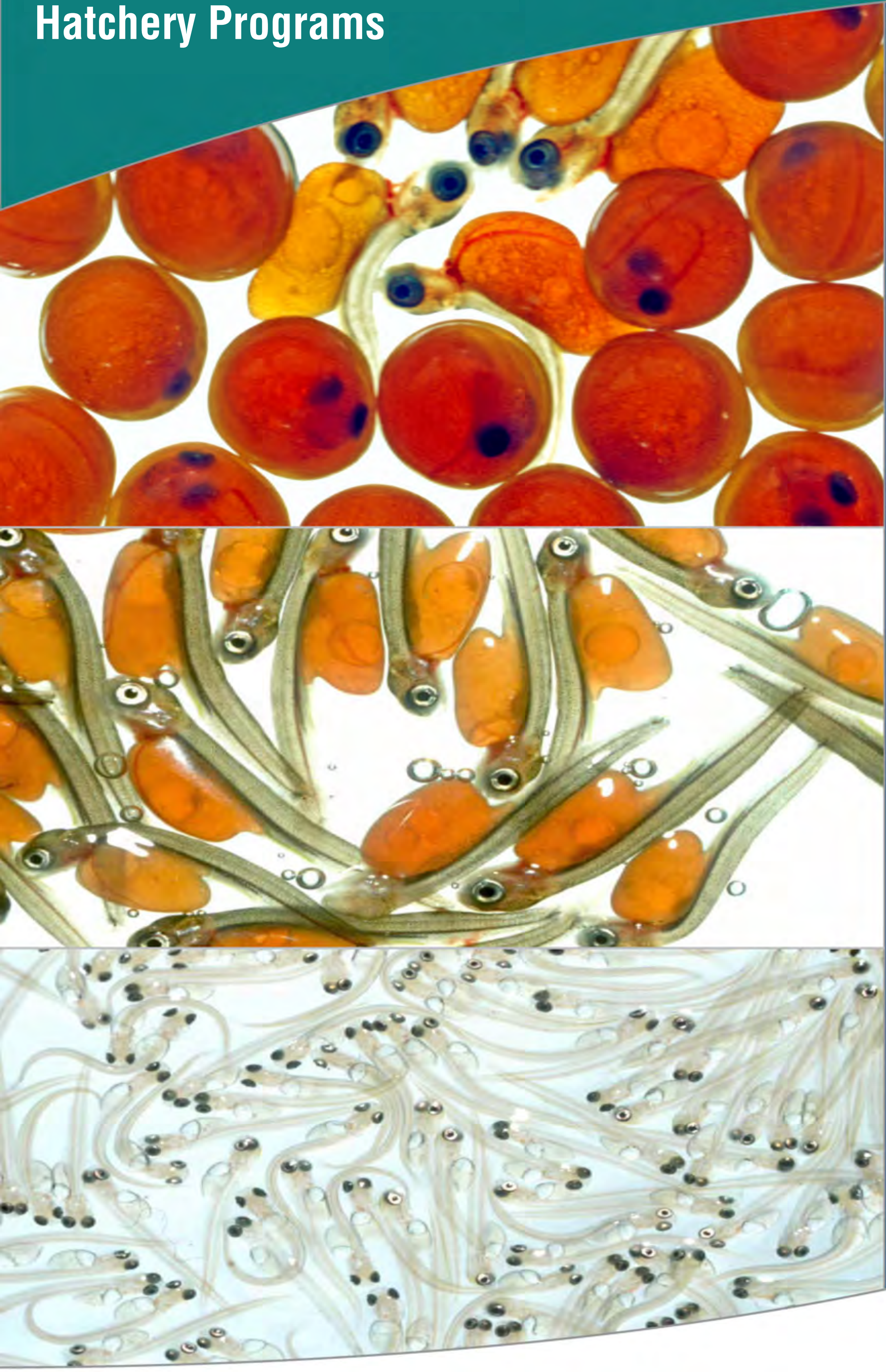
Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs



National Marine Fisheries Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act (NEPA), we enclose for your review the *Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs*.

This final environmental impact statement (FEIS) is prepared pursuant to NEPA to assess the environmental impacts associated with National Marine Fisheries Services' (NMFS) policy development related to Mitchell Act hatchery funding decisions.

Additional copies of the FEIS may be obtained from the Responsible Program Official identified below. The document is also accessible electronically through the NMFS West Coast Region's website at http://www.westcoast.fisheries.noaa.gov/hatcheries/mitchell_act/ma_feis.html.

NMFS is not required to respond to comments received during the agency's 60-day review period as a result of the issuance of the FEIS. However comments received by **November 12, 2014,** will be reviewed and considered for their impact on issuance of a record of decision. Please send comments to the responsible official identified below. The record of decision will be made available publicly following final agency action on or after **November 12, 2014**.

Responsible Program Official:

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Sincerely,

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Digitally signed by MONTANIO.PATRICIA.A.1365839030
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OTHER, cn=MONTANIO.PATRICIA.A.1365839030
Date: 2014.08.27 16:59:49 -04'00'

Patricia A. Montanio
NOAA NEPA Coordinator

Enclosure

Title of Environmental Review
Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs

Responsible Agency and Official
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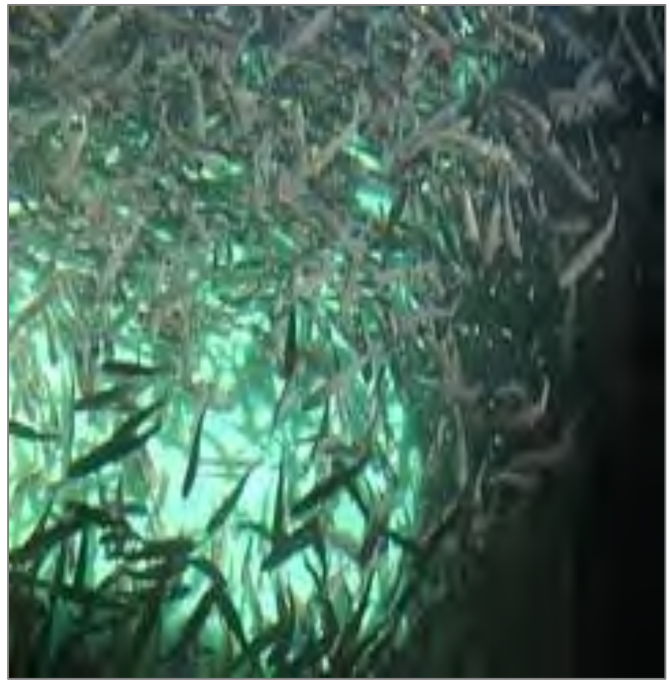
Location of Proposed Activities
The Columbia River Basin, which is located in Oregon, Washington, and Idaho

Proposed Action
To develop a NMFS policy direction that will guide NMFS' distribution of Mitchell Act funds

Abstract
Congress enacted the Mitchell Act in 1938 for the conservation of anadromous fishery resources in the Columbia River Basin. Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities. Annual funding levels for operation and maintenance of the Mitchell Act hatchery program have seen significant reductions in past years and have not kept up with the increasing costs, resulting in decreased production levels. During the same time that production levels were reduced at hatchery facilities funded under the Mitchell Act, NMFS listed eight evolutionarily significant units (ESUs) of salmon and five distinct population segments (DPSs) of steelhead in the Columbia River Basin under the Endangered Species Act (ESA) (i.e., 13 ESUs/DPSs total). The combination of funding pressures under the Mitchell Act and the listing of 13 ESUs/DPSs of salmon and steelhead under the ESA in the Columbia River Basin form the basis for NMFS' proposed action.

Executive Summary

Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs



Introduction

The National Marine Fisheries Service (NMFS) has prepared a final environmental impact statement (EIS) to guide the annual funding of Mitchell Act hatchery programs in the Columbia River Basin.

NMFS began this EIS process in 2004 when it requested scoping help from the public to develop alternatives to evaluate for inclusion in the document. In 2009, NMFS again requested help from the public when it proposed to expand the scope of the EIS to not only evaluate Mitchell Act-funded hatcheries, but all hatcheries within the basin.

In August 2010, NMFS published a draft EIS for public review and comment. In this draft, NMFS evaluated the resource effects of five alternatives (one no action alternative and four action alternatives). NMFS also asked that the public provide NMFS with their ideas for a preferred alternative. The public review of the draft produced over 1,100 comments.

NMFS has been working to incorporate these comments and suggestions, as well as more recent information on the affected resources, into this final EIS. NMFS has formulated and evaluated Alternative 6, the preferred alternative, in this final EIS. This final EIS also provides an updated analysis of the original five alternatives evaluated in the draft EIS.

In addition to identifying the preferred alternative, several other updates and clarifications have been made to the EIS (for a summary of all changes from the draft to the final EIS, see the last section of this Executive Summary). Some of these updates include the following:

- Focusing the scope of the EIS on the purpose of guiding NMFS' decisions on Mitchell Act hatchery program funding

- Updating all baseline data and information in the EIS, including hatchery production, salmon and steelhead harvest, socioeconomic data, and more
- Further clarification of the alternative language, based on public comment

Background

Congress enacted the Mitchell Act (16 United States Code of Federal Regulations [USC] 755 757) in 1938 for the conservation of anadromous (salmon and steelhead) fishery resources in the Columbia River Basin (defined as all tributaries of the Columbia River in the United States [U.S.] and the Snake River Basin). It authorized the establishment, operation, and maintenance of one or more hatchery facilities in the states of Oregon, Washington, and Idaho, scientific investigations to facilitate the conservation of the fishery resource, and "all other activities necessary for the conservation of fish in the Columbia River Basin in accordance with law." While the Mitchell Act provides the authority for the conservation of fishery resources in the Columbia River, Congress must appropriate funds to implement it.

Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities (referred to in this EIS as Mitchell Act hatchery facilities). Each year, Congress allocates a specific portion of the money appropriated for the Mitchell Act to hatchery operations. For each of the past 10 years (2003 to 2012), Mitchell Act hatchery program funding has been between $12 and $22 million dollars. The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, currently distributes these appropriations to the operators of 62 hatchery programs that annually produce more than 63 million fish. Historically, Mitchell Act production levels have been as high as 129 million juvenile fish annually, but these levels have been substantially reduced as inflation, budget reductions, maintenance, and other costs have eroded the amount of funding available for fish production.

During the same time that production levels were reduced at hatchery facilities funded under the Mitchell Act, NMFS listed eight evolutionarily significant units (ESUs) of salmon and five distinct population segments (DPSs) of steelhead in the Columbia River Basin under the Endangered Species Act (ESA) (i.e., 13 ESUs/DPSs total). When listing both salmon and steelhead under ESA, NMFS cited the adverse effects of hatchery operations as one of the factors for the decline of most of these listed ESUs/DPSs.

Purpose and Need

The combination of continued funding pressures under the Mitchell Act and the ESA listing of 13 salmon and steelhead ESUs/DPSs in the Columbia River Basin have resulted in the need for NMFS' proposed action. NMFS' purpose for the action is to develop a policy direction to guide its decisions about the distribution of funds for hatchery production under the Mitchell Act.

The review of hatchery programs in this EIS is comprehensive because information on the effects of all Columbia River Basin hatchery programs throughout the basin and across a full range of alternatives is presented in the EIS. Each alternative identifies a different policy direction that would be used to guide NMFS' decisions on Mitchell Act hatchery production.

What is NMFS' Proposed Action?

The proposed action is to develop a NMFS policy direction that will guide NMFS' annual distribution of Mitchell Act hatchery funds.

What is a policy direction?

A policy direction guides and shapes decisions NMFS makes related to Mitchell Act hatchery production in the Columbia River Basin. It is formed by a series of goals and/or principles (Section 2.4.2, Alternative Performance Goals).

What is the relationship between ESA and the National Environmental Policy Act (NEPA)?

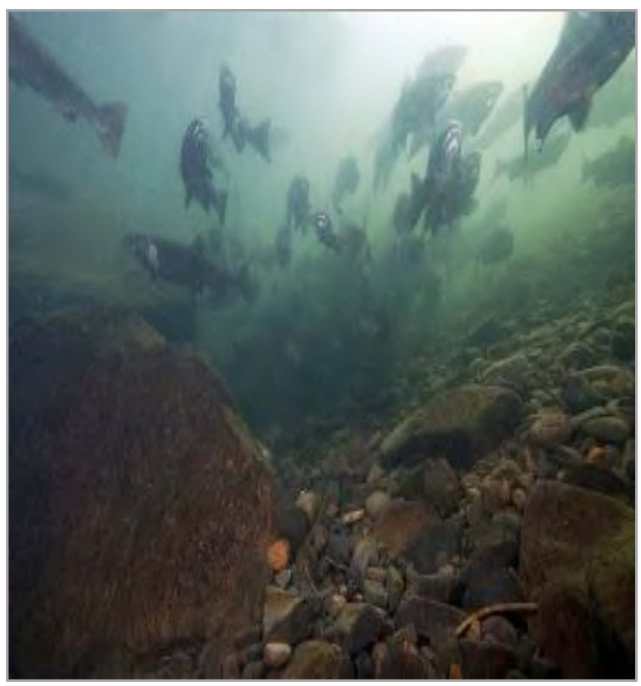
The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a proposed action. However, each law has a distinct purpose, and the scope and standards of review under each statute are different. This EIS analysis under NEPA should not be viewed as contributing to a conclusion about whether an alternative meets or does not meet ESA requirements.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a no-action alternative. Public involvement promotes this purpose.

ESA's purpose is to conserve listed species and the ecosystems upon which they depend. Determinations about whether Mitchell Act hatchery programs meet ESA requirements will be made independent of this EIS, under ESA section 4(d), section 7, or section 10. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analysis and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest to the reader any conclusions relative to ESA. While the Record of Decision (ROD) identifies the selected NEPA alternative, the ROD does not determine whether that alternative complies with ESA.

NMFS acknowledges that the analyses of environmental effects on listed species under ESA and under NEPA are similar and can lead to confusion; however, the analyses under these separate statutes are not functionally equivalent. Language in this final EIS has been chosen in an effort to minimize the confusion between a NEPA analysis and an ESA analysis. For instance, "jeopardize," "endanger," "recover," and similar terms are commonly used to describe the effect of actions under an ESA analysis. This EIS avoids using these terms, using instead, terms and phrases such as "performance goals" and "performance metrics."



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Project Area

The project area covered in this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or may occur in the Columbia River Basin, including the Snake River and all other tributaries of the Columbia River in the United States (Figure S-1). The project area also includes the Columbia River estuary and plume. The project area comprises two salmon recovery domains (the Willamette/Lower Columbia and the Interior Columbia) as established by NMFS under its ESA recovery planning responsibilities. The project area also contains 7 ecological provinces and more than 37 subbasins (i.e., tributaries to the Columbia or Snake Rivers). There are 177 salmon and steelhead hatchery programs in the Columbia River Basin. These hatchery programs originate from more than 80 hatchery facilities, and they produced over 140 million salmon and steelhead in 2010 (Table S-1).

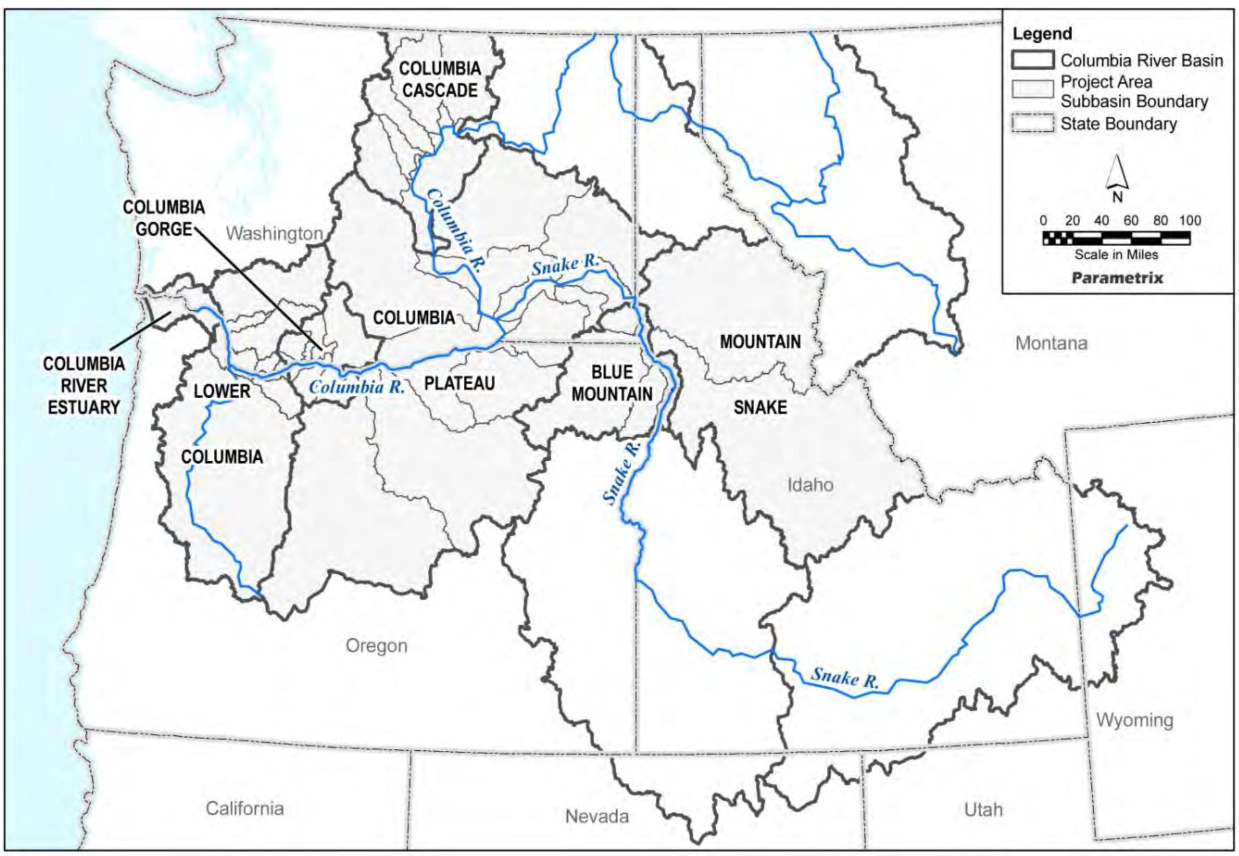

Figure S-1. Project Area by Ecological Province

Table S-1. Total Hatchery-origin Salmon and Steelhead Production within the Columbia River Basin (X 1,000).

Recovery Domain	Fall Chinook Salmon	Spring Chinook Salmon	Summer Chinook Salmon	Coho Salmon	Winter Steelhead	Summer Steelhead	Chum Salmon	Sockeye Salmon	Total
Willamette / Lower Columbia	45,855	13,595	0	15,441	2,011	2,049	250	0	79,201
Interior Columbia	23,129	19,303	3,742	4,299	20	10,537	0	362	61,392
Total	68,984	32,898	3,742	19,740	2,031	12,586	250	362	140,593

Source: Appendix C through Appendix F. Numbers based on production levels in 2010.

Activities that are not considered to be within a reasonable range of potential funding or operational opportunities and that are not, therefore, envisioned within the alternatives in this draft EIS, include the following:

- **Construction of New Hatchery Facilities with Mitchell Act Funds.** Decisions regarding the scope of review in this EIS would not preclude the construction of new or expanded hatchery facilities in the Columbia River Basin. However, current and reasonably foreseeable appropriations under the Mitchell Act for hatchery production would preclude the option to construct new hatchery facilities in the project area (http://www.whitehouse.gov/omb/budget/Overview).

- **Fish Screens and Fishways.** The Mitchell Act Screens and Fishways Program is a separate program with separate congressionally appropriated funding.

- **Habitat Restoration.** While Congress clearly has the discretion to direct Mitchell Act funds toward habitat restoration, it has not done so. Congress consistently and specifically has directed funds to hatchery production (and related monitoring, evaluation, and reform) and to screens and fishways. This EIS is directed at the use of the funds Congress specifically directs towards hatcheries. Through 2014, NMFS has funded habitat restoration through the Pacific Coastal Salmon Recovery Fund, created by Congress in 2000, to address the need to protect, restore, and conserve salmon, steelhead, and their habitat.

- **Hatchery Practices that Increase Adverse Effects.** While not all salmon ESUs or steelhead DPSs in the Columbia River Basin are listed under ESA, there is at least one salmon or steelhead population that is a member of a listed ESU or DPS in each of the major subbasins within the project area. Hatchery practices have been identified as a factor for the decline of most listed salmon and steelhead. Because of these factors, the purpose and need for this action is to establish a policy direction that, among other things, includes information on the effects of alternative hatchery performance goals on natural-origin fish. Implementation of hatchery practices that would likely increase risks to listed species, when compared to existing practices, are not considered in this final EIS.

It is not the purpose of this EIS to determine whether specific actions or hatchery programs meet ESA requirements. These ESA decisions will be made in separate processes consistent with applicable regulations as required by ESA.

Alternatives Analyzed in Detail

In general, the alternatives analyzed in the EIS are designed to reduce or minimize the adverse effects or increase the benefits of hatchery operations on natural-origin salmon and steelhead populations. Hatchery operators will continue to pursue not only the conservation or harvest goals that currently apply to each hatchery program, but also different or additional conservation and harvest goals NMFS anticipates that the resource effects analyzed in this EIS will be informative for policy decisions for approximately 10 years.

The alternatives are varying applications of two hatchery performance goals, *intermediate* and *stronger*. These goals are relative to baseline conditions, e.g., *stronger than baseline*.

What are Hatchery Performance Goals?

The EIS uses the terms *stronger performance goal* (i.e., stronger than baseline conditions) and *intermediate performance goal* (i.e., a level between baseline conditions and stronger performance) to indicate different levels of effects reduction or benefits that hatchery programs can have on natural-origin populations of salmon and steelhead. This EIS avoids terms that may be found in an ESA-related analysis, such as *jeopardy*, *recovery*, or similar concepts. These performance goals are not intended to infer compliance with any legal standard, nor are they intended to be analogous to ESA terminology or threshold standards, but they are helpful in aggregating and describing the effect of multiple hatchery programs on natural-origin populations of salmon and steelhead.

Hatcheries operated using stronger performance goals would maintain or promote beneficial effects (benefits) and minimize adverse effects (risks) of hatchery programs on salmon and steelhead populations when compared to baseline conditions.

Hatcheries operated under intermediate performance goals would, in most cases, reduce the adverse effects (risks) of many hatchery programs on salmon and steelhead populations when compared to baseline conditions.

Alternative 1 (No Action)

Under Alternative 1, there would not be a defined policy direction, and Columbia River Basin hatchery production would continue baseline conditions. Based on NMFS' observations, the following describe the baseline conditions:

- Hatchery operators (both Mitchell Act-funded and other) have made substantial improvements to both programs and facilities to reduce the impacts on ESA-listed and non-listed salmon and steelhead populations in the Columbia River Basin.
- Hatchery programs (both Mitchell Act-funded and other) are used primarily to contribute to harvest (Section 2.3.2, Purpose of Hatchery Programs), although some hatchery programs are designed to help conserve natural-origin salmon and steelhead populations.
- Many hatchery programs are used to meet mitigation agreements. Most mitigation occurs to reduce the effects from hydro development on the fisheries resource.
- Monitoring, evaluation, and reform (MER) activities occur, but they are not guided by a comprehensive basinwide plan. MER plans, where they occur, are usually developed at the individual program level.
- Adaptive management of hatchery programs occurs, but it is usually directed at the performance of the program, i.e., survival of juveniles to adult recruits, and it is not necessarily directed at risk reduction on natural populations.

- Best management practices (BMPs) for hatchery facilities are widely applied, but their application is not universal. In many cases, application is based on available funding and/or whether the BMP is a regulatory requirement.
- The amount of Mitchell Act hatchery funding can vary annually (Table 1-3). Hatchery operators generally receive a consistent proportion of the total funding each year.

Alternative 2 (No Mitchell Act Funding)

Under Alternative 2, the policy direction would be defined by the following goals and/or principles:

- All Mitchell Act-funded hatchery programs and facilities would be closed.
- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to the remaining non-Mitchell Act-funded hatchery programs that affect primary and contributing salmon and steelhead populations. Application of the intermediate performance goal would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Isolated hatchery programs would be better isolated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- No new hatchery programs would be initiated.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect ESA-listed primary and contributing populations.
- BMPs for facilities would be applied to all remaining hatchery facilities.
- Mitchell Act hatchery funding would be eliminated.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under Alternative 3, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations. Application of the intermediate performance goal would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
    - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
    - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- No new hatchery programs would be initiated.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect ESA-listed primary and contributing populations.
- BMPs for facilities would be applied to all hatchery facilities.
- Adaptive management planning related to risk reduction would be required for all programs that affect ESA-listed primary and contributing populations.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 4, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia Recovery Domain. Application of the intermediate performance goal would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
    - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
    - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.

- The stronger performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain. Application of the stronger performance goal would minimize the risks of hatchery programs on natural-origin salmon and steelhead populations more than the intermediate performance goal.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Isolated hatchery programs would be better isolated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- BMPs for facilities would be applied in all hatchery facilities.
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- New conservation hatchery programs could be initiated in the Willamette/Lower Columbia Recovery Domain for populations deemed at high risk of extinction.
- New harvest hatchery programs could be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities below Bonneville Dam, including ocean fisheries.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 5, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain. Application of the intermediate performance goals would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Isolated hatchery programs would be better isolated than under Alternative 1.

- The stronger performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia Recovery Domain. These stronger performance goals would minimize the risks of hatchery programs on natural-origin salmon and steelhead populations more than the intermediate performance goal.
  - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
  - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- BMPs for facilities would be applied in all hatchery programs.
- New conservation hatchery programs could be initiated in the Interior Columbia Recovery Domain for populations deemed at high risk of extinction.
- New harvest hatchery programs may be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities above Bonneville Dam, including treaty Indian commercial fisheries.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 6, the policy direction would be defined by the following goals and/or principles:

- The stronger performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations. These stronger performance goals would minimize the risks of hatchery programs on natural-origin salmon and steelhead populations.
  - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
  - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of conservation hatchery programs must outweigh their risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).

- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- BMPs for facilities would be applied to all hatchery facilities.
- New programs (for conservation, harvest, or both purposes) could be initiated throughout the Columbia River Basin, where appropriate.
- Monitoring, evaluation, and reform would continue to occur. NMFS would continue to work with hatchery operators, basinwide, to develop priorities and strategies for monitoring, evaluation, and reform.
- Adaptive management planning, related to risk reduction, would be required for all programs that affect ESA-listed primary and contributing salmon and steelhead populations in the Columbia River Basin.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Table S-2 summarizes hatchery performance goals for each alternative. Information in the table covers the Willamette/Lower Columbia Recovery Domain and the Interior Columbia Recovery Domain.

Table S-2. Hatchery Performance Goals Identified for Each Alternative's Policy Direction.

Recovery Domain	Population Type*	Hatchery Performance Goals by Alternative					
		Alternative 1	Alternative 2**	Alternative 3	Alternative 4	Alternative 5	Alternative 6 (Preferred Alternative)
Willamette/ Lower Columbia	Primary	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate	Stronger
	Contributing	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate	Stronger
	Stabilizing	Baseline conditions	Intermediate	Baseline conditions	Baseline conditions	Baseline conditions	Baseline Conditions
Interior Columbia	Primary	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger	Stronger
	Contributing	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger	Stronger
	Stabilizing	Baseline conditions	Intermediate	Baseline conditions	Baseline conditions	Baseline conditions	Baseline Conditions

* Each population's role in recovery was designated as primary, contributing, or stabilizing. These designations were used by the Lower Columbia River Fish Recovery Board (LCFRB) in the development of the Lower Columbia Fish Recovery Plan (LCFRB 2004). The Hatchery Scientific Review Group (HSRG) adapted these designations throughout the basin after discussions with the hatchery operators, and they are applied in this EIS (Appendix C through Appendix F). Not all recovery plans for salmon and steelhead utilize this same hierarchical structure to identify recovery goals for listed populations.

** Under Alternative 2, Mitchell Act hatchery funding is assumed to be eliminated. The remaining non-Mitchell Act hatchery programs would be managed to meet the intermediate performance goal.

Summary of Resource Effects

The policy directions that are associated with each of the action alternatives (Section 2.5, Alternatives Analyzed in Detail) are goal-oriented and do not identify specific actions that would be taken under each alternative. This is because the National Marine Fisheries Service (NMFS) understands that specific hatchery actions should be determined on a hatchery-program-by-hatchery-program basis. To analyze, illustrate, and compare the potential environmental effects of each alternative, however, an implementation scenario was developed for the policy direction under each alternative. Each implementation scenario is one example of how each hatchery program could be operated to meet the policy direction of the alternative.

Table S-3 summarizes predicted effects from application of implementations scenarios for the No-action Alternative (Alternative 1) and action alternatives (Alternative 2 through Alternative 6). The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences.

Table S-3. Summary of Environmental Consequences for Each Alternative's Implementation Scenario by Resource.

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6 (Preferred Alternative)
Fish	VSP Indicator[1]: Increase in estimated natural-origin spawner abundance (all ESUs/DPSs)	342,772 (baseline total estimated abundance)	Increase of 15% compared to Alternative 1	Increase of 11% compared to Alternative 1	Increase of 11% compared to Alternative 1	Increase of 10% compared to Alternative 1	Increase of 7% compared to Alternative 1
	VSP Indicator[1]: Increase in ESU/DPS estimated mean adjusted productivity	Estimated baseline productivity for the 17 existing ESUs/DPSs	15 of the 17 ESUs/DPSs with increased productivity compared to Alternative 1	15 of the 17 ESUs/DPSs with increased productivity compared to Alternative 1	15 of the 17 ESUs/DPSs with increased productivity compared to Alternative 1	15 of the 17 ESUs/DPSs with increased productivity compared to Alternative 1	11 of the 17 ESUs/DPSs with increased productivity compared to Alternative 1
	VSP Indicator[1]: Estimated increase of primary[2] and contributing[2] salmon and steelhead populations with stronger performance for genetic diversity	Estimated baseline number of populations meeting stronger performance	Increase of 48% compared to Alternative 1	Increase of 26% compared to Alternative 1	Increase of 35% compared to Alternative 1	Increase of 37% compared to Alternative 1	Increase of 13% compared to Alternative 1

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Table S-3. Summary of Environmental Consequences for Each Alternative's Implementation Scenario by Resource (continued).

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6 (Preferred Alternative)
Socio-economics	Commercial gross ex-vessel value (2009 U.S. dollars [$]) in the Columbia River Basin	$5,591,040 ex-vessel value	Ex-vessel value reduction of 51% compared to Alternative 1	Ex-vessel value reduction of 12% compared to Alternative 1	Ex-vessel value reduction of 5% compared to Alternative 1	Ex-vessel value reduction of 3% compared to Alternative 1	Ex-vessel value increase of 14% compared to Alternative 1[3]
	Total (direct and secondary) economic benefit to income (2009 U.S. dollars [$]) in the Columbia River Basin	$173,564,549 total personal income	Reduction in total income benefit of 33% compared to Alternative 1	Reduction in total income benefit of 7% compared to Alternative 1	Reduction in total income benefit of 4% compared to Alternative 1	Same as Alternative 1	Increase in total income benefit of 8% compared to Alternative 1
	Total (direct and secondary) economic impacts on jobs in the Columbia River Basin	4,503 jobs	32% reduction in jobs compared to Alternative 1	8% reduction in jobs compared to Alternative 1	5% reduction in jobs compared to Alternative 1	Less than 1% reduction in jobs compared to Alternative 1	7% increase in jobs compared to Alternative 1
	Recreational expenditures (2009 U.S. dollars [$]) in the Columbia River Basin	$125,136,636 in recreational expenditures	31% reduction in recreational expenditures compared to Alternative 1	10% reduction in recreational expenditures compared to Alternative 1	8% reduction in recreational expenditures compared to Alternative 1	3% reduction in recreational expenditures compared to Alternative 1	3% increase in recreational expenditures compared to Alternative 1
Environmental Justice	Total tribal fish harvests (commercial, ceremonial, and subsistence) by number of fish in the Columbia River Basin	216,800 fish harvested	42% reduction in fish harvests compared to Alternative 1	11% reduction in fish harvests compared to Alternative 1	10% reduction in fish harvests compared to Alternative 1	5% reduction in fish harvests compared to Alternative 1	3% increase in fish harvests compared to Alternative 1[4]
	Tribal fishing revenue in the Columbia River Basin (2009 U.S. dollars [$])	$2,952,345 tribal fishing revenue	44% decrease in tribal fishing revenue compared to Alternative 1	10% decrease in tribal fishing revenue compared to Alternative 1	9% decrease in tribal fishing revenue compared to Alternative 1	6% increase in tribal fishing revenue compared to Alternative 1	18% increase in tribal fishing revenue compared to Alternative 1[3]
Wildlife	Caspian terns and bald eagles	Populations likely to increase	Potential reductions in abundance, distribution, and fitness relative to Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Table S-3. Summary of Environmental Consequences for Each Alternative's Implementation Scenario by Resource (continued).

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6 (Preferred Alternative)
Wildlife (continued)	Southern Resident killer whale (listed)	80 individuals are currently in Southern Resident stock; populations would continue to fluctuate	Potential reductions in abundance relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	California sea lions	Populations likely increasing	Abundance in Columbia River would probably decline relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Steller sea lions (Eastern)	Populations likely increasing	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Water Quality and Quantity	NPDES permit compliance and water use	NPDES permits and changes in water quality	Continued compliance with NPDES permits	Continued compliance, potential improvements in water quality, and reduction in water use	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
Human Health	Hatchery chemical safety and use	Continued chemical and antibiotic use consistent with Federal and state guidelines; potential pathogen exposure	Potential decrease in use of chemicals and antibiotics; no change in exposure to pathogens	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

[1] Viable Salmonid Population (VSP), based on McElhany (2000), is a conceptual framework for evaluation of the viability of salmonid populations based on four measurable indicators of population health: abundance, productivity, diversity, and spatial structure (See Section 3.2.3.1.1, Effects on the Viable Salmonid Population Concept). The EIS only summarizes effects on abundance, productivity, and diversity here. See Section 4.2.2.1, Methods for Determining Effects on VSP for Salmon and Steelhead, for more information.

[2] "Primary" and "contributing" populations are terms that were used by LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by HSRG (2009) after discussions with the Columbia River fish managers. They are applied in this final EIS (Section 2.4, Alternative Development). Not all recovery plans for salmon and steelhead utilize this same hierarchical structure to identifying recovery goals for listed populations.

[3] Changes in commercial gross ex-vessel value result from a combination of modifications in the total number of fish harvested and variations in the composition of the fish harvest, based on alterations in the hatchery production in the alternative implementation scenario.

[4] Increase in total tribal fish harvested results from changes to hatchery program production numbers and the composition of the species and run-type released, i.e., a higher proportion of upriver bright (URB) Chinook salmon than tule Chinook salmon. These changes can result in more of these fish available for harvest under the EIS harvest rate assumptions.

SUMMARY OF CHANGES FROM DRAFT EIS TO FINAL EIS

This final EIS incorporates many updates to the information presented in the draft EIS, as well as revisions to the document based on comments submitted during the public review period and the inclusion of an additional alternative, Alternative 6, the preferred alternative. Below is a summary of changes made to the document.

General Changes that Apply to all Final EIS Chapters

1) **Terminology.** The terminology used in the final EIS is updated for consistency throughout the document (e.g., isolated hatcheries replace segregated hatcheries). Changes in terminology used for the final EIS are described in the Glossary of Key Terms.

2) **Alternative 6.** A new alternative (Alternative 6) is added to the final EIS, which is described in Chapter 2, Alternatives, and analyzed for all resources in Chapter 4, Environmental Effects. Alternative 6 is developed based on NMFS' response to public comments, and it includes goals and principles that also occur in the other four action alternatives.

3) **Hatchery Production Levels.** The final EIS is updated to reflect hatchery production levels from 2010 (The draft EIS used 2007 production levels). These production levels are shown in Chapter 2, Alternatives; in alternative comparison tables in Chapter 4, Environmental Effects; and in the species-specific appendices (Appendix C through Appendix F).

4) **Response to draft EIS Comments.** Additional information and/or corrections are made in this final EIS to respond to draft EIS public comments. Comments and NMFS' responses to comments are provided in a new appendix (Appendix L).

5) **Information Sources and Uniform Reference Locators (URLs).** Where references that are more current are available, rather than those used in the draft EIS, the current references are used for the final EIS. The URLs for references in the EIS are also updated as needed. URLs are the global addresses of documents and other resources on the World Wide Web.

6) **Grammatical, Numerical, and Editing Changes.** Grammatical, numerical, and editing errors are corrected where observed.

7) **Change from draft EIS to final EIS.** Where applicable, language pertinent to the draft EIS is revised to represent the final EIS.

8) **Table Numbers.** New tables are added to the final EIS. This results in an update to many of the table numbers from that shown in the draft EIS.

Chapter 1

1) **New Information.** Additional historical and background information regarding the Mitchell Act and associated funding is added or updated in the final EIS to improve project understanding. Additional detailed information is provided on Mitchell Act hatchery programs.

2) **Table Revisions.** Draft EIS tables are updated to reflect the updated baseline information and other additional current information.

3) **Purpose and Need.** The purpose and need for the EIS are updated to better reflect how NMFS will use the information analyzed and reviewed herein for future decision-making related to Mitchell Act hatchery funding.

4) **Mitchell Act Hatchery Production.** The Mitchell Act Artificial Production Program description is revised to provide a clearer understanding of the program applications.

5) **Relationship of the EIS to ESA.** Chapter 1 provides further clarification of how NEPA and the analysis in the final EIS relates to ESA and future actions NMFS may take relative to proposed hatchery actions under ESA sections 10, 7, and 4(d).

6) **Non-Mitchell Act-funded Programs.** Further clarification is provided describing the relationship between NMFS and non-Mitchell Act hatchery operators.

7) **Updates on Hatchery Programs.** The hatchery programs and primary hatchery facilities are updated to include the primary facility, program name, program purpose, and funding source.

8) **Draft EIS Public Comment Period.** The date of the draft EIS publication and associated public comment period is added to Chapter 1.

9) **Applicable Plans, Policies, Regulations, Agreements, Laws, and Executive Orders.** This section is revised, based on public comment, to update existing information and include additional background information where needed. Additional applicable plans, policies, regulations, agreements, laws and policies added to this section are as follows:

    - Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments)
    - Columbia Basin Fish Accords
    - Lower Snake River Compensation Plan
    - John Day Mitigation
    - Salmon and Steelhead Recovery Plan

The Washington State's Wildlife Salmonid Policy section (draft EIS) is updated and revised to reflect the current policy entitled "Washington State's Hatchery and Fishery Reform Policy."

Chapter 2

1) **Columbia River Hatchery Programs.** Information on the hatchery programs evaluated in this EIS has been updated and corrected (e.g., number and relative location of hatchery and operational strategies are provided).

2) **Other Factors Affecting Salmon and Steelhead Populations. Harvest, Habitat, and Hydro—the other H's.** Other factors that affect listed salmon in addition to hatchery programs are summarized, along with NMFS' actions to address these factors.

3) **Hatchery Operations.** Additional information is added to the final EIS in recognition that flexibility in NMFS policy is needed for hatchery program operations due to long-term hatchery investments of time, effort, and resources, as well as the site-specific conditions that each hatchery program operates in.

4) **Geographic Scope.** Additional text is provided describing the need for a broad geographic scope of analysis to fully inform NMFS for future hatchery funding actions.

5) **Performance Goals.** The reasoning guiding the need for performance goals for all hatcheries in the Columbia River Basin is provided, along with further clarification and description of the different performance goals (i.e., stronger and intermediate performance goals). The definitions for stronger and intermediate metrics are revised, based on public comment, compared to the definitions presented in the draft EIS.

6) **All Alternatives.** Chapter 2, Alternatives, contains detailed information that describes each of the alternatives analyzed in detail.

7) **New Alternative.** A new alternative (Alternative 6) is added to this chapter. Performance goals are provided for this alternative, along with a detailed description of the associated goals and principles.

8) **Preferred Alternative.** The preferred alternative is identified and described. The draft EIS did not propose a preferred alternative for consideration. Instead, the draft EIS stated that NMFS "will formulate and identify a preferred policy direction [alternative], informed by public comment on the draft EIS, in the final EIS. The preferred policy direction could be one of the alternative policy directions considered in the draft EIS, or it could consist of a combination or blend of the alternative policy direction evaluated in the draft EIS."

9) **Alternatives Not Analyzed in Detail.** Three additional alternatives that are not further evaluated in the EIS are described. Where needed, further description of other alternatives not analyzed in detail is provided.

<u>**Resource Analyses in Chapter 3 and Chapter 4**</u>

<u>**Chapter 4 Introduction**</u>

1) **Implementation Scenarios.** The alternative implementation scenarios provided in Chapter 2 of the draft EIS are moved to this section. New text added, informed by public comment, explains that the implementation scenarios are intended to represent generalized examples of how each alternative's policy goal could be implemented. This section further clarifies that the programs developed under each alternative's implementation scenarios should not be viewed as necessarily consistent with application of ESA since ESA determinations are made during program-specific consultations, which are external to the NEPA process. The implementation scenario for Alternative 6 is also added to this section.

2) **Implementation Measures.** Further clarification is provided stating that NMFS applies these measures within the implementation scenarios to illustrate and disclose the potential effects of applying each alternative's policy direction.

3) **Performance Metrics.** Performance metrics used in the implementation scenarios are further described in this section. The difference between a hatchery performance goal and a performance metric is also described.

4) **Hatchery Practices.** Updates include recognition that hatchery operators use unique approaches to maximize benefits and minimize risks to natural-origin fish.

5) **All-H Analyzer.** More information is provided about the model, reasons for using it for the EIS analysis, and how readers should consider the information produced from the model.

6) **Watersheds and Hatchery Programs.** The table showing Columbia River subbasins or major watersheds where hatchery fish are assumed to not be released, based on each alternative's implementation scenario is revised to reflect the watersheds associated with hatchery programs within each alternative.

7) **New Weirs.** The number of new weirs associated with each alternative implementation scenario is updated for Alternative 3, Alternative 4, and Alternative 5 based on the updated baseline information. Box 4-3 on weirs is corrected to reflect that a permanent weir would be operated with a trapping efficiency needed to achieve the necessary performance goal, but not greater than 95 percent effective.

8) **Populations meeting Performance Metrics.** The number of populations that would meet performance metrics is revised for each alternative to reflect the hatchery programs that are analyzed for each alternative.

9) **Terminated Hatchery Programs.** Hatchery programs assumed to be terminated under the Alternative 6 implementation scenario are added to this section, as well as updated lists of programs assumed to be terminated under Alternative 2 through Alternative 5.

10) **New Hatchery Programs.** The new hatchery programs assumed to be initiated under one or more alternative implementation scenarios are updated for this section.

Fish

Chapter 3

1) **Implementation Scenarios.** Additional information is added, based on public comments, explaining the need for implementation scenarios in order to inform and disclose the potential effects of the action alternatives.

2) **VSP.** The use and value of the VSP concept (see Notes, Table S-3) are described as indicators of salmon population health. The VSP parameter includes abundance, productivity, diversity, and spatial structure. Each of these indicators is described in this section. Additional references are provided as appropriate.

3) **Risks from Disease Transfer.** Recent information on disease outbreaks that have occurred in coastal Washington steelhead hatcheries is provided.

4) **Listed Fish Species.** The Federal and state listing status for fish reviewed in this section is updated.

5) **Lower Columbia River Chinook Salmon ESU.** The current status and trends for this species are updated.

6) **Mid-Columbia River Spring-run Chinook Salmon ESU.** Added to this section is the effort to reintroduce spring-run Chinook salmon into the Walla Walla and Umatilla Basins.

7) **Upper Columbia River Spring-run Chinook Salmon ESU.** The current status and trends for this species are updated.

8) **Upper Willamette River Chinook Salmon ESU.** The current status and trends for this species are updated.

9) **Snake River Spring/Summer-run Chinook Salmon ESU.** More information is provided on the populations at risk.

10) **Snake River Fall-run Chinook Salmon ESU.** The current status and trends for this species are updated.

11) **Lower Columbia River Steelhead DPS.** The current status and trends for this species are updated.

12) **Middle Columbia River Steelhead DPS.** Additional information on the effects of the Pelton Round Butte hydro-complex on this species is added.

13) **Snake River Basin Steelhead DPS.** The current status and trends for this species are updated.

14) **Upper Columbia River Steelhead DPS.** Information on historical releases of hatchery-origin steelhead is revised, along with updates to the current status and trends for this species.

15) **Columbia River Cum Salmon ESU.** The current status and trends for this species are updated.

16) **Snake River Sockeye Salmon ESU.** The current status and trends for this species are updated.

17) **Other Fish Species.** More description is provided that describes the other fish species selected for review in the EIS.

18) **Eulachon.** NMFS' designation of critical habitat for this species is added to this section.

19) **Green Sturgeon.** Additional information on fisheries bycatch of green sturgeon is added to this section.

20) **Nonindigenous Fish Species.** This is a new section added to the final EIS.

Chapter 4

1) **All-H Analyzer.** Information is provided about the model, reasons for using it for the EIS analysis, and how readers should consider the information produced from the model.

2) **BMPs for Hatchery Facility Effects.** The reader is referred to tables where the BMPs are located in the final EIS.

3) **Genetic Diversity.** The methods used to describe genetic diversity are provided.

4) **Effects on VSP Parameters.** Additional information is provided for the salmon and steelhead abundance and productivity VSP parameters.

5) **Populations Meeting Performance Metrics.** All tables describing the number of populations that meet stronger, intermediate, and/or weaker performance goals by alternative are revised based on the hatchery programs evaluated by alternative and modified definitions in the final EIS for stronger and intermediate performance metrics. The text associated with these tables is modified to reflect the table changes.

6) **New Weirs.** The number of new weirs associated with each alternative is revised, along with weir effectiveness estimates for achieving performance metrics.

7) **Other Fish Species.** A description of how the alternative analysis is conducted for other fish species is provided.

8) **Eulachon.** Additional information is provided on this species' known distribution.

9) **Nonindigenous Fish Species.** An environmental effects analysis is provided for nonindigenous fish species that are added to Chapter 3 of the final EIS.

10) **Alternative 6.** Effects on fisheries from the implementation scenario under Alternative 6 are described.

11) **Hatchery Production.** All tables and text that rely on hatchery production numbers are revised based on updated hatchery production numbers developed for this final EIS.

<u>**Socioeconomics**</u>

Chapter 3

1) **Hatchery Production.** All tables and text that rely on hatchery production numbers, costs, and revenues are revised based on updated hatchery production numbers developed for this final EIS and updated costs.

2) **Historical Overview.** The source of background information for the final EIS is added to this section, which includes comments received during review of the draft EIS.

3) **Commercial Harvest and Economic Value.** Additional information on the location of commercial fisheries for tribes and other users is provided. The catch of salmon and steelhead is further described to better understand differences in catch by species.

Chapter 4

1) **Hatchery Smolt Production by Funding Source.** This section states that assignment of hatchery smolt production to either Mitchell Act-funded hatchery programs or to other hatchery program funding is estimated for alternative comparison purposes only.

2) **Alternative Comparisons.** Although the text for this section has numerous changes, they are primarily from quantitative catch and monetary variations based on modifications in hatchery production, more recent available data, and updated costs.

3) **Alternative 6.** Effects on socioeconomic conditions from the implementation scenario under Alternative 6 are described.

Environmental Justice

Chapter 3

1) **Fishing Communities.** Additional reference information is provided on how communities are selected for analysis as environmental justice communities.
2) **Demographic Data.** References are updated for methods used to determine recreational anglers, environmental justice thresholds, and minority and low-income groups. Based on these updated references, which include data from the 2010 census, the table that identifies environmental justice communities of concern is revised.
3) **Nez Perce Tribe.** Updated and corrected information, based on public comment, is provided for this tribe.
4) **Coastal Tribes.** Information is provided on fishing use of the project area by coastal tribes, including their fishing rights.
5) **Importance of Salmon to Tribes.** Additional information is provided in this section that describes the importance of salmon to tribes, as well as how tribes historically and currently use and value salmon within their culture.
6) **Ceremonial and Subsistence Harvests.** Additional information is provided that describes how tribes use salmon for ceremonial use and subsistence. Additionally, the extent of information available quantifying both the tribes' use by salmon species and the relative locations where tribes catch these fish on the Columbia and Snake Rivers is provided.
7) **Tribal Revenues and Hatchery Production.** Tribal revenues and hatchery production by tribes are updated based on most recent available information.
8) **Descriptions of Environmental Justice Groups.** The text for each of the user groups and communities of concern is updated to reflect information obtained from the 2010 census.
9) **Public Outreach.** This section is updated from the draft EIS.

Chapter 4

1) **Hatchery Production.** All tables and text that rely on hatchery production numbers, costs, and revenues are revised based on corrected hatchery production numbers and updated costs.

2) **Fish Harvests and Tribal Values.** Methods to determine tribal fish harvest are further described. Information is provided stating that the economic effects described in this section do not account for the additional social and cultural effects on the tribal way of life and culture.

3) **Ceremonial and Subsistence Harvests.** The additional ceremonial and subsistence harvest information provided in Chapter 3 for environmental justice is further evaluated by alternative in this revised section.

4) **Tribal Salmon Fishing and Hatchery Program Revenue.** Additional information recognizes that spending on tribal hatchery programs provides an indirect source of income to tribal communities where hatcheries are located.

5) **Non-tribal Users of Concern.** Information is provided describing that the EIS analysis for environmental justice focuses primarily on those communities and tribal fishing areas at and north of Astoria, Oregon.

6) **Alternative 6.** Effects on environmental justice user groups and communities of concern from the implementation scenario under Alternative 6 are described.

Wildlife

Chapter 3

1) **Listed Wildlife Species.** The Federal and state listing status for wildlife is updated as needed.

2) **Southern Resident Killer Whale.** This section is revised to further describe the location and use of the project area by Southern Resident killer whales, as well as their most recent documented diet on a seasonal basis.

3) **Steller Sea Lion.** Updates to this section are based on most recent published information regarding Steller sea lion, including the ESA listing status, use of the project area, and its diet.

4) **Gulls, Terns, Cormorants, and Pelicans.** Additional information on gulls, terns, cormorants, and pelicans as predators of salmon and their use of the project area is provided.

5) **Hatchery Predator Control Programs and Weirs.** This section is revised to provide updated information on how hatchery predator control programs and weirs affect wildlife.

6) **California Sea Lion.** Updated information on the presence of California sea lions in the Columbia River and their consumption of salmon, particularly at Columbia River dams, is provided.

7) **Effects of Hatchery Facilities on Wildlife.** More detailed information is provided on the direct and indirect effects of hatchery facilities on wildlife.

8) **Salmon Carcass Benefits.** More detailed information is provided on the value of salmon carcasses for wildlife.

Chapter 4

1) **Salmon and Steelhead Abundance.** Estimated adult and smolt salmon and steelhead abundance is revised for each action alternative based on revised hatchery production numbers. This revision affects those wildlife species that prey on salmon. As a result, the description of the effects of implementation scenarios from the various alternatives for all wildlife species is revised based on the importance of salmon and steelhead in the diet of wildlife for each of the species and wildlife groups reviewed.

2) **Effects of Salmon Carcasses to Wildlife.** This section is revised for consistency with revised Section 3.5.6.5, Nutrients/Distribution of Salmon Carcasses.

3) **Southern Resident Killer Whale.** Based on the updated Southern Resident killer whale information provided under Section 3.5.3, ESA-listed Species, and revised hatchery production numbers, the effects of the alternatives on this species are revised.

4) **Steller Sea Lion.** Based on the updated Steller sea lion description provided under Section 3.5.5, Marine Mammals, and the revised hatchery production numbers, the effects of the alternatives on this species are revised.

5) **All Wildlife Species.** Further clarification is provided for all wildlife that may feed on salmon and steelhead as part of their varied and diverse diet, recognizing that effects on wildlife from changes in hatchery production under several alternatives may be difficult to differentiate from other sources of natural variability in their prey base.

6) **California Sea Lion.** Based on the updated California sea lion information under Section 3.5.5, Marine Mammals, and the revised hatchery production numbers, the effects of the alternatives on this species are revised.

7) **Alternative 6.** Effects on wildlife species from the implementation scenario under Alternative 6 are described.

<u>Water Quality</u>

Chapter 3

1) **Federal Regulations Applicable to Water Quality at Hatcheries.** Further clarification, based on public comment, is provided regarding the Federal regulatory requirements and permits necessary for hatchery facilities.

2) **State Water Quality Compliance for Hatcheries.** Water quality regulatory compliance requirements for hatcheries in Washington and Idaho are revised and updated as needed.

3) **Hatcheries and Pollutants.** The table identifying pollutants potentially associated with hatchery facilities is updated.

Chapter 4

1) **All Alternatives.** This section is updated, based on public comment, to recognize that reductions in pollutant discharge levels would likely occur over time under all alternatives, including the no-action alternative, when hatcheries are required to meet new or renewed National Pollutant Discharge Elimination System (NPDES) permits or total maximum daily load (TMDL) regulations.

2) **Periodic Effluent Exceedances.** Revisions to the text, based on public comment, indicate that periodic effluent water quality permit exceedances may occur on a temporary basis, but would continue to be reported to the appropriate permitting agency.

3) **Permit Status.** Based on public comment, revised language recognizes that some permits (i.e., NPDES permits) still in effect may not reflect current water quality conditions and available technologies, since these conditions change over time.

4) **Alternative 6.** Effects on water quality from the implementation scenario under Alternative 6 are described.

<u>Human Health</u>

Chapter 3

1) **Chemical Properties.** Based on updated information, the table describing properties of chemicals commonly used at hatchery facilities is updated.

2) **Contaminated Fish Feed.** Updated information regarding research on contaminated fish feed at U.S. Fish and Wildlife Service fish hatcheries is provided.

3) **NPDES Reporting Requirements.** Information is provided on NPDES requirements that hatcheries report whether painted and caulked surfaces may come into contact with process water.

Chapter 4

1) **All Alternatives.** This section is updated to note that reductions in pollutant discharge levels would likely occur under all alternatives, including the no-action alternative, when hatcheries are required to meet new or renewed NPDES permits or TMDLs.

2) **Alternative 6.** Effects on human health from the implementation scenario under Alternative 6 are described.

Chapter 5

1) **Projects Identified as Potential Future Actions.** Each of these projects identified in the draft EIS is revised based on current known information.

2) **Tribal Fish Harvest and Tribal Hatchery Revenue.** This section is revised to recognize the potential for cumulative adverse tribal effects from climate change and future development.

Other EIS Chapters and Sections

1) **Glossary.** The glossary is updated to define new terms.

2) **Chapter 7, Distribution List.** This list is updated to reflect the mailing list for the final EIS.

3) **Chapter 8, List of Preparers.** This list is updated to reflect additional NMFS staff and contracted employees who helped prepare the final EIS.

4) **Chapter 9, Index.** An index is added to the final EIS.

Appendices

Appendix A, Hatchery Programs and Facility Information, is updated to reflect 2010 baseline hatchery production and natural-origin population effects.

Appendix C through Appendix F, Species-specific Tables. All tables are updated to reflect 2010 baseline conditions, reapplication of draft EIS alternatives, and the addition of Alternative 6, the preferred alternative.

Appendix G, Overview of the All-H Analyzer, is updated based on comments on the draft EIS.

Draft EIS Appendix I, Socioeconomics Report by the Research Group. This appendix is removed from the final EIS and is used as a reference where needed.

Final EIS Appendix I, The Recovery Implementation Science Team, Hatchery Reform Science, 2009, is added, based on public comment, to give context to some of the methods and principles associated with application of the implementation measures, metrics, and models used in the EIS, relative to hatchery program operations.

Appendix J, Socioeconomic Impact Methods, is updated to reflect recent information available since the draft EIS was published and to incorporate information received during the public review period.

Appendix K, Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act FEIS, is updated to incorporate recent relevant changes in fisheries structure, based on comments received during the public review, as well as updates on managed fisheries in the Columbia River; marine areas of Washington, Oregon, and California; and marine fisheries in British Columbia, Canada, and Southeast Alaska.

Draft EIS Appendix L, Supporting Demographic and Socioeconomic Data for the Analysis of Environmental Justice Impacts, is removed from the final EIS. Relevant data from this appendix is updated and incorporated into the final EIS.

Final EIS Appendix L, Responses to Public Comments, is added to the final EIS. This appendix consists of public comments on the EIS and NMFS' responses to these comments.

Acronyms and Abbreviations

4,4'-DDE	dichlorodiphenyldichloroethylene
AHA	All-H Analyzer
BMP	best management practice
BOD	biochemical oxygen demand
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
BRT	Biological Review Team
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CRP	Community-based Restoration Program
CRITFC	Columbia River Inter-Tribal Fish Commission
CWA	Clean Water Act
DAO	Departmental Administrative Order
DDT	dichlorodiphenyltrichloroethane
DPS	distinct population segment
EA	environmental assessment
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
E.O.	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FDA	Food and Drug Administration

Acronyms and Abbreviations (continued)

FERC	Federal Energy Regulatory Commission
FTE	full-time equivalent
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
HPV	Hatchery Population Viewer
HSRG	Hatchery Scientific Review Group
ICTRT	Interior Columbia Technical Recovery Team
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IHN	infectious hematopoietic necrosis
IHOT	Integrated Hatchery Operations Team
ISAB	Independent Science Advisory Board
JDM	John Day Mitigation
LCFRB	Lower Columbia Fish Recovery Board
LCREP	Lower Columbia River Estuary Partnership
LSRCP	Lower Snake River Compensation Plan
LNG	liquefied natural gas
MER	monitoring, evaluation, and reform
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	natural-origin spawners
NPCC	Northwest Power and Conservation Council

Acronyms and Abbreviations (continued)

NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWIFC	Northwest Indian Fisheries Commission
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCSRF	Pacific Coastal Salmon Recovery Fund
PFMC	Pacific Fishery Management Council
pHOS	proportion of hatchery-origin spawners
PIT	passive integrated transponder (tagging)
PL	Public Law
PNI	proportionate natural influence
pNOB	proportion of natural-origin fish in the broodstock
$PROD_{ADJ}$	adjusted productivity
PSC	Pacific Salmon Commission
PSMFC	Pacific States Marine Fisheries Commission
RPA	Reasonable and Prudent Alternative
RIST	Recovery Implementation Science Team
RM	River Mile
ROD	record of decision
SIWG	Species Interaction Work Group
SRFB	Salmon Recovery Funding Board
the Services	NMFS and USFWS, collectively
TMDL	total maximum daily load

Acronyms and Abbreviations (continued)

TRG	The Research Group
TSS	total suspended solids
URB	upriver bright (Chinook salmon)
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code of Federal Regulations
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSP	viable salmonid population
WDFW	Washington Department of Fish and Wildlife
WHO	World Health Organization

Glossary of Key Terms

Abundance: The number of fish in a population.

