.0000	0.0005	0.0001
	150	0.0008	0.0002	0.00005	0.0000	0.0002	0.0000	0.003	0.0005	0.0002	0.0000	0.0006	0.0001
Metsulfuron	15	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00002	0.0000	0.00000	0.0000	0.00000	0.0000
	50	0.00004	0.0000	0.00000	0.0000	0.00001	0.0000	0.0002	0.0000	0.00001	0.0000	0.00004	0.0000
	100	0.00006	0.0000	0.00000	0.0000	0.00002	0.0000	0.0003	0.0001	0.00002	0.0000	0.00008	0.0000
	150	0.00006	0.0000	0.00000	0.0000	0.00002	0.0000	0.0003	0.0001	0.00002	0.0000	0.00009	0.0000
Picloram	15	0.004	0.09	0.00000	0.0000	0.007	0.2	0.01	0.3	0.00000	0.0000	0.02	0.5
	50	0.03	0.9	0.004	0.1	0.02	0.4	0.1	2.5	0.01	0.3	0.05	1.2
	100	0.06	1.6	0.006	0.1	0.02	0.6	0.2	4.6	0.02	0.4	0.07	1.7
	150	0.07	1.6	0.006	0.2	0.03	0.7	0.2	4.7	0.02	0.4	0.07	1.9
Sethoxydim	15	0.001	0.02	0.0004	0.007	0.006	0.1	0.002	0.03	0.0007	0.01	0.009	0.1
	50	0.02	0.3	0.04	0.6	0.03	0.5	0.02	0.4	0.06	1.0	0.04	0.7
	100	0.04	0.7	0.09	1.5	0.05	0.9	0.06	1.1	0.1	2.3	0.08	1.3
	150	0.07	1.1	0.1	2.0	0.07	1.1	0.1	1.7	0.2	3.0	0.1	1.7
Sulfometuron	15	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000	0.00000	0.0000
	50	0.00002	0.0000	0.00000	0.0000	0.00000	0.0000	0.00002	0.0001	0.00000	0.0000	0.00000	0.0000
	100	0.00005	0.0000	0.00000	0.0000	0.00001	0.0000	0.00005	0.0001	0.00002	0.0000	0.00001	0.0000
	150	0.00006	0.0000	0.00000	0.0000	0.00001	0.0000	0.00006	0.0002	0.00002	0.0000	0.00001	0.0000
Triclopyr	15	0.02	0.06	0.02	0.07	0.02	0.06	0.2	0.6	0.2	0.7	0.2	0.6
	50	0.1	0.5	0.09	0.4	0.05	0.2	1.3	4.8	0.9	3.6	0.5	2.1
	100	0.2	0.9	0.2	0.6	0.09	0.3	2.4	9.4	1.7	6.5	0.9	3.4
	150	0.3	1.2	0.2	0.7	0.1	0.4	3.2	12	2.2	8.5	1.1	4.4

Shaded cells represent HQ values > 1.

2,4 – D

Hazard quotient values greater than 1.0 occurred for fish at typical and maximum application rates on clay soils at all rainfall levels for 2,4-D. The HQ values on clay soils ranged from 1.8–9.0 at the typical application rate, and from 7.0–35 at the maximum application rate. The HQ values increased at rainfall levels of 15–100 inches per year, and decreased slightly at 150 inches per year. No HQ values greater than 1 occurred for soils composed of loam or sand. Adverse effects to listed fish from 2,4-D application in riparian areas are likely to occur only in areas with low permeability soils, but at all rainfall levels within the action area.

Hazard quotient values greater than 1 occurred for aquatic macrophytes at typical and maximum application rates on clay soils at all rainfall levels for 2,4-D. The HQ values ranged from 7.0–30 for the typical application rate, and 28–119 for the maximum application rate. At the maximum application rate, HQ values greater than 1 occurred for aquatic macrophyes on loam and sand soils at rainfall levels of 100–150 inches per year, with HQ values ranging by soil type from 1.1–1.6 and 1.3–3.0, respectively. Adverse effects to habitat for listed fish from 2,4-D riparian application is likely to occur on low permeability soils at all application rates and rainfall levels within the action area, and on loam and sand soils at the maximum application rate at rainfall levels of 100–150 inches per year.

Chlorsulfuron

Hazard quotient values greater than 1 occurred for algae and aquatic macrophytes at typical and maximum application rates for 2,4-D. The HQ values greater than 1.0 for algae occurred at the typical application rate on clay soil at rainfall rates of 100–150 inches per year. At the maximum application rate, HQ values greater than 1.0 for algae occurred on clay soil at annual rainfall levels of 50–150 inches, and on sand at 150 inches. These HQ values for algae were 1.1 at the typical application rate, and ranged from 1.1 to 5 at the maximum application rate. The HQ values greater than 1.0 for aquatic macrophytes occurred at the typical application rate on clay and sand soils at annual rainfall rates of 15–150 and 50–150 inches, respectively. At the maximum application rate, HQ values greater than 1 for aquatic macrophytes occurred on clay, loam, and sand soils at annual rainfall rates of 15–150, 150, and 50–150 inches, respectively. These HQ values for aquatic macrophytes ranged from 1.0–16 at the typical application rate, and 4.5–72 at the maximum application rate. Adverse effects to habitat for listed fish from chlorsulfuron riparian application is likely to occur, but depends soil type and rainfall levels within the action area.

Glyphosate

Glyphosate HQ values greater than 1 occurred for fish at rainfall rates of 50–150 inches per year. The HQ values for fish at 50 inches per year exceeded 1 on all soil types and ranged from 0.4–4.5 at the typical application rate, and 1.4–18 at the maximum application rate. Adverse effects to listed fish from glyphosate application in riparian areas are likely to occur on all soil types at rainfall levels ranging from about 50–150 inches per year, with the exception of application at the typical rate on clay and loam soils at 50 inches per year.

Metsulfuron

An HQ value greater than 1 occurred for aquatic macrophytes at the maximum application rate for metsulfuron on clay at annual rainfall rates of 100–150 inches. Adverse effects to habitat for

listed fish from metsulfuron riparian application are likely to occur, but only on low permeability soils in areas with high rainfall levels.

Picloram

Picloram HQ values greater than 1.0 for fish occurred at typical and maximum application rates. At the typical application rate, HQ values were greater than 1 only on clay soils at rainfall levels of 100 – 150 inches per year. At the maximum application rate, HQ values were greater than 1 on clay and sand soils at all rainfall levels, ranging from 2.5–4.7 on clay and 1.2–1.9 on sand soils. Adverse effects to listed fish from picloram application in riparian areas are likely to occur at the typical application rate on low permeability soils at higher rainfall levels, and at the maximum application rate on low permeability and sandy soils at all rainfall levels.

Sethoxydim

The HQ values greater than 1 for fish occurred at typical and maximum application rates on all three soil types, at rainfall levels of 50–150 inches per year. The HQ values greater than 1.0 ranged from 1.1–3.0. The only HQ value greater than 1.0 at 50 inches per year occurred at the maximum application rate on loam soils. The HQ values greater than 1.0 at 100 inches per year occurred at the typical application rate on loam soils, and for all soils at the maximum application rates. The HQ values greater than 1.0 at 150 inches per year occurred at both the typical and maximum application rates on all soil types.

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

Triclopyr

In the analysis for triclopyr, it was assumed that any triclopyr reaching streams would be in the form of triclopyr acid. Triclopyr HQ values greater than 1.0 occurred for fish at the typical application rate on clay at 150 inches per year, and at the maximum application rate on all three soil types at rainfall levels of 50–150 inches per year. The HQ value greater than 1.0 at the typical rate was 1.2, and ranged from 2.1–12 at the maximum application rate. The HQ exceedences were greatest on clay soils and increased with precipitation rate. Adverse effects to listed fish from triclopyr application in riparian areas are likely to occur at the typical application rate on loam soils when annual rainfall level approaches 150 inches, and at the maximum application rate on all soil types at annual rainfall levels of 50–150 inches.

Application within Perennial Streams

Both glyphosate and imazapyr can be applied between the bankfull level and water's edge of perennial streams, and glyphosate can be applied to emergent knotweed plants. Exposure from

application within stream channels can occur from overspray, foliar rinse by rainfall, erosion, leaching, and site inundation. Juvenile and fry life stages are likely to be at the highest risk of exposure, and the highest risk sites for exposure are stream margins and areas immediately surrounding treated emergent plants.

Exposure of juveniles in stream margins can result from overspray, upstream storms resulting in inundation of treatment sites, rainfall at the treatment sites delivering herbicide to stream margins via percolation or surface runoff, or a combination of these factors.

Juveniles utilizing stream margin habitat are likely to be present in the low flow refuge near the water's edge as stream levels rise. If inundation of recently treated areas occurs, herbicide overspray or wash-off present on the substrate surrounding treated plants, or on the treated plants, may enter solution.

Adverse effects to algae and aquatic macrophytes are not analyzed for stream margin exposures resulting from application to dry portions of perennial channels, since any storm-driven adverse effects are assumed to be less than what would have already occurred during treatment of the area.

Glyphosate

Table 11 displays the potential peak exposure levels likely to occur in stream margins for three application rates if the available glyphosate applied per unit area to dry portions of perennial channels is dissolved into 4 inches or 12 inches of water. The amount of glyphosate available for dissolution (62.5% of the amount applied) is based on assumptions of a foliar wash-off fraction of 0.5 (Durkin 2003), and a 25% overspray rate. Application rates range from 0.5 to 8 pounds per acre.

Table 11. Peak glyphosate concentrations in stream margins from in-channel applications.

Application Rate (pounds/acre)	Depth (inches)	[1, 2] Glyphosate Concentration (mg/l)	Hazard Quotient for Salmonids	Hazard Quotient for Aquatic Invertebrates
0.5	4	0.21	2.1	0.006
2	4	0.83	8.3	0.02
8	4	3.31	33	0.09
0.5	12	0.07	0.7	0.002
2	12	0.28	2.8	0.008
8	12	1.1	11	0.03

[1] Assumes 25% overspray to substrate and foliar wash-off fraction of 0.5, resulting in about 62.5% of applied glyphosate reaching water.
[2] Assumes no leaching contamination from application occurring above bankfull level.

Maximum exposure concentrations (Table 11) range from 0.21–3.3 mg/l at 4 inch depth, with salmonid HQ values ranging from 2.1–33. For the same application range, maximum exposure concentrations at 12-inch depth range from 0.07–1.1 mg/l, with salmonid HQ values ranging from 0.7–11. All HQ values for aquatic invertebrates were less than 1.0.

Numerous factors influence the actual concentration in stream margins near an application site. These are application rate, rainfall proximity and intensity, time since application, soil permeability, and water turbulence and flow rate. Concurrent applications to adjacent riparian areas (above bankfull) are likely to result in additional exposure. Glyphosate is strongly sorbed by most soils (Yu and Zhou 2005), so exposure levels of glyphosate are likely to be attenuated when channel surface substrate contains a substantial soil component. For treatment of emergent plants, the amount of overspray or injection leakage, and water depth and flow are primary determinants of concentration.