Acclimation pond: Concrete or earthen pond or a temporary structure used for rearing and imprinting juvenile fish in the water of a particular stream before their release into that stream.

Adaptive management: 1) A management process involving step-wise evolution of a flexible management system in response to feedback information actively collected to check or test its performance (in biological, social, and economic terms); 2) The process of improving management effectiveness by learning from the results of carefully designed decisions or experiments.

Adfluvial: Fish migrating between lakes and rivers or streams.

Adipose fin: A small fleshy fin with no rays, located between the dorsal and caudal fins of salmon and steelhead. The adipose fin is often “clipped” on hatchery-origin fish so they can be differentiated from natural-origin fish.

All-H Analyzer: The All-H Analyzer is a Microsoft Excel-based model developed to evaluate salmon management options in the context of the four Hs (habitat, hydro-system, harvest, and hatcheries). The model was developed for hatchery managers to explore implications of different ways of balancing habitat restoration, hatchery practices, harvest, and operation of hydroelectric dams to protect and promote presence of natural-origin salmon and steelhead. Appendix G of the EIS provides additional information on the All-H Analyzer used for this EIS.

Anadromous: Fish that hatch and rear in fresh water, migrate to the ocean to grow and mature, and return to freshwater to spawn.

Analysis area: For the purposes of this EIS, the analysis area is the geographic extent that is being evaluated for each resource. For some resources (e.g., socioeconomics), the analysis area is larger than the project area.

Best management practices (BMPs): Generally, BMPs are defined as: policies, practices, procedures, or structures implemented to mitigate adverse environmental effects. For the purposes of this EIS, the term refers to the BMPs related to hatchery facility effects (intake screening, facility effluent, facility failure, etc.).

Glossary of Key Terms (continued)

Broodstock: A group of sexually mature individuals of a species that is used for breeding purposes as the source for a subsequent generation. The analysis in this EIS distinguishes between broodstock that is of hatchery-origin from broodstock that is of natural-origin.

Bycatch: A fish or other marine species that is caught unintentionally while catching certain target fish species.

Captive breeding hatchery program: A type of conservation hatchery program that collects fish from a natural-origin population, spawns them in a hatchery, and rears the progeny to maturity in captivity.

Columbia River plume: The region of the near-shore Pacific Ocean representing the outflow of the Columbia River. The plume is generally defined by a reduced-salinity contour near the ocean surface of approximately 31 parts per thousand. The plume varies seasonally and annually with discharge, prevailing near-shore winds, and ocean currents. For purposes of this EIS, the Columbia River plume is considered to be off the immediate coast of both Oregon and Washington and to extend outward to the continental shelf.

Composite population: A population made up of both hatchery-origin and natural-origin fish.

Conservation hatchery program: An artificial production program that produces fish primarily or exclusively for conservation rather than for harvest. Conservation programs can vary widely in approach and may be used to prevent extinction, increase the abundance of natural spawners, or to provide fish for reintroductions.

Copepod: Any of numerous minute marine and freshwater crustaceans of the subclass Copepoda, having an elongated body and a forked tail.

Cyprinid: Any of numerous often small freshwater fishes of the family Cyprinidae, which includes minnows and carps. Cyprinids are soft-finned mainly freshwater fishes typically having toothless jaws and cycloid scales.

Dewatering: Typically refers to the immediate downstream habitat effects associated with a water withdrawal action that diverts the entire flow of a stream or river to another location.

Glossary of Key Terms (continued)

Direct take: The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Direct take for hatchery activities includes, for example, the collection of ESA-listed fish (adults and juveniles) for hatchery broodstock, the collection of listed hatchery-origin fish to prevent them from spawning naturally, and the collection of listed fish (juvenile and adult fish) for scientific purposes.

Dissolved oxygen (DO): The amount of oxygen that is dissolved in a particular body of water. The amount of DO can be an important indicator of the condition of the water body.

Distinct population segment (DPS): Under the ESA, the term "species" includes any subspecies of fish or wildlife or plants, and any "distinct population segment" of any species or vertebrate fish or wildlife that interbreeds when mature. The ESA thus considers a DPS of vertebrates to be a "species." The Act does not however establish how distinctness should be determined. Under NMFS policy for Pacific salmon, a population or group of populations will be considered a DPS if it represents an evolutionarily significant unit (ESU) of the biological species. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing DPSs (DPS Policy: 61 Fed. Reg. 4722; February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates. See Box 1-1 in Chapter 1, Purpose of and Need for the Proposed Action.

Diversity: For purposes of this document, diversity is the amount and type of variability in fish characteristics that are under some level of genetic control. In general, the term is applied to life history characteristics and genetic markers. Diversity imparts resiliency to a population in responding to environmental challenges and allows it to adapt to changes in environmental conditions.

Ecological province: The Columbia River basin contains 11 ecological provinces as defined by the Northwest Power and Conservation Council. Each ecological province consists of groups of adjoining subbasins with similar climates and geology.

Economic impact region: In this EIS, information about socioeconomic effects are organized according to economic impact regions. The economic impact regions used in the EIS are as follows: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska.

Glossary of Key Terms (continued)

Endangered species: As defined in the ESA, an endangered species means any species that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA): A United States law that provides for the conservation of endangered and threatened species of fish, wildlife, and plants.

Environmental justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Estuary: The area where fresh water of a river meets and mixes with the salt water of the ocean.

Euphasiids: Tiny crustaceans that resemble shrimp from the genus *Euphausia*.

Evolutionarily significant unit (ESU): A concept NMFS uses to identify distinct population segments of Pacific salmon under the ESA (see Distinct Population Segment). An ESU is a population or group of populations of Pacific salmon that 1) is substantially reproductively isolated from other populations, and 2) contributes substantially to the evolutionary legacy of the biological species. See Box 1-1 in Chapter 1, Purpose of and Need for the Proposed Action.

Ex-vessel value: The price received for a product "at the dock."

Federal Register: The United States government's daily publication of Federal agency regulations and documents, including executive orders and documents that must be published per acts of Congress.

Fingerling: A juvenile fish.

First Nation: A term referring to the aboriginal people located in what is now Canada.

First-order stream: A stream that has no permanent tributaries. A first-order stream is also considered an unforked or unbranched stream.

Fish screen: A fish screen is used to prevent entrainment of salmonids into water diversions or intakes at hatchery facilities.

Fishway: A fishway is any structure or modification to a natural or artificial structure for the purpose of providing or enhancing fish passage.

Fluvial: Fish migrating between rivers.

Forage fish: Small fish that breed prolifically and serve as food for predatory fish.

Glossary of Key Terms (continued)

Fry: Juvenile salmon and steelhead that have absorbed their egg sac and are in an early free-swimming, foraging life stage.

Genetic diversity: See **Diversity**.

Gross economic value: For the purposes of this EIS, gross economic value is a metric used to measure the monetary value to commercial or recreational fishers of catching salmon. The gross economic value of salmon caught by commercial fishers is considered equivalent to the ex-vessel value (i.e., the price received for the product 'at the dock') of the harvest. For recreational fisheries, gross economic value is considered equivalent to the anglers' total willingness to pay for salmon fishing, including out-of-pocket trip expenditures plus any surplus value to anglers over and above these expenditures.

Habitat: The physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal; the place where an organism naturally lives.

Habitat capacity: A category of habitat assessment metrics, including habitat attributes that promote juvenile salmon production through conditions that promote foraging, growth, and growth efficiency, and/or decreased mortality.

Hatchery facility: A facility that supports one or more hatchery programs.

Hatchery operators: The Federal agencies, state agencies, and Native American tribes that operate hatchery programs.

Hatchery-origin fish: A fish that originated from a hatchery facility.

Hatchery-origin spawners (HOS): Hatchery-origin fish spawning naturally.

Hatchery program: A program that artificially propagates fish. Most hatchery programs for salmon and steelhead spawn adults in captivity, raise the resulting progeny for a few months or longer, and then release the fish into the natural environment where they will mature.

Haulout: A site where seals, sea lions, and other marine mammals climb out of water to rest on land.

Headwaters: The source or headwaters of a river or stream is the place from which the water in the river or stream originates.

Hydropower: Electrical power generation through use of gravitational force of falling water at dams.

Glossary of Key Terms (continued)

Implementation measures: A generalized set of measures that hatchery managers could implement, if appropriate, to increase the likelihood that the hatchery programs would meet performance goals. For the purposes of this EIS, these measures include reducing production levels, installing weirs, correcting water quality problems, changing program operational strategy, allowing fish to pass through hatchery-related structures, changing program goals, implementing additional terminal selective fisheries, terminating programs, establishing new hatchery programs. This EIS identifies implementation measures that could be taken under each alternative to help meet performance goals.

Implementation scenario: Because the alternatives in this EIS are goal-oriented and do not identify specific actions that would be taken under each alternative, an implementation scenario was developed for each alternative, as an example, so that potential environmental effects could be analyzed, illustrated, and compared.

Incidental take: An unintentional, but not unexpected, taking.

Integrated hatchery program: A hatchery program that includes natural-origin adults in the program broodstock. Generally, an integrated program intends for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the natural environment.

Interior Columbia Recovery Domain: The Interior Columbia Recovery Domain covers all of the Columbia River basin accessible to anadromous salmon and steelhead upstream of Bonneville Dam.

Isolated hatchery program: A hatchery program that intends for the hatchery-origin population to be reproductively isolated from the natural-origin population. This replaces the term segregated hatchery program that was used in the Draft EIS.

Jacks: Precocious or early maturing salmon or steelhead; most are males.

Limiting factors: Physical, chemical, or biological features that impede species and their independent populations from reaching a viable status.

Macroinvertebrates: Invertebrates that are of visible size, such as clams and worms.

Mainstem: The principle channel of a drainage system into which other smaller streams or rivers flow. For the purposes of this EIS, "mainstem" usually refers to the Columbia River as opposed to any of its tributaries.

Glossary of Key Terms (continued)

Masking: Imprecision or bias in assessing the status of natural-origin population attributes, such as abundance and productivity, caused by the presence of hatchery-origin fish in the population. Masking can be caused either by not being able to identify hatchery fish, or by the effects of the hatchery fish on the population, such as increased total abundance due to hatchery fish spawning in the wild.

Mitchell Act: The Mitchell Act was enacted in 1938 to provide for the conservation of the fishery resources of the Columbia River, establishment, operation, and maintenance of one or more stations in Oregon, Washington, and Idaho, and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes.

Mitchell Act production: References in this EIS to "Mitchell Act production," "production under the Mitchell Act," or similar phrases are intended to mean production that is funded by Congressional appropriations authorized by the Mitchell Act.

Monitoring, evaluation, and reform (MER): Mitchell Act MER is a component of the Mitchell Act hatchery program used to: 1) monitor the natural-origin populations in the areas where Mitchell Act hatchery programs operate, 2) evaluate the performance of the hatchery programs toward meeting the program objectives for performance and affect level, and 3) incorporate necessary elements of hatchery reform into the management of Mitchell Act hatchery programs, e.g., natural-origin broodstock collection, weir operations, surveys for hatchery-origin fish on natural spawning grounds.

Mouth of river: The location where a river flows into a larger body of water. For the Columbia River, the mouth of the river is where it meets the Pacific Ocean.

National Marine Fisheries Service (NMFS): A United States agency within the National Oceanic and Atmospheric Administration and under the Department of Commerce charged with the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems.

National Pollutant Discharge Elimination System (NPDES): A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation.

Native fish: Fish that are endemic to or limited to a specific region.

Glossary of Key Terms (continued)

Natural-origin fish: "Natural-origin," "natural," and "wild" are terms used interchangeably throughout this document to refer to fish that are offspring of parents that spawned in the natural environment rather than the hatchery environment unless specifically explained otherwise in the text.

Natural-origin spawners (NOS): Natural-origin fish spawning naturally.

Net economic value: Net economic value for commercial fisheries is the gross economic value received by vessel operators and fish processors minus costs (including wages), operational expenses (such as fuel and equipment), and fixed costs (such as insurance and depreciation).

Nonindigenous fish: A fish species that is occurring outside its native distributional range. May also be referred to as invasive or non-native species.

Outmigration: The downstream migration of salmon and steelhead toward the ocean.

Parts per million (ppm): The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations.

Performance goals: Performance goals are broad goals for hatchery programs related to their effects on natural-origin salmon and steelhead populations. Two performance goals are used in this EIS: stronger and intermediate.

> **Stronger performance goals** would maintain or promote beneficial effects and minimize adverse effects of hatchery programs on salmon and steelhead populations when compared to baseline conditions.
>
> **Intermediate performance goals** would, in most cases, reduce the adverse effects of many hatchery programs on salmon and steelhead populations when compared to baseline conditions.

Performance metrics: For the purposes of this EIS, performance metrics are identified for each performance goal so that the effects of an implementation scenario (one example of an alternative policy direction) can be analyzed. Performance metrics apply to the populations that are being affected by the hatchery programs. Performance metrics include four measurements: estimated natural-origin spawner abundance; estimated mean adjusted population productivity; resulting PNI; and/or resulting pHOS.

Glossary of Key Terms (continued)

pH: A measure of the relative acidity or alkalinity of a solution, expressed on scale from 0 to 14, with the neutral point at 7.0. Acid solutions have pH values lower than 7.0, and basic (i.e., alkaline) solutions have pH values higher than 7.0.

pHOS: Proportion of naturally spawning salmon or steelhead that are hatchery-origin fish.

Piscivorous: An animal that eats fish.

Planktivorous: An animal, such as a fish, that eats plankton.

Plume: See **Columbia River plume**.

pNOB: The proportion of a hatchery program's broodstock that is made up of natural-origin fish.

Policy direction: The overall subject of this EIS. The policy direction will guide and shape decisions made by NMFS related to Mitchell Act hatchery production in the Columbia River Basin, defined by a series of goals and/or principles.

Polychlorinated biphenyls (PCBs): A group of synthetic, toxic industrial chemical compounds that are chemically inert and not biodegradable; they once were used in making paint and electrical transformers.

Polycyclic aromatic hydrocarbons (PAHs): A group of more than 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat.

Population: A group of fish of the same species that spawn in a particular locality at a particular season and does not interbreed substantially with fish from any other group. See Box 1-4 in Chapter 1, Purpose of and Need for the Proposed Action.

> **Primary Populations**, as established by the Washington Lower Columbia Salmon Recovery and Fish and Wildlife Plan (2004), adopted by the Hatchery Scientific Review Group (2009), and utilized in this EIS, are targeted for restoration to high or very high viability. These populations are the foundation of salmon recovery. Primary populations are typically the strongest extant populations and/or those with the best prospects for protection or restoration.

Glossary of Key Terms (continued)

Contributing Populations, as established by the Washington Lower Columbia Salmon Recovery and Fish and Wildlife Plan (2004), adopted by the Hatchery Scientific Review Group (2009), and utilized in this EIS, are those populations for which some improvement will be needed to achieve medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.

Stabilizing Populations, as established by the Washington Lower Columbia Salmon Recovery and Fish and Wildlife Plan (2004), adopted by the Hatchery Scientific Review Group (2009), and utilized in this EIS, are those populations that would be maintained at current levels. These are typically populations currently at very low viability. Stabilizing populations might include those where significance is low, feasibility of improvement is low, and uncertainty is high.

Preferred alternative: The "agency's preferred alternative" is the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors...It is identified so that agencies and the public can understand the lead agency's orientation (Council on Environmental Quality. 1981. Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations).

Productivity (PROD): The rate at which a population is able to produce reproductive offspring.

Project area: Geographic area where the proposed action will take place.

Proportionate natural influence (PNI): PNI is a metric used as an indicator of the genetic influence through interbreeding of the hatchery-origin component of a population with the natural-origin component of a population. Computationally it is a function of both the proportion of naturally spawning salmon or steelhead that are hatchery-origin fish (pHOS) and the proportion of a hatchery program's broodstock that is made up of natural-origin fish (pNOB). It may also include an adjustment for the assumed spawning effectiveness of the hatchery-origin fish spawning naturally.

Recovery domain: An administrative unit for recovery planning defined by NMFS based on ESU/DPS boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed ESUs.

Glossary of Key Terms (continued)

Recovery plan: A recovery plan is prepared for each species listed under the Endangered Species Act. A recovery plan identifies recovery objectives and how to meet these objectives for federally listed species. Recovery plans are considered central organizing tools for guiding each species' recovery process.

Recruitment: The number of fish that enter the harvestable stock due to growth and/or migration.

Reference area: A reference area is used in an environmental justice analysis. It is the area used as a benchmark of comparison when identifying whether a target population has a minority or low-income population that may be subject to disproportionate environmental or economic effects.

Resident fish: Fish that reside in freshwater throughout their life cycle.

Rotifer: Minute aquatic multicellular organisms having a ciliated wheel-like organ for feeding and locomotion; constituents of freshwater plankton.

Run: In the Columbia River Basin, a "run" of salmon is defined by the season they return as adults to the mouth of the Columbia River.

Salmonids: Fish of the family Salmonidae, which includes salmon and steelhead.

Scoping: An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

Section 7 consultation: Section 7 of the ESA requires Federal agencies to consult with NMFS or USFWS (dependent on agency jurisdiction) on any actions that may affect listed species.

Section 10 permit: Section 10(a)(1)(A) of the ESA authorizes the NMFS or USFWS (dependent on agency jurisdiction) to issue permits for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species.

Selective fisheries: Fisheries that target specific fish or fish runs. Selective fisheries often target hatchery-origin fish.

Smolts: Juvenile salmonids that have left their natal stream and are headed downriver toward the ocean.

Smoltification: Refers to those physiological changes anadromous salmonids and trout undergo in freshwater while migrating to saltwater that allow them to live in the ocean.

Glossary of Key Terms (continued)

Spatial structure: The spatial structure of a population refers both to the spatial distributions of individuals in the population and the processes that generate that distribution.

Stray (Straying): For purposes of this EIS, straying refers exclusively to fish spawning in non-natal areas as a result of the effects of weir operations on their spawning migration, such as swimming to another stream to avoid a weir or being trapped and passed above the weir.

Sympatric: Occupying the same or overlapping geographic areas without interbreeding.

Target area: A target area is used in an environmental justice analysis. It is the geographical study area that is potentially affected by EIS alternatives. The target area is compared to a reference area (a benchmark) to determine if there is a substantially larger minority or low-income population within the target area.

Terminal fishery: For the purposes of this EIS, terminal fishery is a fishery that takes place in the last portion of the freshwater migration route of fish returning spawn.

Thalweg: The deepest part of the stream that carries water during low-flow conditions.

Threat: A human action or natural event that causes or contributes to limiting factors; threats may be caused by past, present, or future actions or events.

Threatened species: As defined by Section 4 of the ESA, a threatened species means any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Total maximum daily load (TMDL): A calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards.

Tributary: A stream or river that flows into a larger stream or river.

Turbidity: The amount of solid particles that are suspended in water and that cause light rays shining through the water to scatter. Thus, turbidity makes water cloudy or even opaque in extreme cases.

Viability: As used in this document, a measure of the status of anadromous salmonids that uses four performance criteria: abundance, productivity, spatial distribution, and diversity.

Glossary of Key Terms (continued)

Viable salmonid population (VSP): A population of Pacific salmon or steelhead that has a negligible risk of extinction over a 100-year timeframe. The VSP concept consists of four measurable indicators of population health: abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members cross a subbasin or subbasins).

Water intake screen: A screen used to prevent entrainment of salmonids into a water diversion or intake. Also see **fish screen**.

Weir: For the purposes of this EIS, a weir is a structure placed across a stream, permanently or seasonally, to regulate the upstream migration of adult salmon or steelhead.

Wild fish: See **natural-origin fish**.

Willamette/Lower Columbia Recovery Domain: The Willamette/Lower Columbia Recovery Domain encompasses the Columbia River basin downstream of the Hood River in Oregon and the White Salmon River in Washington.

Zone 1 through 5 fisheries: The statistical zones of the Columbia River commercial fishing area downstream from Bonneville Dam, as defined in Section 635 042 0001 of the Oregon Administrative Rules. Zones 1 through 5 encompass the Columbia River mainstem easterly of a line projected from the knuckle of the south jetty on the Oregon bank to the inshore end of the north jetty on the Washington bank, and westerly of a line projected from a deadline marker on the Oregon bank (approximately 4 miles downstream from Bonneville Dam Powerhouse 1) in a straight line through the western tip of Pierce Island, to a deadline marker on the Washington bank at Beacon Rock.

Zone 6 fisheries: The statistical zone of the Columbia River treaty Indian commercial fishing area upstream from Bonneville Dam running from Bonneville to McNary Dams.

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Science, Service, Stewardship

Chapter 1

Purpose of and Need for the Proposed Action

1 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 Introduction

Congress enacted the Mitchell Act (16 United States Code [USC] 755-757) in 1938 for the conservation of anadromous (salmon and steelhead) fishery resources in the Columbia River Basin (defined as all tributaries of the Columbia River in the United States [U.S.] and the Snake River Basin). The Mitchell Act was one of several Federal acts passed in the 1930s and 1940s, that led to the Federal government's development of Columbia River water resources for major irrigation, flood retention, and hydroelectric projects (Section 1.5.1, Hatchery Facilities in the Columbia River Basin) (http://www.nwcouncil.org/history/DamsHistory).

The Mitchell Act authorized the establishment, operation, and maintenance of one or more hatchery facilities in the states of Oregon, Washington, and Idaho, scientific investigations to facilitate the conservation of the fishery resource, and "all other activities necessary for the conservation of fish in the Columbia River Basin in accordance with law." While the Mitchell Act provided the authority for the conservation of fishery resources in the Columbia River, Congress must appropriate funds to implement it.

Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities (referred to in this environmental impact statement [EIS] as Mitchell Act hatchery facilities). Each year, Congress allocates specific portions of the money appropriated for the Mitchell Act to hatchery operations. The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, currently distributes these appropriations to the operators of 62 hatchery programs that annually produce more than 63 million salmon and steelhead. Historically, Mitchell Act production levels have been as high as 128.6 million juvenile fish annually, but these levels have been substantially reduced as inflation, maintenance, federal budget reductions, and other costs have reduced the amount of funding available for fish production.

Beginning in 1991, NMFS listed eight evolutionarily significant units (ESUs)[1] of salmon and five distinct population segments (DPSs) of steelhead in the Columbia River Basin under the Endangered Species Act (ESA) (i.e., 13 ESUs/DPSs total) (Box 1-1) (Table 1-1).

Box 1-1. What is an ESU? What is a DPS?

Under ESA, NMFS lists salmon as threatened or endangered according to the status of the ESU. An ESU is a population or a group of populations that 1) is substantially reproductively isolated from other groups of populations of the same species and 2) represents an important component of the evolutionary legacy of the species. See http://www.nwfsc.noaa.gov/trt/glossary.cfm#E for formal definitions of ESA-related terms used by NMFS.

Steelhead are listed under ESA in accordance with the joint NMFS-U.S. Fish and Wildlife Service (USFWS) policy for recognizing DPSs under ESA (61 Fed. Reg. 4722, February 7, 1996). This policy is similar to and consistent with the ESU policy. Under the policy, steelhead constitute a DPS when they are “markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors” (61 Fed. Reg. 4722, February 7, 1996). NMFS lists steelhead according to the status of their DPS.

Under ESA, NMFS must make ongoing determinations about how hatchery operations, including Mitchell Act-funded hatcheries, affect ESUs and DPSs listed as threatened or endangered. Analyses of site-specific effects of hatchery production on listed species are not provided in this EIS. These analyses will occur during a site-specific ESA determination process for hatchery programs seeking ESA authorization.

[1] NMFS administers the Federal Endangered Species Act (ESA) for salmon and steelhead. Rather than focusing on salmon populations in its ESA listings, NMFS specifically lists salmon ESUs. An ESU represents a population segment or group of populations that is considered distinct because 1) it is substantially reproductively isolated from other groups of populations of the same species, and 2) it represents an important component in the evolutionary legacy of the biological species. An ESU qualifies as a species under ESA. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing distinct population segments (DPSs) (61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates (Box 1-1).

TABLE 1-1. ESA STATUS OF COLUMBIA RIVER BASIN SALMON AND STEELHEAD.

SPECIES	ESU/DPS	CURRENT ESA LISTING STATUS
Sockeye salmon (*Oncorhynchus nerka*)	Snake River	Endangered (76 Fed. Reg. 50448, August 15, 2011)
Chinook salmon (*O. tshawytscha*)	Upper Columbia River Spring-run	Endangered (76 Fed. Reg. 50448, August 15, 2011)
	Snake River Spring/Summer-run	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Upper Columbia River Summer/Fall-run	Not Listed
	Snake River Fall-run	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Middle Columbia River Spring-run	Not Listed
	Deschutes River Summer/Fall-run	Not Listed
	Lower Columbia River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Upper Willamette	Threatened (76 Fed. Reg. 50448, August 15, 2011)
Coho salmon (*O. kisutch*)	Lower Columbia River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
Chum salmon (*O. keta*)	Columbia River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
Steelhead (*O. mykiss*)	Upper Columbia River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Snake River Basin	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Middle Columbia River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Upper Willamette River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Lower Columbia River	Threatened (76 Fed. Reg. 50448, August 15, 2011)
	Southwest Washington	Not Listed

Source: NMFS

The analyses within the EIS will inform NMFS, hatchery operators, and the public about the current and anticipated cumulative environmental effects of operating Columbia River Basin salmon and steelhead hatchery programs, both Mitchell Act-funded and programs not funded under the Mitchell Act, under a full range of alternatives. The analyses will enable NMFS to consider the likely effects of distributing Mitchell Act hatchery funding to program recipients basinwide. The alternatives evaluated in this EIS, although structured differently, are each designed to reduce or minimize adverse effects of hatchery operations on natural-origin salmon and steelhead populations, compared to the baseline, while hatchery operators continue to pursue not only the conservation or harvest goals that currently apply to each hatchery program, but also different or additional conservation and harvest goals as identified within the alternatives. NMFS anticipates that the resource effects analyzed in this EIS will be informative for policy decisions for approximately 10 years. Site-specific resource conditions may change during the 10-year period and will be assessed as hatchery operators seek ESA compliances.

1.1.1 The Mitchell Act

The Mitchell Act was enacted in 1938 for the conservation of fishery resources in the Columbia River (Box 1-2). The Mitchell Act authorized the establishment, operation, and maintenance of hatchery facilities in the states of Oregon, Washington, and Idaho, scientific investigations to facilitate the conservation of the fishery resource, and "all other activities necessary for the conservation of fish in the Columbia River Basin in accordance with law." This EIS addresses the distribution of Mitchell Act hatchery funds for the operation of hatchery facilities in the Columbia River Basin.

Box 1-2. What is the specific text of the Mitchell Act?

To provide for the conservation of the fishery resources of the Columbia River, establishment, operation, and maintenance of one or more stations in Oregon, Washington, and Idaho, and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the Secretary of the Interior[2] is authorized and directed to establish one or more salmon-cultural stations in the Columbia River Basin in each of the States of Oregon, Washington, and Idaho. Any sums appropriated for the purpose of establishment of such stations may be expended, and such stations shall be established, operated, and maintained, in accordance with the provision of the Act entitled "An Act to provide for a five-year construction and maintenance program for the United States Bureau of Fisheries," approved May 21, 1930, insofar as the provisions of such Act are not inconsistent with the provisions of this Act.

[2] Administration of the Mitchell Act was later transferred to the Secretary of the Department of Commerce upon creation of NOAA in 1970.

Box 1-2. What is the specific text of the Mitchell Act? (continued)

Sec. 2. The Secretary of the Interior is further authorized and directed 1) to conduct such investigations, and such engineering and biological surveys and experiments, as may be necessary to direct and facilitate conservation of the fishery resources of the Columbia River and its tributaries; 2) to construct and install devices in the Columbia River Basin for the improvement of feeding and spawning conditions for fish, for the protection of migratory fish from irrigation projects, and for facilitating free migration of fish over obstructions; and 3) to perform all other activities necessary for the conservation of fish in the Columbia River Basin in accordance with law.

Sec. 3. In carrying out the authorizations and duties imposed by Section 2 of this Act, the Secretary of the Interior is authorized to utilize the facilities and services of the agencies of the States of Oregon, Washington, and Idaho responsible for the conservation of the fish and wildlife resources in such States, under the terms of agreements entered into between the United States and these States, without regard to the provisions of Section 3709 of the Revised Statutes, and funds appropriated to carry out the purposes of this Act may be expected for the construction of facilities on and the improvement of lands not owned or controlled by the United States; Provided, That the appropriate agency of the State wherein such construction or improvement is to be carried on first shall have obtained without cost to the United States the necessary title to, interest therein, right-of-way over, or licenses covering the use of such lands.

Approved May 11, 1938 (Public Law [PL] 75-502) and amended on August 8, 1946 (PL 79-676).

Mitchell Act funding began in 1938 when Congress appropriated $500,000 to support the Act's intent. This appropriation recognized that from 1905 to 1931, inclusive, the government had received more than $500,000 from the lease of seining grounds on Sand Island and Peacock Spit at the mouth of the Columbia River (Laythe 1950). This money was used to assemble data on salmon and steelhead populations in Columbia River tributaries and to compile a catalog of unscreened diversions, impassible waterfalls, log and debris jams, splash dams, and pollution sources (NMFS 1981).

In 1946, Congress amended the Mitchell Act (PL 79-676) to allow additional appropriations to further fund the intent of the Act. Congress also authorized the Secretary of the Interior to use facilities and services in Oregon, Washington, and Idaho.

In 1947, the Lower Columbia River Fisheries Development Program (the term “lower” meant below the McNary Dam) was established to carry out the mandates of the Mitchell Act. Between 1949 and the early 1960s, the Lower Columbia River Fisheries Development Program constructed or improved 22 hatchery facilities with Mitchell Act funds (Box 1-3) (Table 1-2). Several of those facilities are no longer funded under the Mitchell Act.

Box 1-3. What is the difference between fish hatchery programs and fish hatchery facilities?

The terms *hatchery* and *hatchery programs* are often used interchangeably. Both are discussed in this EIS, so a clarification is provided.

A “hatchery” is a physical facility that rears fish, while a “hatchery program” is one unit of production at a hatchery, i.e., the Carson National Fish Hatchery (NFH) spring Chinook salmon program. Here, the Carson NFH is the “hatchery,” and the “hatchery program” produces spring Chinook salmon.

Hatchery facilities include both hatcheries and ancillary facilities (such as acclimation ponds and rearing ponds) that support hatchery programs. Currently there are more than 80 hatchery facilities in the Columbia River Basin that house 177 individual salmon or steelhead hatchery programs (Section 1.5.1, Hatchery Facilities in the Columbia River Basin).

Initially Oregon and Washington were the only states actively engaged in the Lower Columbia River Fisheries Development Program. In 1956, however, Congress instructed that the program be activated above McNary Dam, and Idaho became a participant in 1957. At this time, the word “Lower” was dropped from the program name.

TABLE 1-2. HATCHERY FACILITIES CONSTRUCTED OR IMPROVED USING MITCHELL ACT FUNDS.

HATCHERY FACILITY (LOCATION)	GENERAL LOCATION	FIRST YEAR OF OPERATION	CURRENT FUNDING AGENCY
Abernathy	Longview, WA	1959	NMFS, USFWS
Beaver Creek	Cathlamet, WA	1958	NMFS
Carson	Carson, WA	1932	NMFS, USFWS
Elochoman	Cathlamet, WA	1954	NMFS (closed 2009)
Grays River	Grays River, WA	1961	NMFS
Kalama Falls	Kalama, WA	1959	NMFS
Klickitat	Glenwood, WA	1950	NMFS
Little White Salmon	Cook, WA	1898	NMFS, USFWS
Willard	Cook, WA	1951	NMFS, USFWS
Skamania	Washougal, WA	1956	NMFS, WDF
Spring Creek	Underwood, WA	1901	NMFS, USACE, USFWS
Toutle	Toutle, WA	1952	NMFS
Washougal	Washougal, WA	1958	NMFS
Big Creek	Knappa, OR	1938	NMFS, ODFW
Bonneville	Bonneville, OR	1909	NMFS, USACE, ODFW
Cascade	Cascade Locks, OR	1958	NMFS
Clackamas	Estacada, OR	1979	ODFW, NMFS, PGE
Eagle Creek	Estacada, OR	1957	NMFS
Gnat Creek	Westport, OR	1960	NMFS
Klaskanine	Astoria, OR	1911	NMFS, ODFW
Oxbow	Cascade Locks, OR	1938	NMFS, ODFW
Sandy	Sandy, OR	1950	NMFS

Source: NMFS 1981

When NMFS was listed as a funding agency, Mitchell Act funds were used. In addition to the hatchery facilities included in Table 1-2, several rearing ponds were constructed using Mitchell Act funds, Five of the rearing ponds were constructed in Washington (Alder Creek, Big White Salmon, Gobar, Ringold Salmon, and Ringold Trout), one in Oregon (Wahkenna), and two in Idaho (Decker Flats and Pahsimeroi).

WDF: Washington Department of Fisheries; USACE: U.S. Army Corps of Engineers; ODFW: Oregon Department of Fish and Wildlife; PGE: Portland General Electric

In 1970, administration of the Mitchell Act was transferred from the Department of the Interior to the Department of Commerce. Today, NMFS administers the Columbia River Fisheries Development Program, which consists of two subprograms:

1. **Mitchell Act Artificial Production (Hatchery) Program**
   - Operation of 62 hatchery programs with an annual release of more than 63 million juvenile salmon and steelhead in Oregon, Washington, and Idaho. This includes the basic hatchery operational elements (e.g., administration, personnel, fish food, utilities) needed to run the facilities and programs.
   - Maintenance of the hatchery facilities and their associated equipment.

- Monitoring, evaluation, and reform (MER) to incorporate new and improved information and technologies.
- Fish marking (e.g., adipose fin clips, coded-wire tagging, electronic tags, and other marking devices).
- Implementation of hatchery reform activities such as broodstock management (controlling hatchery-origin, adult-spawning-ground numbers and incorporating natural-origin adults into the hatchery broodstock); spawning ground surveys for hatchery-origin spawner proportion estimates; hatchery facility improvements for fish passage, screening, and pollution abatement; and selective fishery gear research.

2. Mitchell Act Screens and Fishways Program

- Construction, operation, and maintenance of more than 700 fish screens at irrigation diversions to protect juvenile salmon and steelhead in Oregon, Washington, and Idaho
- Ongoing operations and maintenance of 90 fishways to enhance adult fish passage to nearly 2,000 miles of stream habitat in Oregon, Washington, and Idaho

In recent years, Congress annually appropriated funds under the authority of the Mitchell Act in categories that correspond with the Administration's budget request to address operation of hatchery programs separately from funds appropriated for the screens and fishways program. This EIS addresses only NMFS allocation of funds appropriated for the Mitchell Act hatchery program. In the past 10 years, Congress has appropriated funds used for hatchery production under two to four broad categories. These categories are Columbia River hatcheries; conservation marking; monitoring, evaluation, and reform; and fall Chinook salmon rearing (Table 1-3). Each year, NMFS allocates these funds to the hatchery operators. NMFS works with hatchery operators to identify appropriate program goals to ensure that funds used are consistent with the authority Congress established in the Mitchell Act for conserving fishery resources in the Columbia River Basin.

TABLE 1-3. MITCHELL ACT HATCHERY APPROPRIATION LEVELS (IN THOUSANDS OF U.S. DOLLARS).

	FISCAL YEAR											
HATCHERY ACTIVITY	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Columbia River Hatcheries/ Mitchell Act Operations[1]	11,455	11,457	11,457	11,457	11,292	11,292	11,300	10,836	10,782	11,066	11,066	10,906
Conservation Marking/Marking Funds[2]	300		2,690									
Monitoring, Evaluation, and Reform[3]	1,700	1,700	1,700	1,700	1,200	1,200	1,162	1,184	1,689	1,678	1,678	1,696
Fall Chinook Salmon Rearing[4]	600											
Hatchery Reform[5]									2,420	9,972	2,400	5,848
TOTAL	**14,055**	**13,157**	**15,847**	**13,157**	**12,492**	**12,492**	**12,462**	**12,021**	**14,891**	**22,716**	**15,144**	**18,450**

Source: NMFS, updated from the 1997-2009 range presented in the draft EIS.

[1] Congress used two different terms, “Mitchell Act Operations” and “Columbia River Hatcheries,” to indicate that funds should be used for fish food, water, electricity, etc., in support of individual hatchery programs.

[2] Congress used two different terms, “Conservation Marking” and “Marking Funds,” to indicate monies that should be used for marking hatchery-origin fish (adipose fin clip, passive integrated transponder (PIT) tags, etc.). In Fiscal Year 2003, there was also a line item, Marking Trailers-Idaho.

[3] MER money had been included under the Mitchell Act Operations line item before Fiscal Year 2001.

[4] Fall Chinook Salmon Rearing was a line item that was found only in the Fiscal Year 2001 budget.

[5] These funds were appropriated for hatchery reform projects and improvements.

Appropriation levels have been rounded to the nearest thousand dollars.

1.1.2 The Endangered Species Act

The Endangered Species Act of 1973 (16 USC 1531) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range and the conservation of the ecosystems on which they depend. The purposes of the ESA are 1) to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved and 2) to provide a program for the conservation of such endangered species and threatened species. A species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future.

NMFS and USFWS (collectively referred to as the Services) share responsibility for implementing the ESA. Generally, USFWS has authority for land and freshwater species, while NMFS has authority under ESA for marine and anadromous species such as salmon and steelhead. There are currently eight salmon ESUs and five steelhead DPSs in the Columbia River Basin that are federally listed as threatened or endangered (Table 1-2) (Box 1-2) (Box 1-4).

Box 1-4. What is NMFS' policy on listing hatchery-origin fish under ESA?

The viability of salmon and steelhead is defined by their abundance, productivity, spatial structure, and genetic/behavioral diversity. High abundance alone is not adequate to demonstrate viability of a salmon ESU or steelhead DPS (Box 1-1).

NMFS' 1993 interim policy on artificial propagation of Pacific salmon stated that hatchery-origin fish should be listed only if they were essential to the conservation of the species. In 2001, however, the U.S. District Court in Oregon ruled that any hatchery-origin component that is part of a listed ESU must also be listed under ESA (*Alsea Valley Alliance v. NMFS*, 161 F. Supp. 2d 1154, [D. Or. 2001]). NMFS subsequently modified its hatchery policy to conform to this ruling (70 Fed. Reg. 37204, June 28, 2005). NMFS' revised hatchery listing policy proposes that "hatchery stocks be considered part of an ESU [DPS] if they exhibit a level of genetic divergence relative to local natural populations that is no more than what would be expected between closely related populations within the ESU" (70 Fed. Reg. 37204, June 28, 2005).

The revised hatchery listing policy was upheld by the 9th Circuit in *Trout Unlimited v. Lohn*, 559 F3d 946 (2009). NMFS has identified salmon and steelhead hatchery programs that are currently included as part of the listed ESUs or DPSs in the Columbia River Basin (Jones 2011).

With ESA listings and a substantial regional focus on recovering natural-origin salmon and steelhead populations throughout the Columbia River Basin (Box 1-5), changes in hatchery practices have been and will continue to be implemented to accentuate the benefits and to reduce the risks of hatchery programs on natural-origin salmon and steelhead populations (Section 1.5.2, Other Reviews of Columbia River Basin Hatchery Programs; Box 1-5).

Box 1-5. What are recovery plans? What are primary, contributing, and stabilizing populations?

NMFS is required, pursuant to section 4(f) of the ESA, to develop recovery plans for marine species listed under ESA. Recovery plans are required, to the maximum extent practicable, to incorporate a description of site-specific management actions needed to achieve conservation and survival of the species; incorporate objective, measureable criteria that, when met, would result in a determination that the species be removed from the list; and include estimates of the time and cost to carry out the needed measures.

A recovery plan serves as a road map for species recovery; it identifies recovery objectives and describes how best to meet them. Without a plan to organize, coordinate, and prioritize the many possible recovery actions on the part of Federal, state, and tribal agencies; local watershed councils and districts; and private citizens, recovery efforts may be inefficient or even ineffective. Prompt development and implementation of a recovery plan will help target limited resources effectively. Although recovery plans are guidance, not regulatory documents, the ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process.

While NMFS is directly responsible for ESA recovery planning for salmon and steelhead, it believes that ESA recovery plans for these species should be based on the many state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species and whose actions will be most affected by recovery efforts is essential. NMFS, therefore, supports and participates in locally led collaborative efforts to develop recovery plans that involve local communities; state, tribal, and Federal entities; and other stakeholders.

While the primary goal of ESA recovery plans is for the species to reach the point at which it no longer needs the protection of the Act and can be delisted, these locally developed recovery plans may also contain broad-sense goals that go beyond the requirements for delisting to address other legislative mandates or social, economic, and

Box 1-5. What are recovery plans? What are primary, contributing, and stabilizing populations? (continued)

ecological values. The various locally produced plans contain broad-sense goals adopted by local planning entities. These broad-sense goals, although stated in slightly different ways, usually share some combination of the following elements: ensuring long-term persistence of viable populations of natural-origin salmon and steelhead distributed across their native range (viability criteria), enjoying the social and cultural benefits of meaningful harvest opportunities that are sustainable over the long term, and pursuing salmon recovery using an open and cooperative process that respects local customs and benefits local communities and economies. Recovery plans for the Columbia River Basin can be found at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/. For a discussion of viability criteria, see McElhaney et al. (2006) at http://www.nwfsc.noaa.gov/trt/wlc/viability_report_revised.cfm.

In each recovery domain[3], NMFS established a technical recovery team responsible for, among other things, developing scientific recommendations on how populations and subpopulations within an ESU could be managed at different levels of risk depending on their significance while ensuring recovery. The initial recovery plan developed in the Columbia River Basin was by Washington's Lower Columbia Fish Recovery Board (LCFRB). This plan included a recovery scenario that designated individual populations according to the level of recovery contribution for the population (Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan [LCFRB 2004]). The Hatchery Scientific Review Group (HSRG) and this EIS have adopted the designations of the LCFRB. The designations used by the LCFRB are as follows:

Primary Populations. Targeted for restoration to high or very high viability. These populations are the foundation of salmon recovery. Primary populations are typically the strongest extant populations and/or those with the best prospects for protection or restoration.

Contributing Populations. Those for which some improvement will be needed to achieve medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.

[3] For discussion of recovery domains and other geographic designations, see Section 2.2, Description of Project Area.

Box 1-5. What are recovery plans? What are primary, contributing, and stabilizing populations? (continued)

Stabilizing Populations. Those that would be maintained at current levels. These are typically populations currently at very low viability. Stabilizing populations might include those where significance is low, feasibility of improvement is low, and uncertainty is high.

Not all recovery plans for salmon and steelhead utilize this same hierarchical structure to identifying recovery goals for listed populations. NMFS utilizes this structure in this EIS much in the same way as the HSRG did, as a method to bring uniformity to this basinwide analysis and to show the likely effects of assigning different goals for the populations.

In each major region in the Columbia River Basin, tribes, states, local groups, counties, and municipalities are working with NMFS to develop and implement regional recovery plans for the conservation and survival of listed species (Box 1-5). These recovery plans describe specific management actions needed to achieve recovery as defined under ESA, and they include management actions that affect hatchery programs. This EIS includes many of these specific management actions within its alternatives.

1.2 Purpose and Need for Action

As stated in Section 1.1, Introduction, the combination of funding pressures under the Mitchell Act and the ESA listings of 13 salmon and steelhead ESU/DPSs in the Columbia River Basin have resulted in the need for NMFS' proposed action. NMFS' purpose for the action is to develop a policy direction (Box 1-6) related to Mitchell Act hatchery funding that will guide its decisions about the distribution of funds for hatchery production under the Mitchell Act.

Box 1-6. What is a policy direction?

A policy direction guides and shapes decisions NMFS makes related to funding Mitchell Act hatchery programs in the Columbia River Basin. It is formed by a series of goals and/or principles.

The review of hatchery programs is comprehensive in the sense that information on the effects of all Columbia River Basin hatchery programs (Box 1-7) throughout the basin and across a full range of alternatives is exposed in the EIS. Each alternative identifies a different policy direction that would be used to guide NMFS decisions on Mitchell Act funding priorities for Columbia River Basin hatchery production.

Box 1-7. What is the relationship between NMFS and salmon and steelhead hatchery operators in the Columbia River Basin?

Under the authority of the Mitchell Act, NMFS provides the USFWS, states, and tribes with funds that Congress appropriates to manage and operate hatchery programs. NMFS has broad discretion in using these funds either to prescribe narrowly the way Mitchell Act production programs will be operated or to allow hatchery operator discretion in doing so. Historically, NMFS has provided wide latitude in the use of these hatchery funds. NMFS plans to continue to provide flexibility to hatchery operators with regard to the operation of Mitchell Act-funded hatchery programs, but the agency will develop policy guidance, informed by this EIS, on how the Mitchell Act-funded hatchery programs can best operate.

Salmon and steelhead hatchery programs have the potential to affect ESA-listed populations because at least one species of salmon or steelhead is listed under ESA in all anadromous areas of the Columbia River Basin. Program operators, including Mitchell Act, are required to consult with NMFS when seeking ESA authorizations for hatchery operations.

As a result of this environmental review, NMFS anticipates adopting a policy direction that identifies general goals for it to pursue with regard to Mitchell Act-funded hatchery production.

It is not the purpose of this EIS to determine whether specific actions or hatchery programs meet the requirements of the ESA. These ESA decisions will be made in separate processes consistent with applicable regulations as required by the ESA (Box 1-8).

Box 1-8. What is the relationship between the ESA and the National Environmental Policy Act (NEPA)?

The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a proposed action. However, each law has a distinct purpose, and the scope of review and standards of review under each statute are different. This EIS analysis under NEPA should not be viewed as contributing to a conclusion about whether an alternative meets or does not meet ESA requirements.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a no-action alternative. Public involvement promotes this purpose.

The purpose of the ESA is to conserve listed species and the ecosystems upon which they depend. Determinations about whether Mitchell Act hatchery programs meet ESA requirements will be made under section 4(d), section 7, or section 10 of the ESA. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analysis and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest any conclusions to the reader relative to the ESA. While the record of decision (ROD) identifies the selected NEPA alternative, the ROD does not determine whether that alternative complies with the ESA.

NMFS acknowledges that the analyses of environmental effects on listed species under ESA and under NEPA are similar and can lead to confusion; however, the analyses under these separate statues are not functionally equivalent. Language in this final EIS has been chosen in an effort to minimize the confusion between NEPA and ESA analyses. For instance, “jeopardize,” “endanger,” “recover,” and similar terms are commonly used to describe the effect of actions under an ESA analysis. This EIS avoids using these designations, using instead terms and phrases such as performance goals and performance metrics (Section 2.4, Alternative Development, and Section 2.6, Identifying an Implementation Scenario).

1.3 Decisions to be Made

1.3.1 Preferred Alternative Formulated and Identified in the Final EIS

The draft EIS evaluates a full range of reasonable policy directions available to NMFS to guide the funding on Mitchell Act hatchery programs. Potential implementation scenarios were identified and evaluated for each policy direction so that environmental effects could be analyzed. However, no preferred policy direction was identified in the draft EIS.

NMFS has identified a preferred alternative, informed by public comment on the draft EIS, in this final EIS. The preferred policy direction consists of a combination or blend of the alternative policy directions evaluated in the draft EIS. Information from the public review process was used in developing a preferred policy direction and, therefore, a preferred alternative.

1.3.2 Record of Decision

This final EIS will culminate in a ROD that will record the adoption of a policy direction. The ROD will document the impacts expected to result from the implementation of the policy. The ROD will also identify measures that should be considered by the hatchery operators using Mitchell Act funding. Finally, the ROD will consider comments on the final EIS.

1.3.3 Potential Future Decisions in Response to Hatchery Actions

1.3.3.1 Federal Agency Hatchery Actions Requiring Section 7 Consultation

As mentioned above, section 7 of the ESA requires Federal agencies to consult with NMFS on any actions that they authorize, fund, or carryout that may affect listed salmon and steelhead. Section 7 provides a mechanism to exempt the incidental take of listed species from the prohibitions of section 9 of the ESA, should it be found to occur as a result of an otherwise lawful action. In addition to NMFS, several other Federal agencies fund or operate hatchery programs in the Columbia River Basin (USFWS, USACE, Bonneville Power Administration [BPA], U.S. Bureau of Reclamation [BOR], public utility districts, and private utility companies), and they will have to consult with NMFS. Following consultation on these Federal actions, NMFS will issue a biological opinion addressing whether the action will jeopardize listed species and an incidental take statement that will authorize the incidental take (if appropriate) to the Federal agency.

1.3.3.2 ESA Section 10 Permits and Related Section 7 Consultations

Where take of a listed species is the purpose of the action, regardless of whether the action is by a Federal agency, take must be authorized under ESA. Authorization occurs through either a section 10 take permit or a section 4(d) approval (Section 1.3.3.3, ESA Section 4(d) Rules Limiting the Prohibition against Incidental Take and Related Section 7 Consultations). Section 10(a)(1)(A) of the ESA authorizes NMFS to issue permits for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species. As an example, direct take can occur in a hatchery program when the fish that are taken for broodstock are listed under ESA. ESA section 10(a)(1)(A) permits can be issued to either Federal or non-Federal entities.

Issuances of section 10(a)(1)(A) permits are Federal actions that require consultation under ESA section 7 (Section 1.3.3.1, Federal Agency Hatchery Actions Requiring Section 7 Consultation). As a result, section 10 permits cannot be issued without a completed section 7 consultation.

1.3.3.3 ESA Section 4(d) Rules Limiting the Prohibition against Incidental Take and Related Section 7 Consultations

Section 4(d) of the ESA directs NMFS to issue regulations necessary to conserve species listed as threatened. Through the statute itself or through an existing, broad section 4(d) regulation, NMFS automatically prohibits the take of any species listed as threatened or endangered. Section 4(d) does, however, allow NMFS to adopt regulations that limit the broad application of the prohibition against take when it applies to threatened (but not endangered) species under circumstances specified in the rule, so that an activity described in the rule can lawfully proceed. NMFS has adopted 13 such limits, including two that are applicable to hatchery production (one applying to hatchery production generally and one applying to tribal activities generally) (for a full discussion of section 4(d) limits, see http://www.nwr.noaa.gov/permits/section_4d.html). Each of these limits requires management plans to 1) specify the goals and objectives for the hatchery program, 2) specify the donor population's critical and viable threshold levels, 3) prioritize broodstock collection programs to benefit listed fish, 4) specify the protocols that will be used for spawning and raising the hatchery-origin fish, 5) determine the genetic and ecological effects arising from the hatchery program, 6) describe how the hatchery operation relates to fishery management, 7) ensure that the hatchery facility can adequately accommodate listed fish if collected for the program, 8) monitor and evaluate the management plan to ensure that it accomplishes its objective, and 9) be consistent with tribal trust obligations (65 Fed. Reg. 42422, July 10, 2000). The determination that a hatchery management plan qualifies under the section 4(d) rule is a Federal action that triggers the consultation requirements of ESA section 7. As a result, such determinations cannot be made unless the hatchery management plan for which the approval is requested has been found under section 7 not to jeopardize listed species or result in the destruction or adverse modification of their critical habitat. This EIS analysis will not be a substitute for any ESA analyses and/or determinations.

1.3.3.4 NEPA Requirements for NMFS ESA Determinations under Sections 7, 4(d), or 10 on Hatchery Operations

As described above, hatchery operators in the Columbia River Basin are required to consult with NMFS when seeking ESA authorizations for hatchery operations. Such operations could be authorized under ESA sections 7, 4(d), or 10. Authorizations under ESA section 7 do not require a NEPA review by NMFS. However, authorizations under ESA sections 4(d) and 10 do require a NEPA review of the effects on the human environment, under NEPA, from the proposed hatchery activities. To conduct a NEPA review on a future ESA hatchery action in the same project and analysis area as analyzed in this EIS, NMFS will first assess whether the proposed activities fall within the scope of the actions analyzed in this EIS, whether the affected environment has changed since this EIS was prepared, and whether any new information on potential environmental impacts has become available or could be uncovered by conducting further NEPA analysis. If no new information on impacts would be revealed by a new NEPA review, NMFS may seek to avoid repetitive analyses of the same practices on the same resources in an additional EIS and rely upon information in this EIS to disclose the environmental effects of the proposed hatchery action.

1.4 Project and Analysis Area

The project area is the geographic area where the proposed action will take place. The project area covered in this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River Basin, as well as the Snake River and all other tributaries of the Columbia River in the U.S. (Figure 1-1). This area is inclusive of all currently funded Mitchell Act hatchery actions, as well as areas where future funding of hatchery actions could be considered for funding. The project area also includes the Columbia River estuary and plume. For a full discussion of the project area, see Section 2.2, Description of Project Area.

The analysis area is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. For example, while Alaska is not in the project area, because the alternatives would have varying effects on Alaska fisheries (since hatchery-origin fish produced in the Columbia River Basin are caught in Alaska), it is included in the analysis area for socioeconomics. The analysis area for each resource is described at the beginning of Chapter 3, Affected Environment.

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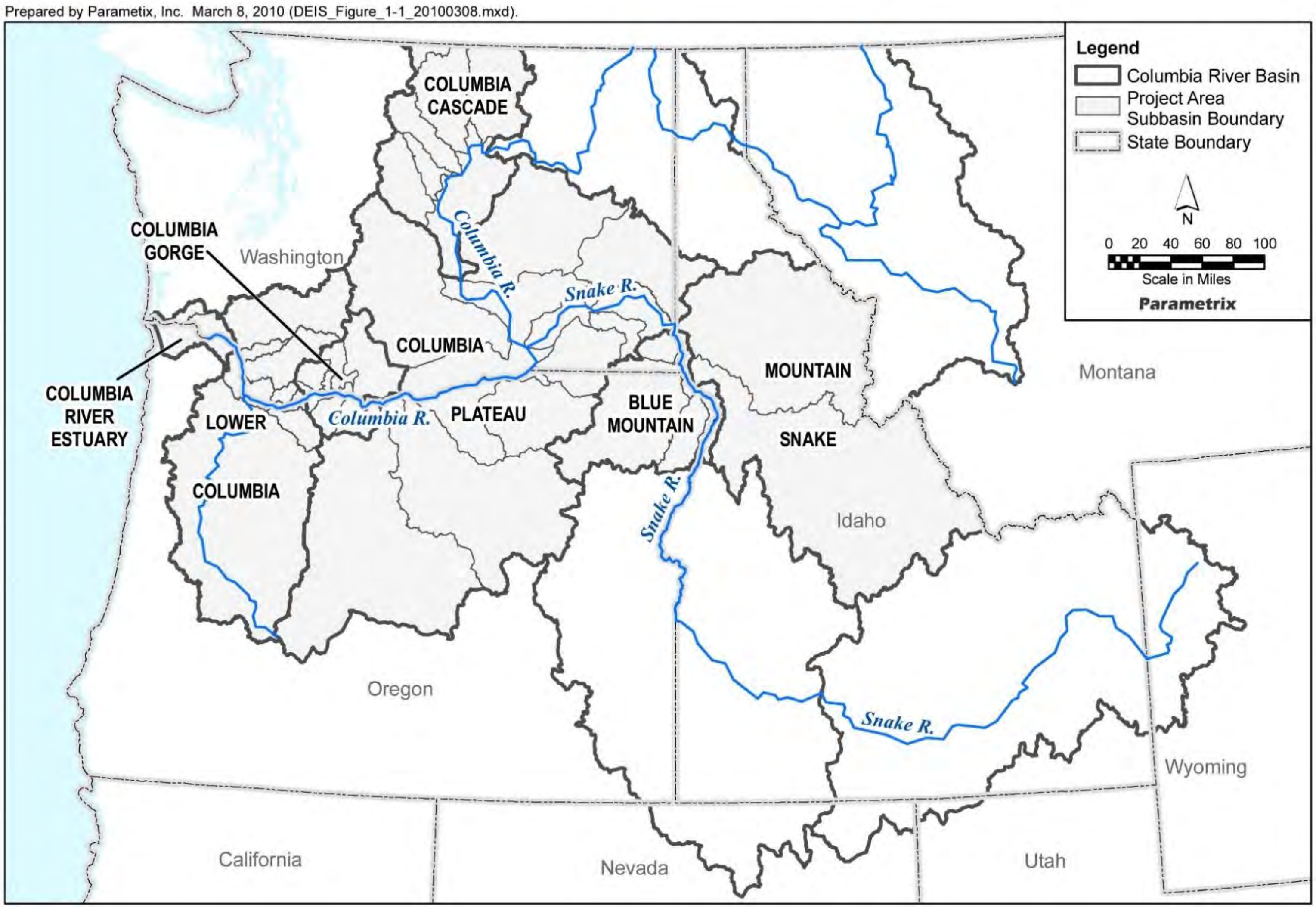

Figure 1-1. Project area by ecological province.

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1.5 Background

1.5.1 Hatchery Facilities in the Columbia River Basin

More than 80 hatchery facilities (including ancillary facilities) for anadromous fish in the Columbia River Basin are operated by Federal and state agencies, tribes, and private interests (Figure 1-2) (Figure 1-3). In 2010, these hatchery facilities supported 177 individual hatchery programs (Table 1-4). Many of the hatchery programs operated at these hatchery facilities are intended to mitigate for lost habitat, mortality of juvenile and adult fish, and other impacts of hydroelectric dams. In 2010, 23 of the hatchery facilities supported one or more hatchery programs fully or partially funded through the Mitchell Act (Table 1-4) (Figure 1-4).

In addition to the hatchery facilities that are home to production programs funded under the Mitchell Act, several other Federal agencies fund Columbia River hatchery production. Hatchery facilities funded under the Lower Snake River Compensation Program are also supported by Federal funds. These hatchery facilities were built to mitigate for the effect of Federal dams on the lower Snake River (Lower Snake River Fish and Wildlife Compensation Plan, Washington and Idaho, March 6, 1985, authorized by the Water Resources Development Act of 1976). The Federal Bureau of Reclamation funds hatchery production to mitigate for the effects of the Grand Coulee Dam. USACE funds substantial hatchery production as mitigation for dams in the mainstem Columbia River and Snake River. Furthermore, the Columbia River Basin Fish and Wildlife Program of the Northwest Power and Conservation Council allocates BPA funding to finance artificial production programs authorized by the Northwest Power Planning and Conservation Act of 1980 (PL 96-501, December 5, 1980). Other hatchery facilities in the Columbia River Basin are funded by private power companies or public utility districts and do not receive Federal funds.

1.5.2 Other Reviews of Columbia River Basin Hatchery Programs

Because of potential adverse effects of hatchery programs on natural salmon and steelhead populations (Section 1.1.2, The Endangered Species Act), Columbia River hatchery programs have undergone several reviews designed to maximize benefits and reduce risks. These reviews have been conducted by Federal and state agencies, tribes, and independent science panels. These reviews have included the following:

- BPA's Regional Assessment of Supplementation (1992) (https://pisces.bpa.gov/release/documents/documentviewer.aspx?pub=P01830-11.pdf)
- BPA's Integrated Hatchery Operations Team (IHOT) (1992) (http://www.nwcouncil.org/media/6876151/IHOT-vol-III.pdf)
- The Northwest Power and Conservation Council's (NPCC's) Artificial Production Review and Evaluation Process (2005) (http://www.nwcouncil.org/media/28959/2004_17.pdf)
- The Ad Hoc Supplementation Work Group (2008) (http://www.nwcouncil.org/fw/program/2008amend/comment?id=444)
- The Columbia River Hatchery Reform Project (HSRG) (2009) (http://www.hatcheryreform.us/hrp/reports/columbia/welcome_show.action)
- USFWS review of its hatchery programs in WA, OR, ID (2013) (http://www.fws.gov/pacific/Fisheries/Hatcheryreview/Reports/regionwide/HRTRegion-WideIssues2FINALREPORTMay-2013.pdf)
- NMFS' ESA consultations (http://www.westcoast.fisheries.noaa.gov/permits/hatchery_permits.html)

Prepared by Parametix, Inc. March 8, 2010 (DEIS_Figure_1-2_20100308.mxd).

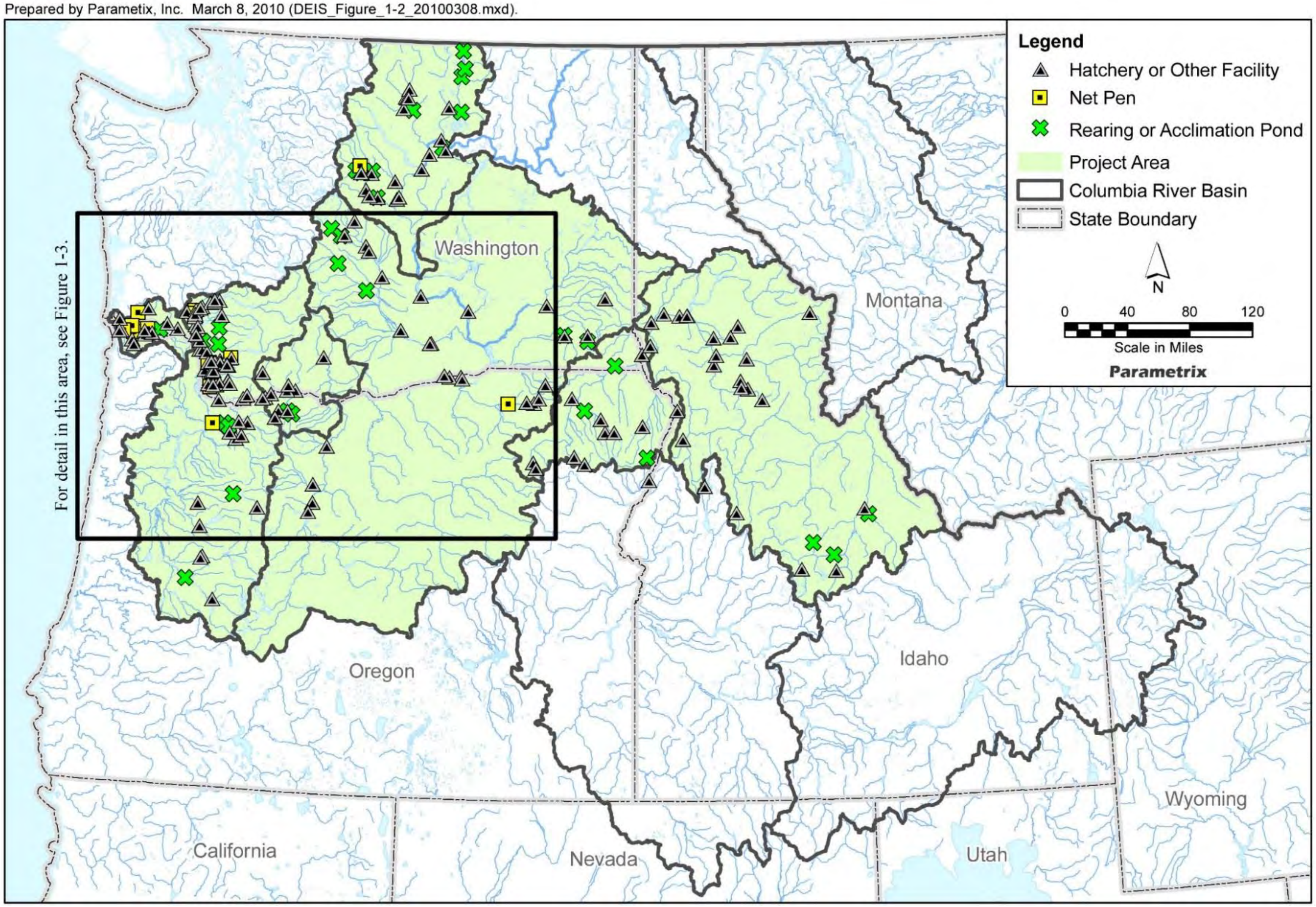

Figure 1-2. Hatchery facilities in the project area.

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Prepared by Parametix, Inc. March 8, 2010 (DEIS_Figure_1-3_20100308.mxd).

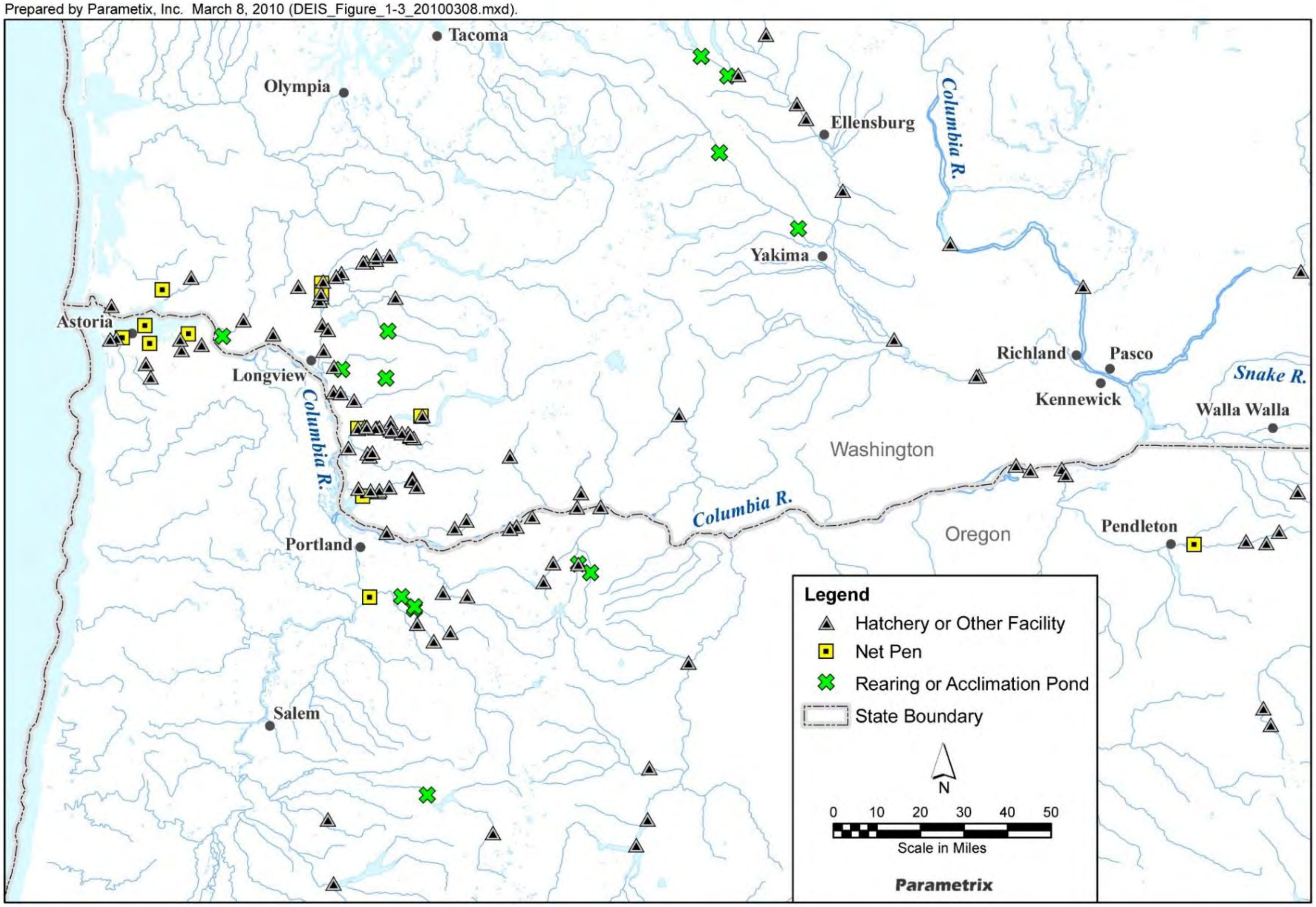

Figure 1-3. Hatchery facilities in the project area (detail area).

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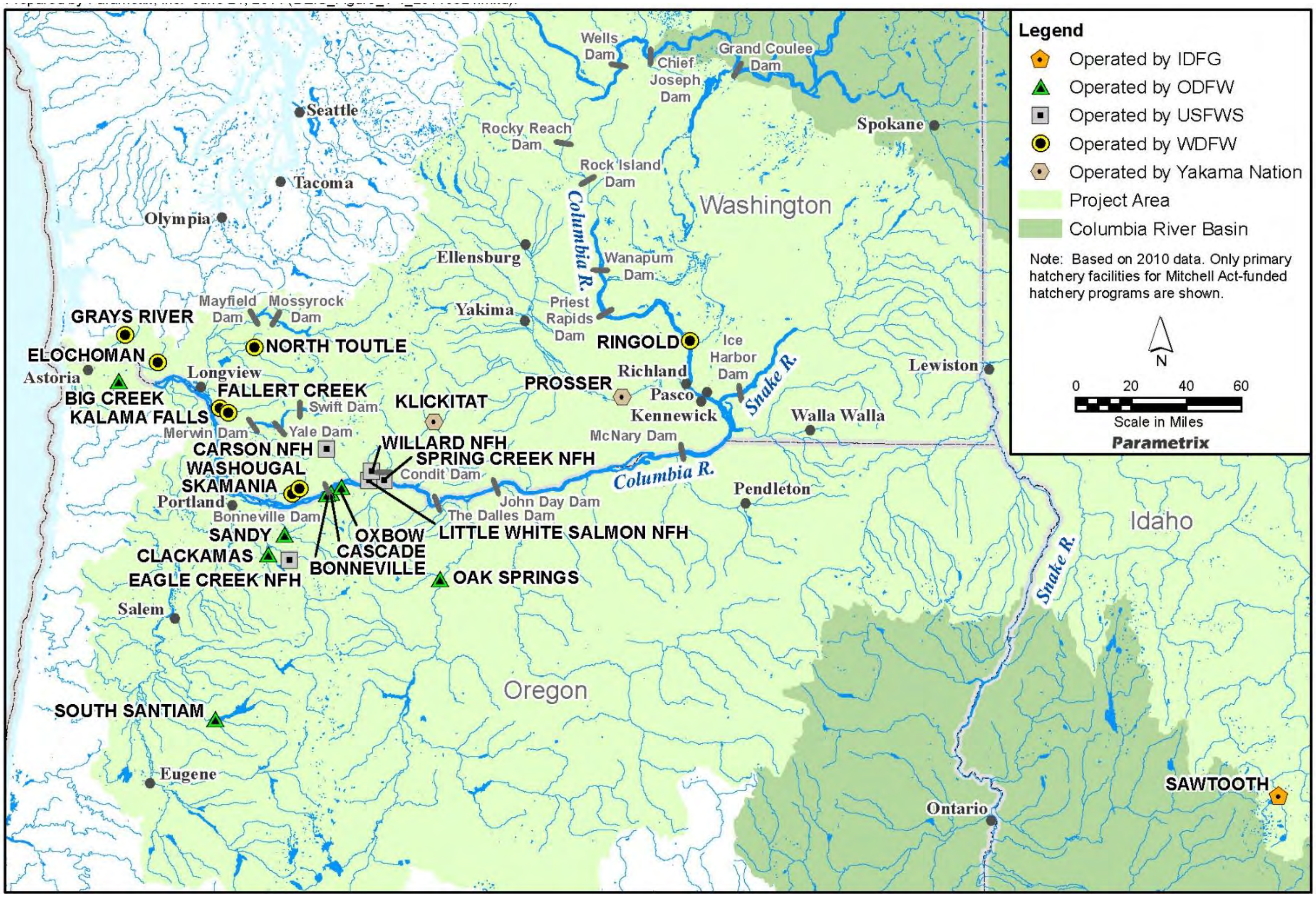

Figure 1-4. Hatchery facilities that support Mitchell Act-funded hatchery programs.

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TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
Confederated Tribes of the Colville Indian Reservation Cassimer Bar	Okanogan Summer Steelhead	Conservation	Other
Confederated Tribes of the Colville Indian Reservation Chief Joseph Hatchery	Okanogan Summer Chinook (First release after 2010)	Both	Other
	Okanogan Spring Chinook (First release after 2010)	Both	Other
Confederated Tribes of the Umatilla Indian Reservation Three Mile Dam Facility	Umatilla Fall Chinook Salmon	Both	Other
Idaho Department of Fish and Game (IDFG) Clearwater Fish Hatchery	Lochsa Spring Chinook Salmon	Harvest	Other
	Upper Selway Spring Chinook Salmon	Harvest	Other
	South Fork Clearwater Summer Steelhead (B-run)	Harvest	Other
	Lemhi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Harvest	Other
IDFG McCall Fish Hatchery	South Fork Salmon Summer Chinook Salmon	Harvest	Other
	East Fork and South Fork Johnson Creek Summer Chinook Salmon	Both	Other
IDFG Oxbow Hatchery	Snake Hells Canyon Spring Chinook Salmon	Harvest	Other
IDFG Pahsimeroi Hatchery	Pahsimeroi Summer Chinook Salmon	Harvest	Other
	Little Salmon Summer Steelhead (A-run)	Harvest	Other
	Pahsimeroi Summer Steelhead (A-run)	Harvest	Other
	East Fork Salmon Summer Steelhead (A-run)	Harvest	Other
IDFG Rapid River Hatchery	Little Salmon Spring Chinook Salmon	Harvest	Other

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
IDFG Sawtooth Hatchery	Upper Salmon Mainstem Spring Chinook Salmon	Harvest	Other
	Little Salmon Summer Steelhead	Harvest	Other
	Redfish Lake Sockeye Salmon (Adult holding, incubation, and rearing at Sawtooth Hatchery)	Conservation	Mitchell Act
	East Fork Salmon Summer Steelhead	Conservation	Other
	Upper Salmon Summer Steelhead (A-run)	Harvest	Other
Nez Perce Tribal Fish Hatchery	Lower Mainstem Clearwater Spring Chinook Salmon	Harvest	Other
	Lower Selway Spring Chinook Salmon	Harvest	Other
	Lower Selway Spring Chinook Salmon	Both	Other
	South Fork Clearwater-Newsome Creek Spring Chinook Salmon	Both	Other
	South Fork Clearwater Spring Chinook Salmon	Harvest	Other
	Lolo Creek Spring Chinook Salmon	Both	Other
ODFW Big Creek Hatchery	Big Creek Fall Chinook Salmon (Tules)	Harvest	Mitchell Act
	Big Creek Coho Salmon	Harvest	Mitchell Act
	Big Creek Winter Steelhead	Harvest	Mitchell Act
	Gnat Creek Winter Steelhead	Harvest	Mitchell Act
	Youngs Bay Tributary Winter Steelhead	Harvest	Mitchell Act
ODFW Bonneville Hatchery	Bonneville Tule Fall Chinook Salmon	Harvest	Other
	Bonneville Upriver Bright (URB) Fall Chinook Salmon	Harvest	Other
	Umatilla URB Fall Chinook	Harvest	Other
	Youngs Bay Coho Salmon	Harvest	Mitchell Act
	Bonneville Coho Salmon	Harvest	Mitchell Act
ODFW Bonneville/Oxbow/Cascade Hatcheries	Umatilla Coho Salmon	Harvest	Mitchell Act

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
ODFW Clackamas Hatchery	Clackamas Summer Steelhead	Harvest	Mitchell Act
	Lower Clackamas Winter Steelhead (Late)	Harvest	Mitchell Act
	Clackamas Spring Chinook Salmon	Harvest	Mitchell Act
ODFW Irrigon Hatchery	Little Sheep Summer Steelhead	Both	Other
ODFW Klaskanine Hatchery (North Fork)	Youngs Bay Fall Chinook Salmon (Rogue River Upriver Brights-Select Area Fisheries)	Harvest	Other
ODFW Lookingglass Hatchery	Lostine Spring Chinook Salmon	Conservation	Other
	Imnaha Spring/Summer Chinook Salmon	Both	Other
	Catherine Creek Spring Chinook Salmon	Conservation	Other
	Lookingglass Creek Spring Chinook Salmon	Both	Other
	Upper Grande Ronde Spring Chinook Salmon	Conservation	Other
ODFW Marion Forks Hatchery	North Santiam Spring Chinook Salmon	Both	Other
ODFW McKenzie Hatchery	McKenzie Spring Chinook Salmon	Both	Other
ODFW Oak Springs Hatchery	Hood Winter Steelhead	Conservation	Other
ODFW Round Butte Hatchery	Deschutes Spring Chinook Salmon	Harvest	Other
	Deschutes Spring Chinook Salmon (fry plants)	Conservation	Other
	Hood Spring Chinook Salmon	Conservation	Other
	Deschutes Summer Steelhead	Harvest	Other
ODFW Sandy Hatchery	Sandy Coho Salmon	Harvest	Mitchell Act
	Sandy Winter Steelhead (Late)	Harvest	Mitchell Act
	Sandy Spring Chinook Salmon	Harvest	Mitchell Act

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
ODFW South Santiam Hatchery	Sandy Summer Steelhead	Harvest	Mitchell Act
	Molalla Spring Chinook Salmon	Both	Other
	South Santiam Spring Chinook Salmon	Harvest	Other
	South Santiam Summer Steelhead	Harvest	Other
	Middle Fork Willamette Summer Steelhead	Harvest	Other
	Mainstem Willamette Summer Steelhead	Harvest	Other
	McKenzie Summer Steelhead	Harvest	Other
	North Santiam Summer Steelhead	Harvest	Other
ODFW Wallowa Hatchery	Wallowa Summer Steelhead	Harvest	Other
ODFW Willamette Hatchery	Youngs Bay Spring Chinook Salmon (Select Area Fisheries)	Harvest	Other
	Middle Fork Willamette Spring Chinook Salmon	Both	Other
ODFW Umatilla Hatchery	Umatilla Summer Steelhead	Both	Other
	Umatilla Fall Chinook Salmon	Harvest	Other
USFWS Carson National Fish Hatchery	Walla Walla Spring Chinook Salmon	Conservation	Mitchell Act
	Wind Spring Chinook Salmon	Harvest	Mitchell Act
	Umatilla Spring Chinook Salmon	Both	Other
USFWS Dworshak Hatchery	North Fork Clearwater Spring Chinook Salmon	Harvest	Other
	Lolo Summer Steelhead (A- and B-run)	Conservation	Other
	East Fork Salmon Summer Steelhead (B-run)	Harvest	Other
	North Fork Clearwater Summer Steelhead (B-run)	Harvest	Other
	Little Salmon Summer Steelhead (B-run)	Harvest	Other
	Upper Salmon Summer Steelhead (B-run)	Harvest	Other
	Lower Clearwater Summer Steelhead (B-run)	Harvest	Other

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
USFWS Eagle Creek National Fish Hatchery	Clearwater Coho Salmon	Conservation	Mitchell Act
	Clackamas-Eagle Creek Coho Salmon	Harvest	Mitchell Act
	Clackamas-Eagle Creek Winter Steelhead (Early)	Harvest	Mitchell Act
USFWS Entiat National Fish Hatchery	Entiat Summer Chinook (First Release 2011)	Harvest	Other
USFWS Kooskia National Fish Hatchery	Middle Fork Clearwater Spring Chinook Salmon	Harvest	Other
USFWS Leavenworth National Fish Hatchery	Wenatchee Spring Chinook Salmon	Harvest	Other
USFWS Little White Salmon/Willard National Fish Hatchery Complex	Wenatchee (White) Spring Chinook Salmon	Conservation	Other
	Wenatchee Coho Salmon	Conservation	Other
	Little White Salmon Fall Chinook Salmon (Upriver Brights)	Harvest	Mitchell Act/Partial
	Little White Salmon Fall Chinook Salmon (Tules)	Harvest	Mitchell Act/Partial
	Little White Salmon Spring Chinook Salmon	Harvest	Mitchell Act
USFWS Magic Valley Hatchery	Upper Salmon Summer Steelhead (B-run/Upper Salmon)	Harvest	Other
USFWS Niagra Springs	Snake Hells Canyon Summer Steelhead	Harvest	Other
USFWS Spring Creek National Fish Hatchery	Spring Creek Fall Chinook Salmon (Tules)	Harvest	Mitchell Act/Partial
USFWS Warm Springs National Fish Hatchery	Deschutes Spring Chinook Salmon	Harvest	Other
USFWS Winthrop Hatchery	Methow Spring Chinook Salmon	Both	Other
	Methow Coho Salmon	Conservation	Other
	Methow (Twisp) Summer Steelhead	Both	Other
	Methow Summer Steelhead	Both	Other
Washington Department of Fish and Wildlife (WDFW) Cowlitz Salmon Hatchery	Cowlitz Upper Cowlitz Coho Salmon	Harvest	Other
	Lower Cowlitz Coho Salmon (Type N)	Harvest	Other
	Upper Cowlitz Spring Chinook Salmon	Both	Other

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
	Lower Cowlitz Fall Chinook Salmon	Harvest	Other
WDFW Cowlitz Trout Hatchery	Lower Cowlitz Summer Steelhead (Skamania)	Harvest	Other
	Lower Cowlitz Winter Steelhead (Early)	Harvest	Other
	Lower Cowlitz Winter Steelhead (Late)	Both	Other
	Upper Cowlitz Winter Steelhead (Late)	Both	Other
WDFW Eastbank Hatchery Complex	Wenatchee Summer Chinook Salmon	Both	Other
	Wenatchee Sockeye Salmon	Conservation	Other
	Wenatchee Summer Steelhead	Both	Other
	Okanogan-Similkimeen Summer Chinook Salmon	Both	Other
	Wenatchee (Chiwawa) Spring Chinook Salmon	Conservation	Other
WDFW Beaver Creek Hatchery	Elochoman Summer Steelhead	Harvest	Mitchell Act
	Elochoman Winter Steelhead (Early)	Harvest	Mitchell Act
	Coweeman Winter Steelhead (Early)	Harvest	Mitchell Act
WDFW Fallert Creek Hatchery	Kalama Summer Steelhead	Harvest	Mitchell Act
	Kalama Summer Steelhead (Skamania)	Harvest	Mitchell Act
	Kalama Coho Salmon (Early/ Type S)	Harvest	Mitchell Act
	Kalama Coho Salmon (Natural)	Harvest	Mitchell Act
	Kalama Winter Steelhead (Early)	Harvest	Mitchell Act
	Kalama Winter Steelhead (Late)	Harvest	Mitchell Act
WDFW Grays River Hatchery	Deep River Spring Chinook Salmon (Cowlitz, Merwin, and Grays)	Harvest	Other
	Grays-Chinook River Chum Salmon	Conservation	Other
	Deep River Coho Salmon (Early/ Type S)	Harvest	Mitchell Act/Partial

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
	Grays Coho Salmon (Late/ Type N)	Harvest	Other
	Grays Winter Steelhead (Early)	Harvest	Mitchell Act
WDFW Kalama Falls Hatchery	Kalama Fall Chinook Salmon	Harvest	Mitchell Act
	Kalama Spring Chinook Salmon	Harvest	Mitchell Act
WDFW Lewis River Hatchery	NF Lewis Spring Chinook Salmon	Harvest	Other
	NF Lewis Coho Salmon (Early/ Type S)	Both	Other
	NF Lewis Coho Salmon (Late/ Type N)	Harvest	Other
WDFW Lyons Ferry Hatchery	Tucannon Spring Chinook Salmon	Conservation	Other
	Snake River/Hells Canyon Fall Chinook Salmon	Both	Other
	Tucannon Summer Steelhead	Conservation	Other
	Snake Lower Summer Steelhead	Harvest	Other
	Walla Walla Summer Steelhead	Harvest	Other
	Touchet Summer Steelhead	Harvest	Other
	Touchet Summer Steelhead	Conservation	Other
	Cottonwood Creek Summer Steelhead (Wallowa)	Harvest	Other
WDFW Merwin Hatchery	North Fork Lewis Summer Steelhead	Harvest	Other
	North Fork Lewis Winter Steelhead	Harvest	Other
WDFW Methow Hatchery	Methow (Methow-Chewuch) Spring Chinook Salmon	Conservation	Other
	Methow (Twisp) Spring Chinook Salmon	Conservation	Other
WDFW Priest Rapids Hatchery Complex	Columbia Lower Middle Hanford Fall Chinook Salmon (Priest Rapids Upriver Brights)	Harvest	Other
WDFW Ringold Springs Hatchery	Ringold Summer Steelhead (Wells)	Harvest	Mitchell Act
	Middle Columbia Fall Chinook Salmon (Upriver Brights)	Harvest	Other

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
WDFW Skamania Hatchery	North Fork Toutle Summer Steelhead	Harvest	Mitchell Act
	South Fork Toutle Summer Steelhead	Harvest	Mitchell Act
	Klickitat Summer Steelhead (Skamania)	Harvest	Mitchell Act
	East Fork Lewis Summer Steelhead (Skamania)	Harvest	Mitchell Act
	East Fork Lewis Winter Steelhead (Skamania)	Harvest	Mitchell Act
	Salmon Creek Winter Steelhead (Skamania)	Harvest	Mitchell Act
	Washougal Summer Steelhead (Skamania)	Harvest	Mitchell Act
	Washougal Winter Steelhead (Early/ Skamania)	Harvest	Mitchell Act
	White Salmon Summer Steelhead (Skamania)	Harvest	Mitchell Act
WDFW North Toutle Hatchery (Green River)	North Toutle Coho Salmon (Early/ Type S)	Harvest	Mitchell Act
	North Toutle Fall Chinook	Harvest	Mitchell Act
	White Salmon Winter Steelhead (Skamania)	Harvest	Mitchell Act
WDFW Washougal Hatchery	Washougal Fall Chinook Salmon	Harvest	Mitchell Act
	Deep River Fall Chinook (Washougal Hatchery)	Harvest	Mitchell Act
	Klickitat Coho Salmon (Washougal)	Harvest	Mitchell Act
	Washougal Coho Salmon	Harvest	Mitchell Act
WDFW Wells Hatchery	Methow Summer Chinook Salmon (Wells)	Both	Other
	Upper Middle Columbia Summer Chinook Salmon (Wells)	Harvest	Other
	Upper Mainstem Columbia Summer Chinook Salmon (Chelan Falls-Turtle Rock)	Harvest	Other
	Upper Columbia Coho Salmon	Conservation	Other
	Okanogan Summer Steelhead (Wells)	Harvest	Other

TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (BASED ON 2010 RELEASES) (CONTINUED).

PRIMARY HATCHERY FACILITY (BY OPERATOR)	HATCHERY PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
Yakama Nation Cle Elum Hatchery	Upper Yakima Spring Chinook Salmon	Both	Other
Yakama Nation Prosser Hatchery	Yakima Fall Chinook Salmon	Harvest	Mitchell Act/Partial
	Yakima Summer Chinook	Both	Other
	Upper Yakima/Naches Coho Salmon	Both	Mitchell Act/Partial
	Yakima Coho Salmon	Both	Mitchell Act/Partial
Yakama Nation Klickitat Hatchery	Klickitat Fall Chinook Salmon (Upriver Brights)	Harvest	Mitchell Act
	Klickitat Spring Chinook Salmon	Both	Mitchell Act
	Klickitat Coho Salmon (Lewis)	Harvest	Mitchell Act

Source: Appendix A

1.6 Scoping and the Relevant Issues

The first step in preparing an EIS is to conduct scoping of the issues that may be associated with the proposed action. This occurs through public and internal scoping processes. The purpose of public and internal scoping is to identify the environmental issues relevant to implementation of the proposed action, eliminate insignificant issues from detailed study, and identify the alternatives to be analyzed. Scoping can also help determine the data required and the necessary level of analysis.

1.6.1 Scoping Process

The scoping process for this EIS involved public and internal scoping activities. These activities are described in the following paragraphs.

1.6.2 Notice of Intent

Public scoping was officially initiated with the Notice of Intent to prepare a draft EIS in the Federal Register on September 3, 2004 (69 Fed. Reg. 53892). This notice announced a 90-day public comment period (September 3, 2004 to December 2, 2004) to gather information on the scope of the issues and the range of alternatives to be analyzed in the EIS. A second notice, published on March 12, 2009 (74 Fed. Reg. 10724), notified the public of NMFS' intent to expand the project scope to include all Columbia River hatchery programs, regardless of funding source.

NMFS developed a website for this EIS, which was available to the public during the draft EIS scoping period and throughout the draft EIS comment and review period. A notice describing the project was also distributed through electronic mail to addresses on a project mailing list of almost 200 individuals, agencies, private businesses, and environmental organizations that have shown an interest in salmon issues. *The Columbian* newspaper and the *Columbia Basin Bulletin* published announcements informing the public that NMFS had initiated public scoping for the project.

1.6.3 Internal Scoping

NMFS began internal project scoping in the spring of 2004. The objective of internal scoping was to identify the environmental parameters considered relevant to hatchery actions associated with the proposed action. An interdisciplinary project team identified resources both likely and unlikely to be affected by the proposed action. The resources identified as likely to be affected by the proposed action were then included in Chapter 3 and Chapter 4 of this EIS. In addition, the internal scoping process included review of comments received from the public during scoping. A range of reasonable alternatives was then created via internal scoping by incorporating key issues identified in public and internal scoping comments. The range of resources identified as likely to be affected by the proposed action was also modified if warranted by public comment.

1.6.4 Written Comments

Twenty comment letters were received during the two public scoping periods, including six letters from governmental agencies, one letter from a tribal organization, seven letters from non-governmental organizations and businesses, and six letters from individual citizens. The letters all originated in Washington and Oregon, except for one from Alaska and one from Illinois.

1.6.5 Issues Identified During Scoping

The following issues were identified during both public and internal scoping. These issues were considered during development of alternatives and in evaluating effects of the proposed action.

- **Hatchery Research, Monitoring, and Performance Standards.** Requests were received to develop a performance-based funding structure based on research and monitoring, as well as a cost-benefit analysis of hatchery programs considered for funding.
- **Distribution of Hatchery Production.** Commenters were divided as to whether funding and production should be prioritized in the upper or lower Columbia River Basins.
- **Location, Type, and Timing of Hatchery Production.** Some comments focused on methods to decrease hatchery fish interactions with natural-origin fish, including timing the release of hatchery-origin fish, eliminating release of non-native fish, eliminating stock transfers among hatchery facilities and off-site release in rivers, constructing fish passage barriers for hatchery facilities, replacing fish screens that may be deficient, and raising fish better adapted to reproduce naturally.
- **Funding.** Comments included requests for information on how funding is allocated among hatchery programs, monitoring, and research.
- **Hatchery Maintenance Projects.** Commenters requested a process for including hatchery facility maintenance backlogs in the hatchery funding process.
- **Hatchery Production.** Comments included requests to both increase and decrease hatchery production.

- **Guidance on Adverse Effects**. Commenters stressed the importance of linking Mitchell Act hatchery policy with an analysis of its effects on natural-origin salmon and steelhead populations. They also stressed the importance of identifying and analyzing the effects of other hatchery production in the basin to determine the effects of the Mitchell Act production.

1.6.6 Public Review and Comment

The draft EIS was issued in August 2010 for a 90-day public review period. The comment period was announced in newspapers, through correspondence with tribes and other interested parties, and by publication in the Federal Register (75 Fed. Reg. 47591, August 6, 2010). This period was extended for an additional 30 days (75 Fed. Reg. 54146, September 3, 2010) for a total of 120 days for public comment. Additionally, NMFS held a series of public meetings where public testimony was taken. These meetings were held in Vancouver, Washington; Kennewick, Washington; Astoria, Oregon; and Lewiston, Idaho, between September 20, 2010 and October 13, 2010. NMFS received more than 1,100 comments on the draft EIS. Following this public review period, responses to public comments were prepared and are included in this final EIS (Appendix I). Responses include changes to the EIS as a result of public comments, where warranted.

1.7 Relationship to Other Plans, Regulations, Agreements, Laws, and Executive and Secretarial Orders

In addition to the ESA and NEPA, other plans, regulations, agreements, laws, and Executive and Secretarial Orders also affect hatchery operations in the Columbia River Basin. Ultimately, Mitchell Act hatchery funding decisions must harmonize with many preexisting plans, regulations, agreements, laws, and orders. Future decisions regarding Mitchell Act hatchery funding will be coordinated through the various management forums that exist in the Columbia River Basin to implement the plans, regulations, agreements, laws, and orders described below.

1.7.1 Executive Order 13175

Issued on November 6, 2000, Executive Order (E.O.) 13175 (Consultation and Coordination with Indian Tribal Governments, http://alaskafisheries.noaa.gov/frules/65fr67249_eo13175.pdf) was issued by President William J. Clinton to establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications.

E.O. 13175 states the following:

> In formulating or implementing policies that have tribal implications, agencies shall be guided by the following fundamental principles:
>
> > (a) The United States has a unique legal relationship with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. Since the formation of the Union, the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal Government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes.
> >
> > (b) Our Nation, under the law of the United States, in accordance with treaties, statutes, Executive Orders, and judicial decisions, has recognized the right of Indian tribes to self-government. As domestic dependent nations, Indian tribes exercise inherent sovereign powers over their members and territory. The United States continues to work with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-government, tribal trust resources, and Indian tribal treaty and other rights.
> >
> > (c) The United States recognizes the right of Indian tribes to self-government and supports tribal sovereignty and self-determination.

1.7.2 Commerce Departmental Administrative Order 218-8

The U.S. Department of Commerce has issued a Departmental Administrative Order (DAO) addressing *Consultation and Coordination with Indian Tribal Governments* (DAO 218-8, April 26, 2012; http://www.osec.doc.gov/opog/dmp/daos/dao218_8.html), which implements relevant E.O.s, Presidential Memoranda, and Office of Management and Budget Guidance. The DAO describes actions to be "followed by all Department of Commerce operating units … and outlines the principles governing Departmental interactions with Indian tribal governments." The DAO affirms that the "Department works with Tribes on a government-to-government basis to address issues concerning . . . tribal trust resources, tribal treaty, and other rights."

1.7.3 Secretarial Order 3206

Issued on June 5, 1997, Secretarial Order 3206 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act, http://www.fws.gov/endangered/what-we-do/tribal-secretarial-order.html) issued by the secretaries of the departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the Order. Secretarial Order 3206 acknowledges the trust responsibility and treaty obligations of the U.S. toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the Order, the Services "will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation."

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Sec. 5, Principal 1).
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Sec. 5, Principal 3).
- Be sensitive to Indian culture, religion, and spirituality (Sec. 5, Principal 4).

1.7.4 *U.S. v. Oregon*

U.S. v. Oregon was originally a combination of two cases, *Sohappy v. Smith* and *U.S. v. Oregon* (302 F. Supp. 899, 1978), which legally upheld the Columbia River Treaty Tribes' reserved fishing rights and tribal entitlement to a fair share of fish runs. Although the *Sohappy* case was closed in 1978, *U.S. v. Oregon* remains under the Federal court's continuing jurisdiction. In his 1969 decision, Judge C. Belloni ruled that state regulatory power over Indian fishing is limited because the 1855 treaties between the United States and the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes preserved their reserved rights to fish at all usual and accustomed places whether on or off reservation. In 1974, Judge George Boldt decided in *U.S. v. Washington* that Belloni's citing of the tribes' fair and equitable share was 50 percent of all of the harvestable fish destined for the tribes' traditional fishing places. The following year, Judge Belloni applied the 50 percent standard to *U.S. v. Oregon*. In 1977, under the jurisdiction in *U.S. v. Oregon*, the Federal court ordered a 5-year plan for in-river harvest sharing between non-Indian and Indian fisheries. In 1988, the Columbia River Fish Management Agreement (Management Agreement) was adopted by the Federal court, and it addressed both harvest management and the supportive hatchery production. The most current Management Agreement was adopted by the Federal court in 2008, and it expires in 2017. It includes goals for many hatchery programs in the Columbia River Basin, including production levels, marking strategies, and release locations (Appendix B). Approximately half of the production currently funded under the Mitchell Act is part of the *U.S. v. Oregon* Management Agreement.

Fisheries in the Columbia River are carefully designed to be consistent with Federal court rulings related to treaty Indian fishing rights. The governing Management Agreement has been cooperatively negotiated by the Federal and state governments and the involved treaty Indian tribes under the continuing jurisdiction of the Federal court to ensure achievement of the tribe's fishing rights. The agreement includes important and substantive commitments related to hatchery production (Appendix B, Table B1 through Table B7) that are "intended to ensure that Columbia River fish runs continue to provide a broad range of benefits in perpetuity." The Management Agreement also includes provisions to "facilitate cooperative action by the Parties with regard to fishing regulations, policy issues or disputes, and the coordination of the management of fisheries on Columbia River runs and production and harvest measures."

The purpose of this EIS is to analyze the environmental effects of a range of reasonable alternatives related to hatchery production. No specific assertions are made in this EIS about consistency between alternatives and the Management Agreement. Rather, NMFS contends that affected parties, including NMFS itself, will exercise their authority regarding production measures, following this environmental analysis, in a manner that is consistent with the most current Management Agreement.

1.7.5 The Columbia Basin Fish Accords

The Columbia Basin Fish Accords (Accords) were signed in May 2008 by the Umatilla, Warm Springs, Yakama, and Colville Tribes, BPA, USACE, and BOR. The partnerships with the Accords secured $900 million for salmon restoration projects throughout the Columbia River Basin. The Accords thus provide certainty and stability in the funding and implementation of projects for the benefit of fish affected by the Federal Columbia River Power System (FCRPS) and the upper Snake water management facilities. These on-the-ground improvement projects include hatchery production projects devised to evaluate fish propagation strategies to maximize conservation and harvest opportunities.

1.7.6 Lower Snake River Compensation Plan

Congress authorized the construction of four dams on the lower Snake River in 1945. When Congress appropriated construction funding in 1954, only adult fish ladders and other minor dam modifications were funded to mitigate for anticipated adverse impacts to salmon and steelhead.

In the mid-1960s, USFWS, NMFS, and state fisheries agencies began to assess the need to compensate for fish and wildlife losses caused by construction and operation of the lower Snake River dams. The assessment was done under the authority of the federal Fish and Wildlife Coordination Act. A joint USFWS/NMFS Coordination Act Report was provided to the USACE in 1972. The report described the short- and long-term impacts of all four lower Snake dams and recommended mitigation and compensation for both fish and wildlife. The report provided the basis for the USACE 1975 Lower Snake River Fish and Wildlife Compensation Plan report to Congress. A year later, Congress authorized the Lower Snake River Compensation Plan (LSRCP) as part of the Water Resources Development Act of 1976 (90 Stat. 2917). A major element of the authorized plan was a program to design and construct fish hatcheries to compensate for some of the losses of salmon and steelhead adult returns. Mitigation goals for the LSRCP program include returning 55,100 adult steelhead, 58,700 adult spring/summer Chinook salmon, and 18,300 fall Chinook salmon to the Snake River (www.fws.gov/lsnakecomplan/aboutus.html).

1.7.7 John Day Mitigation

Congress authorized the John Day Mitigation (JDM) Program in 1978 to offset mainstem fall Chinook salmon (*O. tshawytscha*) production losses that resulted from construction and operation of The Dalles and John Day Dams. The scope of the mitigation was based on historic spawning estimates presented in the project authorization documents and related administrative records. The USACE relied on historic data from USFWS and the states of Oregon and Washington to determine the extent of the mitigation. The specified mitigation was to support escapement of 30,000 adult Chinook salmon to compensate for spawning habitat that was inundated. The USACE funded the design, reconstruction of a number of facilities, and currently funds the production at these facilities to achieve mitigation, which consists of hatchery fall Chinook production.

Since implementation of the JDM program in 1978, adjustments have occurred related to the specific stock of Chinook salmon and the production, rearing, and release locations. The original JDM program mitigation goal of replacing 30,000 spawners has been increased to 107,000 adults (30,000 spawners, plus adults taken in fisheries). This production is divided across two runs of fall Chinook salmon: 80 percent of the production is upriver bright fall Chinook salmon, and 20 percent of the production is tule fall Chinook salmon.

1.7.8 Salmon and Steelhead Recovery Plans

The ESA requires NMFS to develop and implement recovery plans for listed salmon and steelhead species. Recovery plans identify actions needed to restore threatened and endangered species to the point where they are again self-sustaining elements of their ecosystems and no longer need protection. Although recovery plans are guidance, not regulatory documents, the Act envisions recovery plans as the central organizing tool for guiding and coordinating recovery efforts across a wide spectrum of federal, state, tribal, local, and private entities. Recovery planning is an opportunity to find common ground among diverse interests, obtain needed protection and restoration for salmon and their habitat, and secure the economic and cultural benefits of healthy watersheds and rivers. Recovery planning is a collaborative effort that draws on the collective knowledge, expertise, and actions of communities and partnerships.

1.7.9 Clean Water Act

The Clean Water Act (CWA) (33 USC 1251, 1977, as amended in 1987), administered by the U.S. Environmental Protection Agency (EPA) and state water quality agencies, is the principal Federal legislation directed at protecting water quality. The states of Washington and Oregon implement and carry forward Federal provisions, through approval and review of National Pollutant Discharge Elimination System (NPDES) applications. In the state of Idaho, the Federal EPA administers the NPDES permitting process. All three states are responsible for establishing total maximum daily loads for rivers, lakes, and streams and for setting the water quality standards needed to support all beneficial uses, including protection of public health, recreational activities, aquatic life, and water supplies.

The Washington State Water Pollution Control Act, codified as Revised Code of Washington Chapter 90.48, designates the Washington Department of Ecology (Ecology) as the agency responsible for carrying out the provisions of the Clean Water Act in Washington State. Ecology is responsible for establishing water quality standards, making and enforcing water quality rules, and operating waste discharge permit programs. These regulations are described in Washington Administrative Code 173. In Oregon, the Oregon Department of Environmental Quality (ODEQ) is responsible for carrying out the CWA through its water quality program rules adopted by the Environmental Quality Commission as part of Oregon Administrative Rules Chapter 340 and 468b. The Idaho State Environmental Protection and Health Act (Title 39, Chapter 36, Idaho Code) designates the Idaho Department of Environmental Quality (IDEQ) as the agency responsible for setting water quality standards and establishing total maximum daily loads for rivers, lakes, and streams.

1.7.10 Pacific Salmon Treaty

The Pacific Salmon Treaty between Canada and the United States was finalized March 17, 1985 (Pacific Salmon Commission 1985). The treaty established a framework for managing salmon stocks, either originating from one country and intercepted by the other, or affecting the management or the biology of the stocks of the other country. The treaty commits the United States and Canada to equitable cross-border sharing of harvest and conservation of United States and Canadian stocks. The objective of the treaty and the several fishing regimes established in its “Annex IV” is to constrain harvest on both sides of the border and to rebuild depressed salmon stocks. The Pacific Salmon Commission oversees implementation of the treaty and negotiates periodic revisions of the Annex IV fishing regimes. A new agreement was reached on portions of Annex IV in May 2008. The agreement governs the harvest of Chinook and coho salmon, as well as several other salmon species, from 2009 through 2018. The agreement was finalized by exchange of diplomatic notes on December 23, 2008.

1.7.11 Federal Columbia River Power System Biological Opinion

The operation of the FCRPS affects 13 species of Columbia River Basin salmon and steelhead listed for protection under ESA. The ESA requires the agencies that operate the FCRPS (FCRPS Action Agencies) to ensure that their actions are not likely to jeopardize the continued existence of a listed species, nor that they will result in the destruction or adverse modification of habitat designated as critical to its conservation. The three FCRPS Action Agencies are the USACE, BPA, and BOR. The FCRPS Biological Opinion guides the agencies in operating the FCRPS and requires a series of mitigation measures, referred to as Reasonable and Prudent Alternatives (RPAs).

The actions in the 2008 FCRPS Biological Opinion are, in general, a 10-year operations and configuration plan for the FCRPS facilities, as well as for the mainstem effects of various other hydro projects operated for irrigation purposes on Columbia River tributaries. The biological opinion sets performance standards of 96 percent average per-dam survival for spring migrants and 93 percent for summer migrating fish. Additional actions include habitat, hatchery, predation management, and harvest measures to mitigate for the adverse effects of the hydrosystem, as well as numerous research, monitoring, and evaluation actions to support and inform adaptive management decisions. Regional state and tribal entities oversee the implementation of the FCRPS Biological Opinion through the Regional Oversight Implementation Group.

The 2008 FCRPS Biological Opinion was updated with the Adaptive Management Implementation Plan in 2009 and a Supplemental Biological Opinion in 2010. NMFS subsequently developed a 2014 Supplemental FCRPS Biological Opinion to address a 2011 Court Remand Order requiring the agency to reexamine the 2008 and 2010 biological opinions and requiring more specific identification of habitat actions planned for the 2014-2018 period of the opinion. NMFS adopted the 2014 Supplemental FCRPS Biological Opinion on January 17, 2014.

1.7.12 State-level Plans, Regulations, Agreements, Laws

1.7.12.1 State Endangered, Threatened, and Sensitive Species Acts

This EIS will consider the effects of hatchery operations on state endangered, threatened, and sensitive species. The state of Washington has species of concern listings (Washington Administrative Code Chapters 232-12-014 and 232-12-011) that include all state endangered, threatened, sensitive, and candidate species. WDFW manages these species, as needed, to prevent them from becoming endangered, threatened, or sensitive. The state-listed species are identified on WDFW's website (http://wdfw.wa.gov/conservation/endangered/All/); the most recent update occurred in August 2013. The criteria for listing and delisting and the requirements for recovery and management plans for these species are provided in Washington Administrative Code Chapter 232-12-297. The state list is separate from the Federal ESA list; the state list includes species status relative to Washington State jurisdiction only. Critical wildlife habits associated with state or federally listed species are identified in Washington Administrative Code Chapter 222-16-080.

Oregon also has a state ESA (Oregon Administrative Rules 635-100-0001-0180). ODFW is responsible for fish and wildlife under the Oregon ESA, and the Oregon Department of Agriculture is responsible for plants. The Oregon ESA generally affects only the actions of state agencies on state-owned or leased lands.

The state of Idaho's list of threatened and endangered species is under the Idaho Administrative Procedures Act, 13.01.06.000 *et seq*. The Idaho Department of Lands is the legal authority concerning take of a state-listed species and the classification of state-listed wildlife species.

1.7.12.2 Washington State's Hatchery and Fishery Reform Policy

Washington's Hatchery and Fishery Reform Policy (2009) supersedes its Wild Salmonid Policy, which was adopted in 1997. The Hatchery and Fishery Reform Policy guides WDFW in harvest, hatchery, and habitat protection programs. Under the current policy, WDFW will promote the conservation and recovery of wild salmon and steelhead and provide fishery-related benefits by establishing clear goals for each state hatchery, conducting scientifically defensible operations, and using informed decision making to improve management. Furthermore, the policy acknowledges that many state-operated hatcheries are subject to provisions under *U.S. v. Washington* and *U.S. v. Oregon* and that hatchery reform actions must occur in close coordination with tribal co-managers.

1.7.12.3 Oregon Native Fish Conservation Policy

The purpose of Oregon's Native Fish Conservation Policy (Oregon Administrative Rules 635-007-0502 through -0509) is to ensure the conservation and recovery of native fish in Oregon and to focus on natural-origin, native fish. The policy is based on the premise that " . . . locally adapted populations provide the best foundation for maintaining and restoring sustainable naturally produced native fish." (Oregon Administrative Rule 635-007-0505(2)). The intent of this policy is to provide a basis for managing hatchery programs, fisheries, habitat, predators, competitors, and pathogens in balance with sustainable production of natural-origin fish.

1.7.12.4 Oregon Fish Hatchery Management Policy

The Oregon Fish Hatchery Management Policy (Oregon Administrative Rules 635-007-0542 through -0548) describes best management practices that are intended to help ensure the conservation of both hatchery-origin and natural-origin fish in Oregon through the responsible use of hatchery programs. The Hatchery Management Policy complements and supports the Native Fish Conservation Policy (Oregon Administrative Rules 635-007-0502 through -0509) and is implemented through the development of conservation plans.

1.8 Organization of this Final EIS

This EIS has been prepared in accordance with NEPA (40 Code of Federal Regulations [CFR] 1500 to 1508) and NEPA guidelines adopted by NMFS (2003). The contents of this final EIS are described briefly below:

- **Introductory Materials**. Before Chapter 1, there is a cover sheet, executive summary, list of acronyms and abbreviations, glossary of key terms, and table of contents.
- **Chapter 1**. This chapter describes the purpose and need for the action; decisions to be made; scoping and relevant issues; and applicable plans, regulations, and laws.
- **Chapter 2**. This chapter describes each of the alternatives and lists their major components. The No-action Alternative is included, along with five action alternatives.
- **Chapter 3**. This chapter describes the existing environmental setting that would be affected under each of the alternatives. It includes a section on fish, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health.
- **Chapter 4**. This chapter contains a description and analysis of the potential direct and indirect effects of each alternative on the resources identified in Chapter 3. It also compares the action alternatives to the no-action alternative.
- **Chapter 5**. This chapter addresses cumulative impacts, which are the incremental effects of an action when added to other past, present, and reasonably foreseeable actions, regardless of what agency or person undertakes such actions. Climate change is addressed in this chapter.
- **Remaining Material**. After Chapter 5, there are a list of references, a distribution list, a list of preparers, and appendices.

Science, Service, Stewardship

Chapter 2

Alternatives

2 ALTERNATIVES

2.1 Introduction

This chapter describes and compares the six alternatives considered in this final environmental impact statement (EIS), including National Marine Fisheries Service's preferred alternative. The environmental effects of the alternatives are presented in more detail in Chapter 4, Environmental Consequences. Specifically, this chapter describes the following:

- Context for the alternatives
- How the alternatives were developed
- Alternatives that were considered in detail
- Alternatives that were considered but eliminated from detailed discussion
- Process for developing a preferred alternative (Box 2-1)

Box 2-1. Was there a preferred alternative in the draft EIS?

As noted in Chapter 1, Purpose of and Need for the Proposed Action, and explained in further detail in Chapter 2, Alternatives, the draft EIS did not contain a preferred alternative. Rather, it established several distinct policy directions as alternatives that would guide the National Marine Fisheries Service's (NMFS') decisions on distribution of Mitchell Act funds for hatchery production in the Columbia River Basin. NMFS anticipated identifying the preferred alternative in this final EIS after considering comments received on the draft EIS. As described in the draft EIS, NMFS expected that the preferred alternative likely would be a blend of more than one of the alternatives evaluated in the draft EIS. NMFS specifically took public comment on this issue. The environmental effects of the preferred alternative are described in this final EIS (Chapter 4, Environmental Consequences).

2.2 Description of Project Area

As described in Section 1.4, Project and Analysis Area, the EIS project area includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River Basin, including the Snake River and all other tributaries of the Columbia River in the United States (U.S.). The project area also includes the Columbia River estuary and plume[1]. The project area comprises two salmon recovery domains (the Willamette/Lower Columbia and the Interior Columbia) as established by NMFS under its Endangered Species Act (ESA) recovery planning responsibilities. The project area also contains seven ecological provinces and more than 37 subbasins (i.e., tributaries to the Columbia or Snake Rivers) as defined by the Northwest Power and Conservation Council (NPCC) for purposes of administering its Fish and Wildlife Program (Table 2-1).

The Willamette/Lower Columbia Recovery Domain includes the Willamette River Basin and all Columbia River tributaries from the mouth of the Columbia River to the Hood River in Oregon and the White Salmon River in Washington. The domain contains four ESA-listed evolutionarily significant units (ESU) of salmon and two ESA-listed distinct population segments (DPS) of steelhead: Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, Upper Willamette River Chinook Salmon, Lower Columbia River Coho Salmon, Lower Columbia River Steelhead, and Upper Willamette River Steelhead.

The Interior Columbia Recovery Domain covers all of the Columbia River Basin accessible to anadromous salmon and steelhead above Bonneville Dam. The Interior Columbia Recovery Domain contains four ESA-listed ESUs of salmon and three ESA-listed DPSs of steelhead: Middle Columbia River Steelhead, Snake River Sockeye Salmon, Snake River Spring/Summer Chinook Salmon, Snake River Fall Chinook Salmon, Snake River Steelhead, Upper Columbia River Spring Chinook Salmon, and Upper Columbia River Steelhead. The Interior Columbia and Willamette/Lower Columbia Recovery Domains overlap just upstream of Bonneville Dam based on ESU boundaries.

[1] The plume is generally defined by a reduced-salinity contour of approximately 31 parts per thousand near the ocean surface. The plume varies seasonally with discharge, prevailing near-shore winds, and ocean currents. For purposes of this EIS, the plume is considered to be off the immediate coast of both Oregon and Washington and to extend outward to the continental shelf.

TABLE 2-1. PROJECT AREA BY RECOVERY DOMAIN, ECOLOGICAL PROVINCE, AND SUBBASIN.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN[1]
Willamette/ Lower Columbia	Columbia Estuary	Grays River (WA)
		Elochoman River (WA)
		Youngs River (OR)
	Lower Columbia	Cowlitz River (WA)
		Kalama River (WA)
		Lewis River (WA)
		Washougal River (WA)
		Willamette River (OR)
		Sandy River (OR)
Willamette/ Lower Columbia and Interior Columbia[2]	Columbia Gorge	Wind River (WA)
		Little White Salmon River (WA)
		White Salmon River (WA)
		Klickitat River (WA)
		Hood River (OR)
		Fifteen Mile Creek (OR)
Interior Columbia	Columbia Plateau	Yakima River (WA)
		Crab Creek (WA)
		Palouse River (WA)
		Tucannon River (WA)
		Walla Walla River (WA/OR)
		Deschutes River (OR)
		John Day River (OR)
		Umatilla River (OR)
		Lower Middle Columbia River (WA/OR)
		Lower Snake River (WA)
	Columbia Cascade	Wenatchee River (WA)
		Entiat River (WA)
		Lake Chelan (WA)
		Methow River (WA)
		Okanogan River (WA/BC)
		Upper Middle Columbia River (WA)
	Blue Mountain	Asotin Creek (WA)
		Grande Ronde River (WA/OR)
		Imnaha River (OR)
		Snake Hell's Canyon (OR/ID)
	Mountain Snake	Clearwater River (ID)
		Salmon River (ID)

Source: NMFS

[1] Not all subbasins are included in this table.

[2] The Willamette/Lower Columbia Recovery Domain and the Interior Columbia Recovery Domain overlap within the Columbia Gorge Ecological Province.

Each recovery domain consists of several ecological provinces, as identified by the NPCC (see www.nwcouncil.org for more information). Ecological provinces encompass subbasins with similar climates and geography (Figure 1-1). In many cases, the EIS compares alternatives across ecological provinces rather than by recovery domain (which can be too general a comparison) or by subbasin (which can be too detailed a comparison). This project area EIS covers 7 of the 11 Columbia River Basin ecological provinces; anadromous salmon and steelhead do not currently have access to 4 ecological provinces (the Middle Snake, Upper Snake, Intermountain, and Mountain Columbia Ecological Provinces).

2.3 Context for the Alternatives

2.3.1 Distribution of Hatchery Programs

There are 177 salmon and steelhead hatchery programs in the Columbia River Basin (Table 2-2). These hatchery programs originate from 80 hatchery facilities (Figure 1-2). There are 82 hatchery programs (46 percent of the total number) located in the Willamette/Lower Columbia Recovery Domain, and there are 95 hatchery programs (54 percent of the total number) located in the Interior Columbia Recovery Domain (Table 2-2). Approximately 56 percent of all hatchery production (i.e., number of fish released) is in the Willamette/Lower Columbia Recovery Domain, and 44 percent is in the Interior Columbia Recovery Domain.

Of the 177 hatchery programs in the Columbia River Basin, 62 (35 percent) are funded wholly or in part by the Mitchell Act (Table 2-2) (Chapter 1, Purpose of and Need for the Proposed Action); this constitutes 46 percent of all hatchery production, by number of fish released, in the Columbia River Basin (Table 2-3). The remaining 115 (65 percent) hatchery programs are funded primarily by the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), the U.S. Bureau of Reclamation (BOR), public utility districts, and private power companies. The most common species produced are fall Chinook salmon, coho salmon, and spring Chinook salmon in the Willamette/Lower Columbia Recovery Domain and fall Chinook salmon, spring Chinook salmon, and summer steelhead in the Interior Columbia Recovery Domain (Table 2-3). Chum salmon, sockeye salmon, and summer Chinook salmon are the least common species produced.

2.3.2 Purpose of Hatchery Programs

Hatchery programs in the Columbia River Basin are implemented to augment harvest (referred to as harvest augmentation hatchery programs or harvest hatchery programs), to help conserve a population (referred to as conservation hatchery programs) (Box 2-2), or for both purposes. In this EIS, the purpose of each hatchery program was identified by its manager in response to a survey by the Hatchery Scientific Review Group (HSRG) (Box 2-3) (Appendix B through Appendix E). Hatchery program objectives often change over time to accommodate new management objectives for conservation and/or harvest.