Label instructions for the Aquamaster aquatic glyphosate formulation recommend to "always use the higher rate of this product per acre within the recommended range when weed growth is heavy or dense or weeds are growing in an undisturbed (noncultivated) area." For dense infestations, the product label allows an application rate up to 8 pounds/acre. Therefore, it is assumed that application at or near the label maximum is likely to be necessary in some situations for invasive plant control on gravel bars and other instream sites.

Exposure of listed fish from treatment of emergent knotweed with glyphosate is likely to occur via three pathways – overspray, foliar wash-off, and leakage from stem injections. Since delivery via each pathway is driven by different factors (overspray, rainfall, and plant death and breakage), exposure from the three emergent knotweed treatment pathways is very unlikely to overlap in time.

Assuming the same overspray rate used for stream margin exposure calculations (25%) maximum glyphosate concentrations from overspray only at 4-inch water depth would range from 0.15 mg/l at an application rate of 0.5 lbs/acre to 2.2 mg/l at a rate of 8 pounds/acre. The corresponding range of salmonid HQ values is 1.5–22. For the same application rate values, the maximum exposure concentrations in 12-inch water depth would range from 0.05–0.74 mg/l, with salmonid HQ values ranging from 0.5–7.4.

<u>Imazapyr</u>
Analysis was conducted for imazapyr exposure in stream margins from application to dry portions of perennial channels is displayed in Table 12, and is analogous to that displayed above for glyphosate. The stream margin exposure analysis for imazapyr was based on assumptions of a foliar wash-off fraction of 0.9 (Durkin and Follansbee 2004), and a 25% overspray rate. No HQ values exceeded 1.0 for salmonids or aquatic invertebrates.

Table 12. Peak imazapyr concentrations in stream margins from in-channel applications.

Application Rate (pounds/acre)	Depth (inches)	[1, 2] Imazapyr Concentration (mg/l)	Hazard Quotient for Salmonids	Hazard Quotient for Aquatic Invertebrates
0.45	4	0.037	0.007	0.0004
1.5	4	0.12	0.024	0.001
0.45	12	0.11	0.022	0.001
1.5	12	0.37	0.74	0.004

[1] Assumes 25% overspray to substrate and foliar wash-off fraction of 0.9, resulting in about 92.5% of applied imazapyr reaching water.
[2] Assumes no leaching contamination from application occurring above bankfull level.

Adjuvants

The BPA chose adjuvant products for which at least some toxicity information was available, and developed "generic estimated environmental concentrations" (GEEC2) for estimating risk to listed aquatic species (with the exception of marker dyes). The GENEEC2 output tables are contained in BA Appendix F-1. The GEEC is calculated using EPA's GENEEC modeling software and simulates an application of herbicide near a waterbody. The GEEC is conceptually identical to the "estimated environmental concentration" (EEC) used in calculating HQ values from SERA risk assessment WCR values, and is hereon referred to as EEC. As with the SERA risk assessment analysis scenario, these exposure levels represent a higher risk scenario.

In order to provide analytical consistency within this Opinion, NMFS converted the "risk quotients" calculated in the BA Appendix F-1 to HQ values. Hazard quotients are the reciprocal of "risk quotients", and HQ values greater than 1 indicate that adverse effects are likely to occur. The HQ values calculated using the exposure and toxicity values from the BA Table F-4, Appendix F-1, are displayed below in Table 13. As is displayed in Table 13, the HQ values are consistent with the BPA "aquatic level of concern" ratings. The two products for which the HQ values indicate likely adverse effects, Entry II and POEA, are both rated as of "high" concern by BPA.

The analysis summarized in Table 13 represent the best information available, but substantial uncertainty is inherent in risk analysis based solely on LC_{50} values. Relatively little information is generally available for adjuvant effects to fish and aquatic environments in general, and some aquatic risks may not be reflected in the analysis presented in Table 9. However, the two products for which HQ values indicated likely adverse effects, BPA proposes "no-use" within a minimum of 100 feet of stream channels. These no-use buffers were not incorporated into the EEC calculations, and the implementation of the no-use buffers is likely to reduce exposure levels to the degree that adverse effects are not likely to occur.

Table 13. Hazard Quotients and Aquatic Levels of Concern for Proposed Adjuvants.

Product	Application Rates lb. or oz. ai/ac (Maximum)	Estimated Environmental Concentration (EEC)[1] (mg/L)	Toxicity 96-hour LC_{50} (mg/L) Rainbow Trout	Estimated Effects Threshold (1/20 LC_{50} in mg/L)	Hazard Quotient (EEC/Effects Threshold)[1]	BPA Aquatic Level of Concern[2]
Activator 90®	4	0.291	12.7 (Guppy)	0.635	0.46	Moderate
Agri-Dex®	3	0.218	271	13.550	0.02	Low
Entry II®	4	0.291	4.2	0.210	1.4	High
Hasten®	3	0.218	73.8	3.690	0.06	Low
LI 700®	3	0.218	17.2	0.860	0.25	Moderate
R-11®	3	0.218	5.6	0.280	0.78	Moderate
Super Spread MSO®	2	0.146	53	2.650	0.06	Low
Syl-Tac®	4	0.291	18	0.900	0.32	Moderate
Generic POEA	8	0.582	2.1	0.105	5.5	High
41-A®	0.5	0.036	1000	50.000	0.001	Low
Valid®	1	0.073	10	0.500	0.15	Moderate

[1] Refer to BA Appendix F-1 for the GENEEC assumptions and worksheets (EEC calculated using EPA's GENEEC2 model http://www.epa.gov/oppefed1/models/water/geneec2_description.htm)

[2] From BA Table F-4, Appendix F-1

Due to the lack of aquatic risk information for colorants, an effects analysis could not be undertaken. In an effort to minimize risk, the BPA proposed to use only food grade colorants in riparian areas.

Herbicide Application Summary

Adverse effects on listed salmonids, and to the algal and aquatic macrophytes habitat elements, are likely to occur. The magnitude and frequency of these adverse effects are likely to be low. The riparian application scenario modeled in this analysis is likely to be of a larger size and assume more uniform application than for most treatment sites. In addition, application buffers specified in the proposed action are designed to reduce exposure levels. Significant adverse effects to aquatic invertebrates are not likely to occur from herbicide exposure. Herbicides likely to cause adverse effects to listed fish or their habitat are listed in Table 14.

The NMFS believes the proposed application methods, timing restrictions, buffers and other minimization measures will significantly reduce the likelihood of herbicides reaching the aquatic environment in concentrations that will kill or harm listed salmonids Precise application methods can reduce the amount of herbicide required for effective treatment, timing restrictions are designed to increase herbicide degradation prior to mobilization by storms into streams, and no-application buffers can reduce instream exposures by allowing microbial degradation and sorption in soils. . No population or watershed scale effects are likely to occur and effects to water quality PCEs will be minor and short-term. For many of the herbicide treatments that occur more than 100 feet from the water, an immeasurable amount of herbicide will actually reach streams occupied by listed anadromous salmonids. Without the proposed minimization measures specific to this program, NMFS could not make these conclusions.

Table 14. Herbicides and adjuvants in treatment categories likely to adversely affect species groups.

Species Group	Riparian Areas (above bankfull)	Perennial Channel Instream (below bankfull)
Fish	2,4-D amine, glyphosate, picloram, triclopyr	glyphosate
Aquatic Invertebrates	---	---
Algae	chlorsulfuron	glyphosate
Aquatic Macrophytes	2,4-D amine, chlorsulfuron, metsulfuron	glyphosate

Significant adverse effects to listed fish are likely to result from 2,4-D amine, glyphosate, picloram, and triclopyr application in riparian areas. Significant adverse effects to listed fish from brief exposures to low (*i.e.* single digit) HQ exceedences are reasonably likely to occur – for example, increased respiration, reduced feeding success, and subtle behavioral changes that can result in predation. When treatments occur that utilize two or more herbicides in close proximity, exposures to mixtures may occur.

Exposures to expected maximum concentrations of the other herbicides in the activity category are not likely to result in adverse effects to listed fish. However, simultaneous exposure to other herbicides may increase the level of adverse effects from 2,4-D amine, glyphosate, picloram, or triclopyr. Additional adverse effects are most likely to manifest as an additive, and not synergistic, response in fish. Dose addition is considered most appropriate for mixtures with components that affect the same endpoint by the same mode of action, and are believed to behave similarly with respect to uptake, metabolism, distribution, and elimination (Choudhury *et al*., 2000). The precise toxic mechanism(s) in fish are not clearly documented for the herbicides included in the activity category, but effects to the kidney and liver are typical endpoints in terrestrial wildlife. In addition, it is known that the proposed herbicides have bioconcentration factors that fall within a range that does not indicate bioconcentration risk, are relatively soluble, and their chemical structure indicates that they are likely to behave similarly in salmonids.[30] Thus, it is believed that the assumption of similar uptake, metabolism, distribution, and elimination is adequately met in fish for dose-addition analysis at low concentrations.

Adverse effects to algae and aquatic macrophytes are likely to result from herbicide application in both treatment categories, but not always from the same herbicides. Adverse effects to algae and aquatic macrophytes that translate to significant indirect adverse effects (via alteration in food supply, cover, *etc*.) to listed fish may not always result from brief exposures to herbicide exposures at lower (single digit) HQ levels.

Since the herbicides included in the activity category target four different plant metabolic pathways, additive and synergistic effects to aquatic macrophytes may occur when co-exposure to multiple herbicides results from treatments utilizing two or more herbicides in close proximity

[30] Syracuse Environmental Research Associates risk assessments are available at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Therefore, exposure of aquatic macrophytes to multiple herbicides may result in effects greater than predicted, but are still likely to be minor and localized.

Effects on Listed Species

The habitat improvement actions addressed by this programmatic Opinion will have long-term beneficial effects on three salmon and steelhead VSP parameters: abundance, productivity, and spatial structure. One activity subcategory, install and develop wildlife structures will have no effect on salmon and steelhead VSP. As improvements are realized, extinction risks caused by habitat impairment for all species addressed by this Opinion will decrease and the species' potential for recovery will improve. Habitat improvements will help protect existing genetic structure and diversity by reducing the likelihood of localized extinctions caused by habitat impairment.