TABLE 2-2. COUNT OF MITCHELL ACT-FUNDED HATCHERY PROGRAMS AND TOTAL COUNT OF HATCHERY PROGRAMS BY ECOLOGICAL PROVINCE AND BY SPECIES.

		MITCHELL ACT-FUNDED HATCHERY PROGRAMS							
RECOVERY DOMAIN	ECOLOGICAL PROVINCE	CHINOOK SALMON	COHO SALMON	STEELHEAD	CHUM SALMON	SOCKEYE SALMON	TOTAL NUMBER MITCHELL ACT-FUNDED HATCHERY PROGRAMS	TOTAL NUMBER OF HATCHERY PROGRAMS	PERCENT MITCHELL ACT-FUNDED (%)
Willamette/ Lower Columbia	Columbia Estuary	2	3	6	0	0	11	16	69
	Lower Columbia	7	7	17	0	0	31	57	54
	Columbia Gorge	5	2	0	0	0	7	9	78
Interior Columbia	Columbia Gorge[1]	2	0	3	0	0	5	5	100
	Columbia Plateau	2	3	1	0	0	6	24	25
	Columbia Cascade	0	0	0	0	0	0	20	0
	Blue Mountain	0	0	0	0	0	0	14	0
	Mountain Snake	0	1	0	0	1	2	32	6
Total		**18**	**16**	**27**	**0**	**1**	**62**	**177**	**35**

Source: Appendix C through Appendix F. Numbers are based on 2010 production.
[1] The Willamette/Lower Columbia Recovery Domain and the Interior Columbia Recovery Domain overlap within the Columbia Gorge Ecological Province.

TABLE 2-3. TOTAL HATCHERY-ORIGIN SALMON AND STEELHEAD PRODUCTION (RELEASES) WITHIN THE COLUMBIA RIVER BASIN (X 1,000).

RECOVERY DOMAIN	FALL CHINOOK SALMON	SPRING CHINOOK SALMON	SUMMER CHINOOK SALMON	COHO SALMON	WINTER STEELHEAD	SUMMER STEELHEAD	CHUM SALMON	SOCKEYE SALMON	TOTAL
Willamette/Lower Columbia	45,855	13,595	0	15,441	2,011	2,049	250	0	79,201
Interior Columbia	23,129	19,303	3,742	4,299	20	10,537	0	362	61,392
Total	**68,984**	**32,898**	**3,742**	**19,740**	**2,031**	**12,586**	**250**	**362**	**140,593**

Source: Appendix C through Appendix F. Numbers are based on production levels in 2010.

Box 2-2. How can hatchery programs help conserve a salmon or steelhead population?

Hatchery-origin fish can positively affect the status of an ESU by contributing to the abundance and productivity of the natural populations in the ESU. Hatcheries can accelerate recolonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. “Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations” (70 Fed. Reg. 37204, June 28, 2005, at 37215). Conservation hatchery programs may accelerate recovery of a target population by increasing abundance faster than may occur naturally (Waples 1999).

When freshwater habitat-related factors limit the survival and productivity of a natural population, spawning, incubating, rearing, and releasing fish from a hatchery can mitigate these impacts until the factors limiting survival are addressed. Short-term success in increasing the total number of naturally spawning fish has been demonstrated for some hatchery programs (Snake River fall Chinook salmon program, Snake River Sockeye salmon program, Grays River chum restoration program).

Box 2-3. What is the HSRG?

In the past several years, the scientific basis for management of hatcheries in the Pacific Northwest has been examined through the work of the HSRG. Members of the HSRG are regionally and nationally recognized scientists with expertise in hatchery management, genetics, and population biology. Congress initiated the hatchery review process in the Columbia River Basin by creating and funding the HSRG in 2006. The HSRG issued its final report Columbia River Hatchery Reform System-Wide Report (February 2009), which can be found at www.hatcheryreform.us.

According to the hatchery operators, 125 of the total hatchery programs in the Columbia River Basin (71 percent) currently are operated for harvest augmentation only. Twenty-five hatchery programs (14 percent) are operated for conservation only, and 27 hatchery programs (15 percent) are operated for both conservation and harvest augmentation (Figure 2-1).

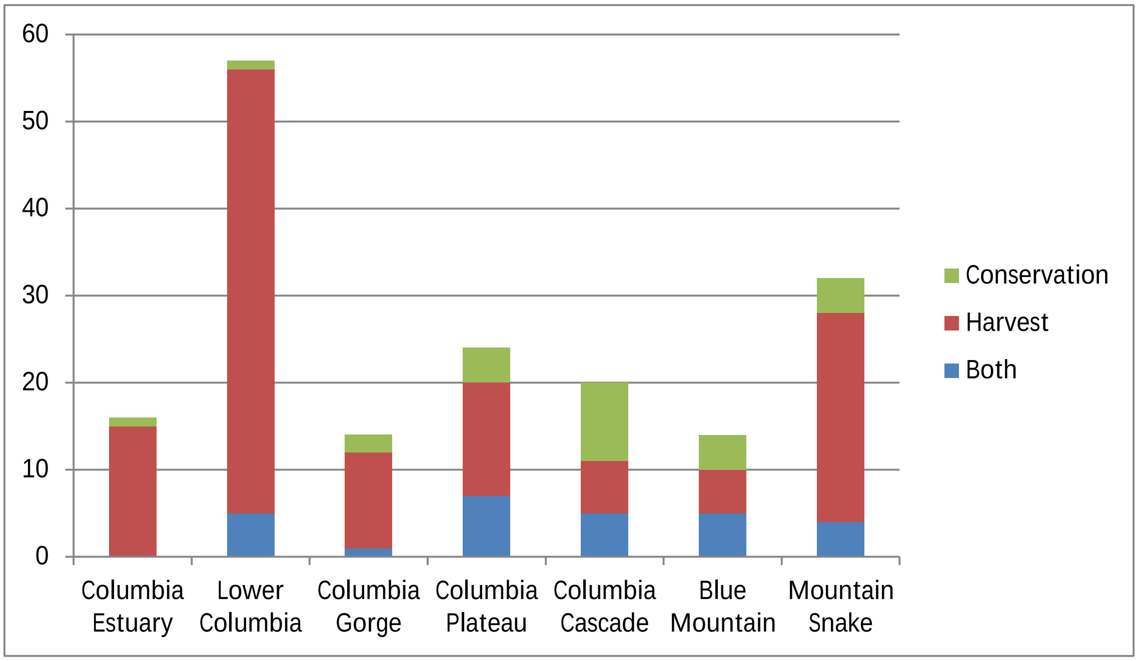


Figure 2-1. Distribution of Columbia River Basin hatchery programs by purpose and ecological province (figure based on 2010 hatchery programs).

2.3.3 Hatchery Program Operational Strategies

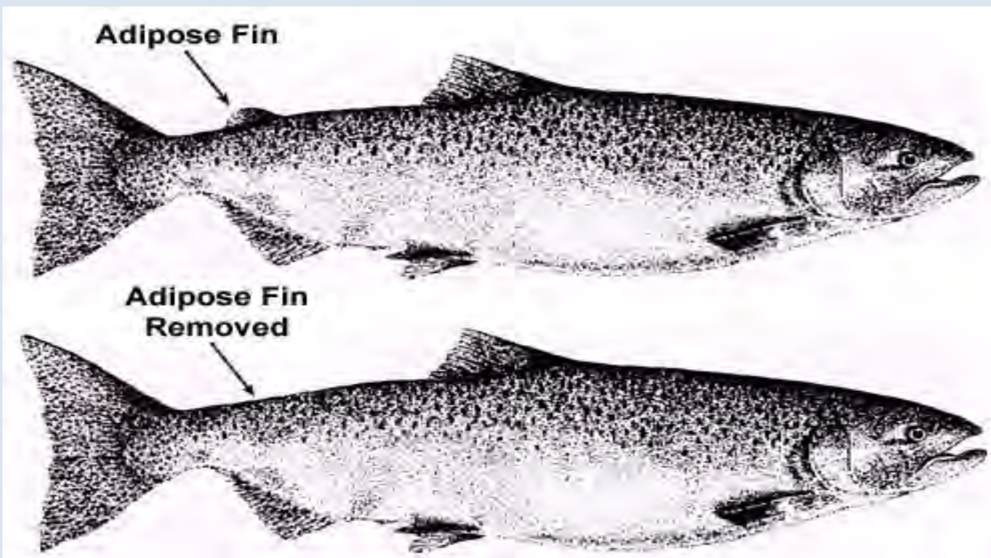
Each hatchery program has both a purpose and an operational strategy. Operational strategies fall into two categories: 1) isolating hatchery-origin fish from natural-origin fish (creating an *isolated* hatchery-origin population and an *isolated* natural-origin population), or 2) integrating hatchery-origin fish and natural-origin fish so that they are genetically similar, creating one *integrated* population.

Isolated hatchery programs seek to minimize reproductive interactions between hatchery-origin and natural-origin fish. Fish are released from hatchery facilities, and the surviving adults are expected to return to the hatchery facility to produce fish for the next generation. Adult traps or weirs and some specially managed fisheries are used to remove the returning hatchery-origin fish to minimize the number of hatchery-origin fish that spawn in nature. A common strategy used to identify hatchery-origin fish externally, for hatchery performance monitoring and for managing hatchery fish on the spawning grounds, is to remove the adipose fin from hatchery-origin fish prior to release (Box 2-4). There are 111 (63 percent) salmon and steelhead hatchery programs in the Columbia River Basin currently designed as isolated hatchery programs (Figure 2-2). Isolated programs are the dominant hatchery type in the Columbia Estuary, Lower Columbia, Columbia Gorge, and Mountain Snake Ecological Provinces.

Box 2-4. What is meant by "mass marking"?

"Mass marking" is a technique commonly used to mark all of the fish in a given hatchery release. Most often, it is used to distinguish hatchery-origin salmon and steelhead from natural-origin fish, but other uses are possible. In Asia, for example, hatchery salmon are mass-marked to allow country-of-origin determination of catch. In the Columbia River Basin, the primary use of mass marking is to identify hatchery fish; the most common method is removal of the adipose fin, a small fatty fin on the fish's back near the tail (diagram below), enabling visual validation of the mark.

Although the adipose clip is the most commonly used technology, depending on the need or objective of the mass marking, many additional technologies are available. Methods include coded-wire tag implant, thermal-marking of the otolith (inner ear bone), passive integrated transponder (PIT) tagging, and ventral fin clipping.



Integrated hatchery programs deliberately combine hatchery-origin and natural-origin fish into a single reproductively connected population. They typically incorporate substantial numbers of natural-origin fish into the hatchery broodstock and limit the number of hatchery-origin fish that spawn in the natural environment in an attempt to produce a population whose adaptation and fitness are influenced predominantly by the natural environment.

There are 66 (37 percent) integrated salmon and steelhead hatchery programs in the Columbia River Basin (Figure 2-2). Most hatchery programs in the Columbia Cascade and Blue Mountain Ecological Provinces are integrated programs.

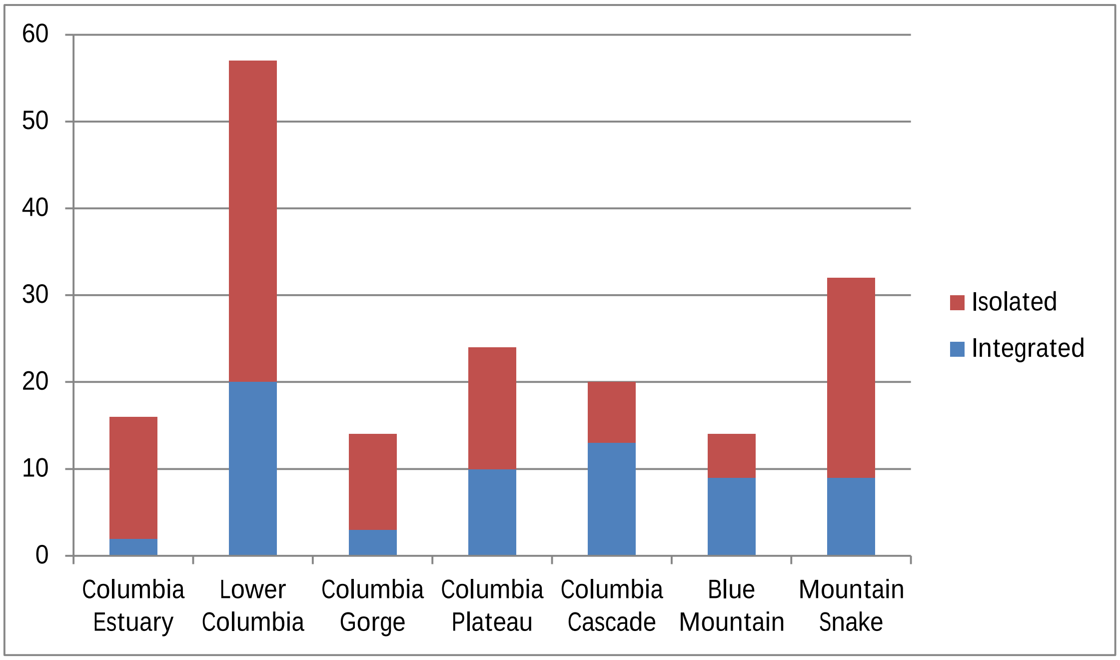


Figure 2-2. Distribution of Columbia River Basin hatchery programs by operational strategy and ecological province (figure based on 2010 hatchery programs).

2.3.4 Harvest, Habitat, and Hydro — the Other "H"s

While this EIS is focused on evaluating the effects of alternative hatchery policy direction (Alternatives) for Mitchell Act hatchery funding in the Columbia River Basin, the effects of hatchery production on the environment, both beneficial and adverse, do not happen in isolation. Other factors, both human and ecological, affect Columbia River salmon and steelhead populations, and in turn, other resources that rely on these fish. These factors include the operation of the Federal Columbia River Power System (FCRPS), continued habitat degradation through land use practices, and the effects of harvest, both in the basin and in the North Pacific.

NMFS works to address these other factors through significant planning, evaluation, and permitting processes (Section 1.7, Relationship to Other Plans, Regulations, Agreements, Laws, and Executive and Secretarial Orders). These include the following:

- The Pacific Coastal Salmon Recovery Fund (PCSRF), created by Congress in 2000, to address the need to protect, restore, and conserve salmon, steelhead, and their habitat http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/pacific_coastal_salmon_recovery_fund.html

- The biological opinion for the FCRPS http://www.westcoast.fisheries.noaa.gov/fish_passage/fcrps_opinion/federal_columbia_river_power_system.html
- The Pacific Salmon Treaty http://www.psc.org/pubs/treaty/treaty.pdf
- The Pacific Fishery Management Council (PFMC) annual fishery management plans http://www.pcouncil.org/salmon/current-season-management/
- The biological opinion for the *U.S. v. Oregon* Management Agreement

2.3.5 Flexibility in Hatchery Operation

Hatchery production and its planning and implementation are long-term investments of time, effort, and resources. Successful hatchery operations must retain a level of flexibility to respond to changes in the natural environment, in funding availability, and in social priorities. Additionally, hatchery operators and NMFS need the flexibility to manage programs for many of the effects of artificial production, both beneficial and adverse. NMFS believes that the development of a policy direction to guide Mitchell Act funding decisions in the Columbia River Basin will provide an effective foundation for current and potential Mitchell Act hatchery operators.

2.4 Alternative Development

2.4.1 Public Involvement

From 2004 through 2009, NMFS solicited and considered public comment on the development of alternatives for this EIS. First, as described in Section 1.6, Scoping and the Relevant Issues, NMFS published a Federal Register notice on September 3, 2004 (69 Fed. Reg. 53892), opening a 90-day public comment period to gather information on the scope of issues and range of alternatives to be analyzed in the draft EIS. In addition, NMFS held a series of internal and external meetings to seek input on potential EIS alternatives for Mitchell Act hatchery production. External meetings were attended by representatives from the Washington Department of Fish and Wildlife (WDFW), the Oregon Department of Fish and Wildlife (ODFW), the USFWS, the Nez Perce Tribe, the Pacific Fishery Management Council, the Northwest Indian Fisheries Commission, the Confederated Tribes of the Colville Reservation, the Columbia River Inter-tribal Fish Commission, the Institute for Tribal Government, and various fishing and environmental groups.

During the scoping process, two challenges became clear (Box 2-5). The first challenge was an incalculable number of hatchery actions, and combinations of actions, that could be implemented for hatchery programs funded under the Mitchell Act. This reality would make formulating alternatives comparing every potential hatchery action an impossible task due to the potential number of actions. The second challenge was that distribution of funds for Mitchell Act-funded hatchery production could be most accurately assessed in the context of operations by all other non-Mitchell Act-funded hatchery programs in the Columbia River Basin—In other words, the effects of operation of all other hatchery programs could be evaluated to optimize the analyses of the effects of Mitchell Act-funded hatchery programs. Once it was recognized that this comprehensive analysis would provide additional policy development benefits, NMFS published a notice in the Federal Register to inform the public that the scope of the earlier notice to prepare an EIS would be expanded to include the examination of environmental effects of all hatchery programs within the Columbia River Basin (Section 1.6.2, Notice of Intent).

Box 2-5. What were the two main challenges in identifying alternatives?

Challenge 1: Unlimited Number of Potential Actions

The number of potential actions that could be implemented through distribution of Mitchell Act hatchery funds, given the number of hatchery programs that could be adjusted, is too large to enable an analysis of all possible alternatives in an EIS. However, NMFS found that any potential action could be characterized under one of several potential policy directions. In other words, all reasonable uses of Mitchell Act hatchery funds could be grouped under a limited number of policy direction alternatives. For example, one policy direction might be to maximize ocean harvest, and a hatchery program could be directed at achieving that policy objective. Another might be to maximize efforts to conserve ESA-listed fish with a hatchery program that could be modified to pursue conservation of ESA-listed fish.

NMFS concluded that the best approach for disclosing environmental effects for this EIS was to formulate each alternative around a discrete policy direction intended to guide the distribution of Mitchell Act funds for hatchery production in the Columbia River Basin (Box 2-6).

Challenge 2: Effects of All Columbia River Basin Salmon and Steelhead Hatchery Production Programs Should be Analyzed

It also became clear during scoping that the environmental effects of alternative policy directions for the use of Mitchell Act-funded hatchery production could be better analyzed when the effects of all other non-Mitchell Act-funded hatchery programs in the Columbia River Basin are analyzed, as well. Like choosing pieces of a complex puzzle, decisions about the salmon and steelhead produced with Mitchell Act funds (e.g., the populations chosen for hatchery production, the size of the hatchery programs, the location of hatchery programs) are all coordinated and interrelated with decisions about the remainder of natural-origin and hatchery-origin production in the Columbia River Basin. Finally, an analysis of the effects of all hatchery programs in the Columbia River Basin provides NMFS with valuable resource information that would be useful if programs not currently funded under the Mitchell Act seek funding in the future.

Ultimately, the scoping and public comment process resulted in the development of six alternatives, each of which (with the exception of the No-action Alternative) centers on a policy direction that would guide the distribution of Mitchell Act funds for individual Columbia River Basin hatchery programs (Box 2-6), by enabling NMFS to utilize the broad-scale analysis in this

EIS to assess the likely cumulative environmental effects for proposed hatchery actions in the basin. Each policy direction is defined by a set of goals and/or principles.

> **Box 2-6. What is a policy direction?**
>
> A policy direction guides and shapes decisions NMFS makes related to Mitchell Act hatchery production in the Columbia River Basin, defined by a series of goals and/or principles.

Harvest goals are identified in some alternatives' policy directions and are described in terms of harvest goals above or below Bonneville Dam. In general, fisheries above Bonneville Dam include recreational fisheries, tribal commercial fisheries, and tribal ceremonial and subsistence fisheries. Fisheries below Bonneville Dam generally include recreational fisheries, non-tribal commercial fisheries, and ocean fisheries.

2.4.2 Alternative Performance Goals

Under each policy direction, performance goals are identified for hatchery programs according to the location of the hatchery programs and the type of salmon and steelhead populations that may be affected. For example, stronger performance goals are applied under some alternatives when the hatchery programs affect populations that have an important role in the recovery of listed ESUs/DPSs or are strongholds of non-listed ESUs or DPSs. Performance goals are intended to minimize or reduce the adverse effects of hatchery programs on natural-origin salmon and steelhead populations. Two performance goals (in addition to the baseline conditions) were identified for use in this EIS: 1) a stronger performance goal and 2) an intermediate performance goal (see Section 2.4.2.1, Performance Goals Defined).

To allow for meaningful comparisons among the alternatives, a level of uniformity had to be applied to the Columbia River Basin natural-origin populations. Each population was designated as primary, contributing, or stabilizing. The Lower Columbia Fish Recovery Board (LCFRB) used these designations in the development of the Lower Columbia River Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004). The HSRG adapted the designations throughout the basin after discussions with hatchery managers, and they are applied in this EIS (Appendix C through Appendix F). In some cases, there are differences between the HSRG classifications and what is found in the most current recovery planning documents (http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/index.html). The HSRG classifications have been updated to be consistent with the current designations in the most recent recovery planning documents.

In general, managers want primary populations to have a low level of biological risk to their continued existence, contributing populations to have a more moderate level of biological risk, and stabilizing populations to maintain their current level of risk. For a full discussion of the role of biological risk among populations in a recovered salmon ESU or steelhead DPS, see "Revised Viability Criteria for Salmon and Steelhead in the Willamette and Lower Columbia River Basins" (April 2006) by the Willamette/Lower Columbia Technical Recovery Team and ODFW, which can be found at http://www.nwfsc.noaa.gov/trt/wlc/viability_report_revised.cfm.

2.4.2.1 Performance Goals Defined

This EIS uses the terms *stronger performance goal* (i.e., stronger than baseline conditions) and *intermediate performance goal* (i.e., a level between baseline conditions and stronger performance) to indicate different levels of effects reduction or benefit that hatchery programs can have on natural-origin populations of salmon and steelhead. This EIS avoids terms that may be found in an ESA-related analysis, such as *jeopardy*, *recovery*, or similar concepts. These goals are not intended to infer compliance with any legal standard, nor are they intended to be analogous to ESA terminology or threshold standards, but they are helpful in aggregating and describing the effects of multiple hatchery programs on natural-origin populations of salmon and steelhead.

Hatcheries operated using *stronger performance goals* would maintain or promote beneficial effects (benefits) and minimize adverse effects (risks) of hatchery programs on salmon and steelhead populations when compared to baseline conditions. Hatcheries operated under *intermediate performance goals* would, in most cases, reduce the adverse effects (risks) of many hatchery programs on salmon and steelhead populations when compared to baseline conditions.

2.4.3 Additional Goals and Principles

In addition to the two primary performance goals (stronger and intermediate) described in Section 2.4.2, Alternative Performance Goals, each alternative's policy direction also includes goals and/or principles related to the following:

- Mitigation agreements
- Initiation of new hatchery programs
- Monitoring, evaluation, and reform
- Adaptive management process
- Best management practices (BMPs) for hatchery facilities
- Disbursement of Mitchell Act funds

2.5 Alternatives Analyzed in Detail

2.5.1 Alternative 1 (No Action)

Under Alternative 1, there would not be a defined policy direction, and Columbia River Basin hatchery production would continue baseline conditions. Based on NMFS' observations, the following describe the baseline conditions:

- Hatchery operators (both Mitchell Act-funded and other) have made substantial improvements to both programs and facilities to reduce the impacts on ESA-listed and non-listed salmon and steelhead populations in the Columbia River Basin.
- Hatchery programs (both Mitchell Act-funded and other) are used primarily to contribute to harvest (Section 2.3.2, Purpose of Hatchery Programs), although some hatchery programs are designed to help conserve natural-origin salmon and steelhead populations.
- Many hatchery programs are used to meet mitigation agreements. Most mitigation occurs to reduce the effects from hydro development on the fisheries resource.
- Monitoring, evaluation, and reform (MER) activities occur, but they are not guided by a comprehensive basinwide plan. MER plans, where they occur, are usually developed at the individual program level.
- Adaptive management of hatchery programs occurs, but it is usually directed at the performance of the program, i.e., survival of juveniles to adult recruits, and it is not necessarily directed at risk reduction on natural populations.
- BMPs for hatchery facilities are widely applied, but their application is not universal. In many cases, application is based on available funding and/or whether the BMP is a regulatory requirement.
- The amount of Mitchell Act hatchery funds can vary annually. Hatchery operators generally receive a similar proportion each year.

2.5.2 Alternative 2 (No Mitchell Act Funding)

Under Alternative 2, the policy direction would be defined by the following goals and/or principles:

- All Mitchell Act-funded hatchery programs and facilities would be closed.
- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to the remaining non-Mitchell Act-funded hatchery programs that affect

primary and contributing salmon and steelhead populations (Table 2-4). Application of the intermediate performance goal would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.

  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Isolated hatchery programs would be better isolated than under Alternative 1.

- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- No new hatchery programs would be initiated.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect ESA-listed primary and contributing populations.
- BMPs for facilities would be applied to all remaining hatchery facilities.
- Mitchell Act hatchery funding would be eliminated.

TABLE 2-4. HATCHERY PERFORMANCE GOALS IDENTIFIED UNDER EACH ALTERNATIVE'S POLICY DIRECTION.

			HATCHERY PERFORMANCE GOALS BY ALTERNATIVE					
RECOVERY DOMAIN	POPULATION TYPE[1]	FUNDING ENTITY	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6 (PREFERRED ALTERNATIVE)
Willamette/ Lower Columbia	Primary	Mitchell Act	Baseline conditions	N/A[2]	Intermediate	Stronger	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate	Stronger
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Stronger	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate	Stronger
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions
Interior Columbia	Primary	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger	Stronger
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger	Stronger
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions

[1] Each population's type (role in recovery) was designated as primary, contributing, or stabilizing. These designations were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004). The HSRG adapted them throughout the basin after discussions with the hatchery operators, and they are applied in this EIS (Appendix C through Appendix F).
[2] N/A means not applicable since hatchery programs would be terminated.

2.5.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under Alternative 3, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations (Table 2-4). Application of the intermediate performance goal would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Isolated hatchery programs would be better isolated than under Alternative 1.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- No new hatchery programs would be initiated.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect ESA-listed primary and contributing populations.
- BMPs for facilities would be applied to all hatchery facilities.
- Adaptive management planning related to risk reduction would be required for all programs that affect ESA-listed primary and contributing populations.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.5.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 4, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia Recovery Domain (Table 2-4). Application of the intermediate performance goal would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Isolated hatchery programs would be better isolated than under Alternative 1.
- The stronger performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain. Application of the stronger performance goal would minimize the risks of hatchery programs on natural-origin salmon and steelhead populations more than the intermediate performance goal.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Isolated hatchery programs would be better isolated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- BMPs for facilities would be applied in all hatchery facilities.
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.

- New conservation hatchery programs could be initiated in the Willamette/Lower Columbia Recovery Domain for populations deemed at high risk of extinction.
- New harvest hatchery programs could be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities below Bonneville Dam, including ocean fisheries.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.5.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 5, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain (Table 2-4). Application of the intermediate performance goals would, in most cases, reduce the risks of hatchery programs on natural-origin salmon and steelhead populations.
  - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
  - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.
- The stronger performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia Recovery Domain. These stronger performance goals would minimize the risks of hatchery programs on natural-origin salmon and steelhead populations more than the intermediate performance goal.
  - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
  - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.

- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of the conservation hatchery program must outweigh the risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- BMPs for facilities would be applied in all hatchery programs.
- New conservation hatchery programs could be initiated in the Interior Columbia Recovery Domain for populations deemed at high risk of extinction.
- New harvest hatchery programs may be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities above Bonneville Dam, including treaty Indian commercial fisheries.
- Monitoring, evaluation, and reform would be guided by a comprehensive basinwide plan.
- Adaptive management planning related to risk reduction would be required for all programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia Recovery Domain.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.5.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 6, the policy direction would be defined by the following goals and/or principles:

- The stronger performance goal (Section 2.4.2.1, Performance Goals Defined) would be applied to all Columbia River Basin hatchery programs that affect primary and contributing salmon and steelhead populations. These stronger performance goals would minimize the risks of hatchery programs on natural-origin salmon and steelhead populations.
    - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
    - ➢ Isolated hatchery programs would be better isolated than under Alternative 1.

- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of conservation hatchery programs must outweigh their risks (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species).
- Many hatchery programs are used to meet mitigation agreements. These programs would be aligned with the performance goals for the alternative.
- BMPs for facilities would be applied to all hatchery facilities.
- New programs (for conservation, harvest, or both purposes) could be initiated throughout the Columbia River Basin, where appropriate.
- Monitoring, evaluation, and reform would continue to occur. NMFS would continue to work with hatchery operators, basinwide, to develop priorities and strategies for monitoring, evaluation, and reform.
- Adaptive management planning, related to risk reduction, would be required for all programs that affect ESA-listed primary and contributing salmon and steelhead populations in the Columbia River Basin.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.6 Implementation Scenarios

The broad policy directions that are associated with each of the action alternatives (Section 2.5, Alternatives Analyzed in Detail) are goal- or objective-oriented, and do not identify specific actions that would be taken under each alternative. For instance, there are many acceptable approaches to enhancing the benefit of and/or reducing the risks associated with hatchery programs. However, to enable this EIS to analyze, illustrate, and compare the potential environmental effects of each alternative, an example implementation scenario, containing specific implementation measures, was developed for each alternative's policy direction. These implementation scenarios under each alternative should be viewed as just one example of how each of the alternative policies could be implemented basinwide. These implementation scenarios should not be viewed as prescribing preference to the measures implemented.

Section 2.6, Identifying an Implementation Scenario, and Section 2.7, Comparison of Implementation Scenarios, have been moved to Chapter 4, Environmental Consequences. Specifically, this information is now found in Subsection 4.1.3, Implementation Scenarios. These draft EIS subsections from Section 2, Alternatives, were moved in the final EIS to assist the reader with information about implementation scenarios, which are integral to the effects analyses in Section 4, Environmental Consequences.

2.7 Alternatives Considered but Eliminated from Detailed Analysis

Most comments received during scoping were incorporated into Alternative 2 through Alternative 5. Four additional alternatives were considered, but they were not further analyzed for the following reasons:

1) The alternative would not provide any additional information beyond what was revealed through evaluation of the four action alternatives described in Section 2.5, Alternatives Analyzed in Detail.

2) The proposed alternatives were inconsistent with the purpose and need of this Federal action, particularly the congressional intent under Mitchell Act appropriations for operating and maintaining hatcheries in the Columbia River Basin (Section 1.1.1, The Mitchell Act) (Table 1-3)[2].

2.7.1 Alternatives that Generally Increase the Adverse Impacts of Hatchery Production

While not all salmon ESUs or steelhead DPSs in the Columbia River Basin are listed under ESA, at least one salmon or steelhead population is a member of a listed ESU or DPS in each of the major subbasins within the project area. Hatchery practices have been identified as one factor for the decline of most listed salmon and steelhead (Section 1.1, Introduction). Because of this, the purpose and need for this action is to establish a policy direction that, among other things, includes information on actions that may *reduce* risks on natural-origin fish. Therefore, implementation of hatchery practices that would *increase* risks on listed species when compared to existing practices is not considered in this EIS because they would not meet the purpose and need for the proposed action.

2.7.2 Alternatives that Would Change the Distribution of the Mitchell Act Screens and Fishways Funding

The Mitchell Act Screens and Fishways Program is a separate program with separate congressionally appropriated funding. NMFS does not have the authority to change the distribution of congressionally allocated funds between the Mitchell Act Hatchery and Screen and Fishways Programs.

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[2] In recent years, the President's Budget Request submitted to Congress has identified funding for Mitchell Act hatchery operations, MER, and the Screens and Fishways Program as three Mitchell Act subaccounts within an account entitled "Salmon Management Activities." Congress has appropriated the total to the Salmon Management Activities account, which the Administration then allocates to the three Mitchell Act activities in amounts requested in the budget.

2.7.3 Construction of New Hatchery Facilities with Mitchell Act Funds

Decisions regarding the scope of review in this EIS would not preclude the construction of new or expanded hatchery facilities in the Columbia River Basin. However, current and reasonably foreseeable appropriations under the Mitchell Act for hatchery production would preclude the option to construct new hatchery facilities in the project area (http://www.whitehouse.gov/omb/budget/Overview).

2.7.4 Alternative that Eliminates All Hatchery Programs in Subbasins that Can Support Natural Production

This alternative would terminate hatchery programs in Columbia River Subbasins where quality aquatic habitat occurs and, alternatively, would use the funds planned for those hatchery programs for habitat restoration in subbasins that could support natural-origin salmon and steelhead production. This alternative was considered but was eliminated from detailed analysis because the Mitchell Act funding subject to this EIS is directed by congressional appropriation to be used for artificial production and cannot be used for habitat restoration. Congress could, but did not, appropriate funds under the authority of the Mitchell Act for habitat restoration. However, the environmental effects of eliminating Mitchell Act-funded hatchery programs are included within the scope of the analysis under Alternative 2 (No Mitchell Act funding). Alternative 2 does not, however, evaluate habitat restoration actions because those actions cannot be funded with Mitchell Act funds Congress designated for hatchery operations. These actions are, thus, beyond the scope of this environmental review. Under Alternative 2, several subbasins would no longer receive direct releases of hatchery salmon or steelhead. However, this does not mean that populations in these subbasins are free of hatchery influences. As an example, no fish are released into the Asotin Subbasin under Alternative 1, but marked hatchery hatchery-origin fish are counted every year at a downstream weir (WDFW unpublished data provided to the HSRG).

2.7.5 Alternative that Converts All Isolated Hatchery Programs to Integrated Hatchery Programs

This alternative would convert all isolated hatchery programs to integrated hatchery programs. An integrated hatchery program uses natural-origin fish in the hatchery broodstock so that the fish produced in the hatchery facility are genetically similar to the natural-origin fish in the subbasin where they are being released. While many integrated hatchery programs already exist in the Columbia River Basin and are analyzed in this EIS, isolated hatchery programs remain valuable in situations where natural-origin populations are not large enough to contribute fish to a hatchery program's broodstock while also sustaining the naturally spawning portion of the population. In such cases, integrated hatchery programs would remove critically needed, naturally spawning adults from a subbasin to provide for hatchery broodstock. The hatchery program would likely be unsuccessful because too few natural-origin fish could be taken for hatchery broodstock due to the need to ensure sufficient natural-origin spawners in the stream. In many cases, this limitation impairs the ability of the population to meaningfully support a hatchery program with either a conservation objective or a harvest objective. In those instances, analysis of the effects of such a program would not add meaningful information to this EIS. The alternatives carried forward for analysis do, however, include many integrated hatchery programs.

2.7.6 Alternative that Focuses on Habitat Improvements Rather than Hatchery Production

Under this alternative, Mitchell Act funds would be diverted from hatchery programs to aquatic habitat improvements. Through its appropriations process, Congress directs NMFS to use the Mitchell Act funds subject to this environmental review specifically for Columbia River hatchery production (Section 1.1.1, The Mitchell Act). As a result, this alternative was eliminated from detailed analysis.

2.7.7 Alternative that Terminates Non-Mitchell Act-funded Hatchery Programs that Meet Performance Goals

Comments were received recommending the termination of some or all hatchery programs. Alternative 2 would eliminate Mitchell Act-funded hatchery programs because these are the only hatchery programs in the Columbia River Basin that are funded by NMFS through specific congressional appropriations, but that are not specifically prescribed by another mitigation agreement (although many Mitchell Act-funded hatchery programs currently are used to fulfill commitments in the 2008 Columbia River Fish Management Plan authorized in *U.S. v. Oregon*). Most currently operating, non-Mitchell Act-funded hatchery programs in the basin either address requirements described in 2008 Columbia River Fish Management Plan, an applicable license issued by the Federal Energy Regulatory Commission, or a congressional mandate (Snake River Compensation Plan). The termination of these hatchery programs, if they cannot not meet performance goals that reduce risks on natural-origin fish, is already analyzed under one or more of the action alternatives (Table 2-4). Further, NMFS does not fund or operate non-Mitchell Act-funded hatcheries and, therefore, could not mandate their termination.

2.7.8 Alternatives that Apply Performance Standards to Stabilizing Populations

Recovery plans in the Columbia River Basin, both in the Willamette/Lower Columbia and in the Interior Columbia Recovery Domains, establish a hierarchical structure for recovery, where some populations, primary and contributing, are identified for high levels of recovery, or viability at recovery. Populations that are identified to maintain their current, typically low, level of viability, even at recovery, are identified in this EIS as stabilizing populations. Given that these stabilizing populations are not a major focus for improvement in the current population status, this EIS has not focused on alternatives that would require changes in hatchery program operations to affect these populations. However, many stabilizing populations would receive risk reduction benefits from the alternatives that are focused on improvements to primary and contributing populations.

2.8 Selection of a Preferred Alternative

As explained in Section 1.3.1, Preferred Alternative Formulated and Identified in the Final EIS, NMFS reviewed public comments received on the draft EIS and has identified a preferred alternative in this final EIS. The preferred alternative was also informed by the concurrent and complex authorities and initiatives that currently exist in the Columbia River Basin, including judicial orders from *U.S. v. Oregon* (Section 1.7.4, *U.S. v. Oregon*), the FCRPS Biological Opinion (Section 1.7.7, Federal Columbia River Power System Biological Opinion), and ESA recovery planning (Section 1.1.2, The Endangered Species Act) (Figure 2-3) (Box 2-1).

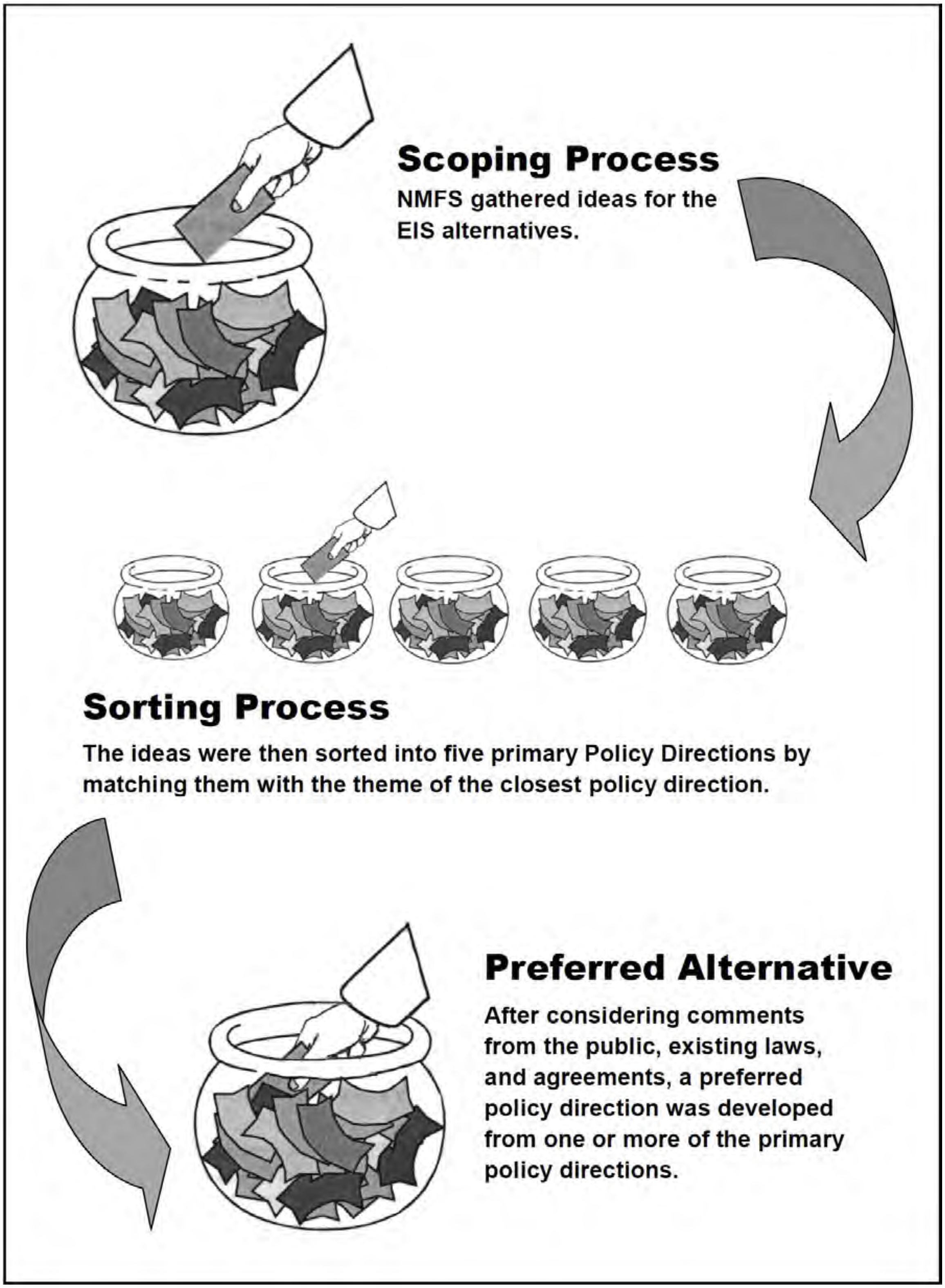


Figure 2-3. Sorting public comments to identify alternative policy directions (alternatives).

Science, Service, Stewardship

Chapter 3

Affected Environment

3.1 Introduction

3.2 Fish

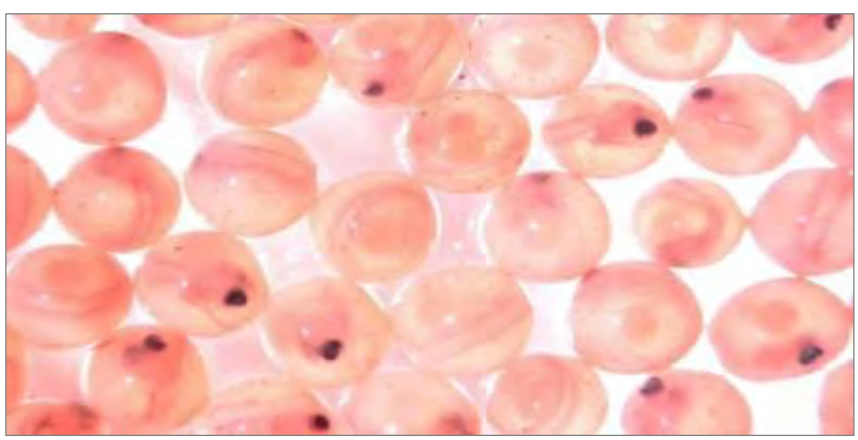
3.3 Socioeconomics

3.4 Environmental Justice

3.5 Wildlife

3.6 Water Quality and Quantity

3.7 Human Health



3 AFFECTED ENVIRONMENT

3.1 Introduction

Chapter 3 describes baseline conditions for six resources that may be affected by implementation of the environmental impact statement (EIS) alternatives: fish, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health. No other resources were identified during scoping that could potentially be impacted by the proposed action or alternatives. Chapter 4 (Environmental Consequences) will analyze effects on these resources from implementing the EIS alternatives. The specific section sequence for this chapter is as follows:

- Introduction (Section 3.1)
- Fish (Section 3.2)
- Socioeconomics (Section 3.3)
- Environmental Justice (Section 3.4)
- Wildlife (Section 3.5)
- Water Quality and Quantity (Section 3.6)
- Human Health (Section 3.7)

The project area for this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River Basin, including the Snake River and all other tributaries of the Columbia River in the United States (U.S.). The project area includes the Columbia River estuary and plume (Section 2.2, Description of Project Area).

Each resource's analysis area includes the project area as a minimum area, but may also include locations beyond the Columbia River Basin if some of the effects of the EIS alternatives on that resource occur outside the project area (Section 1.4, Project and Analysis Area). For example, Alaska is not in the project area, but because the EIS alternatives would have varying effects on Alaska fisheries (since hatchery-origin fish produced in the Columbia River Basin are caught in Alaska), Alaska is included in the analysis area for socioeconomics. Table 3-1 provides a comparative resource summary of the different analysis areas for this EIS. In addition, a separate section titled "Analysis Area" is included in each resource section.

TABLE 3-1. GEOGRAPHIC RANGE OF EACH RESOURCE'S ANALYSIS AREA.

		GEOGRAPHIC RANGE OF RESOURCE'S ANALYSIS AREA					
COLUMBIA RIVER RECOVERY DOMAIN	ECOLOGICAL PROVINCE/ GEOGRAPHIC AREA[1]	FISH	SOCIOECONOMICS[2]	ENVIRONMENTAL JUSTICE	WILDLIFE	WATER QUALITY AND QUANTITY	HUMAN HEALTH
Willamette/ Lower Columbia	Columbia Estuary	X	X	X	X	X	X
	Lower Columbia	X	X	X	X	X	X
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	X	X	X	X	X	X
Interior Columbia	Columbia Plateau	X	X	X	X	X	X
	Columbia Cascade	X	X	X	X	X	X
	Blue Mountain	X	X	X	X	X	X
	Mountain Snake	X	X	X	X	X	X
N/A[3]	Coastal Washington, Oregon, and California		X	X			
N/A	British Columbia, Canada		X	X			
N/A	Puget Sound/Strait of Juan de Fuca		X	X			
N/A	Southeast Alaska		X	X			

[1] See Table 2.1 in Chapter 2 (Alternatives) for a list of subbasins within each ecological province.

[2] Socioeconomic effects are reported by economic impact regions, which in some cases have different boundaries than the geographic areas included in this table. Please see Section 3.3 (Socioeconomics) for details.

[3] N/A = not applicable.

3.2 Fish

3.2.1 Introduction

This section describes current baseline conditions for fish within the analysis area that may be affected by the alternatives. Fish species are grouped into two categories:

1) Salmon and steelhead

2) Other fish species that have a relationship to salmon and steelhead (i.e., predators and prey of salmon

This discussion also describes the ongoing and current general risks to and benefits of hatchery programs for salmon and steelhead species so that the reader has context for the effects analysis found in Section 4.2, Fish. The risks and benefits related to salmon and steelhead are described first (Section 3.2.3, Salmon and Steelhead), followed by a more focused discussion for each evolutionarily significant unit (ESU) or distinct population segment (DPS) (Section 3.2.3.2, Status of Salmon ESUs and Steelhead DPSs). Other fish species are discussed in Section 3.2.4, Other Fish that Have a Relationship with Salmon and/or Steelhead).

As described in Section 2.6, Identifying an Implementation Scenario, implementation scenarios were developed for each of the alternatives, including Alternative 1, to provide a uniform method of analyzing the effects of implementing the alternatives. The development and application of these implementation scenarios, including various implementation measures, are discussed in detail in Chapter 4, Environmental Consequences, and Section 4.1.3, Implementation Scenarios. However, to establish reference environmental conditions, some results from the implementation scenario for Alternative 1 are presented here in Chapter 3, Affected Environment.

3.2.2 Analysis Area

The analysis area for fish in this EIS is the same as the project area as described in Section 2.2, Description of Project Area. Information presented in Section 3.2, Fish, and Section 4.2, Fish, is organized according to species. For salmon and steelhead species, the analysis is further subdivided by ESU and DPS (Box 1-1). The boundaries of each salmon ESU and steelhead DPS cover several subbasins and one or more ecological provinces (Section 2.2, Description of Project Area). Maps of the ESU and DPS boundaries can be found at http://www.westcoast.fisheries.noaa.gov/maps_data/species_population_boundaries.html.

3.2.3 Salmon and Steelhead

3.2.3.1 General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species

Information on current risks to and benefits of hatchery programs for salmon and steelhead were collected from best available science found in existing literature and/or developed through modeling. Information on the methods used to model biological, hatchery facility, predation, and competition effects is found in Section 4.2.2, Methods for Analyzing Effects. Because baseline conditions are assumed to remain constant under Alternative 1, modeled information in this section is identical to modeled data for Alternative 1 in Section 4.2, Fish.

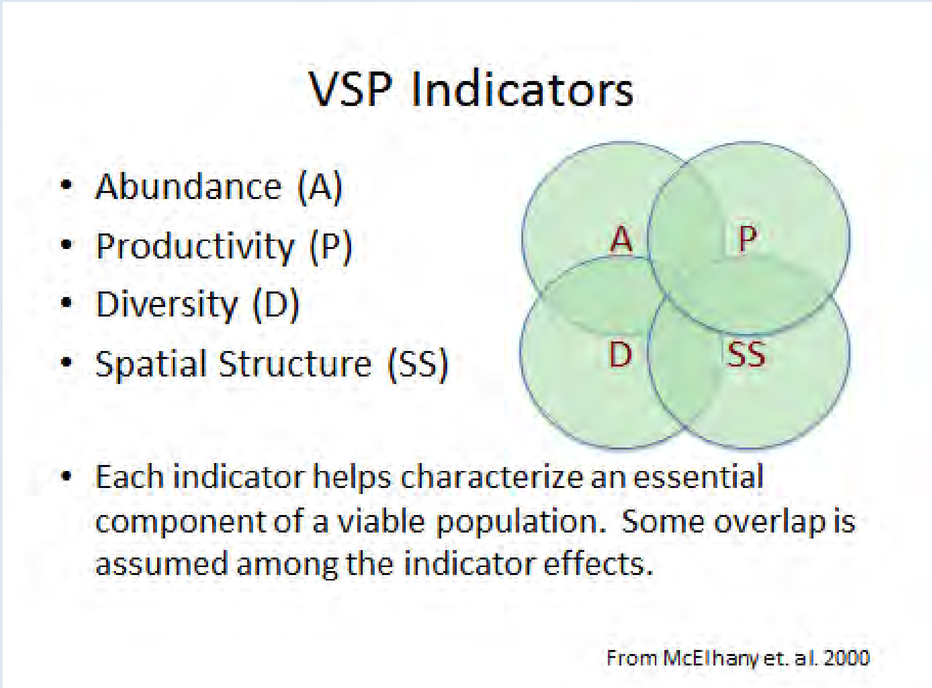
3.2.3.1.1 Effects on the Viable Salmonid Population Concept

McElhany et al. (2000) developed the viable salmonid population (VSP) concept as a means to evaluate the conservation status of Pacific salmon and steelhead. A key part of this approach was the identification of four measurable indicators of population health that should be considered in performing conservation status assessments. These indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins) (Box 3-1). Hatchery programs can provide benefits to some of these VSP indicators under certain circumstances, but can pose risks to VSP as well.

3.2.3.1.1.1 Effects on Abundance and Productivity

A primary benefit conferred by hatchery programs is an increase in the total abundance of a salmon population that returns to spawn naturally. Freshwater, habitat-related factors limiting the survival and productivity of a natural-origin population can be circumvented by spawning, incubating, rearing, and releasing fish from the population in a hatchery facility. In the situation where the hatchery stock is the same genetic population as the natural-origin population, the hatchery may also act as a protection for the population against catastrophic environmental conditions (e.g., Grande Ronde spring Chinook captive broodstock and Snake River sockeye hatchery programs). Productivity may also be increased if hatchery-origin fish improve conditions of spawning gravel or add nutrients to the system.

Box 3-1



Short-term success in increasing the number of naturally spawning, natural-origin fish has been demonstrated for some hatchery programs (e.g., Hood Canal summer chum salmon and Snake River fall Chinook salmon supplementation and reintroduction hatchery programs). However, the long-term success in recovering a self-sustaining, naturally spawning population is yet to be demonstrated and may be difficult without commensurate improvements in the condition of natural habitat.

Table 3-2 shows the estimated, mean adjusted productivity and abundance of salmon and steelhead populations in each Columbia River Basin ESU and DPS under baseline conditions. The abundance and productivity numbers in this table were generated with the All-H Analyzer model using best available data (Section 4.2.2, Methods for Analyzing Effects; and Appendix G, Overview of the All-H Analyzer). Abundance and productivity numbers may vary from numbers included in other documents (e.g., 5-year status updates or biological opinions) given that these numbers are outputs from the All-H Analyzer model. The model makes some uniform assumptions regarding the effect of hatchery-origin fish on the overall productivity of a population. The advantage of using the All-H Analyzer model for analyses in this EIS is that it provides estimates of abundance and productivity that are standardized between ESUs/DPSs and across alternatives (i.e., for an “apples-to-apples” effects comparison), whereas 5-year status updates and biological opinions necessarily reflect the specific biological information relevant to the Endangered Species Act (ESA) delisting criteria for the individual ESU/DPS. For more information on the All-H Analyzer model, see Appendix G, Overview of the All-H Analyzer.

TABLE 3-2. ESTIMATED (MODELED) MEAN ADJUSTED PRODUCTIVITY AND TOTAL NATURAL-ORIGIN SPAWNERS FOR ALL POPULATIONS IN AN ESU/DPS UNDER BASELINE CONDITIONS.

ESU/DPS	Mean Adjusted Productivity	Total Natural-origin Spawners (NOS) Abundance
Lower Columbia River Chinook Salmon	3.3	58,943
Mid-Columbia River Spring-run Chinook Salmon	4.0	16,666
Deschutes River Summer/Fall-run Chinook Salmon	2.4	8,925
Upper Columbia River Spring-run Chinook Salmon	2.6	2,332
Upper Columbia River Summer/Fall-run Chinook Salmon	2.4	74,573
Upper Willamette River Chinook Salmon	3.7	24,775
Snake River Spring/Summer-run Chinook Salmon	2.1	20,699
Snake River Fall-run Chinook Salmon	0.97	2,437
Lower Columbia River Steelhead	3.2	16,988
Middle Columbia River Steelhead	3.0	28,570
Snake River Basin Steelhead	2.4	21,031
Southwest Washington Steelhead	4.5	3,165
Upper Columbia River Steelhead	1.0	2,093
Upper Willamette River Steelhead	5.4	9,255
Lower Columbia River Coho Salmon	1.8	32,851
Columbia River Chum Salmon	1.9	19,304
Snake River Sockeye Salmon	0.13	165

Source: Appendix C though Appendix F. Information was generated with the All-H Analyzer model using best available data.

Abundance ranges from 165 sockeye salmon in the Snake River Sockeye Salmon ESU to 74,573 Chinook salmon in the Upper Columbia Summer/Fall Chinook Salmon ESU. Adjusted productivity ranges from a low of 0.13 for the Snake River Sockeye Salmon ESU up to 5.4 for the Upper Willamette Steelhead DPS (Table 3-2).

Table 3-3 shows the number and percentage of populations with abundance greater than 500 and productivity greater than 1.0. The abundance and productivity numbers in this table were generated with the All-H Analyzer model using best available data. The percentage of populations with both productivity greater than 1.0 and natural-origin abundance greater than 500 ranges from 0 percent in the Upper Columbia River Spring-run Chinook Salmon and Snake River Fall-run Chinook Salmon ESUs to 100 percent in the Deschutes River Summer/Fall-run Chinook Salmon ESU and Upper Willamette River Steelhead DPS (Table 3-3).

Hatchery programs may also pose risks to abundance and productivity because they can lead to additional mortality of natural-origin fish through competition, predation, disease, and fisheries. They may also unfavorably alter the genetic character of the natural-origin population, or restrict the distribution of a population across its habitat.

Abundance and productivity would be the most directly affected by any increased mortality on natural-origin fish. Substantial increases in mortality would be readily observable as a reduction in the abundance of natural-origin fish. Increased mortality would also result in a less efficient reproductive conversion of spawning adults to surviving offspring, which would be detectable as a reduction in productivity. A reduction in productivity would be measured as the ratio of surviving offspring (adults) per parents.

3.2.3.1.1.2 Effects on Genetic Diversity

Salmon and steelhead often differ genetically from population to population because of their strong tendency to return to spawn in their home stream. This behavior allows the forces of natural selection, mutation, and random genetic drift to operate in relative isolation in different streams or subbasins, resulting in genetic differences. In many instances, these differences are adaptive, allowing a local population to have a greater ability to survive and persist in that environment than would another population (Taylor 1991; McElhany et al. 2000).

TABLE 3-3. ESTIMATED NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING EACH ESU/DPS THAT HAVE AN ADJUSTED PRODUCTIVITY ($PROD_{ADJ}$) GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH UNDER BASELINE CONDITIONS.

ESU/DPS	Number of Populations with $PROD_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with both $PROD_{ADJ}$ > 1.0 and NOS > 500	Percent of Populations with $PROD_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with both $PROD_{ADJ}$ > 1.0 and NOS > 500
Lower Columbia River Chinook Salmon	23	16	15	82	57	54
Mid-Columbia River Spring-run Chinook Salmon	10	7	7	100	70	70
Deschutes River Summer/Fall-run Chinook Salmon	1	1	1	100	100	100
Upper Columbia River Spring-run Chinook Salmon	6	2	2	100	33	33
Upper Columbia River Summer/Fall-run Chinook Salmon	3	5	3	50	83	50
Upper Willamette River Chinook Salmon	4	5	4	80	100	80
Snake River Spring/Summer-run Chinook Salmon	25	15	15	86	52	52
Snake River Fall-run Chinook Salmon	0	1	0	0	100	0
Lower Columbia River Steelhead	19	11	11	95	55	55
Middle Columbia River Steelhead	16	15	15	100	94	94
Snake River Basin Steelhead	19	12	12	86	55	55
Southwest Washington Steelhead	7	2	2	100	29	29
Upper Columbia Steelhead	2	2	1	40	40	20
Upper Willamette River Steelhead	4	4	4	100	100	100
Lower Columbia River Coho Salmon	16	12	11	73	55	50
Columbia River Chum Salmon	13	7	7	93	50	50
Snake River Sockeye Salmon	0	0	0	0	0	0

Source: Appendix C though Appendix F. Data were generated with the All-H Analyzer model using best available data. N/A = not available. Primary, contributing, and stabilizing populations are terms that were used by the Lower Columbia Fish Recovery Board (LCFRB) in the development of the Lower Columbia Salmon Recovery and Fish &Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the Hatchery Scientific Review Group (HSRG), after discussions with the Columbia River fish managers, and are applied in this final EIS (Section 2.4, Alternative Development).

While hatchery programs can help to conserve salmon and steelhead populations, particularly those at very low abundance and in danger of extirpation (e.g., Snake River sockeye salmon captive brood program, Tucannon River spring Chinook salmon captive brood program, and the White River [Wenatchee] spring Chinook salmon captive brood program), hatchery programs can also pose genetic risks to salmon and steelhead populations. Populations of fish, adapted to the hatchery environment, that interbreed with natural-origin populations can result in substantial genetic changes (a diversity indicator) that are maladaptive for natural-origin fish in the natural environment. In addition to affecting population diversity, such changes would likely adversely impact the reproductive efficiency of natural-origin populations, lowering productivity. These effects would be most pronounced when highly domesticated and/or non-native hatchery-origin fish from isolated hatchery programs interbreed with natural-origin fish at excessive levels. However, even optimally managed, integrated hatchery programs using native fish can be expected to result in some risks to genetic diversity.