Projects designed to improve habitat complexity will enable increases in population productivity and abundance wherever habitat complexity is a limiting factor. The BPA proposes to fund habitat improvement activities to directly add habitat elements and also propose actions that protect stream function and allow habitat elements to form naturally. Addition of habitat features such as LWD and boulders increases hiding cover, aids in the formation of pools, and helps to trap and retain spawning substrates. Vegetation planted in riparian areas often develops into over-hanging structure. Fencing stream reaches prevents streambank damage and allows undercut banks to develop. Overhead cover is important for rearing, migrating, and spawning salmonids (Bjornn and Reiser 1991). Fish that have cover available are less susceptible to predators and disturbance. Similarly, pools provide resting habitat and deep water areas where fish can escape avian predators. Pools also provide important over-wintering habitat and may be the only ice-free areas in high elevation streams. Increased retention of appropriately sized spawning gravel will increase the total amount of spawning habitat available to adult salmonids. Pools, LWD, and boulders also provide eddies and areas of slower water velocity. Juvenile salmonids use these areas as feeding stations because they have lower water velocities but are still close to swifter velocity waters that carry drifting food items such as aquatic insects. Fish can remain in the slower current areas to save energy and then dart out into faster areas to capture food items. The improvements to physical stream habitat resulting from the habitat improvement actions will increase the likelihood of survival of all salmonid life stages. Over time, small increases in survival can translate directly to much larger increases in juvenile abundance and overall smolt productivity.

Good water quality is essential to completion of all salmonid life stages (Bjornn and Reiser 1991, Spence *et al.* 1996). Salmon and steelhead require cool, clean, water with ample dissolved oxygen. Throughout Oregon, Washington, and Idaho, poor water quality is a major limiting factor for salmonids. The BPA proposes several habitat improvement actions designed to improve water quality. Planting riparian vegetation and excluding livestock by fencing will speed development of shade-producing vegetation thus reducing stream temperatures. Treatment of invasive weeds will allow for recolonization of riparian areas by shade-providing native plants. Funding agricultural practices that reduce the amount of sediment and pollutants reaching streams will improve water quality in streams. Addition of salmon carcasses will add important missing marine nutrients and increase productivity of oligotrophic systems. Salmonids

that reside in streams with suitable stream temperatures and low levels of chemical contaminants are less susceptible to disease, are more metabolically efficient, and generally have higher survival. Improvements in water quality will reduce environmental stressors that limit survival, abundance, and productivity of listed fish.

The BPA proposes some habitat improvement actions that will reconnect blocked habitat. Reconnection of side channel habitat increases the total amount of habitat available and provides important refuge habitat. The proposed wetland restoration reestablishes tidal influence and opens these important nursery areas to juvenile salmonids. Estuary areas are important transitional areas for all species of salmonids, but they are particularly for ocean-type Chinook salmon, such as SR Fall Chinook salmon, that spend a great deal of time in estuaries and do not make long ocean migrations (Groot and Margolis 1991). Although the reconnection of these habitat types at a small scale does not necessarily improve population spatial structure, it does make available additional habitat that can potentially increase population abundance and productivity.

Many of the proposed restoration actions are designed to decrease the amount of fine sediment entering streams. Salmonids need stream substrates relatively free of fine sediments to successfully complete spawning and incubation (Bjornn and Reiser 1991, Waters 1995, Spence *et al.* 1996). Juvenile salmonids also benefit greatly from low fine sediment levels in substrates (Suttle *et al*. 2004). Invertebrates that provide prey for rearing salmonids also require stream substrates with low (less than 30%) fine sediment levels (Waters 1995). Stabilizing eroding streambanks with bioengineering methods decreases inputs of fine sediments. Planting riparian vegetation decreases areas of bare soil and provides a sediment filtering buffer.

Decommissioning roads and maintaining roads in good condition will decrease delivery of fine sediment to streams, as roads in close proximity to streams can convey large amounts of fine sediments. (Furniss *et al.* 1991). As fine sediment decreases in spawning areas, more substrates become suitable for spawning and egg incubation success rates will increase. Rearing juvenile salmonids will have additional interstitial hiding spaces available and greater amounts of prey. These improvements will reduce impediments limiting reproductive success and juvenile survival, abundance, and productivity.

Increases in population distributions from improved fish passage and restored access to previously blocked streams are likely to maintain or improve existing population spatial structure. Activity subcategories that improve fish passage include culvert replacement and removal of unneeded irrigation diversions. Improvements in population productivity and abundance typically follow restoration of fish passage if the habitat made available is in good condition. Fish populations that are well distributed spatially are at a lower risk from stochastic events. In addition to improved spatial structure, the additional available spawning and rearing habitat may produce a larger number of juveniles.

Most adverse effects resulting from the proposed restoration activities are expected to be minor and of short duration (weeks to two years). Degraded water quality and increased turbidity resulting from instream construction will last a maximum of a few weeks. Riparian disturbance

and disturbed soils resulting from accessing work sites will stabilize and begin to revegetate in 1 year.

Fish relocation will result in stress and possible mortality for a small number of fish. The stress of relocation will last only a few hours and will only happen once. Based on information provided by the BPA regarding fish relocation in the past, the anticipated number of juvenile fish to be affected by relocation each year (5,000) is far too small to affect abundance or productivity of any effected populations except SR sockeye. This is because fish relocation will occur across various populations at different times and each population is composed of tens of thousands if not hundreds of thousands of juvenile fish. In the cases of SR sockeye, these fish are not expected to be encountered during fish relocation because there are so few individuals, there range is very limited, and instream work is not scheduled for times when they may be present in the smaller streams they migrate through such as Red Fish Lake Creek and the upper Salmon River.

Adverse effects on individual fish will result from glyphosate applications and possibly from other herbicides where potentially adverse sublethal effects have not been studied. Adverse effects such as increased respiration, reduced feeding success, and subtle behavioral changes that can increase predation risk to listed fish will occur. Other effects from herbicide treatments on listed fish are primarily indirect in the form of reduced algae production and reduced invertebrate production. Due to the proposed design criteria and minimization measures for herbicide treatments, fish exposure to appreciable herbicide contamination will be very infrequent and limited to small areas as explained previously. No observable effect on population abundance or productivity will occur.

All the populations of salmon and steelhead addressed by this Opinion are at abundance levels far below historic and are listed as threatened or endangered. The short-term adverse effects resulting from the proposed restoration actions will not affect enough fish to have a measurable effect on population productivity and abundance. This is because the populations composing these species are distributed over a large area and any given project will affect only a very small number of individuals. The BPA has proposed a suite of minimization measures to reduce the potential adverse effects of the proposed activity categories. Only one species covered by this Opinion, SR sockeye salmon, is at critically low levels. In Oregon and Washington, SR sockeye are only found migrating through the mainstem Columbia and Snake rivers. None of the proposed activities will affect this species while they are present in these large riverine systems. In Idaho, this species is found in the mainstem Salmon River, and in several lakes and their tributaries in the Stanley Basin. The BPA will not authorize any projects involving in-water or near-water construction that will affect this species during migration periods, so no direct effects or take will occur.

Effects on Critical Habitat

The critical habitat analysis begins with a summary of the effects of the proposed habitat improvement activities on critical habitat PCEs. An evaluation of how changes in PCEs affect conservation value at the watershed scale and then the species-wide scale follows.

Freshwater spawning sites

Water quantity: The proposed activities will not reduce water quantity with the exception of construction actions that require work area isolation. In these cases, water quantity in a very small area, typically a maximum of several thousand square feet, may be reduced for a period of hours or days.

Water quality: Short-term adverse effects to water quality will occur when near-water or in-water construction occurs. Increased turbidity and increased levels of chemical contaminants resulting from construction will last for a few hours to a maximum of a few weeks. Minor inputs of chemical herbicides as described earlier will degrade water quality for a period of hours to days.

In the long term, the proposed restoration activities are designed to improve water quality. Planting riparian areas creates shade and thus reduces summer stream temperatures. Projects designed to reduce streambank erosion and inputs of fine sediments from unneeded roads will decrease turbidity.

Substrate: Fine sediments mobilized by construction activities will settle out in downstream substrates resulting in a minor increase in substrate embededdness. Over the long term, many of the habitat improvement activities are designed to reduce inputs of fine sediment. The proposed road activities, fencing, and streambank stabilization will reduce chronic input of fine sediments.

Freshwater rearing sites

Water quantity: Water quantity will be affected as described above.

Floodplain connectivity: No adverse effects to floodplain connectivity will occur, but long-term beneficial effects are expected from several activities including floodplain overburden removal, and reconnection of existing side channels and alcoves. These actions will restore interaction between the stream and its floodplain, raising the water table and improving general riparian function.

Water quality: Water quality will be affected as described above.

Forage: Minor reductions in invertebrate forage will occur as a result of increased fine sediment generated by construction activities. This will affect to a few hundred feet below construction sites, and these areas will be recolonized by invertebrates within a few months. Short-term reductions in algae and macroinvertebrates will occur as described in the analysis of herbicide effects.

In the long term, all of the restoration activities that improve riparian function reduce inputs of fine sediments, and help to encourage establishment of healthy riparian plant community. Food available to juveniles may increase from nutrient enrichment, and the relative abundance of aquatic invertebrates may change locally in response to physical changes in habitat. Where habitat complexity is increased, juveniles are likely to benefit from a wider array of prey species and improved efficiency while foraging.

Natural cover: Riparian disturbance caused by construction activities may result in some minor reduction of overhead cover at project sites. In the long term, many of the activities such as large wood and boulder placement, riparian fencing, streambank stabilization, and riparian planting will improve cover for salmon and steelhead.

Freshwater migration corridors

Free passage: Construction activities may temporarily impede or block fish passage for a maximum of a few days. Proposed culvert replacement, tide gate removal, and removal of irrigation diversions will all improve fish passage once the actions are completed.

Water quantity: Water quantity will be affected as described above.

Water quality: Water quality will be affected as described above.

Natural cover: Natural cover will be affected as described above.

Estuarine areas

Free passage: Construction activities in estuarine areas may temporarily impede fish passage for a maximum of a few days. Removal of tide gates will improve fish passage, allowing access to previously blocked estuary areas.

Water quality: The proposed wetland restoration projects will improve water quality, primarily by reconnecting the estuary to tidal waters.

Water quantity: The proposed estuary restoration actions will not affect water quantity, other than by reestablishing tidal influence.

Salinity: The proposed removal of tide gates will reestablish tidal influence and allow periodic inundations of saltwater. This will restore natural salinity levels to estuary areas.

Natural cover: The restoration of tidal influence and natural plant communities will provide more cover for salmon and steelhead when they are present in estuaries.

Juvenile forage: Juvenile salmon and steelhead feed primarily on small to mid-sized invertebrates while in estuaries (Groot and Margolis 1991). Estuary restoration projects that restore natural vegetation and tidal influence will increase the amount of forage available for juvenile salmonids.

Adult forage: Adult salmon and steelhead feed on small fish and invertebrates in estuary areas (Groot and Margolis 1991). Reestablishment of natural vegetation, tidal influence, and estuary function improves habitat for salmon, steelhead, and their forage species. The proposed wetland restoration will increase the amount of forage available for adult salmon and steelhead.

Effect of the restoration actions on the conservation value of critical habitat at the watershed and species-wide scales

In the area covered by this consultation, there are thousands of streams designated as critical habitat for one or more listed salmonids, and the majority of HIP activities will occur in streams designated as critical habitat. Most of the streams designated as critical habitat were rated[31] as having high or medium conservation value, based largely on the VSP framework. The conservation value is not synonymous with high habitat quality. A degraded stream that marginally provides all PCEs might have a high conservation value in situations where it plays a role that is crucial for maintaining connectivity, genetic diversity, productivity, or any other characteristic of viable populations.

When any of the proposed habitat improvement actions occur in designated critical habitat, they will have long-term beneficial effects to critical habitat PCEs at the project scale or more, and some actions, such as barrier removal, may have beneficial effects at the watershed scale. Adverse effects to PCEs are expected to be minor effects that occur only at the project scale and persist only for a short time (typically a few weeks or less). The BPA proposes a suite of minimization measures that will be effective in limiting the duration and scale of the short-term adverse effects of the proposed activities. None of the anticipated short-term adverse effects will reach a magnitude such that the conservation value of critical habitat will be impaired. In each and every instance where habitat improvement actions are carried out, the actions have a long-term positive effect on the conservation value of critical habitat.

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). Cumulative effects that reduce the ability of a listed species to meet its biological requirements may increase the likelihood that the proposed action will result in jeopardy to that listed species or in destruction or adverse modification of a designated critical habitat.

Between 2000 and 2006, the population of Oregon[32] grew from 3,421,399 to 3,700,758 an increase of approximately 8.2%, the population of Washington[33] grew from 5,894,121 to 6,395,798, an increase of approximately 8.5%, and the population of Idaho[34] grew from 1,293,953 to 1,466,465, and increase of approximately 13.3% . These states are projected to grow at similar rates for the next 5 years. Thus, NMFS assumes that future private and state actions will continue within the action areas, increasing as population density rises.

The most common activities reasonably certian to occur in the action areas addressed by this consultation are agricultural activities, operation of non-Federal hydropower facilities, urban and

[31] See CHART report at: http://www.nwr.noaa.gov/Salmon-Habitat/Critical-Habitat/2005-Biological-Teams-Report.cfm
[32] Information available at: http://quickfacts.census.gov/qfd/states/41000.html
[33] Information available at: http://quickfacts.census.gov/qfd/states/53000.html
[34] Information available at: http://quickfacts.census.gov/qfd/states/16000.html

suburban development, recreational activities, timber harvest, road construction and maintenance, and metals and gravel mining. Many of these activites are not subject to ESA consultation and would result in some adverse effects to salmon, steelhead, and their habitat. Some of the acitivities such as timber harvest and devleopment are subject to regulation under state programs and the effects to fish and stream habitat are reduced to varying degrees under these programs. The adverse effects of these activities will result in negative effect on salmon and steelhead population abundance, productivity, and spatial structure and result in some degredation of the condition of critical habitat PCEs.

Throughout Oregon, Washington, and Idaho, watershed councils, Native American Tribes, local municiplaties, conservation groups, and others carry out resotration projects in support of salmon and steelhead recovery. Many of these actions will be covered by this consultation, or future individual consultations, in which cases their effects are not cumulative effects. Some of the private or state funded actions for which funding commitments and necessary approvals already exist will not undergo consultation and do result in beneficial cumulative effects. They address protection and/or restoration of existing or degraded fish habitat, instream flows, water quality, fish passage and access, and watershed or floodplain conditions that affect stream habitat. These beneficial effects will be similar to those described in the *Effects on Listed Species* section of this Opinion. These effects will result in small improvements to salmon and steelhead population abundance, productivity, and spatial structure and result in some improvement to the condition of critical habitat PCEs.

When considered together, these cumulative effects are likely to have a small negative effect on salmon and steelhead population abundance, productivity, and spatial structure. Similarly, the condition of critical habitat PCEs will be slightly degraded by the cumulative effects.

Conclusion

After reviewing the status of the listed salmon and steelhead addressed by this Opinion, the status of their designated critical habitats, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, NMFS concludes that the program, as proposed, is not likely to jeopardize the continued existence of these species, nor is it likely to destroy or adversely modify their designated critical habitat. These conclusions are based on the following considerations.

All of the actions addressed by this consultation are intended to improve the condition of degraded aquatic habitats or protect high quality habitat. Some minor, short-term negative effects will occur as a result of implementing these actions, but the long-term conservation value of critical habitat will be enhanced. The minimization measures and design criteria proposed by the BPA ensure that these effects remain minor and are scheduled to occur at times that are least sensitive to salmon and steelhead life cycles.

SR sockeye salmon are at critically low abundance levels, but no take or direct effects will occur for this species. The other listed species, although currently well below historic levels, are distributed widely enough and are presently at high enough abundance levels that any short-term adverse effects resulting from the habitat improvement actions will not have an observable effect

on population abundance or productivity. Long-term beneficial effects from improving habitat conditions will result in increased population productivity and abundance. Spatial structure of salmon and steelhead populations will improve as a result of the proposed restoration actions; most notably due to improved fish passage.

The condition of critical habitat throughout Oregon, Washington, and Idaho varies greatly. Implementation of the proposed actions will cause some minor short-term adverse effects to critical habitat PCEs. These effects will last for a few days to a few years at most. The long-term beneficial effects of the restorative actions will persist for decades or longer. The conservation value of critical habitat will increase as a result of the actions implemented under this Opinion.

Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. The following recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the BPA:

> NMFS, along with co-managers, partner agencies, and local groups, is currently developing recovery plans for ESA-listed salmon and steelhead in Oregon, Washington, and Idaho. Some of these plans are currently available at: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Index.cfm. NMFS strongly encourages the BPA to use the recovery plans and related recovery implementation plans and priorities as a primary consideration when planning, funding, and implementing habitat improvement projects.

Please notify NMFS if the BPA carries out this recommendation so that we will be kept informed of actions that minimize or avoid adverse effects and those that benefit listed species or their designated critical habitats.

Reinitiation of Consultation

Reinitiation of formal consultation is required and shall be requested by the Federal agency or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that has an effect to the listed species or designated critical habitat that was not considered in the biological opinion; or (d) if a new species is listed or critical habitat is designated that may be affected by the identified action (50 CFR 402.16). This programmatic consultation expires on December 31, 2012. New projects should not be implemented under this consultation after this date. To reinitiate consultation, contact the Oregon State Habitat Office of NMFS and refer to the NMFS Number assigned to this consultation.

Incidental Take Statement

Section 9(a)(1) of the ESA prohibits the taking of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) extend the prohibition to threatened species. Among other things, an action that wounds or kills an individual of a listed species or modifies its habitat in a way that significantly impairs essential behavioral patterns, is a taking (50 CFR 222.102). Incidental take refers to 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(o)(2) exempts any taking that meets the terms and conditions of a written incidental take statement from the taking prohibition.

Amount or Extent of Take

The proposed habitat improvement activities will occur beside and within streams and estuaries occupied by LCR Chinook salmon, UCR spring-run Chinook salmon, SR fall-run Chinook salmon, SR spring/summer run Chinook Salmon, UWR Chinook salmon, CR chum salmon, SR sockeye salmon, LCR coho salmon, LCR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, and UWR steelhead. Due to the short-term adverse effects of implementing restoration activities, incidental take is reasonably certain to occur. The degraded habitat that will be affected by the proposed habitat improvement actions will typically be of marginal quality and not limited at the site-specific or watershed scale. High quality habitat that will be protected by the proposed activities is less common and likely to play a key role in conservation of listed salmon and steelhead.

Incidental take caused by the adverse effects of the proposed actions will include the following:

1. Capture of listed juvenile salmonids during work area isolation, some of which will be injured or killed. The NMFS anticipates that each year, approximately 100 projects will be implemented under this consultation. At most, half of these projects will involve instream construction with work area isolation. Information provided by the BPA indicates that during a typical isolation and fish relocation, less than 10 salmonids will be captured. In some cases, as many as 100 fish have been encountered. The NMFS anticipates that each year a maximum of 5,000 listed salmon and steelhead will be captured during work area isolations. Because the juvenile salmonids that are likely to be captured, injured, or killed by work area isolation are from different listed species that are similar to each other in appearance and to unlisted species that occupy the same area, it is not possible to assign this take to individual species. The NMFS will, however, allocate this take across two principal recovery domain areas, as it is more practical to predict which fish will be present in these defined areas. In the Interior Columbia Basin, up to 4,000 juvenile salmonids may be taken during work area isolations each year, and up to 200 may die. In the Lower Columbia/Willamette recovery domain, up to 1,000 juvenile salmonids may be taken and up to 50 may die. Of the ESA-listed salmonids to be captured and handled in this way, 98% or more are expected to survive with no injury and no more than 2% are expected to be injured or killed, including delayed mortality. Nonetheless, the more expansive estimate of 5% lethal take will be used here to allow for variations in experience and work conditions. The NMFS does not anticipate that any

adult fish will be taken. SR sockeye salmon are present in the mainstem Snake and Columbia rivers in Oregon and Washington. Their migration in Idaho takes them up the Salmon River, and into the lakes of the Stanley Basin or the hatchery facility located at Redfish Lake. In-water work and work areas isolation will not occur in these migration corridors when SR sockeye are present. No incidental take is anticipated or exempted for SR sockeye.

2. Near-stream and instream construction activities required for some activities categories will result in an increase in turbidity and other pollutants that will cause juvenile fish to move away from the action area. Salmonids exposed to turbidity may experience gill abrasion, decreased feeding, stress, or be unable to use the action area, depending on the severity of the turbidity. Salmonids exposed to petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, may be killed or suffer acute and chronic sublethal effects. Construction activities will also cause a minor increase in fine sediment levels in downstream substrates, temporarily reducing the value of that habitat for spawning and rearing. Operation of heavy equipment will destroy riparian vegetation and damage streambanks, temporarily reducing cover for juvenile and adult salmonids. Take will occur at the project site and as much as 500 feet downstream. Incidental take, other than fish capture, caused by implementing these activity categories cannot be accurately quantified as a number of fish. This is because the future abundance and distribution of listed fish, in relation to the habitat effects of the actions, is indeterminate and so a specific number of individuals taken cannot be predicted. For projects employing activity categories involving near- and in-water construction, the extent of take is best identified as the maximum extent of the turbidity plume generated by construction activities, and by the maximum number of projects covered by this Opinion. For each project, the BPA shall reinitiate consultation if the turbidity plume generated by construction activities is visible above background levels 500 feet downstream from the project area. The BPA shall reinitiate consultation if more than 90 projects including near and in-water construction are covered under this programmatic consultation in any given calendar year.