The biological mechanisms controlling genetic change in hatchery-origin fish are the same as those that cause change in natural-origin populations (e.g., selection, drift, mutation, and gene flow), but the hatchery environment and the way hatchery operations are conducted can cause these mechanisms to have effects that differ in magnitude or direction from their operation in the natural environment. Therefore, local adaptation can be disrupted, and unique patterns of genetic diversity can be lost if the natural-origin population interbreeds with hatchery-origin fish, particularly hatchery-origin fish from an isolated hatchery program. The three important elements determining the severity of this effect are as follows:

1) The extent of genetic dissimilarity between the hatchery-origin fish and the receiving natural-origin population
2) The difference between the hatchery and natural environments
3) The relative amount of genetic material from hatchery-origin fish that enters the natural-origin population and vice versa

The degree to which natural-origin fish differ genetically from hatchery-origin fish can depend a great deal on the way the hatchery program is operated. Choice of hatchery broodstock can be very important, because it can result in gene flow that changes the genetic character of the population. Under natural conditions, some level of gene flow between populations is beneficial to the populations' genetic diversity. When hatchery programs disrupt natural patterns and levels of between-population gene flow, there is a negative effect on the natural population. The greater the geographic separation between the source and recipient population, the greater the likelihood of genetic differences between the two populations (Interior Columbia Technical Recovery Team [ICTRT] 2007) and the greater the potential risk to the genetic diversity of the recipient population.

Berejikian and Ford (2004) summarize evidence from many studies indicating that hatchery-origin fish do not reproduce as well under natural conditions as natural-origin fish. The magnitude of this difference is large when the hatchery-origin fish are from a non-local source, with reproductive rates from 2 percent to 37 percent of what was observed for natural-origin fish under the same conditions. The greatest effects have been found in Hood River steelhead (e.g., Araki et al. 2007; Araki et al. 2008; Christie et al. 2011). Evidence that the presence of hatchery-origin fish can have a depressing impact on the productivity (progeny produced per parent) of natural-origin populations has been demonstrated in steelhead (Chilcote 2003), coho salmon (Nickelson 2003; Buhle et al. 2009), and Chinook salmon (Hoekstra et al. 2007; Chilcote et al. 2011, 2013). However, it is not clear, in most cases, how much of this poor reproductive performance might have been the product of non-genetic factors (Berejikian and Ford 2004). Nickelson (2003) suggests that the effect he measured was largely due to ecological interactions between hatchery-origin and natural-origin smolts during their seaward migration. Other scientists suggest hatchery-origin fish may learn behaviors in hatchery facilities that impair their future performance as spawners (Fleming and Einum 1997; Berejikian et al. 1997).

In contrast to the study findings described above, there is some evidence that differences between hatchery-origin and natural-origin fish may not be that large, especially when the source of the hatchery broodstock was a local natural-origin population. This evidence suggests that the domesticating effect of the hatchery environment may not generally be as large as detected by the Hood River researchers. For example, Williamson et al. (2010) found that a substantial portion of the fitness deficiency in hatchery spring Chinook salmon in the Wenatchee Basin could be explained by spawning location. Hess et al. (2012) found that the difference in relative reproductive success of wild and hatchery Chinook salmon in a Clearwater River tributary was statistically insignificant.

In summary, the weight of the evidence suggests that hatchery-origin fish likely differ genetically from natural-origin fish in ways that can result in differences in reproductive performance when they spawn in the natural environment. When hatchery-origin fish interbreed with natural-origin fish, the productivity of the naturally spawning population may be reduced.

3.2.3.1.1.3 Current Approaches for Reducing Risks to Genetic Diversity

Currently there are three common approaches employed for reducing genetic risks from hatchery programs. These are as follows:

1) Limiting gene flow between hatchery-origin and natural-origin fish
2) Altering hatchery practices to minimize genetic change
3) Limiting the number of years that a hatchery program is operated

These approaches typically are used individually or in combination and concurrently, depending on the hatchery program purpose (Section 2.3.2, Purpose of Hatchery Programs).

The first approach applies a variety of methods (e.g., weirs and acclimation away from spawning areas) to limit the proportion of total natural spawners that are of hatchery origin (proportion of hatchery-origin spawners [pHOS]). The second approach, which can be implemented in combination and concurrent with the first approach, involves methods that reduce negative genetic risks when hatchery-origin fish do escape to spawn naturally, for example, annually incorporating natural-origin fish into the hatchery broodstock at a certain level (proportion of natural-origin broodstock [pNOB]).

The Hatchery Scientific Review Group (HSRG) (2009) and Grant (1997) recommend that pHOS be 0.05 or less when isolated, non-local broodstocks are used in hatchery program. When the hatchery-origin fish are integrated with the local natural-origin population, pHOS can still be a concern. In developing guidelines for integrated hatchery programs, the HSRG (2009) used a concept called proportionate natural influence (PNI), a metric describing the relative influence of hatchery and natural selective forces on the composite population. PNI is calculated as pNOB/(pNOB+pHOS). It can range from 0 to 1; the higher the value, the greater the relative influence of natural selective forces on the integrated population.

Specific actions to reduce pHOS include the following:

1) Improve factors limiting the productivity of the natural population to increase the number of natural-origin fish.
2) Reduce the number of juveniles released.
3) Increase the number of natural-origin fish produced through habitat restoration actions.
4) Release hatchery-origin smolts so that when they return as adults, they will return to the hatchery facility and not to natural spawning areas.

5) Implement selective fisheries to target hatchery-origin fish.
6) Operate weirs to trap and remove hatchery-origin fish before they spawn naturally.

A weir is a barrier to fish movement. Risks from weir operations include the following:

- Isolation of formerly connected populations
- Limiting or slowing movement of non-target fish species
- Alteration of stream flow patterns at varying flows
- Alteration of streambed and riparian habitat
- Alteration of distribution of spawning within a population
- Increased mortality or stress due to injury, delay in upstream migration, capture, and handling
- Impingement of downstream migrating fish
- Forced downstream spawning by fish that do not pass through the weir
- Increased straying risks due either to trapping adults that did not intend to spawn above the weir, or displacing adults into other tributaries by blocking free passage
- Non-optimal operation or weir failure from natural environmental variation (e.g., stream flow) or vandalism

By blocking migration and concentrating salmon into a confined area, weirs may also increase predation efficiency of mammalian predators (Recovery Implementation Science Team [RIST] 2009) (Appendix I). In considering the use of a weir to control movement of hatchery-origin fish, a realistic assessment of weir performance and the likelihood of weir failure are important measures. An inverse relationship often exists between the ecological impacts of a weir and its performance as a fish-sorting tool (RIST 2009) (Appendix I). Due to the potential negative impacts of weirs, more passive measures (such as geographic isolation of hatchery programs from natural-origin populations or reducing hatchery production) should be considered as potential methods for controlling the number of hatchery-origin spawners. However, there may be cases where controlling hatchery-origin fish by using weirs is the best management alternative (RIST 2009) (Appendix I).

Other important actions that should be taken to limit genetic risks include the following:

1) Use local-origin rather than imported broodstock.
2) Reduce the difference between the hatchery and natural environments.
3) Make sure that the fish sampled for broodstock are collected and spawned randomly with respect to age, size, and timing so that genetic variation is not lost from the population[1].

The HSRG (2009) established a series of recommended levels of pHOS and PNI, based on the affected natural-origin population's designation (primary, contributing, or stabilizing). These recommended levels may offer a moderate to high level of genetic risk reduction to the affected natural populations. They recommended that "Primary" populations be managed to a PNI of 0.67, or higher when affected by an integrated hatchery program and managed to a pHOS of less than 0.05, when affected by an isolated hatchery program. They also recommended that "Contributing" populations be managed to a PNI of greater than 0.50 when affected by an integrated hatchery program and managed to a pHOS of less than 0.10 when affected by an isolated hatchery program. The HSRG recommended that "Stabilizing" populations, due to their lower importance, biologically, be managed to no worse than current levels of PNI or pHOS.

Under baseline conditions, the percentage of primary and contributing populations[2] by ESU/DPS that have PNI levels of 0.67 or higher, or pHOS levels of 0.05 or lower ranges from zero for the Upper Columbia Spring-run Chinook Salmon ESU, the Snake River Fall-run Chinook salmon ESU, and the Upper Columbia River Steelhead DPS to 100 percent for the Deschutes River Summer/Fall-run Chinook Salmon ESU (Table 3-4). Under baseline conditions, 57 percent of all primary and contributing populations in the analysis area have PNI levels of 0.67 or higher, or pHOS levels of 0.05 or lower, 7 percent have PNI levels between 0.50 and 0.67, or pHOS levels between 0.10 and 0.05, and 36 percent have PNI levels lower than 0.50, or pHOS levels higher than 0.10 (Table 3-4).

[1] Currently there is some debate about the wisdom of random mating. Some recent work has shown that random mating may have selective effects, creating populations of smaller and younger fish.

[2] Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this EIS (Section 2.4, Alternative Development).

Table 3-4. Estimated (modeled) Number and Percent of Primary and Contributing Populations of Salmon and Steelhead Relative to PNI and/or pHOS level, within Each ESU/DPS under Baseline Conditions.

ESU/DPS	Number of Populations with PNI>0.67 and/or pHOS<0.05	Number of Populations with 0.67>PNI>0.50 and/or 0.10>pHOS>0.05	Number of Populations with PNI<0.50 and/or pHOS>.10	Percent of Populations with PNI>0.67 and/or pHOS<0.05	Percent of Populations with 0.67>PNI>0.50 and/or 0.10>pHOS>0.05	Percent of Populations with PNI<0.50 and/or pHOS>0.10
Lower Columbia River Chinook Salmon	6	3	19	21	11	68
Mid-Columbia River Spring-run Chinook Salmon	6	1	0	60	10	30
Deschutes River Summer/Fall-run Chinook Salmon	1	0	0	100	-	0
Upper Columbia River Spring-run Chinook Salmon	0	1	5	0	17	83
Upper Columbia River Summer/Fall-run Chinook Salmon	2	0	4	33	0	67
Upper Willamette River Chinook Salmon	2	0	3	40	0	60
Snake River Spring/Summer-run Chinook Salmon	22	0	7	76	0	24
Snake River Fall-run Chinook Salmon	0	0	1	0	0	100
Lower Columbia River Steelhead	15	2	3	75	10	15
Middle Columbia River Steelhead	13	2	1	81	13	6
Snake River Basin Steelhead	17	0	5	77	0	23
Southwest Washington Steelhead	6	0	1	86	0	14
Upper Columbia River Steelhead	0	1	4	0	20	80
Upper Willamette River Steelhead	3	0	1	75	0	25
Lower Columbia River Coho Salmon	6	4	12	27	18	55
Columbia River Chum Salmon	12	0	2	86	0	14
Snake River Sockeye Salmon	0	0	1	0	0	100
Total	111	14	69	57	7	36

Source: Appendix C though Appendix F. Information was generated with the All-H Analyzer model using best available data.

Under baseline conditions, the number of weirs that are used in each ecological province to control the number of hatchery-origin fish that spawn naturally ranges from zero for the Columbia Estuary and Columbia Gorge to six in the Lower Columbia (Table 3-5).

TABLE 3-5. THE NUMBER OF WEIRS BY ECOLOGICAL PROVINCE THAT ARE USED TO CONTROL THE NUMBER OF HATCHERY-ORIGIN FISH THAT SPAWN NATURALLY UNDER BASELINE CONDITIONS.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	NUMBER OF WEIRS
Willamette/ Lower Columbia	Columbia Estuary	0
	Lower Columbia	6
	Columbia Gorge	1
Interior Columbia	Columbia Gorge	0
	Columbia Plateau	5
	Columbia Cascade	3
	Blue Mountain	4
	Mountain Snake	5
Total		**24**

3.2.3.1.1.4 Effects on Spatial Structure

Hatchery programs can benefit the spatial structure of salmon and steelhead populations. The potential for a hatchery program to increase total adult returns to a particular river basin (Section 3.2.3.1.1.1, Effects on Abundance and Productivity) can expand the spatial distribution of spawning by forcing fish to inhabit less competitive reaches of the basin. Programs that spatially distribute juvenile releases throughout a particular river basin can increase the distribution of the returning hatchery-origin adults. Additionally, hatchery programs can be used to expand the area of a basin that is used for natural spawning, i.e., by transporting or passing hatchery-origin adults above a dam or other impassable barrier.

Hatchery programs can also pose risks to spatial structure through a number of actions. These include the operation of weirs, sometimes used to address genetic diversity risks (Section 3.2.3.1.1.3, Current Approaches for Reducing Risks to Genetic Diversity), that can impede upstream migration of returning adults or the construction of migration barriers to prevent the entry of spawners into portions of the watershed to ensure that the hatchery facility's water supply is less prone to carrying disease. Indirectly, mortality may reduce a population's spatial structure.

3.2.3.1.2 Hatchery Facility Risks

Potential risks to natural populations of salmon and steelhead from the operation of hatchery facilities include the following:

- Hatchery facility failure (power or water loss leading to catastrophic fish losses)
- Hatchery facility water intake effects (stream dewatering and fish entrainment)
- Hatchery passage effects (blocking upstream or downstream fish passage)
- Hatchery facility effluent discharge effects (deterioration of downstream water quality)

Hatchery facility failures have negative effects on fish being held in the hatchery facility; the second, third, and fourth factors have negative effects on natural-origin fish in the stream.

Hatchery Facility Failure. This risk is of particular concern when facilities rear species listed under ESA. Factors such as water supply flow reductions or failure, flooding, and poor facility conditions may cause hatchery facility failure or the catastrophic loss of fish under propagation.

Hatchery Facility Water Intake Effects. Water withdrawals for hatcheries within spawning and rearing areas can diminish streamflow, impeding migration and affecting the spawning behavior of salmon and steelhead. In addition, that portion of a hatchery facility's water supply that comes from a water source containing natural-origin fish must have an intake structure with adequate screening such that injury and mortality, whether from impingement or permanent removal, is very low or avoided altogether.

Hatchery Passage Effects. Hatchery facilities can have many types of in-stream structures, depending on the location and type of facility. Most commonly, hatchery in-stream structures are for water supply intakes. These structures, typically are used to increase the available water volume for the facility by either utilizing a small dam to back water up and increase depth and pressure for non-pump facility intakes, or increase the depth for pump facility intakes. These facilities typically require a structure across the entire width of the stream or a portion of the stream depending on the site-specific requirements. Many of these facility structures have the ability to allow fish to migrate upstream past the structure—some do not. Some of these passable structures are either insufficient due to design or due to age and condition. These structures can affect access to usable habitat above the hatchery facility. These structures can also affect the downstream migration of fish in the stream, water volumes and flow are significantly affected by the structure or if the structure did not consider downstream migration in the original design.

Hatchery Facility Effluent Discharge Effects. Effluent discharges can change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra 1991). Little information and data exist to show how a hatchery facility's effluent affects salmon and steelhead and other stream-dwelling organisms. Generally, the level of impact depends on the amount of discharge and the flow volume of the receiving stream. Any effects probably occur at the immediate point of discharge, because the effluent would dilute rapidly as it moves downstream. The Clean Water Act (CWA) requires hatcheries (i.e., aquatic animal production facilities) with annual production greater than 20,000 pounds to obtain a National Pollutant Discharge Elimination System (NPDES) permit to discharge effluent to surface waters. Currently the states of Washington and Oregon implement NPDES permit systems. The U.S. Environmental Protection Agency (EPA) currently administers hatchery effluent permitting for the state of Idaho (Section 1.7.8, Clean Water Act). These permits are intended to protect aquatic life and public health and to ensure that every facility treats its wastewater. The effects from the releases are analyzed prior to the issuance of the permit, and site-specific discharge limits are set. Additionally, monitoring and reporting requirements for the permits are subject to enforcement actions (EPA 2006).

3.2.3.1.3 Current Approaches for Reducing Hatchery Facility Risks

The following precautions are considered important to reduce the risk of catastrophic loss resulting from hatchery facility failures and those associated with hatchery facility intakes and other structures:

- Minimize the time adult fish are held in traps.
- Minimize hatchery facility failure through 24-hour-per-day staffing and onsite residence by hatchery facility personnel to allow rapid response to power or facility failures.
- Use low-pressure/low-water-level alarms on water supplies so personnel are notified of water emergencies.
- Use backup generators to respond to power loss.
- Train all hatchery facility personnel in standard fish propagation and fish health maintenance methods.
- Hatchery facilities should be designed to be non-consumptive regarding water resources. That is, water used in the hatchery facility can be returned near the point where it was withdrawn to minimize effects on natural-origin fish and other aquatic fauna.

- The risks associated with water withdrawals can generally be minimized by complying with water rights permits and meeting National Marine Fisheries Service (NMFS) screening criteria (NMFS 1995, 1996, 2004). These criteria for water withdrawal devices set forth conservative standards that help minimize the risk of harming natural-origin salmon and steelhead and other aquatic fauna.
- Risks can also be reduced through the use of well water sources for the operation of all or a portion of the hatchery facility production.
- All hatchery facilities should operate within the limits established in NPDES permits (if required). If production from the hatchery facility falls below the minimum production requirements for an NPDES permit, the hatchery facility would operate in compliance with state or Federal regulations for discharge.
- Hatchery facilities should also operate to allow all migrating species of all ages to bypass or pass through hatchery related structures.

Currently, all hatchery facilities that require NPDES permits operate within the limits established in the permits (Table 3-6). All hatchery facilities that fall below the minimum production requirements (20,000 pounds) for an NPDES permit operate in compliance with state or Federal regulations for discharge (Table 3-6). Seventy-one percent of hatchery facilities in the Columbia River Basin allow all migrating species to bypass through hatchery-related structures (Table 3-6).

For more information on the effects of hatchery facilities on water quality and quantity, refer to Section 3.6, Water Quality and Quantity. Effects of weirs and approaches for reducing risk associated with weirs are described in Section 3.2.3.1.1.2, Effects on Genetic Diversity.

3.2.3.1.4 Risks from Competition with Hatchery-origin Fish

Although competition and predation are treated as risks in this document, they are related to each other and, as a consequence, are frequently lumped together and described in the scientific literature as “ecological” effects. Competition is an interaction among members of the same species or different species utilizing a limited resource (e.g., food or space). Competition typically results in winners and losers. Competition between hatchery-origin and natural-origin fish may result from direct interactions, in which hatchery-origin fish interfere with access to limited resources by natural-origin fish, or indirect interactions, as when utilization of a limited resource by hatchery-origin fish reduces the amount available for natural-origin fish (Species Interaction Work Group [SIWG] 1984). Specific types of competition include competition for food, for territory among stream-rearing juveniles, for mates, and for spawning sites.

TABLE 3-6. COMPLIANCE WITH BEST MANAGEMENT PRACTICES (BMPS) FOR REDUCING HATCHERY FACILITY EFFECTS UNDER BASELINE CONDITIONS.

BMP	PERCENT (%) OF HATCHERY PROGRAMS IN COMPLIANCE WITH BMPS
Hatcheries are operated to allow all migrating species of all ages to bypass or pass through hatchery-related structures.	71
Screens on water intakes are compliant with Integrated Hatchery Operations Team (IHOT), NMFS, or other agency standards.	53
Water supplies are protected by alarms and backup power generators. Staff are notified of emergency situations through the use of alarms, auto-dialers, and/or pagers.	66
All facilities operate within the limits established in NPDES permits. If production from the facility falls below the minimum production requirements for an NPDES permit, the facility will operate in compliance with state or Federal regulations for discharge.	100

Source: Hatchery Program Viewer (HPV) model for Facility Best Management Practices (Appendix H).

For adult salmon and steelhead, effects from competition between hatchery-origin and natural-origin fish are assumed greatest in the spawning areas where competition for mates and spawning habitat occurs (U.S. Fish and Wildlife Service [USFWS] 1994). Hatchery-origin females compete with natural-origin females for spawning sites, and hatchery-origin males compete with natural-origin males for female mates. Although there is evidence that natural-origin fish have a competitive advantage over hatchery-origin fish in these situations (Fleming and Gross 1993; Berejikian et al. 1997) where spawning area is limited and abundances are high relative to available space, competition would likely be high. This circumstance could also result in superimposition (overlaying) of redds.

Juvenile hatchery-origin fish released into the natural environment may compete with natural-origin fish for resources as they migrate downstream. Steelhead, coho salmon, and spring Chinook salmon typically will migrate downstream rapidly once they make a complete physiological transition to the smolt life history stage. Therefore, the hatchery programs posing the least risk from competition are those that consistently produce full-term, rapidly migrating smolts that use river corridors as a “highway” to the ocean with minimal foraging and competition with natural-origin fish along the way. This ideal is difficult to achieve. Not all individuals in a population undergo the smolt transformation at the same time. Evidence suggests that smoltification timing can vary by 45 or more days within a single population (Quinn 2005). Most hatchery programs, however, release fish over a shorter period (e.g., 2 weeks). Such releases will include fish that have not yet smolted, as well as fish for which the peak smolt condition has passed. Juveniles released too early or too late with respect to smoltification are likely to migrate slowly, if at all. Because of their prolonged period in freshwater, such fish have a much greater opportunity to compete with natural-origin fish for food and space. Competition heightens if hatchery-origin fish are more numerous and are of equal or greater size. Although non-migratory, hatchery-origin juveniles (residuals) may eventually die, there will be a period when there may be significant competition with natural-origin fish.

Migrant juvenile chum salmon and fall Chinook salmon spend an extended period in the estuarine environment feeding and growing before they move into marine waters (Quinn 2005). Hatchery programs that release sub-yearling juveniles thus are more likely to create a competitive environment for natural-origin fall Chinook salmon and chum salmon. This situation may be particularly acute in the Columbia River, where the estuary has suffered a major loss of shallow water rearing habitat in the past century (Bottom et al. 2005). These habitat losses are likely to have reduced the capacity of these areas to support juvenile salmon, therefore exacerbating competition between hatchery-origin and natural-origin fish for the remaining habitat.

Competition may also occur within stream habitats when young, pre-migratory fish are released, regardless of the species involved. Release of large numbers of fry or pre-smolts in a small area has great potential for competitive effects because interactions can occur for long periods, up to 3 years in the case of steelhead. The potential effect of competition on the behavior, and hence survival, of natural-origin fish depends on the degree of spatial and temporal overlap, relative sizes, and relative abundance of the two groups (Steward and Bjornn 1990). Effects would also depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

In addition to the freshwater and estuarine environments, competition between hatchery-origin and natural-origin fish may extend into the marine environment. Evidence exists for density-dependent ocean survival affecting pink and chum salmon hatchery programs in Alaska, Russia, and Japan (Pearcy 1992). However, it is unclear whether density-dependent survival is a factor for coho salmon, steelhead, and Chinook salmon. Competition risk in marine waters is difficult to assess because of a lack of data collected at times when hatchery-origin fish and natural-origin fish likely interact and because competition depends on a variety of specific circumstances, including location, fish size, and food availability (SIWG 1984). In marine waters, food is the main limiting resource for natural-origin fish that could be affected by competition posed from hatchery-origin fish. Concentration of fish in a relatively small area during the early marine life stage may create short-term instances where food is in short supply, and growth and survival decline as a result (SIWG 1984). The degree to which food is limiting after the early marine portion of a natural-origin fish's life depends upon the density of prey species. Competition may also occur in more seaward areas.

3.2.3.1.5 Current Approaches for Reducing Risks from Competition with Hatchery-origin Fish

Hatchery operators commonly apply the following measures to reduce competition between hatchery-origin and natural-origin fish:

- Release fish as smolts rather than at younger or older ages (Steward and Bjornn 1990).
- Operate hatcheries so that hatchery-origin fish are reared to sufficient size, and smoltification occurs within nearly the entire population.
- Release smolts in lower river areas, below the upstream areas used for natural-origin salmon and steelhead rearing.
- Time hatchery fish releases to minimize ecological risks (Kostow 2009).

3.2.3.1.6 Risks of Predation from Hatchery-origin Fish

The same situations that lead to competition between hatchery-origin and natural-origin juveniles can cause predation risk. Direct predation occurs when hatchery-origin fish eat natural-origin fish; indirect predation occurs when predation from other sources increases as a result of the added abundance of juvenile salmon and steelhead from hatchery releases.

In direct predation, released smolts may prey on natural-origin fry and fingerlings they encounter during downstream migration. Hatchery-origin smolts, sub-adults, and adults may also prey on natural-origin fish of susceptible sizes and life stages (smolt through sub-adult) in estuarine and marine areas. In general, natural-origin salmon and steelhead populations will be most vulnerable to predation when natural-origin populations are depressed, when predator abundance is high, when present in small streams where migration distances are long, and when environmental conditions favor high visibility. Some reports suggest that hatchery-origin fish can prey on fish that are one half their length (Pearsons and Fritts 1999), but other studies have concluded that hatchery-origin predators prefer fish one third or less their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1993; Columbia Basin Fish and Wildlife Authority 1996). Because chum salmon and most fall Chinook salmon migrate to the ocean as sub-yearlings, they are much smaller than and more vulnerable to predation by hatchery-origin fish when they mix in the mainstem Columbia River. This vulnerability to predation by hatchery-origin fish in the mainstem Columbia is lower for the other species (coho salmon, steelhead, and spring Chinook salmon) because juveniles rear longer in freshwater and pass through the mainstem Columbia River en route to the ocean as older and larger fish. Natural-origin fish may also benefit from the presence of additional hatchery fish as available prey. Appropriately large, natural-origin fish may take advantage of smaller hatchery-origin juveniles as a food source.

In indirect predation, large concentrations of migrating fish may attract other predators (e.g., birds, fish, and seals). There are two types of predator response:

1) Numerical, in which the predators increase in abundance

2) Functional, in which they switch preferred prey types

Hatchery-origin releases, by increasing the size of an outmigration event (often multifold), may consequently cause increased predation pressure on natural-origin outmigrants (Steward and Bjornn 1990). Nickelson (2003) concluded that large releases of coho salmon smolts thus increased predation on natural-origin coho salmon and likely caused reduced productivity in several populations. Large numbers of hatchery-origin fish may also alter natural-origin salmon behavioral patterns, potentially influencing their vulnerability and susceptibility to predation (Hillman and Mullan 1989; USFWS 1994). Hatchery-origin salmon and steelhead released into natural-origin salmon and steelhead production areas, or into migration areas during natural-origin salmon and steelhead emigration periods, may, therefore, pose an elevated, indirect predation risk for natural-origin salmon and steelhead. On the other hand, a mass of hatchery-origin salmon and steelhead migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring, natural-origin salmon and steelhead.

Estuaries are important for providing rearing habitat for growth by serving as a refuge from predation and providing a physiological transition before fish emigrate to higher saline waters in the marine environment (Quinn 2005; Thorpe 1994). In the Columbia River Basin, this is especially the case for fall Chinook salmon and chum salmon because their life history strategies require a longer period of estuarine residence than other species such as coho salmon, steelhead, and spring Chinook salmon (Bottom et al. 2005). Therefore, chum salmon and fall Chinook salmon are more vulnerable to predation in the estuary than coho salmon, steelhead, and spring Chinook salmon.

3.2.3.1.7 Current Approaches for Reducing Risks of Predation from Hatchery-origin Fish

Hatchery operators commonly apply the following strategies to reduce the predation risk from hatchery-origin fish on natural-origin fish:

- Release fish as smolts rather than at younger or older ages (Steward and Bjornn 1990).
- Operate hatcheries so that hatchery-origin fish are reared to sufficient size, and smoltification occurs within nearly the entire population.
- Release smolts in lower river areas, below the upstream areas used for natural-origin salmon and steelhead rearing.
- Minimize size differences between hatchery-origin fish and their natural-origin counterparts.
- Time hatchery fish releases to minimize ecological risks (Kostow 2009)

3.2.3.1.8 Risks Associated with Masking

Unidentifiable adult hatchery-origin fish returning to natural spawning areas confound the ability to determine the status of the population. Abundance and productivity of the natural-origin population can be overestimated, and the productivity and capacity of the habitat can be imprecisely assessed. The abundance and productivity of the natural-origin fish and the condition of the habitat that sustains these fish are, therefore, "masked" by the continued infusion of hatchery-origin fish.

Attempts to identify and remedy anthropogenic factors adversely affecting fish habitat may be impeded through masking of natural-origin fish status. For example, instability and degradation of spawning gravel areas through flooding during critical spawning or egg incubation periods may not be recognized as a limiting factor to natural-origin production if annual spawning ground censuses are subsidized by returning adults from annual hatchery program releases.

In recent years, the masking problem has been greatly alleviated by the implementation of mass marking (marking a hatchery program's entire release), usually accomplished by adipose clip (Box 2-4). Driven by state legislation in Washington and by Federal direction in the Federal budgetary process[3], all Chinook salmon, coho salmon, and steelhead in the Columbia River Basin intended explicitly for harvest, with the exception of the Priest Rapids fall Chinook salmon hatchery program, are currently marked. Hatchery-origin fish released for conservation purposes do not have to be marked (Section 2.3.2, Purpose of Hatchery Programs).

[3] Interior Appropriations Bill, 2003

3.2.3.1.9 Current Approaches for Reducing the Risks of Masking

Hatchery operators commonly apply the following strategies to minimize the impact of masking:

- Mark hatchery-origin salmon and steelhead so they can be differentiated from natural-origin salmon and steelhead. Although 100 percent marking and sampling are not essential, accuracy in estimating the number or proportion of hatchery-origin fish in the sample decreases rapidly as either marking rates or sampling rates decline. Marking includes external fin removal (i.e., adipose fin, ventral fin), thermal marking of the otolith, coded-wire tagging, passive integrated transponder (PIT) tags, and other forms (Box 2-4).
- Monitor the spawning grounds to determine the proportion of hatchery-origin salmon and steelhead.
- Imprint hatchery-origin fish to return areas not used by natural-origin salmon and steelhead for spawning.

3.2.3.1.10 Risks Associated with Fisheries that Target Hatchery-origin Fish

Salmon fisheries, even when they target hatchery-origin fish, affect intermingled natural salmon and steelhead populations (Flagg et al. 1995; Myers et al. 1998). Fish from natural populations, some of which are ESA-listed or other stocks of concern, are encountered during fisheries that target hatchery fish. There is a resulting incidental and/or catch-and-release mortality that may represent a risk to natural populations.

3.2.3.1.11 Current Approaches for Reducing Risks Associated with Fisheries that Target Hatchery-origin Fish

Salmon and steelhead fisheries typically are designed to take advantage of areas and times when there is a prevalence of harvestable hatchery-origin fish or non-listed fish. Additionally, fisheries that may impact ESA-listed or other populations of concern are often managed under total allowable harvest limits to minimize the harvest risks to the populations. For example, most recreational steelhead fisheries now target hatchery-origin fish only, and regulations require that all natural-origin fish be released unharmed. Likewise, many recreational and commercial fisheries for coho salmon are managed to limit the impact on natural-origin fish, through required catch and release, while allowing the harvest of hatchery-origin fish. In many areas, fisheries have been closed to protect natural-origin populations. For example, before 2005, upper Salmon River spring Chinook salmon fisheries were closed to recreational fishing for more than 20 years.

3.2.3.1.12 Benefits of Nutrient Cycling

Salmon act as an ecological process vector, important in the transport of energy and nutrients among the ocean, estuaries, and freshwater environments. The flow of nutrients back upstream via spawning salmon and the ability of watersheds to retain them play vital roles in determining the overall productivity of salmon runs (Cederholm 2001). The flow of energy and biomass from productive marine environments to relatively unproductive terrestrial environments supports high productivity where the two ecosystems meet (Polis and Hurd 1996). Salmon and steelhead are major vectors for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Because of the long migrations of some stocks of Pacific salmon, the link between marine and terrestrial production may be extended hundreds of miles inland. Pacific salmon returning to streams can increase stream nutrient concentration and productivity (Wipfli et al. 2003). Experiments have shown that carcasses of hatchery-produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Bilby et al. 1998). However, at least one study has shown that salmon carcass placement did not significantly change stream chemistry, although the lack of significant change may have been because the stream and riparian areas were able to process and store the added nutrients quickly (Edmonds and Mikkelsen 2006).

3.2.3.1.13 Risks Associated with Disease Transfer

Interactions between hatchery-origin fish and natural-origin fish in the environment may result in the transmission of pathogens, if either the hatchery-origin or the natural-origin fish are harboring fish disease (Table 3-7). This impact may occur in tributary areas where hatchery-origin fish are released and throughout the migration corridor where hatchery-origin and natural-origin fish may interact. As the pathogens responsible for fish diseases are present in both hatchery-origin and natural-origin populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976; Hastein and Lindstad 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress. These densities can lead to greater manifestation and spread of disease within the hatchery-origin population. Consequently, the release of hatchery-origin salmon and steelhead may lead to an increase of disease in natural-origin salmon and steelhead populations. Recent (2007 to 2008) outbreaks of *infectious hematopoietic necrosis* (IHN) in several coastal Washington steelhead hatcheries, some in watersheds with no historical observations of this particular IHN variant (M-clade), demonstrate the potential susceptibility of hatchery program fish to the spread of infectious diseases.

TABLE 3-7. SOME COMMON FISH PATHOGENS FOUND IN COLUMBIA RIVER HATCHERY FACILITIES.

PATHOGEN	DISEASE	SPECIES AFFECTED
Renibacterium salmoninarum	Bacterial Kidney Disease (BKD)	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Ceratomyxa shasta	Ceratomyxosis	Chinook salmon, steelhead, coho salmon and chum salmon
Flavobacterium psychrophilum	Coldwater Disease	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Flavobacterium columnare	Columnaris	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Yersinia ruckeri	Enteric Redmouth	Chinook salmon, chum salmon, steelhead and sockeye salmon
Aermonas salmonicida	Furunculosis	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Infectious hematopoietic necrosis	IHN	Chinook salmon, steelhead, chum salmon sockeye salmon
Saprolegnia parasitica	Saprolegniasis	Chinook salmon, coho salmon, steelhead, chum salmon, sockeye salmon
Vibrio anguillarum	Vibriosis	Chinook salmon, coho salmon and chum salmon

Sources: IHN database http://gis.nacse.org/ihnv/; http://www.nwr.noaa.gov/Salmon-HarvestHatcheries/Hatcheries/Hatchery-Genetic-Mngmnt-Plans.cfm.

3.2.3.1.14 Current Approaches for Reducing Risks of Disease Transfer

Hatchery operators have established fish pathology labs and a number of fish health policies in the Columbia River Basin. These policies establish guidelines to ensure that fish health is monitored, sanitation practices are applied, and hatchery-origin fish are reared and released in healthy conditions (Pacific Northwest Fish Health Protection Committee 1989; IHOT 1995). Fish health policies include the following two strategies:

- Maintain low densities of fish in the hatchery facilities to reduce fish stress.
- Conduct monthly and pre-release checks of hatchery-origin salmon and steelhead by a fish health specialist.

3.2.3.2 Status of Salmon ESUs and Steelhead DPSs

The following status summaries were obtained from three primary sources:

1) The Federal Columbia River Power System (FCRPS) biological opinion for baseline information on listed salmon and steelhead (NMFS 2008)

2) The status review update for salmon and steelhead listed under ESA (Ford 2011)

3) NMFS status reviews for non-listed salmon and steelhead (http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/salmon_steelhead_esa_status_reviews.html)

Within the analysis area, there are four species of salmon (Chinook salmon, chum salmon, coho salmon, and sockeye salmon) plus steelhead. All chum salmon within the analysis area are found in one ESU, and all coho salmon in the analysis area are found in one ESU. Chinook salmon, sockeye salmon, and steelhead have multiple ESUs within the analysis area (Box 1-1). When available, additional information is provided on limiting factors and threats. Limiting factors are physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish that result in reductions in abundance, productivity, spatial structure, and diversity. Threats are human actions or natural events (e.g., forest management, mining activities, fishery management, artificial propagation, agricultural practices, climate change, etc.) that cause or contribute to limiting factors. Threats may be caused by the continuing results of past events and actions as well as by present and anticipated future events and actions. Maps of the individual ESUs/DPSs can be found at http://www.westcoast.fisheries.noaa.gov/maps_data/species_population_boundaries.html.

3.2.3.2.1 Lower Columbia River Chinook Salmon ESU

Background

The Lower Columbia River Chinook Salmon ESU includes all naturally spawned populations from the mouth of the Columbia River upstream to and including the White Salmon River in Washington and the Hood River in Oregon. Additionally, this ESU includes the Willamette River upstream to Willamette Falls (exclusive of the spring-run Chinook salmon in the Clackamas River), as well as 17 hatcheries. There are three components based on run timing: spring Chinook salmon, early fall Chinook salmon (tules), and late fall Chinook salmon (brights). There are six major population groups in this ESU. They include 32 historical populations, seven of which are extirpated or nearly so. Lower Columbia River Chinook salmon numbers began to decline by the early 1900s because of habitat degradation and harvest rates and were listed under ESA as threatened in 1999. The listing was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Trends

Many of the populations in this ESU for which data are available currently have low abundances, and many of the long- and short-term trends in abundance are negative, some severely so. Some of the natural runs have largely been replaced by hatchery program production.

Of the 32 historical populations in the ESU, 28 are considered extirpated or at very high risk. Based on recovery plan analyses, all of the tule populations are considered to be at very high risk except one that is considered at high risk. The modeling conducted in association with tule harvest management suggests that three of the populations (Coweeman, Lewis, and Washougal Chinook salmon) are at somewhat lower risk. However, even these more optimistic evaluations suggest that the remaining 18 populations are at substantial risk because of very low natural-origin spawner abundance (fewer than 100/population), high hatchery fraction, habitat degradation, and harvest impacts (Ford 2011).

Spring Chinook salmon populations remain isolated from access to essential spawning habitat because of hydroelectric dams. Projects to allow access have been initiated in the Cowlitz and Lewis River systems, but these projects are not close to producing self-sustaining populations. The Sandy River spring-run Chinook salmon population, without a mainstem dam, is considered at moderate risk, and it is the only spring Chinook salmon population not considered extirpated or nearly so. Hood River currently contains an out-of-ESU hatchery stock. The two late fall Chinook salmon populations, Lewis and Sandy Rivers, are the only populations considered at low or very low risk. They contain relatively few hatchery fish and have maintained high spawner abundances (especially Lewis River) since 2005 (Ford 2011).

Limiting Factors and Threats

Human effects and limiting factors for the Lower Columbia River Chinook salmon consist of habitat degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. Lower Columbia River Chinook salmon populations began declining in the early 1900s because of habitat changes and high harvest rates. FCRPS effects have been limited, but are most substantial for the five populations that spawn in tributaries above Bonneville Dam. These populations are affected by upstream and downstream passage and the inundation of spawning habitat for fall-run Chinook salmon in the lower reaches of the tributaries to the reservoir.

For populations originating in tributaries below Bonneville Dam, migration and habitat conditions in the mainstem and estuary have been affected by hydrosystem flow operations. Tributary habitat degradation is pervasive due to development and other land uses, and Federal Energy Regulatory

Commission (FERC) licensed hydroelectric projects have blocked some spawning areas. Hatchery program production for Lower Columbia River Chinook salmon has reduced the diversity and productivity of natural populations throughout the ESU. Predators take a substantial number of juveniles and adults, particularly from spring-run populations.

3.2.3.2.2 Mid-Columbia River Spring-run Chinook Salmon ESU

Background

Included in this ESU are spring-run Chinook salmon spawning in the Klickitat, Deschutes, John Day, and Yakima Rivers. There are no fall-run Chinook salmon in this ESU. Historically, spring-run populations from the Walla Walla and Umatilla Rivers may have also belonged in this ESU, but these populations are now considered extinct; however, there are ongoing efforts to reintroduce spring Chinook salmon into the Walla Walla and Umatilla River Basins. NMFS evaluated whether the Mid-Columbia River Spring-run Chinook salmon ESU should be listed under ESA. In 1998, NMFS concluded that Chinook salmon in this ESU are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (63 Fed. Reg. 11497, March 9, 1998). As a result, this ESU was not listed.

Current Status and Recent Trends

Although Chinook salmon in this ESU are not in danger of extinction, habitat problems are common in the range of this ESU. Spawning and rearing habitat are affected by agriculture, including water withdrawals, grazing, and riparian vegetation management. Mainstem Columbia River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat. Hatchery production accounts for a substantial proportion of total escapement to the region. However, there is no hatchery production in the John Day River Basin. Stocks in this ESU experience very low ocean harvest rates and only moderate instream harvest (Pacific Salmon Commission [PSC] 1996).

Recent escapement estimates in the Deschutes and John Day River Basins indicate relatively stable populations, exceeding the estimated 30-year average between 2000 and 2004 (Oregon Department of Fish and Wildlife [ODFW] 2005). These populations also generally exhibit limited hatchery influences, typically with less than 10 percent of hatchery-origin fish spawning naturally. Similarly, the annual number of adult spring Chinook salmon counted at Bonneville, Priest Rapids, and Ice Harbor Dams between 1998 and 2006 were approximately one to five times, two to seven times, and one to three times greater than the 5-year (1992 to 1996) geometric mean abundance estimate of about 25,000 adults, respectively (Fish Passage Center 2007).

Limiting Factors and Threats

Limiting factors and threats have not been identified for this ESU because it is not ESA-listed.

3.2.3.2.3 Deschutes River Summer/Fall-run Chinook Salmon ESU

Background

This ESU includes all naturally spawned populations of summer/fall-run Chinook salmon from the Deschutes River. NMFS evaluated whether the Deschutes River Summer/Fall-run Chinook Salmon ESU should be listed under ESA. In 1999, NMFS concluded that Chinook salmon in this ESU are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (64 Fed. Reg. 50409, September 16, 1999). As a result, this ESU was not listed.

Current Status and Recent Trends

Updated information on the abundance of fall-run Chinook salmon in the Deschutes River indicates that the run continues to remain relatively stable, although the 2008 Deschutes River Basin return of 7,700 adults was only 68 percent of the recent 10-year average of 11,200 adults (ODFW and Washington Department of Fish and Wildlife [WDFW] 2009). This is about a 30 percent decrease compared to the estimated 5-year geometric mean abundance of over 16,000 fish in the late 1990s, when the short-term trend was increasing by 18 percent per year (West Coast Chinook Salmon Biological Review Team 1999).

Limiting Factors and Threats

Limiting factors and threats have not been identified for this ESU because it is not ESA-listed.

3.2.3.2.4 Upper Columbia River Spring-run Chinook Salmon ESU

Background

The Upper Columbia River Spring-run Chinook Salmon ESU consists of one major population group composed of three existing and one extinct populations. These fish spawn and rear in the mainstem Columbia River and its tributaries between Rock Island and Chief Joseph Dams. The Chief Joseph Dam, completed in 1961, now blocks the upriver migration of this species. For 20 years before 1961, migration was blocked by the Grand Coulee Dam. Upper Columbia River spring-run Chinook salmon were listed as endangered under ESA in 1999, and this status was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Recent Trends

Abundance for most populations declined to extremely low levels in the mid-1990s, increased to levels above (Wenatchee and Methow Rivers) or near (Entiat River) the recovery abundance thresholds in the early 2000s, and are now at levels intermediate to those of the mid-1990s and early 2000s. Jack counts in 2007, an indicator of future adult returns, were at the highest level since 1977. Increases in natural-origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low (Ford 2011). Large-scale directed supplementation programs are underway in two of the three extant populations in the ESU. These programs are intended to mitigate short-term demographic risks while actions to improve natural productivity and capacity are implemented. While these programs may provide short-term demographic benefits, there are significant uncertainties regarding the long-term risks of relying on high levels of hatchery influence to maintain natural populations (Ford 2011). Overall, the ESU is at moderate-to-high risk of extinction (Ford 2011).

Limiting Factors and Threats

The key limiting factors and threats for the Upper Columbia River Spring-run Chinook Salmon ESU include hydropower projects, predation, harvest, hatchery program effects, degraded estuary habitat, and degraded tributary habitat. Ocean conditions, which have also affected the status of this ESU, generally have been poor over the last 20 years, improving only recently.

3.2.3.2.5 Upper Columbia River Summer/Fall-run Chinook Salmon ESU

Background

This ESU was first identified as the Middle-Columbia River Summer/Fall-run Chinook Salmon ESU. Previously, Waknitz et al. (1995) and NMFS (1994) identified an ESU that included all ocean-type Chinook salmon spawning in areas between McNary Dam and Chief Joseph Dam (59 Fed. Reg. 48855, September 23, 1994). However, NMFS recently concluded that the boundaries of this ESU do not extend downstream from the Snake River. In particular, NMFS concluded that Deschutes River fall-run Chinook salmon are not part of this ESU. In 1998, NMFS concluded that Chinook salmon in this ESU are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (63 Fed. Reg. 11497, March 9, 1998).

Current Status and Recent Trends

Recent run-size estimates of the Upper Columbia River Summer/Fall-run Chinook Salmon ESU have been relatively stable. Between 2003 and 2008, the adult returns have ranged between 114,500 and 373,200 fish (ODFW and WDFW 2009). However, a steady declining trend occurred from a high of 373,000 fish in 2003 to a low of 114,000 fish in 2007, while the 2008 return was higher at 197,300 fish.

Limiting Factors and Threats

Limiting factors and threats have not been identified for this ESU because it is not ESA-listed.

3.2.3.2.6 Upper Willamette River Chinook Salmon ESU

Background

The Upper Willamette River Chinook Salmon ESU includes all naturally spawned populations of spring-run Chinook salmon residing in the Clackamas River and in the Upper Willamette River above Willamette Falls, but below impassable natural barriers, as well as seven artificial propagation programs. There is only one major population group in this ESU; it consists of seven historical demographically independent populations. Substantial natural production occurs only in the Clackamas and McKenzie Rivers. Upper Willamette River Chinook salmon were listed under ESA as threatened in 1995. This listing was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Recent Trends

Historically, the Upper Willamette supported large numbers (perhaps exceeding 275,000 fish) of spring Chinook salmon. Current abundance of natural-origin fish is estimated to be fewer than 10,000, with substantial natural production occurring in only two populations—the Clackamas and McKenzie River populations. While counts of hatchery- and natural-origin adult spring Chinook salmon over Willamette Falls have increased since 1946, approximately 90 percent of the return is now composed of hatchery-origin fish. Most of the natural-origin populations in this ESU have very low current abundances (fewer than a few hundred fish). Many of the natural runs have largely been replaced by hatchery program production. Of the seven historical populations in the ESU, five are considered at very high risk. The remaining two (Clackamas and McKenzie River Chinook salmon populations) are considered at moderate to low risk (Ford 2011).

Limiting Factors and Threats

Human effects and limiting factors for Upper Willamette River Chinook salmon include habitat loss and degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. FCRPS effects are limited to habitat conditions in the mainstem below the confluence of the Willamette River and in the Columbia River estuary, areas which have been affected by hydrosystem flow operations. Habitat degradation has been pervasive in the Willamette River mainstem and the lower reaches of its tributaries, and both U.S. Army Corps of Engineers (USACE) and FERC-licensed hydroelectric projects have blocked some spawning areas. Habitat loss due to blockages has been especially severe in the North Santiam, Calapooia, and Middle Fork Willamette River Subbasin.

3.2.3.2.7 Snake River Spring/Summer-run Chinook Salmon ESU

Background

The Snake River Spring/Summer-run Chinook Salmon ESU consists of five major population groups that spawn and rear in the tributaries of the Snake River between the confluence of the Snake and Columbia Rivers and the Hells Canyon Dam. The factors that contributed to their decline include intensive harvest and habitat degradation in the early and mid-1900s, high harvest in the 1960s and early 1970s, and Federal and private hydropower development, as well as poor ocean productivity from the late 1970s through the late 1990s. Snake River spring/summer-run Chinook salmon were listed under ESA as threatened in 1992 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

The Snake River Spring/Summer-run Chinook Salmon ESU's five major population groups are further composed of 28 extant populations. Abundance has been stable or has increased on average over the last 20 years. In 2007, jack counts (a qualitative indicator of future adult returns) were the second highest on record. However, on average, the natural-origin components of Snake River spring/summer-run Chinook salmon populations have not replaced themselves. Although recent natural spawning abundance estimates have increased, all populations remain below minimum natural-origin abundance thresholds. The status ratings remain at high risk across all populations within the ESU (Ford 2011).

Limiting Factors and Threats

Limiting factors for the Snake River Spring/Summer-run Chinook Salmon ESU include Federal and private hydropower projects, predation, harvest, the estuary, and tributary habitat. Ocean conditions have also affected the status of this ESU. These conditions have been generally poor for this ESU over at least the last four brood cycles, improving only in the last few years. Although hatchery program management is not identified as a limiting factor for the ESU as a whole, the ICTRT (http://www.nwfsc.noaa.gov/trt/domains.cfm) has indicated potential hatchery program effects for a few individual populations.

3.2.3.2.8 Snake River Fall-run Chinook Salmon ESU

Background

The Snake River Fall-run Chinook Salmon ESU consists of a single population that spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to 1967, which extirpated two of the historical populations. Only 10 to 15 percent of the historical range of this ESU remains. Hatcheries have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s. Snake River fall-run Chinook salmon were listed under ESA as threatened in 1992 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

Total returns to Lower Granite Dam have increased steadily from the mid-1990s to the present. The recent increases in natural-origin abundance are encouraging, but hatchery-origin spawner proportions have increased dramatically in recent years (Ford 2011). The current combined estimates of abundance and productivity population result in a moderate risk of extinction of between 5 percent and 25 percent in 100 years (Ford 2011).

Limiting Factors and Threats

Limiting factors for Snake River fall-run Chinook salmon include mainstem hydroelectric projects in the Columbia and Snake Rivers, predation, harvest, hatcheries, estuary, and tributary habitat. Ocean conditions have also affected the status of this ESU. Generally, ocean conditions have been poor for this ESU over the past 20 years, improving only recently.

3.2.3.2.9 Lower Columbia River Steelhead DPS

Background

The Lower Columbia River Steelhead DPS includes 23 historical anadromous populations in four major population groups located from the Cowlitz River, up to and including the Wind River in Washington, and from the mouth of the Willamette River up to the Hood River in Oregon, excluding steelhead above Willamette Falls. This DPS includes both summer- and winter-run types. The Lower Columbia River Steelhead DPS was listed under ESA as threatened in 1998, and this status was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Recent Trends

Most of the populations comprising this DPS are small, and many of the long- and short-term trends in abundance of individual populations are negative, some severely so. A number of the populations have a substantial fraction of hatchery-origin spawners. Exceptions are the Kalama, North and South Fork Toutle, and East Fork Lewis winter-run populations, which have few hatchery-origin fish spawning in natural spawning areas. Of the 26 historical populations in the ESU, 17 are considered at high or very high risk. Populations in the upper Lewis, Cowlitz, and White Salmon Rivers remain isolated from access to essential spawning habitat because of hydroelectric dams. Projects to allow access have been initiated in the Cowlitz and Lewis River systems, but these projects have not yet produced self-sustaining populations. The populations generally remain at relatively low abundance with relatively low productivity (Ford 2011).

Limiting Factors and Threats

Human effects and limiting factors include habitat degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and ecological factors, including predation. Tributary habitat has been degraded by extensive development and other effects of changing land use. These factors have adversely affected stream temperatures and reduced the habitat diversity needed for steelhead spawning, incubation, and rearing. Steelhead access to tributary headwaters has been restricted or blocked by FERC-licensed dams built without passage facilities or facilities that were inadequate and caused injury and delay. Four populations (Wind River summer-run, Hood River summer-run, Upper Gorge River winter-run, and Hood River winter-run) are subject to FCRPS effects involving passage at Bonneville Dam, and all populations are affected by habitat alterations in the Columbia River mainstem and estuary. Preservation and recovery of this DPS will require concerted and substantial efforts by many parties.

3.2.3.2.10 Middle Columbia River Steelhead DPS

Background

The Middle Columbia River Steelhead DPS includes anadromous populations in Oregon and Washington subbasins upstream of the Hood and Wind River systems to and including the Yakima River. There are four major population groups with 17 populations in this DPS. Almost all populations are summer-run fish; two winter-run populations return to the Klickitat and Fifteenmile Creek watersheds. Blockages have prevented access to sizable historical production areas in the Deschutes, White Salmon, and White Salmon Rivers. The Middle Columbia River Steelhead DPS was listed under ESA as threatened in 1999, and the listing was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Recent Trends

During the most recent 10-year period for which trends in abundance could be estimated, the population trends were positive for approximately half of the populations and negative for the remainder. On average, when only natural production is considered, most of the Middle Columbia River steelhead populations have replaced themselves.

Limiting Factors and Threats

Historically, the key limiting factors for Middle Columbia River steelhead include mainstem hydropower projects, tributary habitat and hydropower (including the Pelton Round Butte hydro-complex), water storage projects, predation, hatchery program effects, harvest, and estuary conditions. Ocean conditions generally have been poor over most of the last 20 years, improving only in the last few years.

As part of the relicensing agreement for the Pelton Round Butte hydro-complex, the facility and operations have improved the management of water flow and temperature to better resemble historical conditions, which has improved passage for juvenile fish. Steelhead fry have been outplanted above the Round Butte hydro-complex, and the capture of 7,700 steelhead smolts in 2010, at Pelton Round Butte, suggests some near-term success from these reintroduction efforts.

3.2.3.2.11 Snake River Basin Steelhead DPS

Background

The Snake River Basin Steelhead DPS includes all anadromous populations that spawn and rear in the mainstem Snake River and its tributaries between Ice Harbor and the Hells Canyon hydro complex. There are five major population groups with 24 populations. Inland steelhead in the Columbia River Basin are commonly referred to as either A-run or B-run, based on migration timing and differences in age and size at return. A-run steelhead are believed to occur throughout the steelhead streams in the Snake River Basin, and B-run are thought to produce only in the Clearwater and Salmon Rivers. This DPS was listed under ESA as threatened in 1997; the listing was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Recent Trends

The level of natural production in the two populations with full data series and the Asotin Creek index reaches is encouraging, but the status of most populations in this DPS remains highly uncertain. Population-level, natural-origin abundance and productivity inferred from aggregate data and juvenile indices indicate that many populations are likely below the minimum combinations defined by the ICTRT viability criteria. Considerable uncertainty remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites (Ford 2011).

Limiting Factors and Threats

Limiting factors identify the most important biological requirements of the species. Historically, the key limiting factors for the Snake River Basin steelhead include hydropower projects, predation, harvest, hatchery program effects, and tributary habitat. Ocean conditions have also affected the status of this DPS. These ocean conditions generally have been poor over at least the last 20 years, improving only in the latest few years.

3.2.3.2.12 Southwest Washington Steelhead DPS

Background

This coastal steelhead DPS occupies the river basins and tributaries to Grays Harbor, Willapa Bay, and the Columbia River below the Cowlitz River in Washington and below the Willamette River in Oregon. In 1996, NMFS evaluated whether the Southwest Washington Steelhead DPS should be listed under ESA and concluded that steelhead in this DPS are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (61 Fed. Reg. 41544, August 9, 1996). As a result, this DPS was not listed.

Current Status and Trends

In NMFS' 1996 status review, it was concluded that all but one (Wynoochee River) of the 12 independent stocks have been declining over the available data series, with a range from a 7 percent annual decline to a 0.4 percent annual increase. Six of the downward trends were significantly different from zero. For Washington streams, these trends are for the late-run, natural-origin component of winter steelhead populations; Oregon data included all stock components. Most of the Oregon trends are based on angler catch, and they may not reflect trends in underlying population abundance. In general, stock condition appears to be healthier in southwest Washington than in the lower Columbia River Basin.

The Biological Review Team (BRT) concluded that the Southwest Washington Steelhead DPS is neither presently in danger of extinction nor likely to become endangered in the foreseeable future. However, the general downward trends, coupled with introductions of hatchery-origin fish from outside the DPS, could threaten the species. Almost all stocks for which data are available have been declining in the recent past, although this may be largely due to recent climate conditions.

The BRT also had a strong concern about genetic introgression from hatchery-origin stocks within the DPS, and a great concern for the status of summer steelhead in this DPS. There is widespread production of hatchery-origin steelhead within this DPS, largely from parent stocks outside the DPS. This production could substantially change the genetic composition of the resource, despite management efforts to minimize introgression of the hatchery-origin gene pool into natural-origin populations. Estimates of the proportion of hatchery-origin fish on natural spawning grounds range from 9 percent in the Chehalis River, the largest producer of steelhead in the DPS, to 82 percent in the Clatskanie River.

Limiting Factors and Threats

Limiting factors and threats have not been identified for this DPS because it is not ESA-listed.

3.2.3.2.13 Upper Columbia River Steelhead DPS

Background

The Upper Columbia River Steelhead DPS includes all anadromous populations that spawn and rear in the middle reaches of the rivers and tributaries draining the eastern slope of the Cascade

Mountains upstream of Rock Island Dam. There are four populations in a single major population group. The Upper Columbia River Steelhead DPS was listed under ESA as threatened on January 5, 2006 (71 Fed. Reg. 834).

Hatchery-origin steelhead have been released into the Methow and Okanogan Rivers since the late 1960s and into the Wenatchee and Entiat River systems since the 1970s. Through the 1980s, operations were designed to accommodate harvest, and there was no attempt to limit introgression of hatchery-origin fish into the native populations. In many cases, the hatchery program broodstock originated from outside the upper Columbia River region.

Since the early 1990s, hatchery programs that operate in the Wenatchee, Methow, and Okanogan River Basins have implemented reforms to support steelhead conservation and recovery. No hatchery-origin steelhead are currently released into the Entiat River system, and the hatchery program broodstock in other watersheds now consists exclusively of steelhead from the Upper Columbia River Steelhead DPS. The hatchery programs are managed to preserve natural genetic resources.

Current Status and Recent Trends

The Upper Columbia River Steelhead DPS consists of four anadromous populations. Upper Columbia River steelhead populations have increased in natural-origin abundance in recent years, but productivity levels remain low. The proportions of hatchery-origin returns in natural spawning areas remain extremely high across the DPS, especially in the Methow and Okanogan River populations. The modest improvements in natural returns in recent years are probably primarily the result of several years of relatively good natural survival in the ocean and tributary habitats (Ford 2011).

Limiting Factors and Threats

The key limiting factors and threats for Upper Columbia River steelhead include hydropower projects, predation, harvest, hatchery program effects, degraded tributary habitat, and degraded estuary habitat. Ocean conditions generally have been poor for this DPS over the last 20 years, improving only in the last few years.

3.2.3.2.14 Upper Willamette River Steelhead DPS

Background

The Upper Willamette River Steelhead DPS includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). There are four populations in this DPS. All four remain extant and produce moderate numbers of natural-origin steelhead each year. The hatchery-origin, summer-run steelhead that occur in the Willamette River basin are an out-of-basin stock that is not part of the DPS. Upper Willamette River steelhead were listed as threatened under ESA in 1999. This listing was reaffirmed in 2011 (76 Fed. Reg. 50448, August 15, 2011).

Current Status and Recent Trends

Current abundance is at the levels observed in the mid-1990s when the DPS was first listed. The DPS appears to be at lower risk than the Upper Willamette River Chinook Salmon ESU, but continues to demonstrate an overall low abundance pattern (Ford 2011). The elimination of the winter-run hatchery release in the basin has reduced hatchery threats, but nonnative summer steelhead hatchery releases are still a concern.

Limiting Factors and Threats

Human effects and limiting factors for Upper Willamette River steelhead include habitat loss and degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. FCRPS effects are limited to habitat conditions in the mainstem below the confluence of the Willamette River and in the Columbia River estuary. These areas have been affected by hydrosystem flow operations. Mainstem Willamette River and tributary habitat degradation has been pervasive, particularly in the lower reaches of tributaries to the Willamette River. Both USACE and privately owned dams have blocked some important spawning areas. Habitat loss due to blockages has been especially severe in the North Santiam and Calapooia Subbasins.

3.2.3.2.15 Lower Columbia River Coho Salmon ESU

Background

The Lower Columbia River Coho Salmon ESU includes all naturally spawned coho salmon populations in streams and tributaries to the Columbia River within Washington and Oregon, from the mouth of the Columbia River up to and including the White Salmon and Hood Rivers; the Willamette River to Willamette Falls, Oregon; and 25 artificial propagation programs. The ESU includes 24 historical populations in three major population groups. The Lower Columbia River Coho Salmon ESU was listed as threatened under ESA in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

Of the 27 historical populations in the ESU, 24 are considered at very high risk (Ford 2011). The remaining three (Sandy, Clackamas, and Scappoose coho salmon) are considered at high to moderate risk. All of the Washington side populations are considered at very high risk, although uncertainty is great because of a lack of adult spawner surveys. Smolt traps indicate there is some natural production in Washington populations, though, given the high fraction of hatchery-origin spawners suspected to occur in these populations, it is not clear that any are self-sustaining (Ford 2011).

Limiting Factors and Threats

Human effects and limiting factors for the Lower Columbia River coho salmon include habitat degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. Lower Columbia River coho salmon populations have been in decline for the last 70 years. FCRPS effects have been limited, but most substantial for the two populations that spawn in tributaries above Bonneville Dam. These populations are affected by upstream and downstream passage and, for Oregon populations, by inundation of some historical habitat by the Bonneville Dam pool.

For populations originating in tributaries below Bonneville Dam, migration and habitat conditions in the mainstem and estuary have been affected by hydrosystem flow operations. Tributary habitat degradation is pervasive due to development and other land uses, and FERC-licensed hydroelectric projects have blocked some spawning areas. Coho salmon populations in the lower Columbia River have been heavily influenced by extensive hatchery program releases. While those releases represent a threat to the genetic, ecological, and behavioral diversity of the ESU, some of the hatchery-origin stocks at present also protect a substantial portion of the ESU's remaining genetic resources.

3.2.3.2.16 Columbia River Chum Salmon ESU

Background

The Columbia River Chum Salmon ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries, as well as three artificial propagation programs. There were 16 historical populations in three major population groups in Oregon and Washington between the mouth of the Columbia River and the Cascade crest. Substantial spawning now occurs for two of the historical populations, meaning that 88 percent of the historical populations are extirpated or nearly so. Because chum salmon spend only a short time in natal streams before emigration, the loss or impairment of rearing habitat in the Columbia River estuary may have been an important factor in their decline. Another important factor was the inundation of historical spawning areas by Bonneville Reservoir. The Columbia River Chum Salmon ESU was listed under ESA as threatened in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

The vast majority (14 out of 17) of chum salmon populations remain extirpated or nearly so (Ford 2011). The Grays River and lower Columbia River Gorge chum salmon populations showed a sharp increase in 2002, but have since declined back to relatively low abundance levels in the range of variation observed over the last several decades. Chinook and coho populations in the lower Columbia and Willamette Rivers show similar increases in the early 2000s, followed by declines to typical recent levels, suggesting the increase in chum may be related to ocean conditions (Ford 2011).

Limiting Factors and Threats

Human effects and limiting factors for the Columbia River Chum Salmon ESU have come from multiple sources, including mainstem and tributary hydropower development and loss or impairment of tributary and estuarine habitat.

3.2.3.2.17 Snake River Sockeye Salmon ESU

Background

The Snake River Sockeye Salmon ESU includes all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake Captive Broodstock Program. Sockeye salmon historically were numerous in many areas of the Snake River Basin prior to the European westward expansion. However, intense commercial harvest of sockeye salmon along with other salmon species beginning in the mid-1880s, the existence of Sunbeam Dam as a migration barrier between 1910 and the early 1930s, the eradication of sockeye salmon from Sawtooth Valley lakes in the 1950s and 1960s, the development of mainstem hydropower projects on the lower Snake and Columbia Rivers in the 1970s and 1980s, and poor ocean conditions from 1977 through the late 1990s probably combined to reduce the stock to a very small remnant population. Snake River sockeye salmon are now found predominantly in a captive broodstock program associated with Redfish Lake and the other Sawtooth Valley lakes. The Snake River Sockeye Salmon ESU was listed as endangered under ESA in 1991, and the listing was reaffirmed in 2005 (70 Fed. Reg. 37160, June 28, 2005). At the time of listing, one, one, and zero fish had returned to Redfish Lake in the three preceding years, respectively.

Current Status and Recent Trends

Between 1991 and 1998, all 16 of the natural-origin adult sockeye salmon that returned to the weir at Redfish Lake were incorporated into the captive broodstock program. The program used multiple rearing sites to minimize chances of catastrophic loss of broodstock and produced several hundred thousand eggs and juveniles, as well as several hundred adults, for release into the wild. In recent years, enough eggs, juveniles, and returning hatchery adults have been available from the captive broodstock-based program to initiate efforts to evaluate alternative supplementation strategies in support of reestablishing natural production of anadromous sockeye. The increased abundance of hatchery-reared Snake River sockeye reduces the risk of immediate loss, but levels of naturally produced sockeye returns remain extremely low (Ford 2011). As a result, although the risk status of the Snake River Sockeye Salmon ESU appears to be on an improving trend, the species still has a very high risk of extinction.

Limiting Factors and Threats

By the time Snake River sockeye salmon were listed in 1991, the species had declined to the point that there was no longer a self-sustaining, naturally spawning anadromous sockeye salmon population. This has been the greatest factor limiting the recovery of this ESU, and it is important in terms of risks due to catastrophic loss and genetic diversity. It is not yet clear whether the existing population retains sufficient genetic diversity to adapt successfully to the range of variable conditions that occur within its natural habitat. However, Kalinowksi et al. (2012) found that sockeye salmon in the Redfish Lake captive broodstock program have retained 95 percent of the genetic variation of the fish that founded the captive population.

3.2.4 Other Fish Species that Have a Relationship with Salmon and/or Steelhead

This section includes review of native Columbia River Basin fish species that have a Federal and/or state listing status and/or a strong relationship with salmon and steelhead that could be affected by implementation of the alternatives (Table 3-8). These species include freshwater fish and anadromous fish, but do not include saltwater fish because the effects of implementing the alternatives are not expected to result in a noticeable impact on or benefit for other saltwater fish species. Federally listed fish include Oregon chub, eulachon, and green sturgeon. Species discussed in this section are organized first by listing status (endangered and then threatened) followed by the remaining species in alphabetical order.

TABLE 3-8. RANGE AND STATUS OF OTHER MARINE AND FRESHWATER SPECIES THAT MAY INTERACT WITH SALMON AND STEELHEAD IN THE ANALYSIS AREA.

SPECIES	RANGE IN COLUMBIA RIVER BASIN	FEDERAL/STATE LISTING STATUS	TYPE OF INTERACTION WITH SALMON AND STEELHEAD
Oregon chub *(Oregonichthys crameri)*	Willamette Valley	Federally threatened[1], Oregon State sensitive species	Freshwater prey of salmon and steelhead
Bull trout *(Salvelinus confluentus)*	Throughout the Columbia River Basin	Federally threatened, Oregon State sensitive species, Washington State species of concern	Predator of salmon and steelhead
Eulachon *(Thaleichthys pacificus)*	Lower Columbia River and tributaries	Southern DPS federally threatened, Washington State species of concern	Freshwater prey of salmon and steelhead
Green sturgeon (*Acipenser medirostris*)	Columbia River estuary	Southern DPS federally threatened	Bycatch in salmon fisheries
Coastal cutthroat trout (*Oncorynchus clarki clarki)*	Throughout the Columbia River Basin	Not listed but southwestern Washington and Lower Columbia River DPS a Federal species of concern, coastal cutthroat trout an Oregon State sensitive species	Similar habitat and prey requirements, but interspecific competition avoided by altering behavior and life history traits, predators of salmon and steelhead young, coastal cutthroat trout can hybridize with steelhead and rainbow trout
Lake chub (*Couseius plumbeus*)	Lakes and tributaries of Okanagan County	Not federally listed, Washington State species of concern	Freshwater prey of salmon and steelhead
Lamprey (Pacific [*Lampetra tridentata*], river [*L. ayresi],* and brook [*L. richardsoni*])	All accessible reaches in the Columbia River Basin	Not listed. Pacific lamprey and river lamprey are Federal species of concern, river lamprey is a Washington State candidate species, Pacific lamprey is an Oregon State sensitive species and an Idaho State endangered species	Freshwater predator species of salmon and steelhead, juvenile lamprey prey of young salmon and steelhead
Leopard dace *(Rhinichthys falcatus)*	Columbia River Basin	Not federally listed, Washington State candidate species	Freshwater prey of salmon and steelhead
Margined sculpin *(Cottus marginatus)*	Tucannon, Walla Walla and Umatilla River basins	Federal species of concern, Washington State sensitive species	Prey on eggs and young of salmon and steelhead
Mountain sucker *(Catostomus platyrhynchus)*	Middle-Columbia and Upper Columbia River watersheds	Not federally listed, Washington State candidate species	Occurs in similar freshwater habitats, but is a bottom feeder and has a different ecological niche

TABLE 3-8. RANGE AND STATUS OF OTHER MARINE AND FRESHWATER SPECIES THAT MAY INTERACT WITH SALMON AND STEELHEAD IN THE ANALYSIS AREA (CONTINUED).

SPECIES	RANGE IN COLUMBIA RIVER BASIN	FEDERAL/STATE LISTING STATUS	TYPE OF INTERACTION WITH SALMON AND STEELHEAD
Northern pikeminnow *(Ptychocheilus oregonensis)*	Throughout the Columbia River Basin	Not listed	Freshwater predator species
Pygmy whitefish (*Prosopium coulteri)*	Cle Elum and Kachess Lakes in Yakima basin; Priest Lake	Federal species of concern, Washington State sensitive species	Freshwater prey of salmon and steelhead
Rainbow trout (*Oncorynchus mykiss)*	Throughout the Columbia River Basin	Not listed	Hatchery-origin fish are competitors, also feed on salmon and steelhead, can hybridize with cutthroat trout (both coastal and westslope) and steelhead
Umatilla dace (*Rhinichthys Umatilla)*	Columbia, Kootenay, Slocan, and Snake Rivers	Not federally listed, Washington State candidate species	Freshwater prey of salmon and steelhead
Westslope cutthroat trout *(Oncorynchus clarki lewisi)*	Upper Columbia River Basin and Snake River	Federal species of concern, , Oregon State sensitive species	Similar habitat requirements, can feed on salmon and steelhead (rare occurrences), can hybridize with rainbow trout and steelhead

Sources: USFWS, WDFW, ODFW, Idaho Department of Fish and Game (IDFG) classifications.

[1] Proposed for delisting on February 6, 2014.

This section is organized by species and includes four sections: background information, current status and trends, limiting factors and threats, and subject species interaction with salmon and steelhead. Information for these discussions was taken from best available literature, and no new species-related studies were conducted as part of this EIS. Use of the terms "limiting factors" and "threats" varied among authors; the terms are represented in these discussions as presented by each author.

3.2.4.1 Oregon Chub

Background

The Oregon chub is a resident minnow (average of 3.5 inches) that is endemic to the Willamette River drainage of western Oregon. The species is found in the Santiam, Middle Fork Willamette, Coast Fork Willamette, and McKenzie Rivers, as well as in several tributaries to the Willamette River downstream of the Coast Fork/Middle Fork confluence. Their habitat is off-channel and slack water areas (such as beaver ponds, oxbows, stable backwater soughs, and flooded marshes), which typically have little or no water flow, silty and organic substrate, and aquatic vegetation and cover for hiding and spawning. The species occurs in aquatic habitats where the average water depth is less than 6 feet and where summer water temperatures exceed 61°F (74 Fed. Reg. 10413, March 10, 2009).

The Oregon chub has a typical lifespan of up to 3 years, although some individuals can live up to 9 years. Spawning occurs from April to September in dense aquatic vegetation. The diet of juvenile and adult Oregon chub consists of rotifers (very small worms), copepods (small animals with a hard shell, antennae, and jointed legs), cladocerans (commonly referred to as water fleas), and chironobid (minute mosquito-like flies) larvae. Outside of spawning, the species is social and non-aggressive with fish of similar size (USFWS 1998a).

Current Status and Trends

The Oregon chub was proposed as threatened under ESA (75 Fed. Reg. 21179, April 23, 2010), and it is currently proposed for delisting (79 Fed. Reg. 7136, February 6, 2014) (Table 3-8). The Oregon chub is also an Oregon State sensitive species. Currently, there are 36 Oregon chub populations; 19 of these populations have more than 500 adults each. Sixteen of these populations are stable or increasing (74 Fed. Reg. 22870, May 15, 2009). On March 10, 2010, USFWS published a final rule regarding designation of critical habitat for the Oregon chub (75 Fed. Reg. 11010, March 10, 2010), which was later corrected for typographical errors (75 Fed. Reg. 18107, April 9, 2010). Critical habitat for Oregon chub is located in Polk, Benton, Linn, Marion, and Lane Counties.

Limiting Factors and Threats

USFWS (2010a) indicates that construction of flood control projects and dams has changed the Willamette River significantly and has prevented the formation of Oregon chub habitat (off-channel slack waters) and natural dispersal of the species. Other factors responsible for the decline of the Oregon chub include habitat alteration and/or loss; accidental chemical spills; runoff from herbicide or pesticide application on farms and timberlands or along roadways, railways, and power line rights-of-way; application of rotenone to manage sport fisheries; unauthorized water withdrawals; diversions or fill and removal activities; sedimentation resulting from timber harvesting in the watershed; and, possibly, demographic risks that result from a fragmented distribution of small, isolated populations.

The introduction of non-native fish and amphibians continues to threaten existing populations of Oregon chub; many non-native species occur in the same habitat type as the Oregon chub and eat small fish, including the Oregon chub (USFWS 2010a). Introduction of non-native fish species in areas of connected floodplains has also impacted the occurrence of Oregon chub, which more frequently occurs in isolated habitats with fewer non-native fish (Scheerer 2002).

Interaction with Salmon and Steelhead

Oregon chub, salmon, and steelhead all occur in the Willamette River Basin. When rearing in freshwater streams, Oregon chub, salmon, and steelhead feed on terrestrial and aquatic insects, amphipods, and other crustaceans. The small size of Oregon chub makes them vulnerable to predation by salmon and steelhead. In addition, there is potential for prey resource overlap among Oregon chub, salmon, and steelhead. However, Oregon chub have coevolved with salmon and steelhead over time. The three species have likely developed different population parameters such as relative abundance, size, spawning, and microhabitat preferences when occurring in the same locations (Hearn 1987; Essington et al. 2000). Interspecific competition among Oregon chub, salmon, and steelhead has not been identified as a factor impacting Oregon chub (USFWS 2008a). Thus, the most likely interaction between Oregon chub and salmon and steelhead is predation of Oregon chub by adult salmon and steelhead.

3.2.4.2 Bull Trout

Background

The bull trout is known to occur from the Yukon River in the Northwest Territories of Canada south to northern Nevada. Within the analysis area, bull trout occur throughout the Columbia River Basin. The bull trout is a char, which includes several fish species of the genus *Salvelinus* that are related to trout and salmon (such as brook trout [*Salvelinus fontinalis]*, lake trout [*Salvelinus namaycush*], arctic char [*Salvelinus alpines*], and Dolly Varden [*Salvelinus malma malma*]). These species are adapted to living in colder water than other salmon species. Bull trout exhibit two forms: resident and migratory. Resident bull trout spend their entire lives in the same stream, while migratory bull trout spend most of their time in lakes or reservoirs (adfluvial), large rivers (fluvial), or the ocean (anadromous), but they spawn in headwater or tributary streams. Resident and juvenile bull trout size range up to 10 inches long, while migratory forms may range up to 35 inches (Natural Resources Conservation Service [NRCS] 2006; USFWS 2010b).

Bull trout reach sexual maturity at between 4 and 7 years of age and are known to live as long as 12 years. Bull trout occur in streams with abundant cover (e.g., cut banks, root wads, debris jams, and boulders) and clean gravel and cobble beds. Adult bull trout spawn from August to November as water temperatures decrease. Their eggs require long gravel resident times (100 to 145 days) dependent on water temperatures. Bull trout may spawn every year or every other year. Both juvenile and adult bull trout tend to remain near stream bottoms and are closely associated with the bottom substrate, submerged wood, and undercut banks. Adults use large cobble and boulder substrates, larger pools, and areas with accumulations of large wood. A complex habitat characterized by a variety of pools, riffles, and water depths and velocities is important to meet the diverse needs of all bull trout life stages (NRCS 2006; USFWS 2010b).

Young bull trout feed on aquatic invertebrates, including mayflies, stone flies, caddisflies, and beetles. As they grow larger, they begin to feed heavily upon other fish, including various trout and salmon species, minnows, suckers, dace, whitefish, and sculpin. Large adults have also been known to eat frogs, snakes, mice, and waterfowl (NRCS 2006).

Current Status and Trends

The bull trout is listed under ESA as a threatened species (64 Fed. Reg. 58909, November 1, 1999) and is a Washington species of concern, as well as an Oregon State sensitive species (Table 3-8). In 2002, USFWS published a draft recovery plan for bull trout that included the Columbia River Basin and areas identified as critical habitat for the species (67 Fed. Reg. 71439, November 22, 2002). Critical habitat was then finalized in 2004 (69 Fed. Reg. 5999, October 6, 2004), revised in 2005 (70 Fed. Reg. 56212, September 26, 2005), and is currently proposed for additional revisions with recommended bull trout recovery units (75 Fed. Reg. 2270, January 13, 2010). Historically, bull trout were found in about 60 percent of the Columbia River Basin. They now occur in less than half their historic range, and they have been eliminated from the mainstems of most large rivers. Populations remain in portions of Oregon, Washington, Idaho, Montana, and Nevada (USFWS 1998b, 2010b).

Twenty-two recovery units support bull trout listed in the Columbia River Basin, 13 of which are potentially affected by hatchery production of salmon and steelhead. Table 3-9 provides a description of each of the bull trout recovery units that are potentially affected by Columbia River anadromous fish hatchery program operations. Recovery units are specific geographic areas that provide habitat for a local population of bull trout.

TABLE 3-9. COLUMBIA RIVER BASIN BULL TROUT RECOVERY UNITS THAT MAY BE AFFECTED BY COLUMBIA RIVER BASIN ANADROMOUS FISH HATCHERY FACILITIES.

RECOVERY UNIT	DESCRIPTION OF RECOVERY UNIT
Willamette River Basin	The Willamette River Basin Recovery Unit encompasses the entire Willamette River Basin and part or all of ten counties in northwestern Oregon. Two core areas were defined: the Upper Willamette River and the Clackamas River.
Lower Columbia River Basin	The Lower Columbia River Basin Recovery Unit includes the Lewis River and Klickitat River core areas in Washington. The Lewis River Core Area consists of the mainstem Lewis River and tributaries downstream to the confluence with the Columbia River with the exclusion of the East Fork of the Lewis River. The Klickitat River Core Area includes the Klickitat River and all tributaries downstream to the confluence with the Columbia River.
Hood River	The Hood River Recovery Unit includes the Hood and the Sandy River Basins, which are located within northern Oregon. The Hood River Recovery Unit Team identified one core area containing two bull trout populations (known as the Clear Branch and Hood River local populations) that will be the center of recovery efforts.
Deschutes River	The Deschutes Recovery Unit encompasses the entire Deschutes River Basin and its tributaries, except for Odell Lake, which is its own recovery unit. The Deschutes River Recovery Unit is located in central Oregon. The primary tributaries include the Little Deschutes, Crooked, Metolius, Warm Springs, and White Rivers, as well as Shitike and Trout Creeks.
John Day River	The John Day River Recovery Unit contains the entire John Day River Basin, including the John Day mainstem and the North, Middle, and South Forks of the John Day River.
Umatilla-Walla Walla	The Umatilla-Walla Walla Recovery Unit is located in northeastern Oregon and southeastern Washington. The unit includes streams extending across portions of Umatilla, Union, and Wallowa Counties in Oregon, as well as Walla Walla and Columbia Counties in Washington.
Grande Ronde	The Grande Ronde River Recovery Unit is located in northeast Oregon and southeast Washington and encompasses 4,632 miles of streams in the Grande Ronde River Basin. This unit includes two main core areas: the Grande Ronde River and the Little Minam River.
Imnaha-Snake River	The Imnaha-Snake River Recovery Unit encompasses the entire Imnaha River Subbasin located in northeastern Oregon. Three core areas identified for the purpose of bull trout recovery are the Imnaha River, Sheep Creek, and Granite Creek.
Clearwater River	The Clearwater River Recovery Unit lies in north central Idaho and extends from the Idaho/Montana border near Missoula, Montana, to the Idaho/Washington border at Lewiston, Idaho. Major tributaries in the recovery unit include the Clearwater, North Fork Clearwater, Middle Fork Clearwater, South Fork Clearwater, Lochsa, and Selway Rivers.
Salmon River	The Salmon River Recovery Unit encompasses the entire Salmon River Basin. Major tributaries to the Salmon River include the Yankee Fork Salmon River, East Fork Salmon River, Lemhi River, Pahsimeroi River, North Fork Salmon River, Panther Creek, Middle Fork Salmon River, South Fork Salmon River, and Little Salmon River.
Middle Columbia River	The Middle Columbia River Unit includes the Yakima River Basin from south central Washington to its confluence with the Columbia River near Richland, Washington. Thirteen local populations of bull trout occur in this unit.
Upper Columbia	The Upper Columbia River Recovery Unit Team identified three core areas, including the mainstem and tributaries of the Wenatchee, Entiat, and Methow Rivers.
Snake River Basin	The Snake River Basin Recovery unit encompasses selected tributaries of the Snake River from Lower Monumental Dam (River Mile [RM] 42) upstream to the mouth of the Grande Ronde River (RM 169). There are two core areas in this recovery unit: the Tucannon River, which contains eight local populations; and Asotin Creek, which contains two local populations.

Limiting Factors and Threats

Both the distribution and abundance of bull trout have declined. Causes of the decline have been attributed to degraded or fragmented aquatic habitats throughout its historical range and the introduction of non-native species. Bull trout habitat degradation has occurred from land use actions (timber harvest, road development, agriculture/livestock production, and urbanization) and instream water uses (which have blocked or restricted access to critical habitat). Temperature is a major factor influencing bull trout distribution, especially for spawning and early rearing. Bull trout require temperatures below 48°F for spawning initiation, 39°F for optimal egg incubation, and 50°F for juvenile rearing. Optional adult rearing temperature ranges from 50 to 54°F. Other limiting factors leading to population declines include degradation of complex structural habitat, loss of refugia, altered stream flow regimes, sedimentation of spawning grounds, redd scouring, loss of habitat connectivity, harvest, and loss of juvenile salmon prey. Although hybridization with the introduced brook trout can dilute the genetic integrity of bull trout populations, most hybrid offspring are sterile, which alternatively depresses local populations through unsuccessful reproductive efforts (NRCS 2006; USFWS 2008b, 2010b).

Interaction with Salmon and Steelhead

Bull trout, salmon, and steelhead can occur in similar aquatic habitat types; however, bull trout are more sensitive than salmon and steelhead to increased water temperatures, poor water quality, habitat conditions, and low flow conditions; thus, they more often occur in higher elevations with less disturbed habitats. Bull trout also require colder water temperatures than other salmon and trout; therefore, bull trout are more likely to occur in headwater streams (where a stream begins, i.e., its origin) where temperatures tend to be cooler. Because bull trout feed primarily on fish (referred to as piscivorous) as subadults and adults, they can be substantial predators of young salmon and steelhead. Juvenile bull trout feed on similar prey as salmon and steelhead (NRCS 2006; USFWS 2008b, 2010b).

3.2.4.3 Eulachon

Background

The eulachon (also known as Columbia River smelt, candlefish, or hooligan) is a small, 9-inch anadromous ocean fish that occurs in the eastern North Pacific Ocean. The southern eulachon DPS consists of populations spawning from the Nass River in British Columbia south to the Mad River in California. The southern eulachon DPS includes core populations in the Columbia and Fraser Rivers and may have historically included the Klamath River. This DPS is listed as a threatened species under ESA throughout its range due to habitat loss and degradation; hydroelectric dams blocking access to historical eulachon spawning grounds and affecting the quality of spawning substrates through flow management, altered delivery of coarse sediments, and siltation; dredging activities; and global climate change where warming trends may have altered prey, spawning, and rearing success (74 Fed. Reg. 10857, March 12, 2009). Critical habitat for the eulachon was recently finalized (76 Fed. Reg. 65324, October 20, 2011), and it includes portions of the Columbia River Basin.

In addition to regular returns to mainstem Columbia River spawning areas (up to Bonneville Dam), eulachon spawn in Skamokawa Creek, as well as the Cowlitz, Grays, Elochoman, Kalama, Lewis, and Sandy Rivers (NMFS 2010). The Columbia River and its tributaries are believed to support the largest eulachon run in the world (NMFS 2008).

Eulachon spend most of their lives in salt water, but return to freshwater to spawn at 3 to 5 years of age. Adult eulachon enter freshwater from December to March, and the young migrate downstream shortly after hatching. Eulachon then rear in nearshore marine areas from shallow to moderate depths. Larval and juvenile eulachon are planktivorous (feed on small plants and animals that float in the water column), while adult eulachon feed on euphausiids (shrimp-like marine invertebrate animals) and copepods (NMFS 2010).

As eulachon mature, they are eaten by many predators including other fish, marine mammals, ducks, and birds. Adult spawning eulachon are also harvested. Columbia-River-caught eulachon are sold for bait and as fresh food fish. Sport fishing for eulachon primarily occurs in tributaries, although the mainstem is also open for sport fishing. Native Americans have fished for eulachon for centuries. Currently, the Yakama Nation harvests eulachon for subsistence purposes.

Current Status and Trends

The southern eulachon DPS is listed under ESA as a threatened species and is a Washington State species of concern (Table 3-8). Based on commercial catch data, Columbia River eulachon populations declined dramatically in the 1990s before increasing between 2001 and 2003. The returns dropped slightly in 2004, however, and then dropped dramatically in 2005, which is reflected in both the commercial landings and catch per unit effort data collected from 2001 to 2007. The decline in the early 1990s appears to coincide with a decline of eulachon in British Columbia, suggesting that a common cause, such as changing ocean conditions (see Limiting Factors and Threats below), was responsible for declines (NMFS 2010).

Limiting Factors and Threats

NMFS (2008 and 75 Fed. Reg. 13012, March 18, 2010) suggests that eulachon may be unable to tolerate the relatively recent rapid climate changes in both the ocean and freshwater environment. The eulachon is a cold-water species adapted to feed on a northern suite of copepods (small zooplankton) in the ocean during the critical transition period from larvae to juvenile. Its recent recruitment (incoming young for future generations) failure may be traced to mortality during this critical period. Climate change may contribute to a mismatch between eulachon life history and their primary prey species. Other limiting factors include commercial harvest of eulachon, bycatch of eulachon in commercial fisheries, and the potential for natural or manmade events to impact its habitat (75 Fed. Reg. 13012, March 18, 2010). In addition, the historical hydropower development on the Columbia River decreased the long-term spawning habitat available for eulachon. Their spawning habitat can also be impacted by dredging, which makes the substrate unstable for incubation of eulachon eggs. Eulachon are considered sensitive to pollutants in freshwater. Eulachon are weak swimmers and concentrate in low-velocity waters, making them especially vulnerable to predators (NMFS 2010).

Interaction with Salmon and Steelhead

Eulachon are important in the food chain as a prey species of salmon and steelhead. Newly hatched and juvenile eulachon are food for a variety of larger marine fish species, including salmon and steelhead. Spawned-out and decomposing eulachon also contribute to the nutrient cycle of freshwater streams (NMFS 2010).

3.2.4.4 Green Sturgeon

Background

The green sturgeon is a long-lived, slow-growing anadromous fish (average length of 50 to 55 inches) that ranges from the Bering Sea, Alaska, to Ensenada, Mexico. A NMFS BRT (2005) determined that the species consists of a northern DPS and a southern DPS. The southern green sturgeon DPS is listed under ESA as a threatened species throughout its range (71 Fed. Reg. 17757, April 7, 2006) (Table 3-8), and critical habitat was identified for this DPS (74 Fed. Reg. 52300, October 9, 2009). The critical habitat includes the Columbia River estuary.

Based on genetic evidence, the southern DPS consists of populations originating from coastal watersheds south of the Eel River and the Central Valley of California. Tracking data, genetic mixed stock analysis, and direct observation indicate that the southern green sturgeon DPS occurs in freshwater rivers and coastal estuaries and bays along the west coast of North America, including estuaries of Oregon and Washington and the lower Columbia River (74 Fed. Reg. 52300, October 9, 2009). The only known spawning population for the southern green sturgeon DPS is the Sacramento River. Outside of their natal system, subadult and adult southern green sturgeon migrate to the lower Columbia River estuary for feeding and optimization of growth (NMFS 2009). The DPS is known to aggregate in the Columbia River estuary and Washington estuaries in the late summer (NMFS 2009). During this period, the Columbia River estuary is believed to have the largest concentration of southern DPS green sturgeon.

Green sturgeon are believed to spawn every 2 to 4 years. Beginning in late February, adult green sturgeon migrate from the ocean into freshwater to begin spawning migration, which occurs from March to July. Eggs and larvae develop in freshwater, and juvenile green sturgeon rear and feed in both fresh and estuarine waters from 1 to 4 years prior to dispersing into marine waters as subadults. The subadult male and females spend at least 6 to 10 years, respectively, at sea before reaching reproductive maturity and returning to freshwater to spawn for the first time. Adults spend as many as 2 to 4 years at sea between spawning events, and they spawn multiple times (71 Fed. Reg. 17757, April 7, 2006). Green sturgeon have been documented as living up to 42 years (Nakamoto and Kisanuki 1995), though some fish biologists believe they may have a maximum life span of 60 to 70 years (NMFS 2005). Green sturgeon are known to feed on benthic invertebrates including shrimp, mollusks, amphipods, as well as small fish, although salmon and steelhead have not been documented as part of their diet (NMFS 2005, 2009).

Current Status and Trends

The southern green sturgeon DPS is a threatened species under ESA (Table 3-8). No reliable data on current population size exist, and data on population trends are lacking. The rationale for the southern green sturgeon DPS listing is as follows:

1) Most spawning adults are concentrated into one spawning river (i.e., the Sacramento River), thus increasing their risk of extirpation due to catastrophic events.
2) Information exists that threats to this species are severe and have not been adequately addressed by conservation measures currently in place.
3) There is evidence of lost spawning habitat in the Sacramento River.
4) Fishery-independent data exhibit a negative trend in juvenile green sturgeon abundance (71 Fed. Reg. 17757, April 7, 2006).

Limiting Factors and Threats

The principal factor in the decline of the southern green sturgeon DPS is the reduction of the southern DPS spawning area to a limited section of the Sacramento River that supports this habitat. This remains a limiting factor due to the increased risk of extirpation from catastrophic events. Other limiting factors and threats include insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), bycatch of green sturgeon in fisheries, potential poaching (e.g., for caviar), entrainment by water projects, influence of exotic species, small population size, impassable barriers, and elevated water temperatures (71 Fed. Reg. 17757, April 7, 2006).

Interaction with Salmon and Steelhead

Green sturgeon occur in similar estuary habitat as salmon and steelhead; however, green sturgeon are considered bottom-dwelling fish that feed on crustaceans and benthic invertebrates on the bottom of estuaries and the ocean. Thus, interactions among green sturgeon and salmon and steelhead are limited to the Columbia River estuary and Pacific Ocean marine waters.

The primary interaction between green sturgeon and salmon and steelhead is green sturgeon bycatch in salmon and steelhead fisheries (NMFS 2009). Although commercial harvest of green sturgeon is not allowed, the species may unintentionally be caught as bycatch in other fisheries harvests. The green sturgeon bycatch is expected to be released back to the water where caught, although the fish can be impacted by handling and exposure. Green sturgeon bycatch was recently estimated for groundfish fisheries (Bellman et al. 2010), as well as for the salmon gillnet fishery by the Klamath Tribes. During the Klamath Tribe fishery, bycatch was estimated to be fairly constant at 200 to 400 fish per year (NMFS 2007).

3.2.4.5 Coastal Cutthroat Trout

Background

The cutthroat trout is native to western North America. It has evolved into 10 subspecies through geographic isolation. Of these subspecies, both the coastal cutthroat trout (*Oncorynchus clarki clarki*) and westslope cutthroat trout (*O. clarki lewisi*) are two subspecies with the potential to interact with salmon and steelhead. The coastal cutthroat is discussed below, and the westslope cutthroat is discussed in Section 3.2.4.15, Westslope Cutthroat Trout.

The native range of coastal cutthroat trout extends from as far north as Prince William Sound in Alaska south to the Eel River of California. The southwestern Washington/lower Columbia River DPS of the coastal cutthroat trout occurs in western Oregon and Washington, including the

Columbia River Basin. Within the analysis area, the geographic range of the DPS is from the Columbia River estuary upstream to the mouth of the Klickitat River. This DPS was proposed for listing and reviewed by USFWS in 1999, 2002, 2005, and 2008. On February 25, 2010, USFWS withdrew its proposal to list the DPS as threatened under ESA, citing that threats to the coastal cutthroat trout as analyzed under the five listing factors described in ESA section 4(a)(1) are not likely to endanger the DPS now or into the foreseeable future (USFWS 2010c).

Four general life-history forms of coastal cutthroat trout are recognized:

1) Nonmigratory coastal cutthroat trout that occur in small streams and headwater tributaries and exhibit little instream movement
2) Fluvial freshwater-migratory coastal cutthroat trout that migrate entirely within freshwater
3) Adfluvial coastal cutthroat trout migrate between freshwater spawning tributaries and lakes
4) Saltwater-migratory coastal cutthroat trout (also known as sea-run trout) that migrate between the ocean or estuary usually for less than 1 year before returning to freshwater

The relationship among these four populations is unknown. The average length of coastal cutthroat trout ranges from 6 to 20 inches, with smaller resident forms (NMFS 1999).

Cutthroat trout typically spawn from December through June, with peak spawning in February (ODFW 1997). Most anadromous coastal cutthroat trout rear in streams for 2 to 3 years before emigrating to salt water. Anadromous coastal cutthroat trout typically spawn in upper tributary areas where the emerging fry have little competition from salmon and steelhead. Unlike other anadromous salmon and steelhead that spend multiple years feeding far out at sea, coastal cutthroat trout prefer to remain within a few miles of the coast, with some overwintering in freshwater streams and feeding at sea only during the warmer months. In rivers with extensive estuary systems, coastal cutthroat trout may move to the intertidal environment to feed. They may also move upriver or out to sea on feeding migrations. Their lifespan is typically 6 to 8 years, and they may spawn more than once (ODFW 2005a).

Coastal cutthroat trout feed on aquatic and terrestrial invertebrates, primarily insects (Romero 2004). As they mature into adults, however, they will prey on fish in a variety of freshwater and estuarine habitats including salmon and steelhead (NMFS 1999).

Current Status and Trends

The coastal cutthroat trout southwestern Washington and Lower Columbia River DPS is a Federal species of concern and an Oregon State sensitive species (Table 3-8). The southwestern Washington-lower Columbia River area historically supported highly productive coastal cutthroat trout populations, and nonmigratory coastal cutthroat trout were widespread. Populations appear to be currently stable, but they are believed to be lower in abundance than historical levels due to habitat loss and competition for food and habitat with introduced rainbow trout. Fluvial and adfluvial coastal cutthroat trout are believed to have healthy populations, although the status of some populations is unknown. Sea-run coastal cutthroat trout are believed to have undergone a substantial decline in population size, most likely due to unfavorable ocean conditions (ODFW 2005a).

Limiting Factors and Threats

Activities that have the potential to affect coastal cutthroat trout habitat include forest management practices, agriculture and livestock management, dams and barriers, urban and industrial development, mining, and estuary degradation (ODFW 2005a). Other impacts on anadromous coastal cutthroat trout include effects on genetics and fisheries from widespread use of hatchery-origin, sea-run cutthroat trout in coastal Oregon and lower Columbia River streams (ODFW 2005a). To decrease this latter impact, ODFW terminated hatchery-origin trout stocking in coastal and Columbia River streams inhabited with native sea-run cutthroat trout and placed restrictive angling regulations (ODFW 1997; USFWS 2009a). Predation also occurs from sea lions and harbor seals within the lower Columbia River (NMFS 1999) (Section 3.5.5, Marine Mammals).

Interaction with Salmon and Steelhead

NMFS (1999) reviewed the interactions of coastal cutthroat trout with other salmon species. NMFS (1999) stated that coastal cutthroat trout are less affected by interspecific competition when in contact with salmon because coastal cutthroat trout have developed a variety of habitat-partitioning techniques and life histories that are different from other salmonids, which is believed to reduce the potential for hybridization. NMFS (1999) summarizes several studies demonstrating that, when in the presence of other salmonids, coastal cutthroat trout have altered their behavior and life history traits to avoid interspecific competition for the same food and resources. For example, their small size at maturity may give coastal cutthroat trout an adaptive advantage for using small streams for spawning and rearing, reducing interspecific competition with other anadromous spawning salmonids. Conversely, post-spawning coastal cutthroat trout or those on feeding migrations are larger than outmigrating juveniles of other Pacific salmon species, which allows coastal cutthroat trout to prey on these fish in a variety of freshwater and estuarine habitats (NMFS 1999).

Previous studies regarding the presence of coastal cutthroat trout and steelhead in the same stream locations have shown that these species have different behaviors (e.g., feeding on different prey) when sympatric (occupying the same or overlapping geographic areas without interbreeding), which can help avoid and/or minimize interspecific competition (Pearcy et al. 1990). However, an additional important interaction with salmon and steelhead is hybridization of coastal cutthroat trout with steelhead and rainbow trout (NMFS 1999; Ostberg et al. 2004).

3.2.4.6 Lake Chub

Background

The freshwater lake chub has a wide range of distribution throughout much of Canada and the northern United States. Its distribution pertinent to the analysis area is limited to lakes and their tributaries in Okanagan County. The lake chub is a minnow (4 to 6 inches long) and a bottom dweller most frequently found in shallow water of large lakes and rivers with a preference for clear water and gravel bottoms of glacial scour lakes and tributary rivers. Its habitat consists of clear and cool water, substrate composed of large sand or gravel, deep pools, presence of large woody debris, overstream vegetation, and absence of large species of predacious fishes (Roberge et al. 2002; Stasiak 2006).

Lake chub live an average of 5 years. They spawn in the spring, usually April to May, when they move to shallow waters of rivers and streams that have rocky or gravelly bottoms. Lake chub prey include insect larvae, mobile aquatic and terrestrial insects, freshwater shrimp, algae, zooplankton, and fish eggs. Large chub will also consume small fish (Roberge et al. 2002; Stasiak 2006).

Current Status and Trends

The lake chub is not an ESA-listed species, but it is a Washington State species of concern (Table 3-9). The lake chub is considered stable throughout most of the main portion of its range in Canada and in the north central United States and New England regions. However, some populations found in headwater streams and in areas of groundwater seepage are not as stable (Stasiak 2006).

Limiting Factors and Threats

The primary threats to lake chub include habitat alteration, declining water quality and quantity, and introduction of non-native fish species. Water development activities that alter natural flow regimes have led to habitat degradation and stream fragmentation. Non-native species negatively affect lake chub through the combined pressures of predation, competition, potential for new parasites and disease, and altering behavior components of the native fish assemblage (Stasiak 2006).

Interaction with Salmon and Steelhead

Stream-dwelling lake chub are vulnerable to predation from salmon and steelhead wherever the two species coexist (Stasiak 2006).

3.2.4.7 Lamprey

Background

Three lamprey species are native to the Columbia River Basin: Pacific lamprey, river lamprey, and western brook lamprey. The Pacific lamprey (15 to 25 inches in length) is the most widely distributed lamprey species on the U.S. West Coast, and its range includes Japan, Russia, Alaska, Canada, the United States, and Mexico. The river lamprey (6 to 28 inches in length) occurs from near Juneau, Alaska, south to San Francisco Bay, California. The western brook lamprey (4 to 7 inches in length) is widespread on the West Coast, occurring from Alaska south to California (USFWS 2004). All three species occur in the Columbia River Basin.

The Pacific and river lamprey are both anadromous and parasitic species, and the western brook lamprey is non-anadromous and nonparasitic. After spending 1 to 3 years in the marine environment, adult Pacific and river lamprey cease feeding and migrate to freshwater between February and June. They are believed to overwinter and remain in freshwater habitat for about 1 year before spawning. Pacific lamprey spawning occurs between March and July. Young eventually move downstream, reaching the ocean between late fall and spring where they mature into adults. Very little is known about river lamprey. They are believed to spawn from April to May in California and likely have a life history similar to Pacific lamprey. For western brook lamprey, young (referred to as ammocoetes), feed mostly on diatoms and other microscopic plant and animal matter. When mature, in 3 to 5 years, western brook lamprey spawn from mid-April to May and die shortly thereafter (Confederated Tribes of the Umatilla Indian Reservation 2004; USFWS 2004, 2009b).

Young Pacific and river lamprey are filter feeders. As they mature and move over larger areas, they feed on bottom fauna and fish. As adults, Pacific and river lampreys attach themselves to the side of fish (including salmon and steelhead) and whales and feed on their skin and muscles. In comparison, adult western brook lamprey do not eat. They live only a few months for breeding purposes and may shrink up to 20 percent in size as nonfeeding adults (USFWS 2004, 2008c; ODFW 2005b).

Current Status and Trends

The Pacific lamprey and the river lamprey are Federal species of concern. The river lamprey is also a Washington candidate species, and the Pacific lamprey is an Oregon State sensitive species and an Idaho State endangered species (Table 3-8). Although lamprey were believed to have distributions similar to salmon, recent data indicate that their distribution has been reduced throughout the region. There is currently no commercial harvest allowed for lamprey, although tribal harvest occurs for Pacific lamprey.

Abundance of western brook lamprey appears to be maintaining, while Pacific lamprey are believed to be declining (Kostow 2002). Within the Columbia River Basin, Pacific lamprey are believed to have declined to only a remnant of their population prior to human development, and river lamprey are considered to be at "dangerously low numbers" and not present at many historical sites they previously occupied (Kostow 2002). ODFW (2005b) reports declining western brook lamprey throughout its range in Oregon. Thus, all three species are believed to be declining in at least one area of their overall range (Kostow 2002; Butte County Association of Governments 2007; USFWS 2008c, 2009b).

Limiting Factors and Threats

Lamprey are susceptible to many of the same limiting factors and threats facing listed salmon and steelhead: barriers to passage, reduced access to spawning habitat, degradation of spawning and rearing areas, loss of emigrating juveniles to turbine entrainment, and the presence of nonindigenous predators (Kostow 2002; Columbia River Basin Lamprey Technical Workgroup 2010). Data suggest that lamprey in the Columbia River experience poor recruitment in the uppermost reaches of rivers where this fish historically has been captured (Moser and Close 2003).

Interaction with Salmon and Steelhead

Lamprey prey on a variety of fish and marine mammals (whales), including salmon. However, adult lamprey have been considered an important buffer for upstream-migrating adult salmon from predation by seals and sea lions. As prey of seals and sea lions, lamprey are easier to capture than adult salmon; they have a higher caloric value per unit weight than salmonids, and their migration in schools provides fertile feeding patches for their predators. Additionally, lamprey are richer in fats compared to salmon and are, therefore, preferred prey of seals and sea lions over salmon and steelhead (Confederated Tribes of the Umatilla Indian Reservation 2004). Thus, while the primary interaction among lamprey and salmon and steelhead in the analysis area is the potential food source of salmon and steelhead for lamprey, this interaction may be mitigated by the presence of seals and sea lions preferably feeding on lamprey.

3.2.4.8 Leopard Dace

Background

The freshwater leopard dace is a small (2 to 5 inches in length) cyprinid (carps and minnows) freshwater fish that is restricted to the Columbia and Frasier River systems of the Cascade Mountains, as well as the Snake River Basin below Shoshone Falls. Leopard dace inhabit slower and deeper water streams with clean substrates of rock, bounders, and cobble where water velocity is strong enough to prevent siltation from embedding interspaces (NatureServe Explorer 2010a; IDFG 2010a).

The life span of the leopard dace is believed to be about 5 years. Leopard dace spawning occurs from May to August, dependent on location. Their eggs are adhesive and attach to gravel and stones. Young-of-the-year feed on aquatic insect larvae during June and July, switching to terrestrial insects in September. Adults also feed on aquatic insect larvae, algae, terrestrial insects, and earthworms (Roberge et al. 2002; FishBase 2010; Idaho Fisheries Society 2010; NatureServe Explorer 2010a).

Current Status and Trends

The leopard dace is not listed under ESA, but it is a Washington State species of concern due to its limited distribution (Table 3-8). Its current status and trends are unknown.

Limiting Factors and Threats

Dace, in general, are threatened by reduced water flows, increasing water demands, and barriers to movement, which have isolated leopard dace populations. Historic land and water management practices have altered stream habitats, resulting in reduced flows and sedimentation. Introduction of non-native fish species has also impacted leopard dace populations by increased predation (IDFG 2010a).

Interaction with Salmon and Steelhead

Leopard dace, salmon, and steelhead occur in similar habitat types and feed on insects; thus, there is a potential for interspecific competition for prey. However, insects or other prey have not been identified as a limiting factor that has impacted leopard dace survival. Dace are known to be prey of salmon and steelhead (as well as bull trout), due to their small size; thus, the primary interaction between leopard dace and salmon and steelhead is predation.

3.2.4.9 Margined Sculpin

Background

The margined sculpin is a small (average length of 3 inches) freshwater species that is currently found in the Columbia River Basin from the Walla Walla River system in Washington to the Umatilla River system in Oregon. The margined sculpin has the most limited distribution of all freshwater sculpins (Lonzarich 1996). Within the analysis area, the margined sculpin occurs in the Tucannon and Walla Walla drainages. The species is primarily a pool dweller within streams and is normally found in cooler waters less than 68°F. Adults occur in deeper water than juveniles (WDFW 1998a).

Little is known about margined sculpin reproduction and life span. Under laboratory observation, gravid margined sculpin occur during May and June, and eggs are deposited under rocks. Young of the year appear in electrofishing samples in the fall. As a bottom feeder, its food preferences are unknown, although other species of sculpin feed on aquatic invertebrates, young fish (including salmon), and fish eggs (WDFW 1998a).

Current Status and Trends

The margined sculpin is a Federal species of concern and a Washington State sensitive species (Table 3-9). The margined sculpin has a limited distribution, and much of the stream habitat where it occurs has been degraded. The species has also been included in Washington's Priority Species Program and has been identified for priority management and preservation (WDFW 1998a).

Limiting Factors and Threats

The primary threats to margined sculpin are agricultural practices (grazing, channelization, and chemical use), logging and associated roads, shoreline development including removal of native vegetation, chemical use and septic problems, and the margined sculpin's limited distribution.

These human activities have resulted in reduced pool habitats, unstable banks, associated sedimentation of bottom substrate, and elevated stream temperatures (WDFW 1998a).

Interaction with Salmon and Steelhead

Margined sculpin are known to prey on salmon and steelhead eggs and young (WDFW 1998a). Sculpin are also prey of bull trout.

3.2.4.10 Mountain Sucker

Background

The freshwater mountain sucker occurs throughout large portions of Canada and the western United States, including Washington, Oregon, Idaho, Montana, South Dakota, North Dakota, Wyoming, Utah, Colorado, and California. Within the analysis area, the mountain sucker occurs within the Middle-Columbia and Upper Columbia River watersheds. Mountain suckers are found primarily in small headwater streams, but they have also been collected in rivers, such as the Columbia River and its tributaries (the Snake, Yakima, and Willamette Rivers). Within streams, mountain suckers are most common in low-gradient, mountain stream segments that consist of a mixture of riffles, pools, and runs. During the non-breeding period, mountain suckers usually are found in deep parts of streams with lower current velocities. Mountain suckers spawn in riffle habitats, and young of the year use shallow and low velocity habitats (Belica and Nibbelink 2006).

The mountain sucker is a small (6 to 8 inches) moderately long-lived sucker with a maximum age of 9 years (Belica and Nibbelink 2006). Spawning generally occurs between May and mid-August. The mountain sucker is a benthic feeder, browsing on stream bottoms for diatoms, algae, small invertebrates, and organic matter (Roberge et al. 2002; Belica and Nibbelink 2006).

Current Status and Trends

The mountain sucker is not a listed species under ESA, but it is a Washington State candidate species (Table 3-8). At the regional scale, several researchers have commented on perceived declines in mountain sucker populations. However, there is insufficient monitoring of the mountain sucker to confirm population trends (Belica and Nibbelink 2006).

Limiting Factors and Threats

Limiting factors for the mountain sucker are habitat isolation due to passage barriers and habitat degradation (such as sedimentation). Non-native fish also prey on the mountain sucker. Hybridization with other suckers is a concern in some areas (Belica and Nibbelink 2006).

Interaction with Salmon and Steelhead

Mountain suckers and salmon coexist in headwater streams. Due to their small size, mountain suckers can be prey of salmon and steelhead. Mountain sucker feeding behavior and diet differ from those of salmon and steelhead because mountain suckers primarily feed by scraping algae off rocks and consuming other diatoms and small invertebrates on stream bottoms (Belica and Nibbelink 2006), thus avoiding interspecific competition with native salmon and steelhead.

3.2.4.11 Northern Pikeminnow

Background

The northern pikeminnow is native to the Pacific slope of western North America from the Nass River in British Columbia south to Oregon (LCFRB 2004). The species has successfully adapted to a relatively large range of spawning and habitat conditions. The northern pikeminnow is considered a trophic generalist (able to feed on a wide variety of prey and food sources).

Northern pikeminnow are a long-lived, slow-growing freshwater fish species with a maximum age of 16 years and an average length of 23 inches. Spawning occurs in June and July within rivers and lake tributaries of the Columbia River Basin, coastal areas, and Puget Sound. Newly emerged larvae drift downriver during July where they reside within rivers and reservoirs throughout their lifespan. Northern pikeminnow are generally scavengers, and their diet ranges from small insects to sculpins, minnows, and larger fish. Young feed on insects until they grow larger. Northern pikeminnow in the midsize range feed on plankton and small fish, such as salmonid fry and minnows. Large northern pikeminnow that live offshore feed only on fish. During the salmon spawning season, they also feed on eggs that are being deposited in redds (LCFRB 2004).

Adult northern pikeminnow preferred prey is the American shad (*Alosa sapidissima*) (a non-native fish species first observed in the Columbia River in 1876), but they also prey on other fish species, including perch, suckers, salmon, and steelhead. Increases in American shad are believed to help augment the overall abundance and productivity of northern pikeminnow (U.S. Geological Survey [USGS] 2009).

Current Status and Trends

The northern pikeminnow is not a listed species under ESA (Table 3-8). Since 1990, a controlled harvest program within the Columbia River has been in place to decrease the northern pikeminnow's predatory effect on salmon and steelhead. Although over 2 million northern pikeminnow have been removed by controlled harvest, the population continues to have high productivity throughout the Columbia River Basin. It is especially abundant in specific locations, such as the estuary to Bonneville and the following reservoirs: Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite (LCFRB 2004).

Limiting Factors and Threats

Outside of the controlled harvest program, the northern pikeminnow population could be affected by competition for food and habitat from other species. Although the northern pikeminnow is the only native piscivorous fish (a fish species that preys on other fish) in Columbia River reservoirs, other non-native predatory fish species have been introduced into the Columbia River Basin (e.g., walleye [*Sander vitreus*], smallmouth bass [*Micropterus dolomeui*], and channel catfish [*Ictalurus punctatus*]) (LCFRB 2004). Zimmerman (1999) examined diets of smallmouth bass, walleye, and northern pikeminnow and found that juvenile salmonids represented the majority of fish prey consumed by northern pikeminnow, whereas sculpins, minnows, suckers, trout, and perch were more commonly consumed by smallmouth bass and walleye. In a study Ward and Zimmerman (1999) conducted, there was no change in the number of smallmouth bass based on removal of northern pikeminnow. Thus, competition between the northern pikeminnow and non-native species is not likely a dominant force limiting northern pikeminnow populations and its predation on native fish. Predation of northern pikeminnow is also not considered a limiting factor on their populations (LCFRB 2004).

Interaction with Salmon and Steelhead

The northern pikeminnow is an important predator of juvenile salmon and steelhead within the Columbia River Basin. An adult can feed on as many as 15 salmon or steelhead smolts in a single day while these prey move downstream to the Columbia River estuary (USGS 2009).

3.2.4.12 Pygmy Whitefish

Background

The pygmy whitefish is a small (5 to 6 inches in length) forage freshwater fish that occurs throughout western Canada, Southeast Alaska, Russia, Washington State (which represents the southern edge of its native range in North America), and Priest Lake, Idaho. The species occurs in deep waters of cool lakes and streams (moderate to swift currents) of mountainous regions and is believed to have a limited distribution within Washington. Pygmy whitefish are most frequently captured at depths from 23 to 300 feet and in water temperatures below 50°F. The species inhabits cold water with a narrow range of temperature requirements (WDFW 1998b).

Pygmy white fish are generally short-lived and grow slowly. Most pygmy whitefish live 3 years, although the oldest known pygmy whitefish is 9 years. Pygmy whitefish spawn from late summer to early winter and are believed to scatter their eggs over coarse gravel. Pygmy whitefish prey consists of crustaceans, aquatic insect larvae and pupae, fish eggs, and small mollusks (WDFW 1998b).

Current Status and Trends

Pygmy whitefish are a Federal species of concern and a Washington State sensitive species (Table 3-8). Pygmy whitefish have been eliminated from 40 percent of their range in Washington. Because of their limited distribution and short life span, the species is vulnerable to population losses during poor recruitment years. The species is included in Washington State's Priority Species Program and has been identified for priority management and preservation (WDFW 1998b).

Limiting Factors and Threats

Water temperatures greater than 50°F and dissolved oxygen less than 5 milligrams per liter in deep-water zones may limit pygmy whitefish habitat. In addition, water quality degradation and siltation that occur from forest management practices and increased development may impact stream-dwelling pygmy whitefish. Construction of bridges and other instream structures near pygmy whitefish spawning areas may cause abandonment of spawning areas or disruption of spawning migration. Other threats are the use of piscicides (chemical substance poisonous to fish) and exotic fish introductions (WDFW 1998b).

Interaction with Salmon and Steelhead

Stream-dwelling pygmy whitefish occupy similar habitats as salmon and steelhead and likely feed on similar prey**.** There is potential for overlap among prey of the different species. However, pygmy whitefish have coevolved with salmon and steelhead over time, and the different species have likely developed different population parameters when occurring in the same locations, such as relative abundance, size, spawning, and microhabitat preferences (Hearn 1987; Essington et al. 2000). Interspecific competition between pygmy whitefish and salmon and steelhead has not been identified as a factor affecting pygmy whitefish (WDFW 1998b). Thus, the primary interaction between pygmy whitefish and salmon and steelhead is believed to be predation on pygmy whitefish due to their small size (5 to 6 inches).

3.2.4.13 Rainbow Trout

Background

The rainbow trout represents the same species as steelhead (*Oncorynchus mykiss*). Both rainbow trout and steelhead spawn in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams; however, rainbow trout remain in freshwater throughout their entire life. Juvenile steelhead may spend up to 7 years in freshwater before migrating to estuarine areas as smolts and then into the ocean to feed and mature. They can then remain at sea for up to 3 years before returning to freshwater to spawn. Some steelhead populations return to freshwater after their first season in the ocean, but do not spawn, and then return to the sea after one winter season in freshwater (NRCS 2000).

Within North America, the historic range of rainbow trout extends from Alaska to Mexico, including the Columbia River Basin. Rainbow trout also inhabit the eastern coast of Asia and the waters of the Pacific Ocean. The species exhibits an extremely diverse suite of life-history strategies, ranging from completely freshwater resident to anadromy. The resident form typically is referred to as rainbow trout. Within the inland Columbia River Basin, the resident form is referred to as redband trout [*O. mykiss gairdneri*]; west of the Cascade/Sierra Mountain divide, the resident form of rainbow trout [*O. mykiss irideus*)] is referred to as the coastal rainbow trout. The anadromous form is referred to as steelhead (Section 3.2.3.2.9, Lower Columbia River Steelhead DPS, through Section 3.2.3.2.14, Upper Willamette River Steelhead DPS) (NRCS 2000; Thurow et al. 2007).

At least three life history patterns of rainbow trout have been identified: adfluvial (migrate from lakes to rivers), fluvial (move from low-order tributaries to large rivers), and resident (restricted movements). Maximum life span for resident rainbow trout is typically 6 years.

Rainbow trout are a coldwater species (average length of 20 to 23 inches) that spawn in moving water over gravel or cobble substrate. If migratory, young will move out of natal streams from 1 to 2 years after birth. Rainbow trout feed on insects, crayfish, and other crustaceans. Adults feed on fish eggs, alevin (newly hatched salmon), fry, smolts, and salmon carcasses. Introduced rainbow trout also interbreed with native rainbow trout, cutthroat trout (several subspecies), and steelhead (Kozfkay et al. 2007). Extensive release of hatchery-origin rainbow trout has also occurred throughout their range, thereby increasing competition for food and habitat and impacting genetic integrity (NRCS 2000).