3. In some cases, activities not involving in-water or near-water construction will cause harm or harassment of listed salmonid juveniles and adults. Take resulting from these activities categories will occur primarily as harassment or as harm caused by increased delivery of fine sediments to streams and human activities in or around streams. For instance, surveys funded by the BPA will disturb fish, causing them to leave areas with overhead cover and become more susceptible to predation. Unlike take resulting from activities involving in-water construction, take resulting from these activity categories will occur more sporadically, and over a larger area. The total amount of incidental take resulting from these non-construction activities will be much less than the amount of take occurring from in-water and near-water construction. Incidental take, caused by non-construction activity categories cannot be accurately quantified as a number of fish. This is because the future abundance and distribution of listed fish, in relation to the effects of the actions, is indeterminate and so a specific number of individuals taken cannot be predicted. For these activity categories, the extent of take is best identified by the total number of projects implemented in each year. The BPA shall reinitiate consultation if

more 50 projects not involving in-water or near-water construction are covered under this programmatic consultation in a given calendar year.

4. Application of chemical herbicides will result in short-term degradation of water quality which will cause injury to fish in the form of sublethal adverse physiological effects. This is particularly true for herbicide applications in riparian areas or in ditches that may deliver herbicides to streams occupied by listed salmonids. These sublethal effects, described fully in the effects analysis for this Opinion, will include increased respiration, reduced feeding success, and subtle behavioral changes that can result in predation. As with the take pathways described above, the future abundance and distribution of listed fish, in relation to the effects of the herbicide application, is indeterminate and so a specific number of individuals taken cannot be predicted. For herbicide application, the extent of take is best identified by the total number of riparian acres treated each year (riparian buffer is defined by footnote 7 on page 11 of this Opinion). The BPA shall reinitiate consultation if more than 2,500 total riparian acres are treated in a calendar year under this programmatic consultation.

For projects involving incidental take resulting from multiple pathways described above, the BPA will account for each take pathway for the purpose of tracking the amount and extent of take. For instance, if a proposed project to be authorized by this Opinion, involves both inwater construction and application of chemical herbicides in the riparian buffer zone, that action shall be counted toward the amount and extent of take in both take pathway categories as described above. NMFS recognizes that additional habitat improvement projects, beyond the number authorized by this incidental take statement, may be beneficial to the conservation of listed salmon and steelhead. However, these actions will require individual consultations

Reasonable and Prudent Measures

Reasonable and prudent measures are nondiscretionary measures to avoid or minimize take that must be carried out by cooperators for the exemption in section 7(o)(2) to apply. The BPA has the continuing duty to regulate the activities covered in this incidental take statement where discretionary Federal involvement or control over the action has been retained or is authorized by law. The protective coverage of section 7(o)(2) will lapse if the BPA fails to exercise their discretion to require adherence to terms and conditions of the incidental take statement, or to exercise that discretion as necessary to retain the oversight to ensure compliance with these terms and conditions.

The NMFS believes that full application of minimization measures included as part of the proposed action, together with use of the reasonable and prudent measures and terms and conditions described below, are necessary and appropriate to minimize the impact of incidental take of listed species due to the performance of the proposed program.

The BPA shall implement the following reasonable and prudent measures:

1. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for HIP II implementation process.
2. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for surveying, operation, and maintenance activities.
3. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for surveying stream channel, floodplains, and uplands, and installing monitoring devices.
4. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for protecting streambanks using bioengineering methods.
5. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for installation of habitat forming natural materials.
6. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for improvement of secondary channel habitat.
7. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for creation, rehabilitation, and enhancement, of riparian and wetland habitat.
8. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for improvement of fish passage.
9. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for supplementing in-channel nutrients.
10. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for construction of fences for livestock control.
11. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for installation of off-channel livestock watering facilities.
12. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for hardening fords for livestock crossing of streams.
13. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for conversion of irrigation to drip or sprinkler systems.
14. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for conversion of irrigation water conveyance from open ditch to pipeline or line leaking ditches and canals.

15. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for conversion of instream diversions to groundwater wells for primary water source.
16. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for installation of new fish screens or the upgrading or maintenance of existing fish screens.
17. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for consolidation of irrigation diversions or replacement of existing irrigation diversions with pump stations or removal of un-needed diversions.
18. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for installation or replacement of return flow cooling systems.
19. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for installation of irrigation water siphon beneath a waterway.
20. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for management of vegetation using physical controls.
21. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for management of vegetation using herbicides.
22. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for maintaining roads.
23. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for maintaining, removing, or replacing bridges, culverts, and fords.
24. The BPA shall minimize incidental take of listed anadromous salmonids by implementing proposed minimization measures and terms and conditions for decommissioning roads.
25. The BPA shall complete a monitoring and reporting program to confirm that the Terms and Conditions in this Incidental Take Statement are effective in avoiding and minimizing incidental take from permitted activities.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the BPA and their cooperators, must fully comply with minimization measures described as part of the proposed action and the following terms and conditions that implement the reasonable and prudent measures described above. Partial compliance with these terms and conditions may invalidate this take exemption. The BPA has requested that all mandatory minimization measures for each activity category be reiterated in the Terms and Conditions below so project planners can locate all of the conservation requirements in a single location. The following terms and conditions include the proposed minimization measures and any additional measures appropriate to reduce the impact of incidental take on listed species.

1. To implement reasonable and prudent measure #1 (implementation process), the BPA shall ensure that all of the following conditions are met: (A) Follow all steps listed in the *Implementation Process* section of this Opinion; (B) confirm that each project funded under this Opinion is within the present or historic range of an ESA-listed salmon or steelhead (fish), or designated critical habitat; (C) individually review and approve each project to ensure that all adverse effects to fish and their designated critical habitats are within the range of effects considered in this Opinion; (D) include each applicable minimization measure as necessary to minimize the impact of incidental take described in the amount or extent of take section as an enforceable condition of every contract issued under this Opinion; and (E) retain the right of reasonable access to projects authorized using this Opinion to monitor the use and effectiveness permit conditions.

2. To implement reasonable and prudent measure #2 (surveying, operation, and maintenance activities), the BPA shall ensure that minimization measures 1-20 are followed.

3. To implement reasonable and prudent measure #3 (surveying stream channel, floodplains, and uplands, and installing monitoring devices), the BPA shall ensure that minimization measures 21-29 are followed.

4. To implement reasonable and prudent measure #4 (protecting streambanks using bioengineering methods) the BPA shall ensure that minimization measure 30 is followed.

5. To implement reasonable and prudent measure #5 (installation of habitat forming natural materials) the BPA shall ensure that: (A) Minimization measure 31 is followed; (B) boulders shall be installed in gravel/cobble bed streams and shall not be installed in sand bed streams; (C) boulders shall be machine placed, no end dumping is allowed; (D) projects that propose use of rock shall occur only in channels with well vegetated riparian areas or be conducted in conjunction with vegetation restoration or management (E) individual boulder clusters may not exceed 25% of the channel bankfull width; (F) no standing dead or living trees shall be taken from within the bankfull stream width or within 50 feet of the bankfull stream width for use as LWD; (G) gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible, gravel of the same lithology as found in the watershed will be used.

6. To implement reasonable and prudent measure #6 (improvement of secondary channel habitat) the BPA shall ensure that: (A) Minimization measures 32-33 are followed; (B) for removal of sediment bars or terraces, no more than 25 cy of sediment may be removed from within 50 feet of the mouth of the stream; and (C) A site assessment will be carried out to ensure that no contaminants are present. The assessment should include a review of the readily available records of prior contamination events; a site visit to observe various industrial processes and condition of the property; interviews with knowledgeable people, such as, site owners, operators, occupants, neighbors, and local government officials; a report that includes an a assessment of the likelihood that contaminants are present at the site.

7. To implement reasonable and prudent measure #7 (creation, rehabilitation, and enhancement, of riparian and wetland habitat) the BPA shall ensure that: (A) minimization measure 34 is followed; and (B) A site assessment will be carried out to ensure that no contaminants are present. The assessment should include a review of the readily available records of prior contamination events; a site visit to observe various industrial processes and condition of the property; interviews with knowledgeable people, such as, site owners, operators, occupants, neighbors, and local government officials; a report that includes an a assessment of the likelihood that contaminants are present at the site.

8. To implement reasonable and prudent measure #8 (improvement of fish passage) the BPA shall ensure that minimization measures 35-37 are followed.

9. To implement reasonable and prudent measure #9 (supplementing in-channel nutrients) the BPA shall ensure that (A) minimization measures 38-42 are followed; (B) applicable processes will be followed to ensure that placed carcasses are pathogen-free; and (C) no carcasses will be placed in or upstream of streams listed under the Clean Water Act section 303(d) list for excess nutrients.

10. To implement reasonable and prudent measure #10 (construction of fences for grazing control) the BPA shall ensure that minimization measure 43 is followed.

11. To implement reasonable and prudent measure #11 (installation of off-channel water facilities) the BPA shall ensure that minimization measures 44-47 are followed.

12. To implement reasonable and prudent measure #12 (hardening fords for livestock crossing of streams) the BPA shall ensure that minimization measure 48-55 are followed.

13. To implement reasonable and prudent measure #13 (conversion of water delivery systems to drip or sprinkler irrigation) the BPA shall ensure that any in-water or near-water work required to remove unneeded irrigation infrastructure will follow applicable portions of Term and Condition #2.

14. To implement reasonable and prudent measure #14 (conversion of water conveyance from open ditch to pipeline or line leaking ditches and canals) the BPA shall ensure any in-water or near-water work required to remove unneeded irrigation infrastructure will follow applicable portions of Term and Condition #2.

15. To implement reasonable and prudent measure #15 (conversion of instream diversions to groundwater wells for primary water source) the BPA shall ensure that minimization measures 56 is followed.

16. To implement reasonable and prudent measure #16 (installation of new fish screens or the upgrading or maintenance of existing fish screens) the BPA shall ensure that minimization measures 57-61 are followed.

17. To implement reasonable and prudent measure #17 (consolidation of irrigation diversions or replacement of existing irrigation diversions with pump stations or removal of un-needed diversions) the BPA shall ensure that minimization measures 62-66 are followed.

18. To implement reasonable and prudent measure #18 (installation or replacement of return flow cooling systems) the BPA shall ensure that any in-water or near-water work required to complete this activity category will follow applicable portions of Term and Condition #2.

19. To implement reasonable and prudent measure #19 (installation of irrigation water siphon beneath a waterway) the BPA shall ensure that minimization measures 67-74 are followed.

20. To implement reasonable and prudent measure #20 (management of vegetation using physical controls) the BPA shall ensure that minimization measures 75-78 are followed.

21. To implement reasonable and prudent measure #21 (management of vegetation using herbicides) the BPA shall ensure minimization measures 79-87 are followed.

22. To implement reasonable and prudent measure #22 (maintaining roads) the BPA shall ensure that minimization measures 105-121 are followed.