Current Status and Trends

The rainbow trout is not a Federal or state listed species (Table 3-8). Despite the wide distribution of redband trout, local extirpation and declines have occurred. Strong redband trout populations were reported in 17 percent of their potential range (Thurow et al. 2007). However, because of the likelihood of hybridization with other hatchery-origin rainbow trout and other salmon species, genetic integrity of some large populations may be questionable. Habitat degradation, fragmentation, and the pervasive introduction of non-native species suggest that further declines are likely throughout the range of redband trout. Interior Columbia River Basin redband trout have mostly absent, depressed, or unknown populations (Thurow et al. 2007). Coastal rainbow trout have decreased in population where pollution from urbanization or industrial activities occurs and/or where stream temperatures have increased, either from harvest activities and/or urbanization (Thurow et al. 2007).

Limiting Factors and Threats

Rainbow trout have declined within specific areas of their range. Limiting factors and threats contributing to their decline include habitat loss from dams, habitat degradation, habitat fragmentation, and non-native species introductions. In addition, hybridization has also impacted populations (Thurow et al. 2007).

Interaction with Salmon and Steelhead

Introduced, non-native rainbow trout are a highly adaptable species that, when released as hatchery-origin fish, have the ability to outcompete native fish for food resources (including insects, crustaceans, mollusks, frogs, and small fish) and habitat space (Gawrylewski 2004). Adult rainbow trout also prey on young salmon and steelhead, although this is not their only prey source (NRCS 2000). When occurring in areas where they are native fish species, rainbow trout tend to occupy a wider range of environmental conditions than other native salmonids. They are found in more extreme conditions than those associated with other salmon species, including warmer waters and more heavily disturbed habitats, although, as described above, the species has also been shown to be sensitive to human disturbances (Thurow et al. 2007). Interspecific competition is not believed to occur when native rainbow trout, salmon, and steelhead are found in the same locations. Rainbow trout can hybridize with coastal cutthroat trout, westslope cutthroat trout, and steelhead (NMFS 1999; NRCS 2007).

3.2.4.14 Umatilla Dace

Background

The small (2 to 5 inches) freshwater Umatilla dace occurs from British Columbia south to Oregon and Idaho, including the Columbia River Basin. Within the analysis area, the Umatilla dace is restricted to the Columbia, Kootenay, Slocan, and Snake Rivers. The Umatilla dace is a low-elevation riverine cyprinid (belonging to the carp and minnow fish family) that prefers cover provided by cobbles and larger stones where the current is fast enough to prevent siltation. The species is found along riverbanks at depths less than 1 meter and occurs in rivers that are relatively warm and productive. The species is absent from cold-water tributaries (IDFG 2010b).

There is a lack of information on the Umatilla dace's life history, distribution, and populations. Mature fish have been observed to spawn in July to early August. The species is considered a bottom feeder that preys on aquatic insects, as well as feeding on plant material and zooplankton (NatureServe Explorer 2010b; IDFG 2010b).

Current Status and Trends

The Umatilla dace is not a listed species under ESA, but is a Washington State candidate species (Table 3-8).

Limiting Factors and Threats

Historical land and water management practices have altered stream habitats resulting in reduced flows and sedimentation, which impact Umatilla dace habitat. Isolation of Umatilla dace populations has occurred due to dam construction, diversions, and road crossings. Non-native fish introduction has also been cited as impacting this species because of predation (IDFG 2010b).

Interaction with Salmon and Steelhead

Umatilla dace, and salmon and steelhead occur in similar habitat types and feed on insects; thus, there is a potential for interspecific competition for prey. However, the Umatilla dace is a bottom feeder, and it typically uses a different ecological niche to find its prey. Dace, in general, are also known to be prey of salmon and steelhead (as well as bull trout) due to their small size (2 to 5 inches).

3.2.4.15 Westslope Cutthroat Trout

Background

The westslope cutthroat trout is a freshwater species that occurs from British Columbia and Alberta south through Washington, Montana, Oregon, and Idaho. Within the analysis area, the species occurs in the Upper Columbia River and northern tributaries of the Snake River. Generally, the species occurs in cold-water streams west of the Rocky Mountains. Westslope cutthroat trout require well-oxygenated water; clean, well-sorted gravels with minimal fine sediments for successful spawning; temperatures lower than 70°F; and a complex instream habitat structure, for example, large woody debris, pools, backwater, and overhanging banks. Other requirements include secure connected habitats and protection from introduced non-native fish (Shepard et al. 2003).

The westslope cutthroat trout has an average length of 8 to 12 inches and matures within 4 to 6 years, although it may live as long as 12 years. The species spawns between March and July. Its diet is primarily aquatic invertebrates (insects and zooplankton), with larger trout occasionally preying on other fish (IDFG 2010c).

Current Status and Trends

The westslope cutthroat trout is a Federal species of concern, an Oregon State sensitive species, and an Idaho State threatened species (Table 3-8). The species occupies 59 percent of its historical range in the United States, while the Columbia River Basin contains approximately 48 percent of its historical range (Shepard et al. 2003). A USFWS (2003) status review determined that the westslope trout does not warrant listing as a federally threatened species under ESA. Although not listed in Washington State, the species is included in Washington's Priority Species Program and has been identified for priority management and preservation.

Limiting Factors and Threats

Westslope cutthroat trout populations are in decline due to land-use activities that isolate previously connected habitats, habitat loss, hybridization with introduced rainbow trout, overfishing, and competition/predation from other introduced non-native salmonids (McIntyre and Rieman 1995; Shepard et al. 2003; NRCS 2007). Other limiting factors for westslope cutthroat trout include isolation of existing populations through barriers (such as blocked culverts) (IDFG 2010c). Warming of stream temperatures due to removal of shoreline riparian vegetation has also contributed to habitat loss and a decrease in spawning, hatching, and rearing survival (WDFW 1992).

Interaction with Salmon and Steelhead

Westslope trout have similar habitat, reproduction, and feeding requirements as native salmon and steelhead. They compete directly with non-native salmonids (rainbow, brook, and brown trout) for food and habitat, while hybridizing with rainbow trout (Shepard et al. 2003; Kozfkay et al. 2007). Westslope cutthroat trout are prey of bull trout, lake trout, brook trout, and sculpins (McIntyre and Rieman 1995). Interspecific competition with native salmonids and steelhead has not been cited as a threat to the species. Westslope cutthroat trout have been rarely observed feeding on salmon (IDFG 2010c).

3.2.5 Nonindigenous Fish Species

Nonindigenous fish species in the Columbia River Basin increasingly have been identified as contributing to the decline of native fish species, including endangered salmon, as summarized in Sanderson et al. (2009) and Independent Science Advisory Board (ISAB) (2008). For the Columbia and Snake Rivers, Sanderson et al. (2009) identified 21 to 30 nonindigenous fish species occurring within the rivers and contributing tributaries. The authors state that nonindigenous fish species can outnumber native fishes, comprising 54 percent, 50 percent, and 60 percent of the total number of fish species in Washington, Oregon, and Idaho, respectively.

Nonindigenous fish can impact native fish species through predation, competition, hybridization, infection (disease and parasites), and habitat alteration (Mack et al. 2000; Simberloff et al. 2005; ISAB 2008). Those nonindigenous fish species that have the greatest impact on and relationship with salmon and steelhead include American shad (*Alosa sapidissma*), brook trout, channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus salmoides*), and walleye (*Sander vitreus*), among others. Outside of American shad, which spawns in freshwater and migrates to the ocean as an adult, these nonindigenous fish species reside in freshwater.

USGS conducted research on American shad in the Columbia River from 2007 to 2011 (USGS 2011), including developing a bioenergetics model to understand its ecological interactions with Columbia River salmon. Findings from this study discussed its trophic interactions with fall Chinook salmon and concluded that American shad provide food for juvenile fall Chinook salmon, but also compete with this species for prey, as documented by Haskell et al. (2006). In addition, the large numbers of American shad in the Columbia River (5,000,000 million fish [ISAB 2008]) may alter or deplete zooplankton populations that sustain rearing salmon and contribute to the growth and population size of large predator fishes that feed on juvenile salmon

(USGS 2011). Furthermore, Hershberger et al. (2010) report that American shad carry and have the potential to transmit an infectious parasite to co-occurring salmon and steelhead in the Columbia River.

Levin et al. (2002) demonstrated that the presence of brook trout correlated with a 12 percent reduction in the survival of juvenile Chinook salmon in Snake River Basin streams. The cause of this reduction was believed to be the more aggressive nature of brook trout potentially outcompeting Chinook salmon for prey and habitat. In addition, brook trout prey on the eggs of Chinook salmon. As described in Section 3.2.4.2, Bull Trout, brook trout are known to hybridize with bull trout.

Older studies conducted in the 1980s (Rieman et al. 1991; Vigg 1991) demonstrated that northern pikeminnow (a native fish species) (Section 3.2.4.11, Northern Pikeminnow), walleye, smallmouth bass, and channel catfish prey on seaward-migrating juvenile salmon. The highest consumption rates occurred in July, concurrent with maximum water temperatures and abundance of juvenile salmon. At the time of the study, the primary predators were the northern pikeminnow, which was responsible for 78 percent of the loss of juvenile salmon; walleye, which accounted for 13 percent of the salmon loss; and smallmouth bass, which accounted for 9 percent of the salmon loss. Vigg (1991) reported that large channel catfish consume thousands of juvenile salmon, which comprise 50 to 100 percent of their diets. Fritts and Persons (2004) report that smallmouth bass consume 35 percent or more of juvenile salmon outmigrants. Smallmouth bass predation was also shown to result in heavy losses of subyearling fall Chinook salmon. In addition, natural-origin fall Chinook salmon may be more vulnerable to smallmouth bass predation than hatchery-origin fish due to their smaller size and later migration period (Sauter et al. 2004). Although not as well documented, largemouth bass have been shown to feed on salmon, as indicated in a study that recorded 98 percent of largemouth bass diet was coho salmon in western Washington lakes (Bonar et al. 2004). A separate study recorded Chinook salmon representing a large portion of largemouth bass diet in Lake Washington (Tabor et al. 2007).

3.3 Socioeconomics

3.3.1 Introduction

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. Issues addressed in this section include socioeconomic effects related to hatchery operations, gross and net economic values derived from production and harvest of hatchery-origin fish, and the ways hatcheries and the fish produced in Columbia River Basin hatcheries affect personal income and employment. Information on socioeconomic conditions related to tribal harvests is provided in Section 3.4, Environmental Justice.

This section describes recent trends and baseline conditions for hatchery program costs, harvest, economic values associated with commercial (tribal and non-tribal) and recreational fisheries, and regional economic conditions. An historical overview of salmon and steelhead harvest is also included to provide the reader with context for the description of baseline conditions. Harvest data from 2002 and 2009 are presented, corresponding to a recent period in which documented harvest data are available for most affected fisheries. Economic values and effects are evaluated for average conditions over this period. Table values and corresponding values in the sections are not rounded to aid in finding corresponding numbers between tables and text. However, the use of unrounded numbers should not be interpreted as suggesting unusually high levels of precision in the estimates. All numbers represent a best estimate of the underlying values. Last, harvest numbers reported for each affected economic impact region represent the total number of salmon and steelhead harvested in that economic impact region, not just those originating from the Columbia River Basin.

3.3.2 Analysis Area

The analysis area for socioeconomics includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California; 2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska (Figure 3-1). The analysis area includes sites outside the project area because salmon that are produced within the project area can migrate outside the project area and contribute to fisheries in these areas. Changes in salmon fisheries may lead to socioeconomic effects. The contribution of Columbia River-origin salmon to fisheries outside the project area is shown in Table 3-10. Chinook salmon and coho salmon are the only two Columbia River Basin salmon species that contribute meaningfully to fisheries outside the project area. Columbia River Basin steelhead are not generally caught in fisheries outside the project area.

TABLE 3-10. ESTIMATED CATCH OF COLUMBIA RIVER BASIN STOCKS AS A PERCENTAGE OF TOTAL HARVEST BY AREA AND FISHERY.

Species	Fishery Location				
	Southeast Alaska	British Columbia	Puget Sound/ Strait of Juan de Fuca (WA)	North of Cape Falcon[1] (Northern OR and WA Coast)	South of Cape Falcon[2] (OR, CA Coast)
Chinook Salmon					
Commercial (%)	28	7	1	32	0
Recreational (%)	22	1	6	47	0
Tribal (%)	N/A[3]	N/A	N/A	22	0
Coho Salmon					
Commercial (%)	0	<1	0	1	11
Recreational (%)	0	<1	0	47	40
Tribal (%)	N/A	N/A	N/A	6	N/A

Source: The Research Group (TRG) 2009.

[1] North of Garibaldi, Oregon. Includes salmon fisheries in the Astoria area of northern Oregon but does not include the Washington coast net fishery for Chinook salmon.

[2] South of Garibaldi, Oregon.

[3] N/A = not available.

Information in Section 3.3 (Socioeconomics) and Section 4.3 (Socioeconomics) is organized according to the following economic impact regions: lower Columbia River, mid-Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska. Four of these economic impact regions occur in the Columbia River Basin (lower Columbia River, mid-Columbia River, upper Columbia River, and lower Snake River) (Figure 3-2). These four economic impact regions encompass the seven ecological provinces and two recovery domains that make up the project area (Section 2.2, Description of Project Area). The remaining six economic impact regions (Oregon Coast, Washington Coast, California Coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska) are in the Pacific Ocean and Puget Sound.

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Prepared by Parametix, Inc. April 29, 2010 (DEIS_Figure_3-1_20100429.mxd).

Figure 3-1. Analysis area for socioeconomics by economic impact region.

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Prepared by Parametix, Inc. July 24, 2014 (DEIS_Figure_3-2_20140724.mxd).

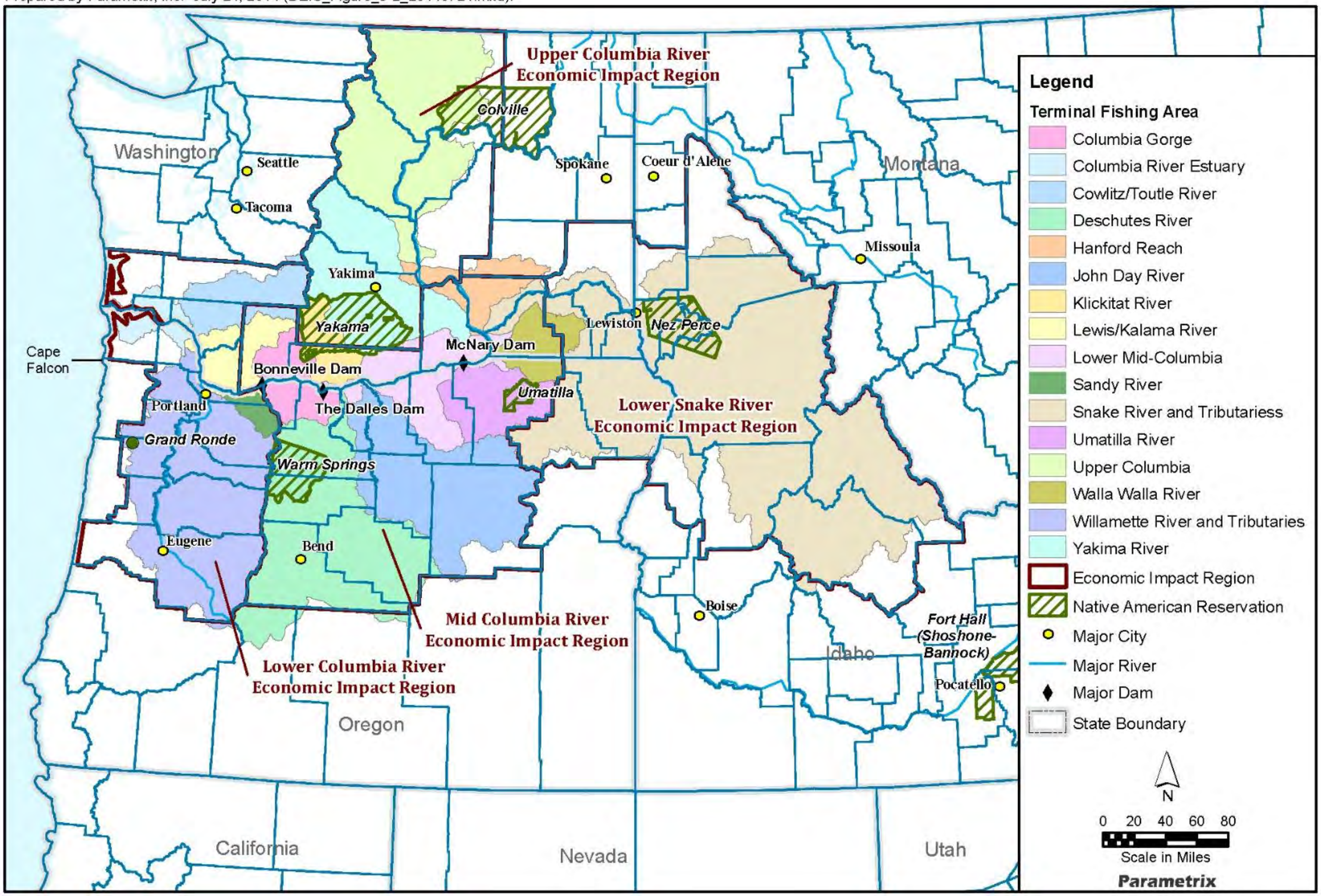

Figure 3-2. Economic impact regions and terminal fishing areas in the Columbia River Basin.

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3.3.3 Hatchery Program Costs

In addition to providing fish for harvest, hatchery programs in the Columbia River Basin directly affect socioeconomic conditions in the economic impact regions where the hatcheries operate. Hatcheries generate economic activity (personal income and jobs) by providing employment opportunities and through local procurement of goods and services for hatchery operations. Hatchery-related spending affects regional economies where hatchery operations occur and where the businesses that provide materials and services are located. This spending also extends to communities where hatchery administration and management decisions take place (sometimes referred to as headquarter costs).

Salmon and steelhead hatchery programs have operated in the states of Oregon and Washington for more than 100 years. Currently, 176 salmon and steelhead hatchery programs operate at 80 hatcheries and associated artificial production facilities in the Columbia River Basin (Section 1.5.1, Hatchery Facilities in the Columbia River Basin) (Figure 1-2) (Table 1-4). Slightly more than one-third of the hatchery programs (62 hatchery programs) in the Columbia River Basin are funded through the Mitchell Act (Table 1-2) (Table 1-4). The remaining 115 hatchery programs are primarily funded through the Bonneville Power Administration (BPA), USACE, U.S. Bureau of Reclamation, USFWS, public utility districts, and private power companies (Appendix A). The hatchery programs are operated by the Confederated Tribes of the Colville Reservation, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of Warm Springs, Idaho Fish and Game, Nez Perce Tribe, ODFW, USFWS, WDFW, and Yakama Nation. (Appendix A).

In 2010, approximately 140 million hatchery-origin salmon and steelhead were produced in the Columbia River Basin (Table 3-11). Approximately 45 percent of the estimated hatchery-origin smolt production (64 million smolts) was either wholly or partially funded by the Mitchell Act in recent years (Table 4-4). As shown in Table 3-11, the most common species produced in Columbia River Basin hatchery programs are fall Chinook salmon and coho salmon in the Willamette/Lower Columbia Recovery Domain and fall Chinook salmon, spring Chinook salmon, and summer steelhead in the Interior Columbia Recovery Domain. Chum salmon, sockeye salmon, winter steelhead, and summer Chinook salmon are the least common species produced at Columbia River Basin hatchery facilities (Table 3-11).

TABLE 3-11. HATCHERY PRODUCTION (NUMBER OF FISH) OF SALMON AND STEELHEAD WITHIN THE COLUMBIA RIVER BASIN IN 2010.

	RECOVERY DOMAIN		
SPECIES	WILLAMETTE/ LOWER COLUMBIA	INTERIOR COLUMBIA	TOTAL
Fall Chinook Salmon	45,855,000	23,129,000	**68,984,000**
Spring Chinook Salmon	13,595,000	19,303,000	**32,898,000**
Summer Chinook Salmon	0	3,742,000	**3,742,000**
Coho Salmon	15,441,000	4,299,000	**19,740,000**
Winter Steelhead	2,011,000	20,000	**2,031,000**
Summer Steelhead	2,049,000	10,537,000	**12,586,000**
Chum Salmon	250,000	0	**250,000**
Sockeye Salmon	0	362,000	**362,000**
TOTAL	**79,201,000**	**61,392,000**	**140,593,000**

Source: NMFS. Number rounded to nearest thousand.

Hatchery program expenses include production, headquarters administrative and management, acclimation and liberation, and hatchery facility and other fixed costs. Information pertinent to estimating hatchery facility costs was developed by TRG (2009) and includes the following:

- **Hatchery production costs**. Hatchery production costs include expenses accrued at the primary hatchery facility, as well as other hatchery facilities where the fish might be taken for rearing. Unit cost information includes the following:
  - Time spent in the hatchery facility affects production costs. The size of most released smolts ranges from 10 to 15 smolts per pound for spring Chinook salmon and coho salmon, to between 20 to 25 smolts per pound for fall Chinook salmon. The spring Chinook salmon and coho salmon spend about 18 months in the hatchery system, and the fall Chinook salmon spend about 9 months in hatcheries.
  - Feed costs range from $0.40 to $0.80 per pound of feed.
  - Marking hatchery-origin fish is a Federal directive for federally operated, administered, or funded programs that produce fish for harvest. The two most common methods to mark hatchery-origin fish are with an adipose fin clip and/or a coded wire tag. Marking costs are about $0.05 per smolt, depending on the proportion of smolts receiving coded wire tag inserts, which are about $0.20 per smolt.
  - Labor costs (excluding labor overhead) are the largest component of production costs, usually comprising about 50 percent of production costs.

- **Headquarters administrative and management costs.** Headquarters administrative and management costs include indirect expenses for central office overhead, with management and administration, ranging from about $0.03 to $0.40 per smolt produced by Mitchell Act-funded hatchery programs. Similar headquarters cost would be assumed for hatchery programs funded through other entities.
- **Acclimation and liberation costs.** Some hatchery programs produce fish at a hatchery facility and then move the fish to a different location before release. Fish are then acclimated to the water at the new site before release. There are additional costs associated with this process.
- **Hatchery facility and other fixed costs**. This includes the cost of maintaining and/or improving hatchery facilities.

The cost to operate the 80 hatcheries and associated facilities in the Columbia River Basin varies by the operating agency. Production cost information for the primary Mitchell Act operating agencies is presented in Table 3-12. Average cost information from Table 3-12 was used, along with facility-specific budget information, to estimate the total cost of production at all hatchery facilities in the Columbia River Basin.

TABLE 3-12. AVERAGE COST PER SMOLT FROM MITCHELL ACT-FUNDED HATCHERY PROGRAMS.

AGENCY/SPECIES	AVERAGE COST PER SMOLT ($)[1,2]
ODFW	
Coho Salmon	1.179
Chinook Salmon	0.743
Steelhead	2.147
USFWS	
Coho Salmon	1.283
Chinook Salmon	1.174
Steelhead	3.260
WDFW	
Coho Salmon	0.683
Chinook Salmon	1.095
Steelhead	2.696
Yakama Nation	
Coho Salmon	0.462
Chinook Salmon	0.829

Source: Compiled by TCW Economics (Appendix J).
[1] All dollar values are expressed in 2007 dollars, as presented in the source document identified in Appendix J. The computation of total costs for smolt production were adjusted to 2009 dollars for estimating regional economic effects of the alternatives (Section 4.3, Socioeconomics).
[2] Includes operation costs, headquarters' overhead costs, amortized capital costs, and acclimation and transport costs, where applicable.

For the 2008 fiscal year, the budget for operating WDFW hatchery facilities above the Bonneville Dam that produce salmon or steelhead was $6.1 million, and the number of full-time equivalent (FTE) jobs was 61.4 positions. For the 12 WDFW hatchery facilities below Bonneville Dam that produce salmon or steelhead, the annual 2008 fiscal year budget was $6.2 million, and the number of FTE jobs was 64 positions.

Budget and jobs information also are available for hatchery facilities operated by ODFW and the Yakama Nation. For 2009, ODFW identified a projected budget of $5.2 million for six Columbia River Basin hatcheries (Big Creek, Bonneville, Cascade, Clackamas, Oxbow, and Sandy) that produce salmon and steelhead and an estimated 31 FTE jobs. For the Klickitat hatchery facility operated by the Yakama Nation, a budget of $521,400 was projected for 2007 and an estimated 5.5 FTE jobs.

Based on available smolt production and budgetary information (Table 3-11 and Table 3-12) from USFWS, WDFW, ODFW, and the Yakama Nation on their hatchery programs that are funded through the Mitchell Act, hatchery production costs (excluding weir operating costs) at all salmon and steelhead hatchery facilities in the Columbia River Basin are estimated to total about $80.8 million. These costs are used to characterize hatchery program costs for Alternative 1, as described in Section 4.3, Socioeconomics.

3.3.4 Historical Overview

Much of the information presented in this section was compiled based on several key documents. Unless otherwise noted, information presented below is from the following documents: the Final Programmatic Environmental Impact Statement for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin (NMFS 2003); Economic and Social Analysis Sections (Preliminary Version 2.1) for the Mitchell Act EIS (TRG 2009). Information provided in comments by the Columbia River Inter-Tribal Fish Commission (CRITFC) and other commenters on the draft EIS has also been used to supplement these sections.

3.3.4.1 Columbia River Basin

Historically, salmon and steelhead extensively used the Columbia River and its tributaries. Chinook salmon migrated nearly 1,200 miles up the Columbia River to Lake Windemere, Canada, and 600 miles up the Snake River to Shoshone Falls near Twin Falls, Idaho. Adult salmon and steelhead runs before development in the Columbia River Basin are estimated to have ranged between 10 and 16 million fish annually.

For thousands of years, Native Americans have fished for salmon and steelhead, as well as other species, in the tributaries and mainstem of the Columbia River. Native Americans fish for ceremonial, subsistence, and economic (commercial) purposes. A wide variety of gears and methods used over the years includes hoop and dip nets, spears, weirs, and traps (usually in smaller streams and headwater areas).

The development of non-tribal fisheries began about 1830, and commercial fishing had become an important economic activity in the Columbia River Basin by 1861. Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800s. Although harvest activity spiked during the late 1980s, and there was a brief uptick between 2001 and 2004, the overall trend in commercial salmon landings has been downward since the late 1930s. With total pounds landed and the value of salmon harvested in the Columbia River Basin appearing to have bottomed out in the 5-million-pound and $10-million range, recent harvest levels are a fraction of historical levels.

Fishing pressure, especially in the late 19th and early 20th centuries, has long been recognized as a significant factor in the decline of Columbia River salmon runs. Hydropower development and habitat degradation are other factors contributing to the decline (National Research Council 1999). As salmon stocks began to decline, salmon hatcheries were constructed to replace and/or supplement natural production.

Present-day treaty fisheries consist primarily of set gillnets, but dip-net fishing still occurs on the Columbia River and tributary locations. Tribal fisheries generally take place above Bonneville Dam, but other locations are sometimes used to fulfill treaty and trust responsibilities. Harvest of salmon for tribal ceremonial and subsistence purposes occurs both in the mainstem and terminal areas of the mid Columbia River, upper Columbia River, and lower Snake River regions. Although ceremonial and subsistence harvest can include coho salmon, steelhead, and summer and fall Chinook salmon, harvest typically is focused on spring Chinook salmon. According to information provided by CRITFC in comments on the draft EIS, subsistence fishing in the Columbia River Basin occurs throughout the year. In addition, some limited commercial fishing often occurs before the spring ceremonial fishing and some tribes use surplus hatchery fish for cultural purposes (funerals, etc.). Spring, summer, and fall Chinook salmon and coho salmon, steelhead, and white sturgeon are routinely harvested for commercial sale.

Harvesting and canning salmon have played a key role in the economic development of the Pacific Northwest. In 2007, 61 processor businesses purchased tribal and non-tribal salmon caught in the Columbia River Basin (TRG 2009). These processor businesses can be characterized in the following terms:

- Buyers who purchase fish that they then market themselves (including buyers from retail markets or farmer's markets from the Seattle, Washington, and Portland, Oregon, areas)
- Buyers who purchase fish mainly for smoking or canning
- Tenders/buyers who purchase fish mostly for resale to larger processors
- Medium and large processors (includes buyers who purchase fish and then sell them to distributors or haul them to Seattle, Washington, for further processing and marketing)

Additionally, a number of tribal harvesters make direct sales to the public. Compared to non-tribal gillnetters who fish the Lower Columbia River, a greater proportion of the commercial catch by tribal fishers is sold directly to the public (TRG 2009).

While the Astoria, Oregon, and Ilwaco, Washington, port areas were historically important salmon processing centers, declining harvests in the Columbia River have led to major declines in these industries. Groundfish, shrimp, and crab fisheries that occur off the coast support most processing or buying operations in the Lower Columbia River. As reported by TRG (2009), two salmon buyers/processors are located in Cathlamet, Washington, and one each in Longview and Vancouver, Washington. In the early 2000s, there were 35 salmon buyers/processors identified in Astoria, but fewer than five had substantial operations. Salmon purchasing agents range up and down the Columbia River, but, until recently, processing operations had been limited to Astoria. Very little product is processed into fillets in the Astoria area. Most purchases are hauled to cold storage and processing facilities in the Seattle and Bellingham, Washington, areas (TRG 2009). Recently, USACE constructed the East White Salmon Fish Processing Facility with the goal of giving tribes more control over their fishery resources and to increase the role of tribal fishers within the salmon market. The facility is operated by a company CRITFC member tribes formed to process salmon harvested by the Umatilla, Warm Springs, Yakama, and Nez Perce Tribes.

Processors of Columbia River Basin salmon supply products to a growing market for wild-caught fish. In addition to seafood products, TRG (2009) reports that one local processor in the Astoria area produces a salmon byproduct from carcasses. This byproduct is used in the manufacture of fishmeal and oil. It has also been used at Columbia River Basin hatcheries as fish food.

3.3.4.2 Pacific Ocean and Puget Sound

Commercial fisheries in Pacific Ocean waters are limited to trolling, a method where a vessel tows numerous lines with attached lures or baits through the water. Vessels range from less than 20 feet to more than 50 feet long. Trollers target salmon on salmon migration and feeding grounds, which extend from shore out to approximately 25 miles. Many trollers (typically the larger ones) are also used in Dungeness crab, albacore, sablefish, halibut, and rockfish fisheries. Some troll vessels hold permits in more than one state and travel to areas distant from their homeports to take advantage of season openings when their own area is closed or better fishing opportunities occur elsewhere.

Commercial trolling has been practiced in Pacific Coast salmon fisheries since 1912. The Pacific Coast troll fleet grew rapidly in the 1970s, along with rising hatchery production of coho salmon, peaking at 11,239 vessels in 1980. By the mid-1970s, fishery managers believed the fleet was overcapitalized and initiated license limitation programs to control participation in salmon fisheries. Permits were first required in Washington in 1974 and in Oregon in 1980. Tribal fishers who participate in ocean trolling are not subject to state license requirements or limitations.

The proportion of salmon harvested in fisheries of the West Coast by commercial and recreational fishers has changed over the years in response to abundance conditions and perceived social and economic priorities. From the mid-1970s to 1990, the commercial fleet took approximately 64 percent of the coho salmon and 81 percent of the Chinook salmon. During the1990s, the commercial fleet harvested approximately 40 percent of the coho and 73 percent of the Chinook salmon. This pattern of allocating increasing amounts of harvest to recreational fisheries appears to have continued into the decade following 2000.

The commercial harvest in the Pacific Fishery Management Council (PFMC) management area (i.e., in Federal waters off the coasts of Washington, Oregon, and California), is allocated between tribal and non-tribal fishers in accord with judicial interpretations of state treaty obligations. Tribal harvest is taken primarily for commercial purposes, but some presumably small numbers of fish harvested off the coast of Washington are for ceremonial and subsistence needs.

Before and during much of the 1970s, fishing seasons for ocean trollers were open from April through September for Chinook salmon and from June through September for coho, with relatively few restrictions. During the 1980s, increased conservation concerns led to cutbacks in season lengths and increased area restrictions. Species-specific fishing regulations became common, and retention of Chinook salmon or coho salmon was limited or prohibited according to time and area.

Ocean troll fisheries became increasingly restricted in the 1990s. Some of the major changes in seasons in recent years, compared to the 1980s, include the elimination of coho salmon fishing off California and increased closures for Chinook salmon in the Klamath Management Zone and nearby areas. The most severe ocean fishing cutbacks occurred in 1984 in response to poor ocean salmon survival attributed to El Niño ocean conditions, and then again recently in 2008 and 2009.

Between 1995 and 1997, more than 1,900 firms had state processor/buyer licenses. These firms included both operators of processing plants and buyers who may do little more than hold the fish before their shipment to a processor or market. In some cases, the buyers may be owners of vessels who also own licenses, thus allowing them to sell fish directly to the public or retail markets. The largest salmon buyers tend to buy salmon from four to eight ports. In California, salmon buyers/processors are largely concentrated in the Monterey/Santa Cruz and San Francisco areas. In past years, a substantial number of buyers/processors were located in Humboldt County.

3.3.5 Commercial Harvest and Economic Value

This section contains reports on recent historical levels of harvest of salmon and steelhead in the following fisheries: Columbia River Basin salmon and steelhead fisheries; California, Oregon, and Washington coastal salmon fisheries, Puget Sound (Washington) salmon fisheries, British Columbia salmon fisheries, and Southeast Alaska salmon fisheries. Unless otherwise noted, all information presented was based on annual harvest reports produced by PFMC, PSC, Pacific States Marine Fisheries Commission (PSMFC), the Joint Staff Reports of the Columbia River Compact, or annual reports for the states and tribes of the Columbia River Basin.

3.3.5.1 Columbia River Basin

The Columbia River mainstem commercial salmon and steelhead fishery is currently divided into a non-tribal commercial fishery and a tribal commercial fishery. The non-tribal commercial fishery is located downstream of Bonneville Dam in Zones 1 to 5, as well as in the Select Areas (i.e., off channel areas of the lower Columbia River). The tribal commercial fishery is located in the Zone 6 fishery between Bonneville Dam and McNary Dam, as well as in the tribal fishing area just downstream of Bonneville Dam, in specific Zone 6 tributaries (Wind, Little White Salmon, Drano Lake, and Klickitat Rivers), and in parts of the Clearwater Basin. Tribal commercial fishing has also occurred in the past in Icicle Creek in the Wenatchee River basin, but not in recent years.

Commercial fishing also occurs in terminal areas of the Columbia River Basin, such as tributaries and bays. Commercial fisheries in terminal areas are designated as non-tribal below Bonneville Dam and tribal above Bonneville Dam. For additional details on harvest by Columbia River tribes, refer to Section 3.4.4, Environmental Justice Populations Reviewed.

For tribal and non-tribal commercial harvests in the Columbia River Basin, more salmon are harvested from the lower and mid-Columbia River economic impact regions than from the other two economic impact regions (Table 3-13 and Table 3-14). Within the lower Columbia River economic impact region, the harvest is primarily from non-tribal commercial fisheries for coho salmon. With an average (2002 through 2009) annual harvest of about 56,238 fish, the coho salmon non-tribal commercial fishery accounts for 58 percent of the total salmon harvest in the mainstem of the Lower Columbia River (97,451 fish) (Table 3-13). Chinook salmon account for the remaining non-tribal commercial fishing harvest because non-tribal commercial fishers do not harvest steelhead.

Coho salmon also dominate the non-tribal commercial harvest in the terminal areas (Select Area Fishery Enhancement [SAFE] areas and the Willamette River) of the lower Columbia River region, accounting for 79 percent (61,053 fish) of the annual average salmon harvest in these areas (77,284 fish) (Table 3-13). Some (less than 1,000 annually) chum salmon are also caught in the mainstem, but these catches are incidental to the coho salmon and Chinook salmon harvest.

In the tribal commercial fisheries between Bonneville Dam and McNary Dam (which represents the mid Columbia River economic impact region), the harvest of Chinook salmon dominates the catch in the mainstem (Table 3-14). Of the 161,447 salmon and steelhead, on average, caught in this economic impact region (Table 3-14), Chinook salmon accounted for 79 percent (127,879 fish) of the total tribal harvest. Tribal commercial fishing in the terminal areas in the mid Columbia River is more balanced between species compared to the mainstem, with coho salmon accounting for about 63 percent (17,532 fish) of the average annual harvest (total of 27,673 fish), Chinook salmon about 30 percent (8,406 fish), and steelhead about 7 percent (1,735 fish) (Table 3-14). The tribal commercial fisheries in the upper Columbia River and lower Snake River economic impact regions are mostly Chinook salmon fisheries, although smaller numbers of steelhead and very small numbers are also caught in the Lower Snake River economic impact region (Table 3-14). Additionally, small numbers of sockeye salmon are caught in the mid Columbia River economic impact region.

TABLE 3-13. COLUMBIA RIVER BASIN IN-RIVER HISTORICAL (2002 THROUGH 2009) CATCH FOR NON-TRIBAL COMMERCIAL FISHERIES.

ECONOMIC IMPACT REGION/AREA/SPECIES	NON-TRIBAL COMMERCIAL FISHERIES (NUMBER OF FISH)								
	2002	2003	2004	2005	2006	2007	2008	2009	ANNUAL AVERAGE
Lower Columbia River									
Mainstem (Zones 1 to 5)									
Chinook Salmon	49,992	61,448	54,477	35,476	35,208	16,272	35,142	41,692	41,213
Coho Salmon	94,900	143,800	66,600	30,300	27,200	30,200	13,100	43,800	56,238
TOTAL	**144,892**	**205,248**	**121,077**	**65,776**	**62,408**	**46,472**	**48,242**	**85,492**	**97,451**
Terminal Areas									
Chinook Salmon	20,257	17,529	23,204	11,102	11,802	11,307	18,483	16,165	16,231
Coho Salmon	69,266	117,133	51,944	65,807	37,653	10,516	55,151	80,950	61,053
TOTAL	**89,523**	**134,662**	**75,148**	**76,909**	**49,455**	**21,823**	**73,634**	**97,115**	**77,284**
CHINOOK SALMON	**70,249**	**78,977**	**77,681**	**46,578**	**47,010**	**27,579**	**53,625**	**57,857**	**57,445**
COHO SALMON	**164,166**	**260,933**	**118,544**	**96,107**	**64,853**	**40,716**	**68,251**	**124,750**	**117,290**
TOTAL	**234,415**	**339,910**	**196,225**	**142,685**	**111,863**	**68,295**	**121,876**	**182,607**	**174,735**

Source: Catch data are from Joint Columbia River Management Staff (2003a, 2004a, 2005a, 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, and 2011b)

TABLE 3-14. COLUMBIA RIVER BASIN IN-RIVER HISTORICAL (2002 THROUGH 2009) CATCH FOR TRIBAL COMMERCIAL AND CEREMONIAL AND SUBSISTENCE FISHERIES.

	Tribal Commercial and Ceremonial and Subsistence Fisheries (number of fish)								
Economic Impact Region/Area/Species	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Annual Average**
Lower Columbia River									
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mid Columbia River									
Mainstem (Zone 6)									
Chinook Salmon	164,464	147,344	151,890	128,509	101,557	54,380	137,287	137,602	127,879
Coho Salmon	1,649	5,670	10,287	5,413	7,577	8,035	21,626	15.675	9,492
Steelhead	19,217	20,553	20,518	17,413	22,646	22,416	31,593	38,255	24,076
TOTAL	**185,330**	**173,567**	**182,695**	**151,335**	**131,780**	**84,831**	**190,506**	**191,532**	**161,447**
Terminal Areas									
Chinook Salmon[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8,406
Coho Salmon[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17,532
Steelhead[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,735
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**27,673**
Upper Columbia River									
Chinook Salmon[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,870
Coho Salmon[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Steelhead[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**2,870**
Lower Snake River									
Chinook Salmon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9,404
Coho Salmon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,019
TOTAL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**11,448**
CHINOOK SALMON	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**148,559**
COHO SALMON	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**27,049**
STEELHEAD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**27,830**
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**203,438**

Source: Catch data for the mid Columbia River (mainstem) economic impact region are from Joint Columbia River Management Staff (2003a, 2003b, 2004a, 2004b, 2005a, 2005b, 2006a, 2006b, 2007a, 2007b, 2008a, 2008b, 2009a, 2009b, 2010a, 2010b, 2011b).

[1] N/A = not available. Average annual values are based on modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team for Alternative 1.

[2] Represents annual average catch from 2008 to 2011. Calculated based on catch data provided by the Nez Perce Tribe.

In terms of economic value, the average annual harvest value (known as the ex-vessel value, which is the price received for the product at the dock) of salmon caught in the non-tribal commercial fisheries in the lower Columbia River economic impact region was $2,831,177 (Table 3-15). The harvest value of salmon and steelhead caught by tribal commercial fishers was $2,761,765, in the mid Columbia River economic impact region and $136,754 in the lower Snake River economic impact region (Table 3-15). All tribal harvests in the upper Columbia River economic impact region were for ceremonial and subsistence purposes, generating commercial ex-vessel value. Based on net economic value factors identified in Appendix J (Table A-3), the net income for tribal and non-tribal commercial fishers associated with the annual (2002 through 2009) average harvest of salmon and steelhead in the Columbia River Basin is estimated at about $5.2 million. No monetary value has been assigned to tribal ceremonial and subsistence harvests, which from a tribal perspective, have significant religious, social, and cultural value that differs from the economic value of tribal commercial fisheries, as discussed in Section 3.4.4.1.2, Ceremonial and Subsistence Harvests.

3.3.5.2 Pacific Ocean and Puget Sound

This section describes historical harvest conditions and associated economic values for commercial salmon fisheries in the Pacific Ocean and Puget Sound. Catch values and associated economic values presented in this section are for all salmon stocks, not just salmon stocks from the Columbia River Basin.

As previously indicated, Columbia River stocks of Chinook salmon and coho salmon contribute to commercial fisheries in the Pacific Ocean and, to a much lesser extent, to salmon fisheries in the Puget Sound. About 32 percent of the Chinook salmon in non-tribal commercial fisheries and 22 percent of the Chinook salmon harvested in tribal commercial fisheries north of Cape Falcon consist of Columbia River stocks (Table 3-10). Stocks of Columbia River Chinook salmon do not substantially contribute to the salmon fisheries south of Cape Falcon (Table 3-10); however, Columbia River stocks of Chinook salmon do contribute to Chinook salmon commercial fisheries in the Astoria area of northern Oregon. The contribution of Columbia River Chinook salmon to Puget Sound fisheries is minor, accounting for an estimated 1 percent of the commercial harvest (Table 3-10). Columbia River stocks account for about 28 percent of Chinook salmon harvested in the Southeast Alaska commercial fishery and about 7 percent of the commercial harvest of Chinook salmon harvested in British Columbia marine waters (Table 3-10).

TABLE 3-15. AVERAGE ANNUAL (2002 THROUGH 2009) CATCH AND COMMERCIAL EX-VESSEL VALUE FOR TRIBAL COMMERCIAL AND CEREMONIAL AND SUBSISTENCE FISHERIES AND NON-TRIBAL COMMERCIAL FISHERIES IN THE COLUMBIA RIVER BASIN.

	TRIBAL		NON-TRIBAL COMMERCIAL	
ECONOMIC IMPACT REGION/SPECIES	AVERAGE CATCH (NUMBER OF FISH)	EX-VESSEL VALUE ($)[1]	AVERAGE CATCH (NUMBER OF FISH)	EX-VESSEL VALUE ($)[1]
Lower Columbia River				
Chinook Salmon	0	0	57,445	1,827,878
Coho Salmon	0	0	117,290	1,003,299
Steelhead	0	0	0	0
TOTAL	**0**	**0**	**174,735**	**2,831,177**
Mid Columbia River				
Chinook Salmon	136,285	2,383,612	0	0
Coho Salmon	27,024	194,843	0	0
Steelhead	25,811	183,310	0	0
TOTAL	**189,120**	**2,761,765**	**0**	**0**
Upper Columbia River				
Chinook Salmon	2,870	0[2]	0	0
Coho Salmon	0	0[2]	0	0
Steelhead	0	0[2]	0	0
TOTAL	**2,870**	**0[2]**	**0**	**0**
Lower Snake River				
Chinook Salmon	9,404	122,249	0	0
Coho Salmon	25	166	0	0
Steelhead	2,019	14,339	0	0
TOTAL	**11,448**	**136,754**	**0**	**0**
CHINOOK SALMON	**148,559**	**2,505,861**	**57,445**	**1,827,878**
COHO SALMON	**27,049**	**195,009**	**117,290**	**1,003,299**
STEELHEAD	**27,830**	**197,649**	**0**	**0**
TOTAL	**203,438**	**2,898,519**	**174,735**	**2,831,177**

Sources: Average catch estimates are based on 2002 through 2009 historical averages, 2008 through 2011 historical averages (for the Lower Snake River economic impact region), and modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team for Alternative 1 (Table 3-13 and Table 3-14). Tribal catch includes commercial and ceremonial and subsistence harvests. See Appendix J for an explanation of how ex-vessel values were derived.

[1] All dollar values are expressed in 2009 dollars. Ex-vessel value estimates are based solely on estimated commercial catch and exclude any value attributable to ceremonial and subsistence catch.

[2] All catch in the upper Columbia River economic impact region is for ceremonial and subsistence purposes. Therefore, no commercial ex-vessel value has been estimated for this region.

For coho salmon, commercially caught south of Cape Falcon, which is located on the Oregon Coast south of Garibaldi, Columbia River coho stocks account for an estimated 11 percent of all coho salmon harvested in these waters by non-tribal commercial fishers; however, Columbia

River coho stocks do not substantially contribute to tribal commercial fisheries south of Cape Falcon. Columbia River coho stocks do not contribute substantially to commercial fisheries in Southeast Alaska, British Columbia, and/or Puget Sound. Columbia River coho stocks do contribute to tribal commercial fisheries off the Washington Coast, at a rate of 6 percent of all coho salmon harvested (Table 3-10).

As indicated in Section 3.3.2, Analysis Area, Chinook salmon leaving the Columbia River Basin generally turn north in Pacific Coast waters, and coho salmon turn south, although fish of both species can migrate in either direction (NMFS 2003). Non-tribal commercial fishing along the northern Oregon coast (basically, the Astoria area) is divided between Chinook salmon and coho salmon fisheries, with Chinook salmon accounting for, on average, a slightly larger proportion (55 percent [6,808 fish]) of the total commercial salmon harvest in Oregon (12,496 fish) (Table 3-16). Along the Washington Coast, Chinook salmon comprises most (81 percent [29,056 fish]) of the salmon harvest [35,654 fish] in non-tribal commercial, fisheries although coho salmon accounts for a slight majority (53 percent [31,481 fish]) of the total tribal commercial [59,951 fish] fishery (Table 3-16 and Table 3-17, respectively). Further north in the British Columbia economic impact region, where the fisheries are more affected by local river systems and less by Columbia River stocks, Chinook salmon is the only substantial contributor from the Columbia River to local fisheries. In Southeast Alaska, Columbia River stocks are substantial contributors to the Chinook salmon commercial fisheries, accounting for about 28 percent of the commercial harvest (Table 3-10).

In terms of economic value, the average annual harvest value (ex-vessel value) of Chinook salmon caught along the Washington Coast by tribal commercial fishers was $1,201,946, and by non-tribal commercial fishers was $1,457,827 (Table 3-18). The average annual harvest value of coho salmon caught in non-tribal commercial fisheries along the coasts of Oregon and Washington combined was $165,308 (Table 3-18). Based on the non-tribal and tribal harvest identified in Table 3-16 and Table 3-17 and on net economic value factors identified in Appendix J, the net income associated with the annual average harvest of salmon along the Oregon and Washington coasts for non-tribal commercial fishers was $968,400, and for tribal commercial fishers was $781,700.

TABLE 3-16. HISTORICAL (2002 THROUGH 2009) SALMON CATCH IN NON-TRIBAL PACIFIC OCEAN AND PUGET SOUND FISHERIES SUPPORTED BY COLUMBIA RIVER STOCKS.

	Non-tribal Commercial Fisheries (number of fish)								
Economic Impact Region/Species	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Annual Average**
Oregon Coast (Astoria[1])									
Chinook Salmon	12,797	10,384	3,118	10,085	10,489	1,443	5,434	712	6,808
Coho Salmon	1,515	6,441	8,839	2,618	1,414	11,553	435	12,688	5,688
TOTAL	**14,312**	**16,825**	**11,957**	**12,703**	**11,903**	**12,996**	**5,869**	**13,400**	**12,496**
Washington Coast									
Chinook Salmon	53,819	56,202	35,372	35,066	16,769	14,268	8,636	12,316	29,056
Coho Salmon	180	8,957	13,293	1,442	1,265	5,886	1,706	20,055	6,598
TOTAL	**53,999**	**65,159**	**48,665**	**36,508**	**18,034**	**20,154**	**10,342**	**32,371**	**35,654**
Puget Sound/Strait of Juan de Fuca									
Chinook Salmon	13,019	4,469	1,576	2,572	4,521	2,145	2,203	2,808	4,164
Coho Salmon	24,386	17,619	39,070	19,422	9,605	12,804	6,157	20,313	18,672
TOTAL	**37,405**	**22,088**	**40,646**	**21,994**	**14,126**	**14,949**	**8,360**	**23,121**	**22,836**
British Columbia									
Chinook Salmon	211,577	289,183	336,345	318,420	262,341	176,156	147,317	133,661	234,375
Coho Salmon	0	0	0	5,989	2,399	1,424	N/A[2]	N/A	3,271
TOTAL	**211,577**	**289,183**	**336,345**	**324,409**	**264,740**	**177,580**	**147,317**	**133,661**	**237,646**
Southeast Alaska									
Chinook Salmon	292,450	311,300	354,941	316,667	287,100	265,287	138,023	181,420	268,398
Coho Salmon	-	-	-	-	-	-	-	-	-
TOTAL	**292,450**	**311,300**	**354,941**	**316,667**	**287,100**	**265,287**	**138,023**	**181,420**	**268,398**
CHINOOK SALMON	**583,662**	**671,538**	**731,352**	**682,810**	**581,220**	**459,299**	**301,613**	**330,917**	**542,801**
COHO SALMON	**26,081**	**33,017**	**61,202**	**29,471**	**14,683**	**31,667**	**8,298**	**53,056**	**34,229**
TOTAL	**609,743**	**704,555**	**792,554**	**712,281**	**595,903**	**490,966**	**309,911**	**383,973**	**577,030**

Sources: Catch data for the Oregon and Washington Coasts are from PFMC (2003, 2004, 2005, 2006, 2007, and 2011). Catch data for Puget Sound/Strait of Juan de Fuca are from PSMFC (2008). Catch data for British Columbia and Southeast Alaska are from PSC (2003, 2004, 2005, 2006, 2007, 2008, 2009, and 2011).

[1] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook salmon and coho salmon commercial ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

[2] N/A means data not available.

Note: Catch values reported in this table are for all stocks, not just Columbia River Basin stocks.

TABLE 3-17. HISTORICAL (2002 THROUGH 2009) SALMON CATCH IN TRIBAL PACIFIC OCEAN AND PUGET SOUND FISHERIES SUPPORTED BY COLUMBIA RIVER STOCKS.

ECONOMIC IMPACT REGION/SPECIES	TRIBAL FISHERIES (NUMBER OF FISH)								
	2002	2003	2004	2005	2006	2007	2008	2009	ANNUAL AVERAGE
Washington Coast									
Chinook Salmon	38,451	35,141	42,627	37,439	27,888	21,843	18,323	6,050	28,470
Coho Salmon	17,502	11,125	62,305	24,041	31,945	38,513	13,637	52,787	31,481
TOTAL	**55,953**	**46,266**	**104,932**	**61,480**	**59,833**	**60,356**	**31,960**	**58,837**	**59,951**
Puget Sound/Strait of Juan de Fuca									
Chinook Salmon	31,685	25,171	53,998	39,431	42,463	48,226	42,886	44,799	41,082
Coho Salmon	123,522	121,674	317,161	184,156	140,670	124,619	145,963	221,642	172,425
TOTAL	**155,207**	**146,845**	**371,159**	**223,587**	**183,133**	**172,845**	**188,849**	**266,441**	**213,507**
British Columbia									
Chinook Salmon	-[1]	-	-	-	-	-	-	-	-
Coho Salmon	-	-	-	-	-	-	-	-	-
TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Southeast Alaska									
Chinook Salmon	-	-	-	-	-	-	-	-	-
Coho Salmon	-	-	-	-	-	-	-	-	-
TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CHINOOK SALMON	**70,136**	**60,312**	**96,625**	**76,870**	**70,351**	**70,069**	**61,209**	**50,849**	**69,552**
COHO SALMON	**141,024**	**132,799**	**379,466**	**208,197**	**172,615**	**163,132**	**159,600**	**274,429**	**203,906**
TOTAL	**211,160**	**193,111**	**476,091**	**285,067**	**242,966**	**233,201**	**220,809**	**325,278**	**273,458**

Sources: Catch data for the Oregon and Washington Coasts are from PFMC (2003, 2004, 2005, 2006, 2007, and 2011). Catch data for Puget Sound/Strait of Juan de Fuca are from PSMFC (2008).
[1] Dashes mean data not available or unreported because no effects from Mitchell Act actions are expected.

Note: Catch values reported in this table are for all stocks, not just Columbia River Basin stocks.

TABLE 3-18. AVERAGE ANNUAL (2002 THROUGH 2009) CATCH AND COMMERCIAL EX-VESSEL VALUE FOR TRIBAL AND NON-TRIBAL COMMERCIAL FISHERIES FOR THE PACIFIC OCEAN AND PUGET SOUND.

	Tribal		Non-tribal Commercial	
Economic Impact Region	**Average Catch (Number of Fish)[1]**	**Ex-vessel Value ($)[2]**	**Average Catch (Number of Fish)[1]**	**Ex-vessel Value ($)[2]**
California Coast				
Chinook Salmon	-	-	-	-
Coho Salmon	-	-	-	-
TOTAL	**-**	**-**	**-**	**-**
Oregon Coast (Astoria[3])				
Chinook Salmon	0	0	6,808	361,859
Coho Salmon	0	0	5,688	78,221
TOTAL	**0**	**0**	**12,496**	**440,080**
Washington Coast				
Chinook Salmon	28,470	1,201,946	29,056	1,457,827
Coho Salmon	31,481	335,178	6,598	87,087
TOTAL	**59,951**	**1,537,124**	**35,654**	**1,544,914**
Puget Sound/Strait of Juan de Fuca				
Chinook Salmon	41,082	879,988	4,164	89,194
Coho Salmon	172,425	1,846,697	18,672	199,980
TOTAL	**213,507**	**2,726,685**	**22,836**	**289,174**
British Columbia				
Chinook Salmon	-	-	234,375	13,798,782
Coho Salmon	-	-	3,271	25,089
TOTAL	**-**	**-**	**237,646**	**13,823,870**
Southeast Alaska				
Chinook Salmon	-	-	268,398	13,003,266
Coho Salmon	-	-	0	0
TOTAL	**-**	**-**	**268,398**	**13,003,266**
CHINOOK SALMON	**69,552**	**2,081,934**	**542,801**	**28,710,928**
COHO SALMON	**203,906**	**2,181,875**	**34,229**	**390,377**
TOTAL	**273,458**	**4,263,809**	**577,030**	**29,101,304**

Sources: Average catch estimates are 2002 through 2009 historical averages (Table 3-16 and Table 3-17). See Appendix J for a description of how ex-vessel values were derived.

[1] Catch values reported in this table are for all stocks, not just Columbia River Basin stocks.

[2] All dollar values are expressed in 2009 dollars.

[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook and coho salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

3.3.6 Recreational Harvest and Economic Value

3.3.6.1 Columbia River Basin

The recreational fishery on the mainstem Columbia River below Bonneville Dam includes two main management areas: the mainstem Columbia River extending from Bonneville Dam downstream to the Tongue Point/Rocky Point line, and the Buoy 10 area extending from below the Tongue Point/Rocky Point line to Buoy 10, which marks the ocean/in-river boundary. About 53 percent (161,313 fish) of the annual (2002 through 2009) average recreational harvest of salmon and steelhead in the Columbia River Basin (305,168 fish) occurred in the Lower Columbia River and tributaries (Table 3-19). This percentage was previously reported to be 80 percent in the final EIS for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin (NMFS 2003), but recent data show that the percentage has decreased. The recreational fisheries above Bonneville Dam, which account for the remainder of the harvest, are geographically widespread, but socially important. Much of the recreational harvest in both the lower and upper Columbia River occurs in tributaries (NMFS 2003).

According to NMFS (2003), the Cowlitz, Lewis, Kalama, and Elochoman Rivers in Washington and the Willamette, Sandy, and Santiam Rivers in Oregon account for approximately 45 percent of the Lower Columbia River Basin salmon and steelhead harvest. Above Bonneville Dam, the Klickitat, White Salmon, and Little White Salmon tributaries in Washington, the Deschutes in Oregon, and other tributaries account for approximately 60 percent of the salmon and steelhead harvest. The Snake River and its main tributaries, the Clearwater and Salmon, account for 35 percent of the upriver steelhead harvest from the Columbia River system (NMFS 2003).

Recent harvest and trends in recreational fisheries in the Columbia River Basin are shown in Table 3-20. Within the lower Columbia River economic impact region, about 54 percent (86,533 fish) of the total salmon and steelhead harvest (161,313 fish) occurred in the terminal areas (Table 3-20). Recreational fisheries in the mainstem accounted for about 28 percent (45,747 fish) of the total harvest in the lower Columbia River economic impact region, and Buoy 10 fisheries accounted for about 18 percent (29,033 fish) (Table 3-20). Overall, Chinook salmon is the dominant species caught by recreational anglers in the lower Columbia River economic impact region (accounting for 48 percent [77,497 fish] of all salmon and steelhead harvested), although harvest of steelhead and coho contribute to much of the catch in the terminal areas (Table 3-20).

TABLE 3-19. AVERAGE ANNUAL (2002 THROUGH 2009) CATCH, NUMBER OF TRIPS, AND TRIP EXPENDITURES FOR RECREATIONAL FISHERIES FOR THE COLUMBIA RIVER BASIN.