23. To implement reasonable and prudent measure #23 (maintaining, removing, or replacing bridges, culverts, and fords) the BPA shall ensure that minimization measures 88-104 are followed.

24. To implement reasonable and prudent measure #24 (decommissioning roads) the BPA shall ensure that 105-121.

25. To implement reasonable and prudent measure #25 (monitoring and reporting) the BPA shall: (A) Use the NMFS Public Consultation Tracking System- Consultation Initiation and Reporting System (CIRS) (http://www.nmfs.noaa.gov/pcts) when this online system becomes available and BPA have been trained to use it; (B) prior to the CIRS becoming available, the BPA shall continue to provide project notification and completion reports using the monitoring forms in Appendix A of the BA; (C) prior to the launch of the CIRS system, the BPA shall track implementation of this programmatic consultation at a regional level to ensure that the amount and extent of take identified in *Amount and Extent of Take* section is not exceeded; and (D) the BPA will ensure that for individual projects involving instream and near-water construction, the extent of take (turbidity is not visible above background levels more than 500 feet downstream of the project site) is not exceeded.

NOTICE. If a sick, injured or dead specimen of a threatened or endangered species is found in a project area, the finder must notify NMFS through the contact person identified in the transmittal letter for this Opinion, or through NMFS Office of Law Enforcement at 1-800-853-1964, and follow any instructions. If the proposed action may worsen the fish's

condition before NMFS can be contacted, the finder should attempt to move the fish to a suitable location near the capture site while keeping the fish in the water and reducing its stress as much as possible. Do not disturb the fish after it has been moved. If the fish is dead or dies while being captured or moved, report the following information: (1) NMFS consultation number (found on the top left of the transmittal letter for this Opinion), (2) the date, time, and location of discovery, (3) a brief description of circumstances and any information that may be relevant to the cause of death, and (4) photographs of the fish and where it was found. NMFS also suggests that the finder coordinate with local biologists to recover any tags or other relevant research information. If the specimen is not needed by local biologists for tag recovery or by NMFS for analysis, the specimen should be returned to the water in which it was found, or otherwise discarded.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions, or proposed actions that may adversely affect EFH. Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Section 305(b) also requires NMFS to recommend measures that may be taken by the action agency to conserve EFH.

The Pacific Fishery Management Council (PFMC) designated EFH for Pacific groundfish (PFMC 1998a), coastal pelagic species (PFMC 1998b), and Pacific salmon (PFMC 1999). The proposed action and covered area are detailed above in the Introduction Section of this document. The BPA is the action agency for the proposed Program for Fish Habitat Improvement Activities in Oregon, Washington, and Idaho. The covered area includes habitats designated as EFH for various life-history stages of Pacific salmon, groundfish, and coastal pelagic species (Table 15). In addition, the covered activities will occur in, or adjacent to, habitats designated as Habitat Areas of Special Concern (HAPC) for Pacific groundfish (PFMC 2005). These HAPCs include estuaries, canopy kelp, seagrasses, rocky reefs, and the coastal waters and substrates of the States of Oregon and Washington from the mean higher high water line seaward to the three nautical mile boundary of the territorial sea.

Based on information provided in the Biological Assessment and the analysis of effects presented in the Effects of the Action section of this document, the proposed program may result in adverse impacts to a variety of habitat parameters important to salmonids. Because the minimization measures included as part of the proposed program to address ESA concerns are adequate to avoid, minimize, or otherwise offset potential adverse effects to the EFH of groundfish and coastal pelagic species in Table 17 no adverse impacts to EFH or HAPCs of those species are anticipated.

The Biological Assessment clearly identifies anticipated impacts to the EFH for Pacific salmon that are likely to result from the proposed activities and the measures that are necessary and

appropriate to minimize those impacts. These effects include delivery of sediments to streams through in-water and near-water construction activities associated with many of the practices.

NMFS determined that the action will have adverse effects on EFH for Chinook salmon and coho salmon as follows:

1. Short-term degradation of water quality (turbidity) from in-water and near-water construction.
2. Short-term degradation of instream habitat elements such as cover resulting from riparian disturbance caused by in-water and near water construction.
3. Short-term increases in stream substrate embeddedness due to the delivery of fine sediments to streams from various proposed activites such as road maintenance and culvert and bridge replacement.

4. Short-term reduction in salmon food sources as a result of herbicide treatments to control invasive plant species.

All of these effects influence the ability of affected areas to support salmonid spawning, incubation, larval development, juvenile growth and mobility, and adult mobility. For a more detailed description and analysis of these effects, see Effects of the Action section of this document.

EFH Conservation Recommendations

The minimization measures included in the Biological Assessment as part of the proposed activities are adequate to avoid, minimize, or otherwise offset the potential adverse effects, described above, from these activities to designated EFH for Chinook salmon and coho salmon. NMFS understands that the BPA intends to implement these minimization measures to minimize potential adverse effects to the maximum extent practicable.

NMFS recommends that in order to track implementation of restoration actions that occur in EFH, the BPA implement the following conservation recommendations:

1. The BPA should use the NMFS Public Consultation Tracking System- Consultation Initiation and Reporting System (CIRS) (http://www.nmfs.noaa.gov/pcts) when this system becomes available and the BPA staff have been trained to use it.
2. The BPA should implement Reasonable and Prudent Measures 1–25 of the Incidental Take Statement portion of this document. The EFH conservation recommendations do not include minimization measures designed to reduce effects during fish handling.

Statutory Response Requirement

Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations [50 CFR 600.920(j)(1)]. The response must include a description of measures proposed to avoid, mitigate, or offset the

adverse effects of the activity on EFH. If the response is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations.

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

Supplemental Consultation

The BPA must reinitiate EFH consultation 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(k)]. This consultation expires at the end of calendar year 2012.

Table 15. Species of fishes with designated EFH occurring in Washington and Oregon.

Groundfish Species	redstripe rockfish *S. proriger*	Dover sole *Microstomus pacificus*
spiny dogfish *Squalus acanthias*	rosethorn rockfish *S. helvomaculatus*	English sole *Parophrys vetulus*
big skate *Raja binoculata*	rosy rockfish *S. rosaceus*	flathead sole *Hippoglossoides elassodon*
California skate *Raja inornata*	rougheye rockfish *S. aleutianus*	petrale sole *Eopsetta jordani*
longnose skate *Raja rhina*	sharpchin rockfish *S. zacentrus*	rex sole *Glyptocephalus zachirus*
Ratfish *Hydrolagus colliei*	splitnose rockfish *S. diploproa*	rock sole *Lepidopsetta bilineata*
Pacific cod *Gadus macrocephalus*	striptail rockfish *S. saxicola*	sand sole *Psettichthys melanostictus*
Pacific whiting (hake) *Merluccius productus*	tiger rockfish *S. nigrocinctus*	starry flounder *Platichthys stellatus*
black rockfish *Sebastes melanops*	vermilion rockfish *S. miniatus*	arrowtooth flounder *Atheresthes stomias*
Bocaccio *S. paucispinis*	yelloweye rockfish *S. ruberrimus*	
brown rockfish *S. auriculatus*	yellowtail rockfish *S. flavidus*	**Coastal Pelagic Species**
canary rockfish *S. pinniger*	shortspine thornyhead *Sebastolobus alascanus*	anchovy *Engraulis mordax*
China rockfish *S. nebulosus*	cabezon *Scorpaenichthys marmoratus*	Pacific sardine *Sardinops sagax*
copper rockfish *S. caurinus*	lingcod *Ophiodon elongatus*	Pacific mackerel *Scomber japonicus*
darkblotch rockfish *S. crameri*	kelp greenling *Hexagrammos decagrammus*	market squid *Loligo opalescens*
greenstriped rockfish *S. elongates*	sablefish *Anoplopoma fimbria*	**Pacific Salmon Species**
Pacific ocean perch *S. alutus*	Pacific sanddab *Citharichthys sordidus*	Chinook salmon *Oncorhynchus tshawytscha*
quillback rockfish *S. maliger*	butter sole *Isopsetta isolepis*	coho salmon *O. kisutch*
redbanded rockfish *S. babcocki*	curlfin sole *Pleuronichthys decurrens*	Puget Sound pink salmon *O. gorbuscha*

DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

Utility: Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users.

This ESA consultation concludes that the proposed programmatic actions will not jeopardize the affected listed species or adversely modify or destroy designated critical habitat. Therefore, the BPA can fund these actions in accordance with their authorities under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501). The intended users are the BPA and the various state, private, and tribal entities the BPA funds to carry out project.

Individual copies were provided to the BPA. This consultation will be posted on the NMFS Northwest Region website (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

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.

Objectivity:

Information Product Category: Natural Resource Plan.

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

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

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

LITERATURE CITED

Asbridge, G. 2004. Using large woody material to help restore stream channels and floodplains. Proceedings of the 16th International Conference, Society for Ecological Restoration. Victoria, British Columbia, Canada. August 24-26. 8 p.

Bedford, B.L. 1996. The need to define hydrologic equivalence at the landscape scale for freshwater mitigation. Ecological Applications 6(1):57-68.

Berg, L. (ed.). 2001. Yakima subbasin summary. Draft report (Available form the Northwest Power and Conservation Council, 851 SW Sixth Ave., Suite 1100, Portland OR 97204).

Berg, N. 2005. Assessment of Herbicide Best Management Practices: Status of Our Knowledge of BMP Effectiveness. Pacific Southwest Research Station, USDA Forest Service, Albany, CA.

Berman, C.H., and T.P. Quinn. 1991. Behavioural thermoregulation and homing by spring Chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), in the Yakima River. Journal of Fish Biology. 39:301–312.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperatures and aquatic habitat: fisheries and forest interactions. *Cited in* Streamside management: forestry and fishery interactions. E.O. Salo and T.W. Cundy, Editors., Univ. Washington, Institute of Forest Resources.

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

Bjornn, T.C., D. Craddock, and D. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, *Oncorhynchus nerka*. Transactions of the American Fisheries Society. 97:360- 373.

Bjorn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138, in W.R. Meehan (editor) Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. American Fisheries Society, Bethesda, Maryland.

Bolander, P. and A. Yamada. 1999. Dust palliative selection and application guide. USDA Forest Service, Technology and Development Program. 9977 1207-SDTDC. San Dimas Technology and Development Center, San Dimas, CA. 20p.

Bottom D. L., C. A. Simenstad, A. M. Baptista, D. A. Jay, J. Burke, K. K. Jones, E. Casillas and M. H. Schiewe. 2001. Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon, NOAA, NWFSC.

Busby, P., S. Grabowski, R. Iwamoto, C. Mahnken, G. Matthews, M. Schiewe, T. Wainwright, R. Waples, J. Williams, C. Wingert, and R. Reisenbichler. 1996. Review of the status of steelhead (*Oncorhynchus mykiss*) from Washington, Idaho, Oregon, and California under the U.S. Endangered Species Act.

Chapman, D.W. and K.L. Witty. 1993. Habitats of weak salmon stocks of the Snake River basin and feasible recovery measures: Recovery issues for threatened and endangered Snake River Salmon, Technical report 1 of 11. Report to Bonneville Power Administration. Contract Number DE-AM79-93BP99654. Portland, Oregon

Choudhury, H. Cogliano, J., Hertzberg, R., Mukerjee, D., Rice, G., and Teuschler, L. 2000. Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures. U.S. Environmental Protection Agency, Washington, DC 20460

Compton, J.E. and 10 coauthors. 2006. Ecological and water quality consequences of nutrient addition for salmon restoration in the Pacific Northwest. Frontiers in Ecology and the Enviroment 4(1): 18-26.

Cooney, T. 2004. Updated trend data sets for Interior Columbia basin ESUs. (October 14, 2004). Available at: http://www.salmonrecovery.gov/remand/analysis_reports/updated_interior_brt_trend_data.pdf.

Cryer, S.A., and P.L. Havens. 1999. Regional sensitivity analysis using a fractional factorial method for the USDA model GLEAMS. Environmental Modeling and Software. 14:613-624.

Durkin, P. 2001. Sethoxydim [Poast] – human health and ecological risk assessment final report. Syracuse Environmental Research Associates, Inc., Fayetteville, NY.

Durkin, P. 2003. Glyphosate – human health and ecological risk assessment final report. Syracuse Environmental Research Associates, Inc., Fayetteville, NY.

Durkin, P., and M. Follansbee. 2004. Imazapyr – human health and ecological risk assessment final report. Syracuse Environmental Research Associates, Inc., Fayetteville, NY.

Everest, F.H., and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile Chinook salmon and steelhead trout in two Idaho streams. Journal of fisheries research board of Canada. 29(1):91-100.

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

Fisher T. and R. Hinrichsen. 2004. Preliminary abundance-based trend results for Columbia basin salmon and steelhead ESUs. Report for J.Geiselman, Bonneville Power Administration, Portland, OR. October 25.

Frenkel, R.E. and J.C. Morlan. 1991. Can we restore our salt marshes? Lessons form the Salmon River, Oregon. Northwest Environmental Journal 7:119-135.

Foerster, R. E. 1968. The sockeye salmon. Bulletin of the Fisheries Research Board of Canada. No. 162. 422 p.

Forest Ecosystem Management and Assessment Team (FEMAT). 1993. Forest Ecosystem Management: An Ecological, and Social Assessment. July.

Fulton, L. A. 1968. Spawning areas and abundance of Chinook salmon, *Oncorhynchus tshawytscha*, in the Columbia River basin – past and present. U.S. Fish and Wildlife Service, Special Scientific Report, Fisheries 571:26.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. *In:* W.R. Meehan (editor) Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. American Fisheries Society, Bethesda, Maryland.

Garcia, A. P., S. Bradbury, B. D. Arnsberg, S. J. Rocklage, and P. A. Groves. 2005. Fall Chinook salmon spawning ground surveys in the Snake River basin upriver of Lower Granite Dam, 2004. Annual Report to Bonneville Power Administration, Project number 199801003, Contract 98-AI-37776, Portland, Oregon.

Good, R.P., R.S. Waples, and P.Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA tech. Memo. NMFS-NWFSC-66, 598 p.

Gregory, R.S., and C.D. Levings. 1998. Turbidity reduces predation on migrating juvenile pacific salmon. Transactions of the American Fisheries Society 127:275-285.

Gregory, S. L., Ashkenas, D. Oetter, P. Minear, and K. Wildman. 2002a. "Historical Willamette River channel change," pp. 18-26 in D. Hulse, S. Gregory, and J. Baker, eds. for the Pacific Northwest Ecosystem Research Consortium. *Willamette River Basin planning atlas: Trajectories of environmental and ecological change*. Corvallis, OR: Oregon State University Press.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, R. Wildman, P. Minear, S. Jett, and K. Wildman. 2002b. "Revetments," pp. 32-33 in D. Hulse, S. Gregory, and J. Baker, eds. for the Pacific Northwest Ecosystem Research Consortium. *Willamette River Basin planning atlas: Trajectories of environmental and ecological change*. Corvallis, OR: Oregon State University

Gregory, S., L. Ashkenas, P. Haggerty, D. Oetter, K. Wildman, D. Hulse, A. Branscomb, and J. VanSickle. 2002c. "Riparian vegetation," pp. 40-43 in D. Hulse, S. Gregory, and J. Baker, eds. for the Pacific Northwest Ecosystem Research Consortium. *Willamette River Basin planning atlas: Trajectories of environmental and ecological change*. Corvallis, OR: Oregon State University Press.

Groot, C., and L. Margolis. 1991. Pacific salmon life histories. UBC Press, Vancouver, British Columbia, Canada.

Hebdon, J.L., P. Kline, D. Taki, and T.A. Flagg. 2004. Evaluating reintroduction strategies for Redfish Lake sockeye salmon captive broodstock strategy. Pages 401-413 *in* M. J. Nickum, P.M. Mazik, J. G. Nickum, and D.D. MacKinlay, editors. Propogated fish in resource management. American Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.

Heffner, K. 1996. Water quality effects of three dust abatement compounds. U.S. Forest Service. Idaho Panhandle National Forest. May. 7p.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedell. 1991. Responses of salmonid to habitat change. p. 483-518 *In* W.R. Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Soc., Bethesda, Maryland. 751 p.

Interior Columbia Basin Technical Recovery Team (ICBTRT). 2003. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River domain (July 2003).

ICBTRT. 2005. Memorandum on updated population delineations in the Interior Columbia River Basin. (May 2005).

Johnson G. E., H. Diefenderfer, T. Berquam, B. D. Ebberts and J. D. Wilcox. 2003. Research, Monitoring, and Evaluation Plan for the Columbia River Estuary and Plume, Draft. The U.S. Army Corps of Engineers Prepared by Bonneville Power Administration, Portland District, and the Pacific Northwest National Laboratory.

Johnson, R. R., F. W. Fisher, and D. D. Weigand. 1992. Use of growth data to determine the spatial and temporal distribution of four runs of juvenile Chinook salmon in the Sacramento River, California. U.S. Fish and Wildlife Service, Red Bluff, California.

Keller, E.A., A. Macdonald, T. Tally, and N.J. Merrit. 1985. Effects of large organic debris on channel morphology and sediment storage in selected tributaries of Redwood Creek, Northwets California. Geomorphic processes and aquatic habitat in the Redwood Creek basin, Northwestern California, US Geological Survey 29: P1-P29.

Kostow, K. (editor). 1995. Biennial Report on the Status of Wild Fish in Oregon. OR. Dep. Fish Wildl. Rep., 217 p. + app. December 1995. (Available at: http://www.dfw.state.or.us/ODFWhtml/Research&Reports/WildFishRead.html)

Lassettre, N.S. and R.R. Harris. 2001. The geomorphic and ecological influence of large woody debris instreams and rivers. Unpublished report. Department of Landscape Architecture and Environmental Planning. University of California-Berkely. 68p.

Lee, D.C., JR. Sedell, B.E. Reiman, R.F. Thurow, and J.E. Williams. 1997. Broadscale assessment of aquatic species and habitats. P. 1058-1496 in: T.M. Quigley and S.J. Arbelbide, eds. An Assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins. U.S. Forest Service General Technical Report PNW-GTR-405. Portland, OR. http://www.icbemp.gov/science/scipubs.shtml

Leonard, S., G. Kinch, V. Elsbernd, M. Borman, and S. Swanson. 1997. Riparian area management. TR 1737 14. Grazing management for riparian wetland areas. USDI Bureau of Land Management and USDA Forest Service. 63 p.

Line, D.E., W.A. Harman, G.D. Jennings, E.J. Thompson, and D.L. Osmond. 2000. Nonpoint-source pollutant load reductions associated with livestock exclusion. Journal of Environmental Quality 29:1882-1890.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. Journal of fisheries research board of Canada. 27(7):1215-1224.

Lloyd, D.S., J.P. Koenings, and J.D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management 7:18-33.

Matthews, G.M., and R.S. Waples, 1991. Status review for SR spring and summer Chinook salmon. US. Department of Commerce, NOAA Technical Memo.

McElhany, P., M. Ruckleshaus, M. J. Ford, T. Wainwright, and E. Bjorkstedt. 2000. Viable salmon populations and the recovery of evolutionarily significant units. U. S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS-NWFSC-42. 156 p. http://www.nwfsc.noaa.gov/publications/techmemos/tm42/tm42.pdf

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 Years, 1935 to 1992. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-321. February.

Merz. J.E. and L.K.O. Chan. 2005. Effects of gravel augmentation on macroinvertebrate assemblages in a regulated California river. River Research Application 21: 61-74.

Millar, R.G. and M.C. Quick. 1998. Stable width and depth of gravel-bed rivers with cohesive banks. Journal of Hydraulic Engineering 124: 1005-1013.

Moyle, P.B. and J.A. Israel. 2005. Untested assumptions: Effectiveness of screening diversions for conservation of fish populations. Fisheries 30(5):20-29.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska- requirements for protection and restoration. NOAA Costal Ocean Program Decision. Analysis Series No. 7. October. 156 p.

Murphy, M.L. and W.R. Meehan. 1991. Stream Ecosystems. p. 17-46 *In* W.R. Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Soc., Bethesda, Maryland. 751 p.

Murota, T. 2003. The marine nutrient shadow: A global comparison of anadromous salmon fishery and guano occurrence. *In:* Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. American Fisheries Society Symposium 34, Bethesda, MD.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35, 443 p.

NMFS (National Marine Fisheries Service). 1995b and 1996. *Juvenile Fish Screen Criteria* (revised February 16, 1995) and *Addendum: Juvenile Fish Screen Criteria for Pump Intakes* (May 9, 1996) (guidelines and criteria for migrant fish passage facilities, and new pump intakes and existing inadequate pump intake screens), (http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/juv-screen-crit.pdf).

NMFS (National Marine Fisheries Service). 1996. Factors for decline: A supplement to the notice of determination for West Coast Steelhead under the Endangered Species Act. Protected Resources Division, Portland Oregon, 83p.

NMFS. 1998. Conclusions regarding the updated status of Puget Sound, Lower Columbia River, Upper Willamette River, and Upper Columbia River spring-run ESUs of West Coast Chinook Salmon. Memorandum to U. Varanasi (Northwest Fisheries Science Center, NMFS), W. Stelle (NWFSC, NMFS), and W. Hogarth (Southwest Fisheries Science Center, NMFS) from M. Schiewe (Northwest Fisheries Science Center, NMFS), 12 February 1999. 62 p.

NMFS. 1999. Status review update for chum salmon from Hood Canal summer-run and Columbia River ESUs. February. Available at: http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR1999-chum.pdf

NMFS. 2005a. Updates to the May 18, 2004, Salmonid Hatchery Inventory and Effects Evaluation report. Salmon Recovery Division. Portland, OR.

NMFS. 2006. 2006 Report to Congress Pacific Coastal Salmon Recovery Fund 2000-2004. NMFS, Northweat Region, Seattle, Washington. 46 p.

NMFS. 2007. Anadromous Salmonid Passage Facility Design. 2007 working document, subject to annual updates (see http://www.nwr.noaa.gov/). NMFS Northwest Region, Hydro Division.

NRC (National Research Council). 1996. Upstream– Salmon and Society in the Pacific Northwest. National Academy Press, Washington, D.C. 452p.

NRCS. 1999. Conservation Practice Standard, Waterwell Code 642.

Neff, J.M. 1985. Polycyclic aromatic hydrocarbons. *In*: Fundamentals of aquatic toxicology, G.M. Rand, and S.R. Petrocelli (eds.), pp. 416-454. Hemisphere Publishing, Washington, D.C.

ODFW/ODF (Oregon Department of Fish and Wildlife/Oregon Department of Forestry). 1995. A Guide to Placing Large Wood in Streams. 13 pp. May 1995. http://www.oregon.gov/ODF/PRIVATE_FORESTS/docs/fp/WoodPlacmntGuide1995.pdf

ODFW and ODF. 1999. Oregon aquatic habitat restoration and enhancement guide.

ODOT. 1999. Routine Road Maintenance: Water Quality and Habitat Guide, Best Management Practices. 21 pp. + appendices. July 1999.

Overton, C. K, J. D. McIntyre, R. Armstrong, S. L. Whitwell, and K. A. Duncan. 1995. Users guide to fish habitat: descriptions that represent natural conditions in the Salmon River basin, Idaho. U.S. For. Serv. Gen. Tech. Rep. INT-GTR-345.

PFMC (Pacific Fishery Management Council). 1998a. Final Environmental Assessment/ Regulatory Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon (October). http://www.pcouncil.org/groundfish/gffmp/gfa11.html

PFMC (Pacific Fishery Management Council). 1998b. The Coastal Pelagic Species Fishery Management Plan: Amendment 8. Pacific Fishery Management Council, Portland, Oregon (December 1998). http://www.pcouncil.org/cps/cpsfmp.html

PFMC (Pacific Fishery Management Council). 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended conservation measures for Salmon. Pacific Fishery Management Council, Portland, Oregon (March). http://www.pcouncil.org/salmon/salfmp/a14.html

Platts, W. S. 1991. Livestock grazing. pp. 389-424 in Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Soc., Bethesda, Maryland. 751 p.

Polacek, M.C., and P.W. James. 2003. Diel microhabitat use of age-0 bull trout in Indian Creek, Washington. Ecology of Freshwater fish. 12:81-86.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press. Seattle, WA.

Redding, J.M., C.B. Schreck, and F.H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Transactions of the American Fisheries Society 116: 737-744.

Reeves, G.H., F.H. Everest, and J.D. Hall. 1987. Interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*) in western Oregon: the influence of water temperature. Canadian Journal of Fisheries and Aquatic Sciences 44: 1603-1613.

Reeves, G.H., J.D. Hall, T.D. Roelfs, T.L. Hickman, and C.O. Baker. 1991. p. 519-557 *In* W.R. Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Soc., Bethesda, Maryland. 751 p.

Roni, P. and T.P. Quinn. 2001a. Density and size of juvenile salmonids in response to placement of large woody debris in western Oregon and Washington streams. Canadian Journal of Fisheries and Aquatic Science 58: 282-292.

Roni. P. and T.P. Quinn. 2001b. Effect of wood placement on movement of trout and juvenile Coho salmon in natural and artificial stream channels. Transactions of the American Fisheries Society 130: 675-685.

Roni, P., T. Bennett, S. Morely, G.R. Pess, K. Hasnon, D. Van Slyke, and P. Olmstead. 2006 (*in press*). Rehabilitation of bedrock stream channels: The effects of boulder weir placement on aquatic habitat and biota. River Research and Applications. Published online in Wiley InterScience (interscience.wily.com.).

Roussel, J.M., and A. Bardonnet. 1999. Ontogeny of diel pattern of stream-margin habitat use by emerging brown trout, *Salmo trutta*, in experimental channels: influence of food and predator presence. Environmental Biology of Fishes. 56:253-262.

Seaman M. H. 1977. Columbia River Estuary: Inventory of Physical, Biological and Cultural Characteristics. Columbia River Estuary Studies Taskforce. Astoria, OR: 302.

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

Sedell, J.R., F.N. Leone, and W.S. Duval. 1991. Water transportation and storage of logs. p.325-368 *In* W.R. Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Soc., Bethesda, Maryland. 751 p.

Servizi, J.A. and Martens, D.W. 1991. Effects of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 48: 493:497.

Sherwood C. R., D. A. Jay, R. B. Harvey, P. Hamilton and C. A. Simenstad. 1990. Historical Changes in the Columbia River Estuary. In: Angel and R.L. Smith (Ed). Columbia River: Estuarine System. Progress in Oceanography. 25: 299-352.

Slaney P.A. and B.R. Ward. 2003. Experimental nutrient addition to the Keogh River and application to the Salmon River in Coastal British Columbia. *In:* Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. American Fisheries Society Symposium 34, Bethesda, MD.

Spence, B.C, G.A. Lomnicky, R.M. Hughes, R.P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon. (December). http://www.nwr.noaa.gov/1habcon/habweb/habguide/ManTech/front.htm

Storch, R.L. 1979. Livestock-streamside management programs in eastern Oregon. *In*: Proceedings, grazing and riparian-stream ecosystem forum. Trout Unlimited, Vienna, Virginia 56-59.

Suttle, K.B, M.E. Powers, J.M. Levine, and C. McNeely. 2004. How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. Ecological Applications 14(4): 969-974.

Swanston, D.N. 1991. Natural processes. P. 139-179 *In* W.R. Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Soc., Bethesda, Maryland. 751 p.

Thomas D. W. 1983. Changes in the Columbia River Estuary Habitat Types over the Past Century. Columbia River estuary data development program. Columbia River estuary study taskforce (CREST). Astoria, Oregon: 51.

Thomas, S.A., T.V. Royer, G.W. Minshall, and E. Snyder. 2003. Assessing the historic contributions of marine-derived nutrients to Idaho streams. . *In:* Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. American Fisheries Society Symposium.

Tierney, K.B., P.S. Ross, H.E. Jarrard, K.R. Delandy, and C.K. Kennedy. 2006. Changes in Juvenile Coho Salmon Electro-Olfactogram During and After Short-Term Exposure to Current-Use Pesticides. Environmental Toxicology and Chemistry. 25:2809-2817.

Schwendeman, T. 1981. Dust control study. U.S. Forest Service. Gallatin National Forest. Report USGS/BRD/ITR-2003-0002. U.S. Government Printing Office, Denver, CO.

U.S. Army Corps of Engineers (USACE). 2001. Biological Assessment, Columbia River Channel Improvements Project.

U.S. Department of Agriculture (USDA) and U.S. Department of Interior (USDI). 1995. Environmental Assessment for the Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). March.

U.S. Forest Service. 2005. Region 6 invasive plant biological assessment. USFS Region 6 Regional Office, Portland, OR.

WDF (Washington Department of Fisheries), Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1992. 1992 Washington State Salmon and Steelhead Stock Inventory. March 1993. (Available at: http://wdfw.wa.gov/fish/sassi/sassi.htm)

WDF (Washington Department of Fisheries), and WWTIT (Western Washington Treaty Indian Tribes). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Internal Report to Washington Department of Fisheries and Wildlife, Olympia, Washington Wash. Dep. Fish Wildl., Olympia, WA, 212 p. plus 5 regional volumes.

WDFW, WDOT, WDOE. 2003. Integrated Streambank Protection Guidelines. (http://www.wa.gov/wdfw/hab/ahg/ispgdoc.htm)

Wan, M.T, D.J. Moul, and R.G. Watts. 1987. Acute toxicity to juvenile Pacific salmonids of Garlon 3A, Garlon 4, triclopyr, triclopyr ester, and their transformation products: 3,5,6-tricholoro-2-pyridinol and 2-methoxy-3,5,6-trichloropyridine. Bulletin of Environmental Contamination and Toxicology. 39:721-728.

Waples, R.S. 1991. Definition of 'Species' Under the Endangered Species Act: Application to Pacific Salmon. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS- F/NWC-194. http://www.nwfsc.noaa.gov/publications/techmemos/tm194/waples.htm

Waples, R.S., P.B. Aebersold and G.A. Winans. 1997. Population genetic structure and life history variability in *Oncorhynchus nerka* from the Snake River basin. Report to Bonneville Power Administration, Contract No. 1993BP05326, Project No. 199306800. BPA Report DOE/BP-05326-1.

Ward, B.R., D.J Mcubbins, and P.A. Slaney. 2003. Evaluation of addition of inorganic nutrients and stream habitat structures in the Keogh River watershed for steelhead trout and coho salmon. *In:* Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. American Fisheries Society Symposium 34, Bethesda, MD.

Waters, Thomas. 1995. Sediment in streams: sources, biological effects and control. American Fisheries Society Monograph 7.

Weber, E.D., and K.D. Fausch. 2004. Abundance and size distribution of ocean-type juvenile Chinook salmon in the upper Sacramento River margin before and after hatchery releases. North American Journal of Fisheries Management. 24:1447-1455.

Wedemeyer, G.A., B.A. Barton, and D.J. McLeay. 1990. Stress and acclimation. *In:* Schreck, C.B., and P.B. Moyle (eds.), Methods for fish biology, pp. 451-490. American Fisheries Society, Bethesda, Maryland.

Wentz, D.A., B. A. Bonn, K. D. Carpenter, S. R. Hinkle, M. L. Janet, F. A. Rinella, M. A. Uhrich, I. R. Waite, A. Laenen, and K. E. Bencala. 1998. Water Quality in the Willamette Basin, Oregon, 1991-95: U.S. Geological Survey Circular 116, online at http://water.usgs.gov/pubs/circ1161, updated June 25, 1998

Wilson, G.A., K.I. Ashley, R.W. Land, and P.A. Slaney. 2003. Experimental enrichment of two oligiotrophic rivers in south coastal British Columbia. *In:* Nutrients in Salmonid Ecosystems: Sustaining production and Biodiversity. American Fisheries Society Symposium 34, Bethesda, MD.

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves, and J.R. Sedell. 1994. Ecological Health of River Basins in Forested Regions of Eastern Washington and Oregon. Gen. Tech. Rep. PNW-GTR-326. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 65 p.

Yu, Y., and Q. Zhou. 2005. Adsorption characteristics of pesticides methamidophos and glyphosate by two soils. Chemosphere. 58:811-8.