ECONOMIC IMPACT REGION/SPECIES	AVERAGE CATCH (NUMBER OF FISH)	NUMBER OF TRIPS	TRIP EXPENDITURES ($)[1]
Lower Columbia River			
Chinook Salmon	77,497	373,089	30,604,491
Coho Salmon	43,629	181,788	14,912,070
Steelhead	40,187	211,511	17,350,247
TOTAL	**161,313**	**766,388**	**62,866,808**
Mid Columbia River			
Chinook Salmon	17,889	84,674	7,053,375
Coho Salmon	15,920	66,333	5,525,567
Steelhead	23,243	122,332	10,190,221
TOTAL	**57,052**	**273,339**	**22,769,163**
Upper Columbia River			
Chinook Salmon	9,076	46,168	3,845,829
Coho Salmon	0	0	0
Steelhead	1,741	9,163	763,291
TOTAL	**10,817**	**55,332**	**4,609,120**
Lower Snake River			
Chinook Salmon	7,660	40,316	3,358,305
Coho Salmon	0	0	0
Steelhead	68,326	359,611	29,955,557
TOTAL	**75,986**	**399,926**	**33,313,862**
CHINOOK SALMON	**112,122**	**544,247**	**44,862,000**
COHO SALMON	**59,549**	**248,121**	**20,437,637**
STEELHEAD	**133,497**	**702,617**	**58,259,316**
TOTAL	**305,168**	**1,494,985**	**123,558,953**

Sources: Average catch estimates are based on 2002 through 2009 historical averages and modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team for Alternative 1 (Table 3-20). See Appendix J for how the number of trips and trip expenditures was derived.

[1] All dollar values are expressed in 2009 dollars.

In the mid Columbia River economic impact region, steelhead dominates the recreational harvest in the mainstem, but Chinook salmon is more important in the terminal areas (Table 3-20). Chinook salmon is important in the upper Columbia River recreational fisheries, and steelhead dominates the harvest in the lower Snake River economic impact region (Table 3-20). An average of 68,326 steelhead were estimated to have been caught annually in the Lower Snake River recreational fisheries. Steelhead account for about 45 percent (139,507 fish) of all salmon and steelhead caught in recreational fisheries in the Columbia River Basin (311,252 fish) (Table 3-20).

Table 3-20. Columbia River Basin In-river Historical (2002 through 2009) Catch for Recreational Fisheries.

	Recreational Fisheries (number of fish)								
Economic Impact Region/Area/Species	2002	2003	2004	2005	2006	2007	2008	2009	Annual Average
Lower Columbia River									
Buoy 10									
Chinook Salmon	19,438	16,316	16,016	9,287	1,710	3,776	8,349	5,941	10,104
Coho Salmon	6,205	54,440	15,169	6,878	3,683	8,356	8,573	48,127	18,929
Steelhead	0	0	0	0	0	0	0	0	0
TOTAL	**25,643**	**70,756**	**31,185**	**16,165**	**5,393**	**12,132**	**16,922**	**54,068**	**29,033**
Mainstem (mouth to Bonneville Dam)									
Chinook Salmon	44,674	45,921	43,602	31,512	25,411	16,830	33,127	34,298	34,422
Coho Salmon	3,011	1,145	1,273	586	1,173	881	2,248	3,989	1,788
Steelhead[2]	11,900	9,600	8,800	7,400	10,100	10,700	9,100	8,700	9,537
TOTAL	**59,585**	**56,666**	**53,675**	**39,498**	**36,684**	**28,411**	**44,475**	**46,987**	**45,747**
Terminal Areas									
Chinook Salmon[1]	29,140	32,918	36,665	16,293	19,162	14,743	7,674	11,596	32,971[1]
Coho Salmon	24,400	22,100	12,200	9,900	15,500	23,200	40,100	35,900	22,912
Steelhead[2]	39,300	28,700	47,900	28,100	33,600	15,900	29,100	22,600	30,650
TOTAL	**92,840**	**83,718**	**96,765**	**54,293**	**68,262**	**53,843**	**76,874**	**70,096**	**86,533**
Mid Columbia River									
Mainstem (Bonneville Dam to McNary Dam, and McNary Dam to Highway 395 bridge)									
Chinook Salmon	4,680	6,125	5,216	4,333	3,801	4,292	6,430	4,214	4,886
Coho Salmon[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,916
Steelhead[4]	27,681	18,618	13,309	15,110	20,297	19,085	N/A	N/A	19,017
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**31,819**
Terminal Areas									
Chinook Salmon[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13,003
Coho Salmon[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8,004
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,226
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**25,233**

TABLE 3-20. COLUMBIA RIVER BASIN IN-RIVER HISTORICAL (2002 THROUGH 2009) CATCH FOR RECREATIONAL FISHERIES (CONTINUED).

ECONOMIC IMPACT REGION/AREA/SPECIES	RECREATIONAL FISHERIES (NUMBER OF FISH)								
	2002	2003	2004	2005	2006	2007	2008	2009	ANNUAL AVERAGE
Upper Columbia River									
Chinook Salmon[5]	7,325	6,457	8,082	7,542	4,055	4,614	5,638	6,553	9,076[5]
Coho Salmon	0	0	0	0	0	0	0	0	0
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,741
TOTAL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**10,817**
Lower Snake River									
Chinook Salmon[6]	866	513	1,224	76	190	287	516	515	7,660[6]
Coho Salmon	0	0	0	0	0	0	0	0	0
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	68,326
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**75,986**
CHINOOK SALMON	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**112,122**
COHO SALMON	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**59,623**
STEELHEAD SALMON	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**139,507**
TOTAL	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**311,252**

Source: Catch data, with the exception of steelhead for the mid Columbia economic impact regions, are from Joint Columbia River Management Staff (2011a, 2011b).

1 Catch reported for 2002 to 2009 represents catch of spring Chinook salmon, but does not include catch of fall Chinook salmon. Average annual value for terminal areas of the Lower Columbia River economic impact region is based on reported catch of spring Chinook salmon plus the modeled harvest estimate for fall Chinook salmon developed by the Mitchell Act Fishery Modeling Team for Alternative 1. Therefore, the average of the annual catch over the 2002 to 2009 period does not match the average annual catch shown in the last column.

2 Steelhead catch is harvest of summer steelhead only (lower river and upper river origin fish); no winter steelhead are included.

3 N/A= not available. Average annual values for economic impact regions are based on modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team for Alternative 1.

4 Source for steelhead catch for the mid-Columbia River mainstem: S. Ellis, pers. comm., CRITFC, Harvest Biologist, February 3, 2012.

5 Catch reported for 2002 to 2009 represents catch of fall Chinook salmon in the Hanford Reach and does not include spring and summer Chinook salmon catch in upper Columbia River tributaries. Average annual value for the economic impact region is based on reported catch in the Hanford Reach, plus the modeled harvest estimate for tributary areas developed by the Mitchell Act Fishery Modeling Team for Alternative 1. Therefore, the average catch over the 2002 to 2009 period does not match the average annual catch shown in the last column.

6 Catch reported for 2002 to 2009 represents catch of fall and spring Chinook salmon in the Snake River mainstem and does not include spring and summer Chinook salmon catch in Snake River tributaries. Average annual value for the economic impact region is based on reported catch in the Snake River mainstem, plus the modeled harvest estimate for tributary areas developed by the Mitchell Act Fishery Modeling Team for Alternative 1. Therefore, the average catch over the 2002 to 2009 period does not match the average annual catch shown in the last column.

Based on estimated recreational fishing effort ranging from 4.2 fishing days per fish caught for coho salmon to 5.3 fishing days per fish caught for steelhead (TRG 2009) and per-day, trip-related expenditures ranging from $82.03 to $83.30 (TRG 2009), anglers expended an estimated $123,558,953 in trip-related expenditures to catch the annual average number of salmon and steelhead (305,168 fish) (Table 3-19) taken in recreational fisheries in the Columbia River Basin. Based on the average annual number of salmon and steelhead (305,168 fish) caught and on average net economic values reported in Appendix J, anglers are estimated to have accrued $91.3 million in total annual net economic values, representing anglers' estimated willingness to pay over and above expenditures for these fishing opportunities. Willingness to pay is a concept used to measure the value of a non-market good, such as a recreational fishing experience.

3.3.6.2 Pacific Ocean and Puget Sound

Recreational fishing for salmon in Pacific Coast waters is limited to hook-and-line gear and is conducted mostly from privately owned pleasure craft and charter boats. There is little shore-based (e.g., piers and jetties) angling in the ocean for salmon. Coho salmon and Chinook salmon contribute fairly evenly to recreational salmon fisheries along the West Coast (including Southeast Alaska), with an estimated 224,023 coho salmon and 224,058 Chinook salmon caught annually (Table 3-21). Coho salmon accounts for 97 percent (51,707 fish) of the recreational salmon harvest along the Oregon coast (53,432 fish), 77 percent (81,896 fish) of recreational salmon harvest along the Washington coast (106,880 fish), and 100 percent (743 fish) of recreational salmon harvest along the California coast (Table 3-21). In the Puget Sound/Strait of Juan de Fuca economic impact region, coho salmon accounts for 66 percent (61,219 fish) of the recreational harvest (92,426 fish) (Table 3-21), but few if any of these coho salmon originate from the Columbia River Basin (Table 3-10). Columbia River stocks contribute more substantially to the Puget Sound Chinook salmon recreational fishery although the number of fish is estimated to still be small (6 percent) (Table 3-10). In British Columbia and Southeast Alaska, Chinook salmon recreational fisheries dominate (Table 3-21), and Columbia River stocks contribute substantially to the Southeast Alaska Chinook salmon recreational fisheries (accounting for an estimated 22 percent of the total recreational harvest) (Table 3-10).

TABLE 3-21. HISTORICAL (2002 THROUGH 2009) SALMON CATCH IN RECREATIONAL PACIFIC OCEAN AND PUGET SOUND FISHERIES SUPPORTED BY COLUMBIA RIVER STOCKS.

ECONOMIC IMPACT REGION/SPECIES	RECREATIONAL FISHERIES (NUMBER OF FISH)[1]								
	2002	2003	2004	2005	2006	2007	2008	2009	ANNUAL AVERAGE
California Coast									
Chinook Salmon	-[2]	-	-	-	-	-	-	-	-
Coho Salmon	828	613	1,424	699	1,626	746	0	8	743
TOTAL	**828**	**613**	**1,424**	**699**	**1,626**	**746**	**0**	**8**	**743**
Oregon Coast									
Chinook Salmon (Astoria[2])	2,754	2,330	2,183	3,635	509	594	817	980	1,725
Coho Salmon	36,537	113,659	71,835	13,706	15,577	60,653	12,085	89,606	51,707
TOTAL	**39,291**	**115,989**	**74,018**	**17,341**	**16,086**	**61,247**	**12,902**	**90,586**	**53,432**
Washington Coast									
Chinook Salmon	57,821	34,183	24,907	36,369	10,667	8,944	14,635	12,351	24,984
Coho Salmon	74,134	139,096	112,936	51,770	36,087	83,788	18,870	138,493	81,896
TOTAL	**131,955**	**173,279**	**137,843**	**88,138**	**46,754**	**92,732**	**33,505**	**150,844**	**106,880**
Puget Sound/Strait of Juan de Fuca									
Chinook Salmon	29,562	29,544	25,821	23,433	31,837	49,860	28,577	31,018	31,207
Coho Salmon	66,639	92,002	83,746	58,287	26,750	65,217	21,465	75,649	61,219
TOTAL	**96,201**	**121,546**	**109,567**	**81,720**	**58,587**	**115,077**	**50,042**	**106,667**	**92,426**
British Columbia									
Chinook Salmon	107,089	114,172	129,902	106,599	88,493	107,229	94,056	100,426	105,995
Coho Salmon	11,889	34,589	40,229	41,874	16,834	25,334	-	-	28,458
TOTAL	**118,978**	**148,761**	**170,131**	**148,473**	**105,327**	**132,563**	**94,056**	**100,426**	**134,453**
Southeast Alaska									
Chinook Salmon	64,683	68,852	78,505	70,040	63,500	61,851	25,662	48,089	60,147
Coho Salmon	-	-	-	-	-	-	-	-	-
TOTAL	**64,683**	**68,852**	**78,505**	**70,040**	**63,500**	**61,851**	**25,662**	**48,089**	**60,147**
CHINOOK SALMON	**261,909**	**249,081**	**261,318**	**240,076**	**195,006**	**228,478**	**163,747**	**192,864**	**224,058**
COHO SALMON	**190,027**	**379,959**	**310,170**	**166,336**	**96,874**	**235,738**	**52,420**	**303,756**	**224,023**
TOTAL	**451,936**	**629,040**	**571,488**	**406,412**	**291,880**	**464,216**	**216,167**	**496,620**	**448,081**

Sources: Catch data for the California, Oregon, and Washington Coasts are from PFMC (2003, 2004, 2005, 2006, 2007, and 2011). Catch data for Puget Sound/Strait of Juan de Fuca are from WDFW (2008). Catch data for British Columbia and Southeast Alaska are from PSC (2003, 2004, 2005, 2006, 2007, 2008, 2009, and 2011).

[1] Catch values reported in this table are for all stocks, not just Columbia River Basin stocks.

[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

Based on an estimated range in effort of 0.8 to 1.2 fishing days per fish caught and average spending estimates ranging from $119.70 to $147.52 per day (TRG 2009), anglers incurred an estimated $20,724,018 in trip-related expenditures to catch coho salmon and Chinook salmon (160,312 fish) in recreational fisheries along the Washington and Oregon coasts (Table 3-22). Coho salmon accounts for about 84 percent ($17,451,294) of trip-related recreational expenditures along the Washington and Oregon coasts ($20,724,018) (Table 3-22). For British Columbia and Southeast Alaska, the average recreational catch was 134,453 and 60,147 fish and trip-related expenditures were $21,136,673 and $9,455,404, respectively (Table 3-22).

3.3.7 Regional Economic Conditions

3.3.7.1 Columbia River Basin

Commercial and recreational fisheries generate personal income and support jobs in regional and local economies throughout the Columbia River Basin. Commercial landings of salmon and steelhead are frequently sold directly, or after processing, to persons or businesses located outside the region. The transfer of money to businesses within the region supports payments of wages and other forms of compensation, and that money is then re-spent regionally (i.e., the multiplier effect). Similarly, non-local recreational anglers (i.e., anglers who live outside the local area) spend money on guide services, lodging, and other goods and services within the Columbia River Basin that generate income for local and non-local communities. Last, money spent on hatchery operations and management, which often comes from state or Federal sources located outside the local area, provides an additional infusion of income to local economies.

The estimated amount of personal income and the number of jobs supported in Columbia River Basin economic impact regions by all Columbia River Basin stocks (both hatchery-origin and natural-origin salmon and steelhead) is shown in Table 3-23. These estimates, which total $108,564,946 in personal income and 3,218 jobs, are based on average annual harvest conditions for all salmon and steelhead caught in each economic impact region. The lower Columbia River economic impact region benefits the most from the harvest of salmon and steelhead, accounting for $52,577,674 in personal income generated and supporting about 1,333 jobs. Harvest in the mid-Columbia River economic impact area also generates substantial regional economic effects, estimated at $28,158,598 in personal income and supporting about 841 jobs in that region (Table 3-23).

TABLE 3-22. AVERAGE ANNUAL (2002 THROUGH 2009) CATCH, NUMBER OF TRIPS, AND TRIP EXPENDITURES FOR RECREATIONAL FISHERIES FOR THE PACIFIC OCEAN AND PUGET SOUND.

ECONOMIC IMPACT REGION	AVERAGE CATCH (NUMBER OF FISH)[1]	NUMBER OF TRIPS	TRIP EXPENDITURES ($)[2]
California Coast			
Chinook Salmon	-	-	-
Coho Salmon	743	917	143,014
TOTAL	**743**	**917**	**79,602**
Oregon Coast			
Chinook Salmon (Astoria[3])	1,725	2,104	251,829
Coho Salmon	51,707	63,057	7,548,591
TOTAL	**53,432**	**65,161**	**7,800,420**
Washington Coast			
Chinook Salmon	24,984	20,478	3,020,895
Coho Salmon	81,896	67,128	9,902,703
TOTAL	**106,880**	**87,606**	**12,923,598**
Puget Sound/Strait of Juan de Fuca			
Chinook Salmon	31,207	49,535	3,639,331
Coho Salmon	61,219	97,173	7,139,301
TOTAL	**92,426**	**146,708**	**10,778,632**
British Columbia			
Chinook Salmon	105,995	86,881	16,662,935
Coho Salmon	28,458	23,326	4,473,738
TOTAL	**134,453**	**110,207**	**21,136,673**
Southeast Alaska			
Chinook Salmon	60,147	49,301	9,455,404
Coho Salmon	-	-	-
TOTAL	**60,147**	**49,301**	**9,455,404**
CHINOOK SALMON	**224,058**	**208,299**	**33,030,394**
COHO SALMON	**224,023**	**251,601**	**29,207,347**
TOTAL	**448,081**	**459,900**	**62,237,741**

Source: Average catch estimates are 2002 through 2009 historical averages (Table 3-21). See Appendix J for a description of how number of trips and trip expenditures were derived.

[1] Catch values reported in this table are for all stocks, not just Columbia River Basin stocks

[2] All dollar values are expressed in 2009 dollars.

[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

TABLE 3-23. REGIONAL ECONOMIC EFFECTS OF COLUMBIA RIVER BASIN HATCHERY OPERATIONS AND ASSOCIATED HARVEST.

	HATCHERY OPERATIONS[1]			HARVEST-RELATED EFFECTS[1]	
ECONOMIC IMPACT REGION	**OPERATING COSTS ($)[2]**	**PERSONAL INCOME ($)[2]**	**NUMBER OF JOBS[3]**	**PERSONAL INCOME ($)[2]**	**NUMBER OF JOBS[3]**
Lower Columbia River					
Tribal	-[4]	-	-	0	0.0
Non-tribal commercial	-	-	-	6,232,855	158.0
Recreational	-	-	-	46,344,819	1,174.5
TOTAL	**29,500,000**	**22,728,721**	**455**	**52,577,674**	**1,332.5**
Mid Columbia River					
Tribal	-	-	-	11,629,274	374.4
Non-tribal commercial	-	-	-	0	0.0
Recreational	-	-	-	16,529,324	493.8
TOTAL	**13,300,000**	**10,276,254**	**206**	**28,158,598**	**841.2**
Upper Columbia River					
Tribal	-	-	-	0	0
Non-tribal commercial	-	-	-	0	0.0
Recreational	-	-	-	3,346,001	110.9
TOTAL	**9,200,000**	**7,073,996**	**141**	**3,346,001**	**110.9**
Lower Snake River					
Tribal	-	-	-	298,401	11.4
Non-tribal commercial	-	-	-	0	0.0
Recreational	-	-	-	24,184,272	922.4
TOTAL	**31,200,000**	**24,009,550**	**480**	**24,482,673**	**933.8**
TOTAL (ALL ECONOMIC IMPACT REGIONS)	**83,200,000**	**64,088,521**	**1,282**	**108,564,946**	**3,218.4**

[1] Source: Hatchery operation costs, which include related weir operation costs, are from Table 4-85, and the number of jobs was estimated using jobs per million dollars of production cost factors described in Appendix J. Harvest-related effects on personal income and jobs are based on average annual harvest estimates (Table 3-13, Table 3-14, Table 3-16, Table 3-17, and Table 3-20) and on application of personal income and jobs factors identified in Appendix J.

[2] All dollar values are expressed in 2009 dollars.

[3] Jobs are expressed in full- and part-time jobs.

[4] Dashes mean unknown because funding for hatchery operations is not allocated among user groups.

Hatchery operations (including related ongoing weir operations) in the Columbia River Basin also generate direct, indirect, and induced economic effects within the basin's four economic impact regions, as shown in Table 3-23. Hatchery production spending on labor and procurement of goods and services is estimated to generate a total of $64,088,521 in personal income and about 1,282 jobs in the basin (Table 3-23). Hatchery-generated economic activity is greatest in the lower Snake River economic impact region, where $24,009,550 in personal income and 480 jobs are estimated to be supported by hatchery operations (Table 3-23). Economic activity is similar in the lower Columbia River economic impact region, where $22,728,721 in personal income and 455 jobs are estimated to be supported by hatchery operations (Table 3-23).

3.3.7.2 Pacific Ocean and Puget Sound

Columbia River stocks support fisheries that contribute generate personal income and support jobs in affected economic impact regions and local economies throughout the Columbia River Basin and Pacific Coast. However, unlike the Columbia River Basin, economic impact regions and local economies outside the Columbia River Basin (that are within the Pacific Ocean and Puget Sound) are generally more dependent on fish originating from their local river systems, even though Columbia River stocks contribute to the fisheries. Fisheries that affect the Oregon and Washington Coasts, however, are exceptions. As shown in Table 3-10, fisheries in these areas depend substantially on Columbia River Basin stocks. The amount of personal income and the number of jobs supported in these economic impact regions by all salmon and steelhead stocks (not just Columbia River Basin stocks) is as follows:

- Average annual harvest of salmon in commercial and recreational fisheries along the Washington coast generates $13,199,490 in personal income and supports an estimated 389 jobs.
- Commercial and recreational salmon fisheries along the Oregon coast generate $4,231,696 in personal income and 126 jobs.

These reported values for personal income and jobs on the Washington and Oregon coasts represent average annual conditions over the 2002 through 2009 period. These numbers, therefore, do not match the modeled values for Alternative 1 in Section 4.3, Socioeconomics. Additional socioeconomic and demographic information for western U.S. coast fishing communities can be found on the NMFS Northwest Fisheries Science Center website at: http://www.nwfsc.noaa.gov/research/divisions/sd/communityprofiles/index.cfm.

3.4 Environmental Justice

3.4.1 Introduction

EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." See the following website for more information on environmental justice:

(http://www.epa.gov/compliance/basics/ejbackground.html).

Under Executive Order (E.O.) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, EPA states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Further, EPA guidance recommends that the environmental justice analysis also determine whether such populations or communities have been sufficiently involved in the decision-making process (EPA 1998).

Generally, minority and low-income target populations are defined as follows:

- **Minority** – All people of the following origins: Black, Asian, American Indian and Alaska Native, Native Hawaiian or Other Pacific Islander, and Hispanic (considered an ethnic and cultural identity and not the same as race)
- **Low income** – Persons whose household income is at or below the U.S. Department of Health and Human Services poverty guidelines (EPA 1998)

As it pertains to environmental justice, the affected environment presented in this section includes an overview of policy and regulatory considerations, the analysis area for environmental justice, a description of methodology for conducting the environmental justice analysis, identification of communities and groups of concern for the analysis based on existing demographic data and established thresholds, and a summary of the public outreach process. In Section 4.4, Environmental Justice, the analysis of environmental justice effects is based on changes in selected indicators that affect communities and groups of concern.

3.4.2 Analysis Area

The analysis area for environmental justice includes the project area (Section 2.2, Description of Project Area), plus the following areas: 1) coastal areas of Washington, Oregon, and California;

2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska. The analysis area for environmental justice is the same as the analysis area for socioeconomics (Figure 3-1). The analysis area includes areas outside the project area because salmon and steelhead that are produced within the project area can migrate outside the project area and contribute to fisheries in these areas. Changes in salmon and steelhead fisheries may lead to environmental justice effects.

Most of the environmental justice information presented in this section is at the county level. However, for consistency with the socioeconomic conditions presented in Section 3.3 (Socioeconomics), and the related analysis in Section 4.3 (Socioeconomics), information is generally presented and discussed by economic impact region.

3.4.3 Environmental Justice Methodology

The environmental justice methodology considers the range of analytical procedures identified in EPA's guidelines on environmental justice analysis (EPA 1998), particular circumstances related to the affected economic impact regions, and alternative approaches available to evaluate environmental justice issues for Federal fishery management programs and projects in the Pacific Northwest.

3.4.3.1 Approach for Identifying Environmental Justice User Groups and Communities of Concern

The methodology used to identify potentially affected environmental justice user groups and communities of concern is outlined below. Environmental justice user groups and communities of concern are identified in Washington, Oregon, California, and Idaho in order to analyze the effects on selected indicators of environmental justice effects (Section 3.4.2, Analysis Area). Potentially affected user groups and communities of concern in British Columbia, Canada, and Southeast Alaska are primarily tribes, which were considered, but were not analyzed further. The inability to assess environmental justice effects on tribal communities in these areas was based on the lack of available information on the commercial marine salmon harvest allocation between non-tribal and tribal communities within the British Columbia, Canada, and Southeast Alaska regions. Because this allocation cannot be reliably assessed due to a lack of data distinguishing non-tribal and tribal harvest allocations, an assessment of environmental justice effects specific to tribal communities in these areas was not possible. The analyses of environmental justice effects included the following six steps.

Step 1: Establish the Target Area. Environmental justice analyses are conducted by target areas. The target area is the geographical study area that is potentially affected by the Proposed Action or EIS alternatives. For this assessment, the target area is similar to the analysis area (Section 3.4.2, Analysis Area), except that the two most distant economic impact regions (British Columbia and Southeast Alaska) are not included. A complete list of the counties comprising the target area, organized by economic impact region, is presented in Table 3-24.

Identifying effects on environmental justice user groups and communities of concern in British Columbia and Southeast Alaska was considered to be speculative because demographic information on the location and the extent of potentially affected fishery participants in these areas is limited. Additionally, it appears that fish produced at Columbia River hatcheries make relatively small or even negligible contributions to the tribal and personal use catch of salmon in the areas (G. Blair, pers. comm., ICF International, Senior Fisheries Biologist, June 5, 2009). As a result of these and other information constraints, this EIS did not include user-group-specific fisheries to analyze potential harvest effects in these areas (Appendix K, Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS). For these reasons, Southeast Alaska and British Columbia are not considered part of the target area for analysis of environmental justice effects and are not discussed further in the analysis.

Step 2: Identify the Population Areal Unit. A population areal unit is the geopolitical unit containing populations that, in aggregate, define the target area. When analyzing environmental justice effects at the regional scale, the population areal unit used is mostly the county for the Columbia River Basin economic impact regions. However, when assessing distinct user groups, sub-economic impact regions may be considered. For commercial fish harvesters and processors, the population areal units are the affected fishing ports and communities where these user groups are concentrated. Along the Pacific coast, the areas included are Neah Bay, La Push, Westport, and Ilwaco in Washington; Astoria, Tillamook, Newport, Coos Bay, and Brookings in Oregon; and Crescent City, Eureka, Fort Bragg, San Francisco, and Monterey in California. In the inland areas of the lower Columbia River, the commercial fishing fleet is concentrated in the smaller ports of St. Helens-Rainier, Clatskanie, and Dodson, Oregon, and the Washington communities of Cathlamet, Skamokawa, Kalama, Longview, and Vancouver (inland fishing communities were identified based on information presented in NMFS [2003]). For additional information on fishing communities in the target area, see NMFS (2003) and NMFS (2009). For Native American tribes, the population areal unit is the reservation.

TABLE 3-24. ECONOMIC IMPACT REGIONS AND MAJOR COUNTIES AND RESERVATIONS WITHIN THE TARGET AREA.

ECONOMIC IMPACT REGION	COUNTY (STATE)	NATIVE AMERICAN RESERVATION
Lower Columbia River	Benton (OR), Clackamas (OR), Clatsop (OR)[1], Columbia (OR), Lane (OR), Linn (OR), Marion (OR), Multnomah (OR), Polk (OR), Washington (OR), Yamhill (OR), Clark (WA), Cowlitz (WA), Lewis (WA), Pacific (WA)[1], Wahkiakum (WA)	Grand Ronde Reservation
Mid Columbia River	Crook (OR), Deschutes (OR), Gilliam (OR), Grant (OR), Hood River (OR), Jefferson (OR), Morrow (OR), Sherman (OR), Umatilla (OR), Wasco (OR), Wheeler (OR), Benton (WA), Franklin (WA), Grant (WA), Klickitat (WA), Skamania (WA), Walla Walla (WA)	Warm Springs and Umatilla Reservations
Upper Columbia River	Chelan (WA), Douglas (WA), Kittitas (WA), Okanogan (WA), Yakima (WA)	Yakama and Colville Reservations
Lower Snake River	Adams (ID), Clearwater (ID), Custer (ID), Idaho (ID), Latah (ID), Lemhi (ID), Lewis (ID), Nez Perce (ID), Shoshone (ID), Valley (ID), Union (OR), Wallowa (OR), Asotin (WA), Columbia (WA), Garfield (WA), Whitman (WA)	Nez Perce Reservation
Washington Coast	Clallam (WA), Grays Harbor (WA), Jefferson (WA), Pacific (WA)[1]	
Oregon Coast	Clatsop (OR)[1], Coos (OR), Curry (OR), Lincoln (OR), Tillamook (OR)	
California Coast	Del Norte (CA), Humboldt (CA), Mendocino (CA), Monterey (CA), San Francisco (CA)	
Puget Sound/Strait of Juan de Fuca	Regional analysis of tribal ceremonial and subsistence effects only	

[1] Included in two economic impact regions.

Note: Economic impact regions are included in this table so that the reader can cross-reference between Section 3.3 (Socioeconomics) and Section 3.4 (Environmental Justice). However, the geographic scale of a multicounty economic impact region is considered too large for conducting a quantitative-based analysis of environmental justice effects.

Step 3: Identify the Target Population. The target population includes the potentially affected residents of each county, port, community, or reservation. Because this EIS analyzes hatchery management activities in the Columbia River Basin that affect fish harvests, the primary target populations for analysis are the non-tribal commercial and sport fishers and tribal members harvesting these stocks. Once salmon are landed, there may be secondary effects on people within the target area, such as fish processors (commercial harvests), recreation-serving business operators (recreational harvests), and tribal members who consume the salmon harvested.

Step 4: Identify the Reference Area. A reference area is the area used as a benchmark of comparison when identifying whether a target population has minority or low-income populations that may be subject to disproportionate environmental and economic effects, thereby warranting further consideration in the context of environmental justice. The reference areas for this analysis are the states where each county, fishing port, community, or reservation is located. The states include Washington, Oregon, Idaho, and California.

Step 5: Establish Thresholds to Identify Environmental Justice User Groups and Communities of Concern. Quantitative thresholds were established to determine whether a target area has a significantly higher minority or low-income population relative to the reference area. The environmental justice thresholds used in this analysis are described in Section 3.4.3.2, Environmental Justice Thresholds.

Step 6: Identify Environmental Justice User Groups and Communities of Concern. In this step, socio-demographic data for target populations and applicable reference areas were compared to the thresholds established in Step 5. If the affected population within a target area had minority or low-income populations exceeding the thresholds, the population was identified as an environmental justice user group or community of concern. The environmental justice user groups and communities of concern were evaluated in more detail in the impact analyses to determine if, and to what extent, they would experience disproportionate environmental and economic effects.

3.4.3.1.1 Environmental Justice Approach for Native American Tribes

EPA guidance regarding environmental justice extends beyond statistical threshold analyses to consider explicit environmental justice effects on Native American tribes (EPA 1998). Federal duties under the Environmental Justice Executive Order, the presidential directive on government-to-government relations, and the trust responsibility to Indian tribes may merge when the action proposed by EPA or another Federal agency potentially affects the natural or physical environment of a tribe. The natural or physical environment of a tribe may include resources reserved by treaty or lands held in trust; sites of special cultural, religious, or archaeological importance, such as those protected under the National Historic Preservation Act or the Native American Graves Protection and Repatriation Act; and other areas reserved for hunting, fishing, and gathering (usual and accustomed), which may include ceded lands that are not within reservation boundaries. Potential effects of concern may include ecological, cultural, human health, economic, or social impacts when those impacts correlate with impacts on the natural or physical environment (EPA 1998).

A number of Native American tribes either have treaty fishing rights or otherwise demonstrated historic linkages with fishery management in the analysis area. Based on the close relationship between fishery management and the welfare of Native American populations, all tribes potentially affected by the EIS alternatives were considered an environmental justice group of concern, and accordingly, tribal effects were a specific focus of the environmental justice analysis.

3.4.3.1.2 Environmental Justice Approach for Non-tribal User Groups and Communities

When determining whether affected user groups are an environmental justice group of concern, the demographic characteristics specific to these groups must be considered. For this analysis, two key non-tribal user groups could be affected by hatchery management: 1) commercial fishers and processors and 2) recreational anglers and support businesses. The prevalence of significant minority and low-income populations among commercial fishers and processors in the economic impact regions requires demographic data for those groups that are not readily available. Consequently, available data for coastal fishing communities in Washington, Oregon, and California were used as a proxy for the demographic makeup of these user groups and compared to the environmental justice thresholds presented in Section 3.4.3.2, Environmental Justice Thresholds.

For recreational anglers, demographic data are also limited and available only at the state level. For this group, demographic data were obtained from the *2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (USFWS 2014). In this study, race and ethnicity data were organized based on four minority groups: Black, Asian, Other, and Hispanic. Further, income-related data were presented based on income brackets, rather than poverty rates or per capita income levels. As a result, the methodology used for recreational anglers in this analysis deviates slightly from the approach used to assess other potential groups or communities of concern.

For recreational anglers, two minority categories were used: percent non-white and percent Hispanic. The minority percentages for recreational anglers within a particular state were compared to the corresponding values for the general population in that same state (i.e., reference area) to determine if these groups were an environmental justice group of concern. Due to the organization of the USFWS (2014) income data, determining whether recreational anglers are classified as low-income populations was based on comparing the percentage of recreational anglers in the two lowest income brackets (less than $10,000 annually and $10,000 to $20,000 annually) relative to the annual income of the state's population. If the percentage of recreational anglers in these two low-income brackets was higher than the corresponding state value, then the group was identified as an environmental justice group of concern. Potential environmental justice effects on recreational support businesses were considered as part of the assessment of county-wide local income effects.

3.4.3.2 Environmental Justice Thresholds

The Council on Environmental Quality (CEQ) established guidance on defining minority and low-income areas in *Environmental Justice Guidance under the National Environmental Policy Act (*CEQ 1997). CEQ's guidance states the following:

> Minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis. .. The selection of the appropriate unit of geographical analysis may be a governing body's jurisdiction, a neighborhood, a census tract, or other similar unit that is chosen so as not to artificially dilute or inflate the affected minority population (CEQ 1997).

CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations.

For this study, the approach used to identify environmental justice areas and groups of concern was based on the determination of whether minority and low-income populations in affected counties (Table 3-24) and across user groups were *meaningfully greater* than the reference population (i.e., states where each county, fishing port, community, and/or reservation is located). Five minority and low-income categories were considered in the analysis: 1) percent non-white population, 2) percent Native American population, 3) percent Hispanic population, 4) per capita income, and 5) poverty rate. Based on ethnicity data from the 2010 census (U.S. Census Bureau, 2010 Census, 2011) and economic data from the U.S. Census Bureau's American Community Survey 5-year estimates (2005 to 2009) database (U.S. Census Bureau, 2005-2009 American Community, 2011), thresholds for each of the environmental justice categories were established and used to determine if the proportion of minority or low-income populations characterizing an affected county or user group was sufficiently different from these same populations within the reference area.

Table 3-25 shows the total population, number of counties, and threshold values for the five environmental justice categories for each of the four reference areas used in the analysis. These reference areas were established so that environmental justice user groups and communities of concern could be identified (Section 3.4.3.1, Approach for Identifying Environmental Justice

User Groups and Communities of Concern). The reference areas are the states of Washington, Oregon, California, and Idaho. Based on these threshold values for each area, counties and user groups in the affected economic impact regions with minority populations or poverty rates that exceed the threshold values for each group or community were determined to be environmental justice user groups or communities of concern.

3.4.3.2.1 Native American Tribal Thresholds

As indicated above in Section 3.4.3.1.1, Environmental Justice Approach for Native American Tribes, all Native American tribes with a vested interest in fishery management along the Columbia River qualify as environmental justice communities of concern, as do other affected tribes in the Columbia River Basin and Puget Sound/Strait of Juan de Fuca regions. While individual tribes may not meet traditional environmental justice analysis thresholds for minority or low-income populations, they are, nonetheless, regarded as affected groups for environmental justice purposes by defined EPA guidance (EPA 1998).

TABLE 3-25. ENVIRONMENTAL JUSTICE THRESHOLDS FOR REFERENCE AREAS.

			Threshold Values[1]				
Reference Area (State)	Total Population	Number of Counties	Non-white (%)	Native American (%)	Hispanic (%)	Poverty Rate (%)	Per Capita Income (2009 $)
California	37,253,956	58	42.5	2.8	47.7	18.0	20,300
Idaho	1,567,582	44	19.3	2.2	23.9	16.2	17,940
Oregon	3,831,074	36	20.9	2.5	15.7	17.3	20,320
Washington	6,724,540	39	23.7	3.7	18.7	19.1	20,480

Sources: U.S. Census Bureau, 2010 Census, Table DP-1: Profile of General Population and Housing Characteristics—2010 Demographic Profile; U.S. Census Bureau, 2005-2009 American Community Survey, Table B17001: Poverty Status in the Past 12 Months by Sex by Age, Table B19301: Per Capita Income in the Past 12 Months (in 2009 Inflation Adjusted Dollars)

.[1] Thresholds for each category were developed by ranking all of the counties comprising the state serving as the reference area and identifying the value constituting the minimum of the highest quintile (top twentieth percentile) for percent non-white, percent Native American, percent Hispanic, and percent of households below the poverty line; conversely, the value constituting the maximum of the bottom quintile was used for per capita income.

3.4.3.2.2 Minority Thresholds

The minority threshold values for non-white populations ranged from 19.3 percent of the population in Idaho to 42.5 percent of the population in California. For Native American populations, the minority thresholds ranged from 2.2 percent of the population in Oregon to 3.7 percent of the population in Washington. Last, the threshold values for Hispanic populations ranged from 15.7 percent of the population in Idaho to 47.7 percent of the population in California (Table 3-25).

3.4.3.2.3 Low-income Thresholds

Environmental justice thresholds for low-income populations were based on poverty rates and annual per capita income levels. For poverty rates, threshold values ranged from 16.2 percent of the population being below the poverty rate in Idaho to 19.1 percent in Washington. For annual per capita income, the threshold value was lowest in Idaho at $17,940 and highest in Washington at $20,480 (Table 3-25).

3.4.4 Environmental Justice Populations Reviewed

Using the methodology outlined in Section 3.4.3, Environmental Justice Methodology, 37 communities and 11 user groups (in addition to Native American tribes), were identified as environmental justice concerns and were carried forward for further analysis as part of the environmental justice impact assessment in Section 4.4, Environmental Justice. Summaries of potentially affected communities and groups are presented in the following sections. Native American tribes of concern are discussed first, followed by a discussion of non-tribal user groups and communities of concern.

3.4.4.1 Native American Tribes of Concern

The EIS alternatives may affect eight groups of Native Americans within the Columbia River Basin: the Nez Perce Tribe, Confederated Tribes of Umatilla Indian Reservation, Confederated Tribes of Warm Springs, Yakama Nation, Confederated Tribes of the Colville Reservation, Cowlitz Indian Tribe, Confederated Tribes of the Grand Ronde, and Shoshone-Bannock Tribes. Below is a brief overview of each tribal group obtained from NMFS (2003), from tribal websites, or through personal communication (refer to Figure 3-2 for the mapped location of tribal reservations).

- **Nez Perce Tribe.** The Nez Perce Indian Reservation contains 770,000 acres in north-central Idaho. The Nez Perce Tribe, in its 1855 Treaty with the United States, reserved "[t]he exclusive right of taking fish in all the streams where running through or bordering said reservation is further secured to said Indians; as also the right of taking fish at all usual and accustomed places in common with citizens of the Territory..." 12 Stat. 957. Salmon and steelhead are central to the tribe's culture, spiritual beliefs, economics, and way of life. The tribe is committed to rebuilding salmon and steelhead to healthy, harvestable levels and fairly sharing the conservation burden so that they may fully exercise their right to take fish at all usual and accustomed fishing places. The tribe currently conducts ceremonial, subsistence, and commercial fisheries in the mainstem

Columbia "Zone 6" fishery and at its usual and accustomed fishing places throughout most of the Columbia and Snake River Basin (M. Oatman, pers. comm., Nez Perce Tribe, Chairman, Tribal Executive Committee, December 2, 2010).

- **Confederated Tribes of the Umatilla Indian Reservation.** Three tribes make up the Confederated Tribes of the Umatilla Indian Reservation: Cayuse, Umatilla, and Walla Walla. The Umatilla Indian Reservation is approximately 172,000 acres, comprising about 8 percent of Umatilla County, Oregon. There are an estimated 2,800 tribal members. Approximately half of the tribal members live on or near the reservation, in conjunction with about 300 American Indians from other tribes and 1,500 non-American Indians. Salmon and steelhead fishing remains the foundation of the tribe's culture and religion. The tribe typically harvests spring, summer, and fall Chinook salmon; coho salmon; sockeye salmon; and steelhead (NMFS 2003).

  Tribal members fish in the Columbia River and its tributaries located in southeastern Washington and northeastern Oregon. Approximately 30 tribal members conduct commercial fishing activities for about 60 days each year, typically in Zone 6 (between Bonneville and McNary Dams) of the Columbia River, harvesting Chinook salmon in the fall, and steelhead and sturgeon in the winter. In addition, as many as 100 tribal members participate in ceremonial and subsistence fisheries (NMFS 2003).

- **Confederated Tribes of Warm Springs.** Three tribes make up the Confederated Tribes of Warm Springs: the Warm Springs, Wasco, and Paiute Tribes. The Warm Springs Indian Reservation covers more than 641,000 acres in parts of Jefferson and Wasco Counties, Oregon. It is characterized by both forest and rangeland. The tribe has 3,755 members; approximately 3,200 members live on the reservation along with 460 non-members (NMFS 2003).

  Salmon and steelhead fishing is important to the way of life of the Warm Springs Tribes. Tribal harvests typically occur from March through October and include spring, summer, and fall Chinook salmon, sockeye salmon, and steelhead. Tribal members fish primarily in Zone 6 of the Columbia River, the Deschutes River, and the Willamette River, with some additional harvests in the Hood and John Day Rivers. Warm Springs Tribe members share the Columbia River with the Yakama Nation, Confederated Tribes of Umatilla, and Nez Perce Tribe. They share the John Day River with the Confederated Tribes of Umatilla. Approximately 15 tribal members conduct commercial fishing activities for fall Chinook salmon in Zone 6 (between Bonneville and McNary Dams) of the Columbia River. Further, several hundred tribal members conduct ceremonial and subsistence harvests in the Columbia and Deschutes Rivers. Tribal members conduct ceremonial and subsistence fishing activities regularly over a 6-month period and intensively for 4 to 6 weeks within that period (NMFS 2003).

- **Yakama Nation.** The Yakama Nation consists of 14 bands and tribes: Palouse, Pisquose, Yakama, Wenatchapam, Klinquit, Oche Chotes, Kow way saye ee, Sk'in-pah, Kah-miltpah, Klickitat, Wish ham, See ap Cat, Li ay was, and Shyiks. The Yakama Indian Reservation covers about 1.4 million acres in Klickitat and Yakima Counties in southcentral Washington. The reservation includes agricultural land, range or grazing land, and forested areas. There are 8,870 tribal members (NMFS 2003).

  Tribal members have historically depended on the Columbia River and salmon for their subsistence. The tribe places greatest cultural importance on harvesting wild salmon for ceremonial uses. Subsistence fishing is permitted year-round in the mainstem Columbia River unless closed by tribal regulation to meet management guidelines. Tribal harvests typically occur all year and include spring, summer, and fall Chinook salmon, coho salmon, sockeye salmon, and summer and winter steelhead. The Yakama Nation harvests fish primarily in Zone 6 (between Bonneville and McNary Dams) of the Columbia River, its tributaries (Yakima and Klickitat Rivers), and Icicle Creek (which is a tributary to the Wenatchee River (NMFS 2003).

  Commercial salmon and steelhead fishing provides a means for continuing with parts of the tribe's historical lifestyle and represents a main source of livelihood for some tribal members. Tribal commercial fishing is permitted in Zone 6 of the Columbia River except in specific areas where closures are established to protect stocks. The Yakama Nation also occasionally authorizes commercial fisheries in some tributaries and terminal fishing areas such as the Klickitat River and Drano Lake. In addition, salmon are an essential part of tribal ceremonies and subsistence and are considered an important part of tribal members' diets. The ceremonial and subsistence fisheries can occur at any time of the year on the Columbia River and from early April until the end of October on the various tributaries (NMFS 2003).

- **Shoshone-Bannock Tribes.** The Shoshone-Bannock Tribes are made up of four distinct bands of Shoshone and one northern Paiute band, the Bannocks. The Fort Hall Indian Reservation, home of the Shoshone-Bannock Tribes, covers approximately 544,000 acres in southeastern Idaho. The reservation lies partially in Bingham, Bannock, Power, and

Caribou Counties. There are an estimated 5,400 tribal members. The tribes are the second-largest employer in southeast Idaho, employing both tribal members and non-tribal individuals.

The Shoshone-Bannock Tribes have a long history of salmon fishing (which their treaty refers to as *hunting*) in the Columbia River Basin. One of the names for the Shoshone-Bannock Tribes is the Agaidikas, (Salmon-Eater Shoshone). Currently, tribal members do not fish the Zone 6 commercial tribal fishery (located between Bonneville and McNary Dams). Tribal members fish mostly in the Salmon and Snake Rivers in Idaho, but they plan to continue to develop fisheries in northeast Oregon and southwest Washington (K. Kutchins, pers. comm., Shoshone-Bannock Tribes, Former Anadromous Fisheries Biologist, February 17, 2010) (C. Broncho, pers. comm., Shoshone-Bannock Tribes, Policy Representative, February 17, 2010) (L. Denny, pers. comm., Shoshone-Bannock Tribes, Fisheries Biologist, February 17, 2010).

- **Confederated Tribes of the Colville Reservation.** Twelve bands comprise the Confederated Tribes of the Colville Reservation: Wenatchee (Wenatchi), Nespelem, Moses-Columbia, Methow, Colville, Okanogan, Palus, San Poil, Entiat, Chelan, Nez Perce, and Lake. The size of the reservation is about 1.4 million acres (2,100 square miles), and total tribal enrollment is 9,365 people. Although salmon fishing remains an important food source, salmon runs are restricted due to the construction of Grand Coulee and Chief Joseph Dams on the Columbia River, but tribal members continue to fish on the numerous lakes and streams on the reservation, often for subsistence.

The Confederated Tribes of the Colville Reservation have a long-established fisheries program, and they are involved in on- and off-reservation salmon and steelhead fisheries management. They are specifically involved in the following activities (D. R. Michel, pers. comm., Upper Columbia United Tribes, Executive Director, February 17, 2010) (J. Peone, pers. comm., Confederated Tribes of the Colville Reservation, Director of Fish and Wildlife, February 17, 2010):

- The tribes have received Pacific Coastal Salmon Recovery Funds since 2001 to reestablish salmon runs on the Columbia and Okanogan Rivers.
- The tribes have worked with Federal, state, and local governments, as well as Canada First Nations, to reestablish runs in the Okanogan River subbasin.

- For the past several years, the tribes have tested various selective fishing techniques to increase the availability of natural-origin fish on the spawning grounds while reducing negative effects of hatchery-origin fish.
- The tribes are part of the technical management team for the Leavenworth National Fish Hatchery.
- The tribes have negotiated production and harvest agreements with the state of Washington to protect their interest and needs.
- The tribes are in the process of developing, constructing, and operating a hatchery facility for salmon and steelhead as part of the original mitigation due to the construction of Grand Coulee Dam and the continued operation of the rest of the FCRPS.

- **Cowlitz Indian Tribe.** The Cowlitz Tribe consists of approximately 3,600 members. Tribal members are located throughout western Washington and Oregon. Today, the enrolled members of the Cowlitz Indian Tribe continue traditional observances related to religion and food, especially involving salmon.

  The Cowlitz Tribe has no legally established fishing rights in the Columbia Basin. The tribe has expressed particular interest in salmon and steelhead in the lower Columbia estuary and associated tributaries and has participated in the development of the salmon recovery plan in southwest Washington. The tribe receives Pacific Coastal Salmon Recovery Funds for salmon restoration efforts (T. Aalvik, pers. comm., Cowlitz Tribe, Tribal Director of Natural Resources, February 17, 2010).

- **Confederated Tribes of the Grand Ronde.** The Confederated Tribes of the Grand Ronde include the Umpqua, Mololla, Rogue River, Kalapuya, and Chasta Tribes. Their reservation is located in the coast range of Oregon (http://www.grandronde.org). When the tribes' Federal recognition was restored in 1983, there remained some potential conflicts with the state of Oregon regarding fishing rights (K. Dirksen, pers. comm., Cowlitz Tribe, Tribal Fish and Wildlife Program Manager, February 17, 2010). In 1986, the tribe and the state of Oregon signed a consent decree, which identified and explained, in part, how the tribe would manage and fish for salmon. Tribal members engage in ceremonial and subsistence fishing throughout original ceded lands. The tribe has participated in salmon recovery planning covering the reservation and ceded lands.

In addition to tribes described above, tribes along the Washington coast and Puget Sound/Strait of Juan de Fuca would be potentially affected by hatchery management activities, but to a lesser extent than the Columbia River tribes described above. Of the tribes that are not located in the Columbia River Basin, the Makah, Quileute, and Quinault Tribes would be most impacted.

Information about these coastal tribes is described in the Final Programmatic Environmental Impact Statement for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin (NMFS 2003). The Makah, Quileute, and Quinault Tribes all have active troll fleets. The Hoh Tribe fish for salmon and steelhead in the Hoh River, but do not currently fish in the ocean; however, they do have fishing rights to all ocean species.

- **Makah Tribe.** The Makah Tribe has a relatively large and active fleet of trollers and gillnetters that fish for salmon in the ocean and Strait of Juan de Fuca and in somewhat smaller river fisheries. The tribe also maintains a large and active long-line fleet for halibut and black cod fishing, and they operate several large trawlers targeting whiting and a few smaller trawlers pursuing other demersal species. The tribe participates in a diverse array of fish and shellfish subsistence fisheries.

- **Quileute Tribe.** The Quileute Tribe's participation in salmon and steelhead fisheries predominantly occurs in the Quillayute River. The tribe maintains a few salmon trollers, is involved in longline fisheries for halibut and black cod, and participates in pot fisheries for Dungeness crab. The tribe also has a reserved right to fish for whiting.

- **Quinault Indian Nation.** The Quinault Tribe's salmon and steelhead gillnet fisheries occur predominantly in Grays Harbor, at the mouths of adjacent rivers, in the Quinault and Queets River, and in other on-reservation rivers. In addition to fishing for salmon and steelhead, the tribe fishes for white sturgeon in Grays Harbor. The tribe maintains a relatively small fleet for salmon ocean fishing. Active long-line fleets fish for halibut and black cod. The tribe also maintains a relatively large and active Dungeness crab fleet and participates in a relatively small crab pot fishery. The tribe engages in a razor clam fishery on coastal beaches, and a diverse fish and shellfish subsistence fishery. A tribe operates a plant in Taholah, Washington, that processes fresh, smoked, and canned salmon and steelhead, sturgeon, and razor clams.

Other tribes in Washington that may be impacted include, but are not limited to, the Lower Elwha Klallam, Jamestown S'Kallam, Port Gamble S'Kallam, Suquamish, Lummi, Nooksack, Swinomish, and Tulalip. A discussion of these tribes and their salmon and steelhead fisheries can be found in the Puget Sound Chinook Salmon Harvest EIS (NMFS 2004).

3.4.4.1.1 Fish Harvests and Tribal Values

Historical tribal harvests are provided in Table 3-14 (Columbia River Basin) and Table 3-17 (Pacific Ocean and Puget Sound area). Most in-basin tribal harvest of Columbia River salmon occurs in the mid Columbia River economic impact region. There are also substantial levels of tribal harvest along the Washington coast and in the Puget Sound/Strait of Juan de Fuca, but only a very small percentage of the fish taken by tribes in Puget Sound originate from the Columbia River Basin (W. Beattie, pers. comm., Northwest Indian Fisheries Commission, Conservation Planning Coordinator, May 22, 2009). No quantifiable tribal harvests occur in the Lower Columbia River or along the Oregon and California coasts.

Importance of Salmon to Tribes

Salmon is a key resource for the Indian tribes within the Columbia River Basin. Salmon fishing has been a focus for the economies, cultures, lifestyles, and identities of regional tribes for more than 1,000 years (Lane et al. 2004). These fisheries continued without interruption during most of the nineteenth century, barring natural disasters such as floods, droughts, or landslides. Considerable interference with Indian fisheries began after statehood with the introduction of state fishing regulations, development of large urban areas, suburban areas and farms, the construction of dams, and the destruction of fish habitat. Indian people in the region continued to fish but were faced with many obstacles, including the depletion of resources as a consequence of land development, dams, and overfishing by non-Indians. Tribal fishermen continued to assert their treaty-protected rights, sometimes at considerable risk to themselves. The "Boldt," or District Court decision in *U.S. v. Washington,* affirmed by the Ninth Circuit Court of Appeals and the United States Supreme Court, ushered in a new era for Indian fisheries (Lane et al. 2004). The historical struggles of regional Indian tribes to protect and maintain their salmon fisheries, and the historical trauma diminished fisheries caused for Indians, are well documented in Dupris et al. (2006), Dompier (2005), and Whitbeck et al. (2004).

Salmon is ubiquitous in Indian culture in the region. Beyond generating jobs and income for commercial tribal fishers, individuals and families regularly eat salmon and serve it at gatherings of elders and to guests at feasts and traditional dinners (NMFS 2004). Indians throughout the region treat salmon ceremoniously today and have done so for centuries. Salmon is of nutritional, cultural, and economic importance to tribes. To Indians of this region, salmon is a core symbol of tribal identity, individual identity, and the ability of Indian cultures to endure. It is a constant reminder to tribal members of their obligation as environmental stewards (NMFS 2004).

Traditional Indian concepts stress the relatedness and interdependence of all beings, including humans, in the region. Thus, the survival and well-being of salmon are seen as inextricably linked to the survival and well-being of Indian people and the cultures of the tribes. Many Indian people share traditional stories that explain the relationship among mountains, the origins of rivers, and the origins of salmon that inhabit the rivers (Ballard 1929 *in* NMFS 2004). In traditional stories, even the humblest of creatures play important roles in sustaining life and balance in the ecological niche that has supplied food for Indian people for generations (Ballard 1927 *in* NMFS 2004). Stories recount the values Indian people place on supporting healthy, welcoming rivers and good salmon runs. Salmon is also a symbol used in art and other representations of tribal identity. Its significance for the health of the tribes and that of individual members cannot be overstated.

The relationship of tribal people to salmon is spiritual, emotional, and cultural, as well as economic. Salmon evoke sharing, gifts from nature, responsibility to the resource, and connection to the land and the water. Salmon are strongly associated with the use and knowledge of water, use and knowledge of appropriate harvesting techniques, and knowledge of traditional processing techniques. The struggle to affirm the right to fish has made salmon an even more evocative symbol of tribal identity (Lane et al. 2004).

As discussed in greater detail in Lane et al. (2004), regional tribes use salmon in many and various ways, including the following:

- *Personal and Family Consumption.* Indian people in the region value and eat salmon whenever it is available. This includes fresh, frozen, vacuum packed, canned, and smoked salmon. Salmon is prepared in many ways. Some Indian people consume nearly every part of the salmon in some form, including eggs, flesh, skin, and bones. Some tribes help individual members with processing and storing salmon for home use. Some tribes have community smokehouses, pressure cookers (for canning), and machines for vacuum packing that tribal members may borrow.

- *Informal Interpersonal Distribution and Sharing.* Sharing and informal distribution of fish help to bind communities in a system of relationships and obligations. There are many informal, everyday ways that salmon are shared and distributed within each tribe and between tribes.

- *Formal Community Distribution and Sharing.* There are formal, frequent, or periodic occasions during which salmon is expected or required to be served. Examples include elders' dinners or luncheons, distributions to elders, communitywide and intertribal traditional dinners, cultural dinners with other tribes, dinners for guests or invited outsiders, events honoring students, food-basket distributions, weddings, and health fairs.
- *Ceremonial Uses.* As discussed in more detail in the following "Ceremonial and Subsistence Harvests" section, salmon is a key food, among other traditional foods, in tribal ceremonies.

Salmon also facilitates the transmission of tribal fishing culture to young tribal members, who are taught from an early age to fish and to understand that they, as tribal members, have a special responsibility to the salmon and to the habitat in which it thrives. This education includes teaching young people to work with fishing gear; encouraging young people to help elders and relatives with smoking fish, thus learning the skills required for traditional smoking; and giving young people an awareness of the environment and the place of fish in the environment (Lane et al. 2004).

The obligation to salmon articulated by Indian people is one concerned with renewal, reciprocity, and balance (Lane et al. 2004). Tribal identity is realized and expressed in the many daily acts in which tribal members engage. For the Indian people within the region, many of those acts involve or include salmon. Tribal people have a strong continuous connection with salmon, and they share a passionate concern for the future of salmon in the rivers and marine waters of the region.

3.4.4.1.2 Ceremonial and Subsistence Harvests

Ceremonial and subsistence harvest of salmon, primarily Chinook salmon and coho salmon, plays a key role in the cultural viability of tribes in the affected economic impact regions. Ceremonial and subsistence fish refers to non-commercial fish caught by tribal members and used by tribes for either ceremonial or subsistence purposes. Tribal fishers may open a fishery specifically to catch fish for ceremonial or other community uses when there is no concurrent commercial or recreational fishery. Tribal fishers engaged in commercial fisheries may take a portion of their catch for ceremonial and subsistence use, designating it as "take-home fish," to be used as subsistence food (NMFS 2004). In this context, subsistence refers to the ways in which indigenous people use the environment and resources provided by it to survive, i.e., to meet the nutritional needs of members of the society. Salmon species provide a major part of the subsistence resources for tribes within the region.

Salmon harvested for ceremonial and subsistence purposes is important to maintaining cultural viability, and it is a key food, among other traditional foods, in ceremonies. Tribes whose fisheries are depleted are helped by buying salmon from other tribes or receiving donations of fish. Tribes make an effort to keep salmon on hand or send out special boats for these occasions, including for the following:

- *Winter ceremonials.* Winter ceremonials require meals that include salmon. Ceremonies may last many days. Guests who have traveled from throughout the region must be served. These ceremonials are held frequently during the winter months.
- *First salmon ceremony.* Salmon ceremonies as practiced today focus on thanking the fish for returning and assuring the entire community of a good harvest. These ceremonies also draw attention to the responsibility Indian people have for providing a clean, welcoming habitat for the returning fish. Many tribes incorporate a blessing of the Indian fishing fleets or individual fishermen or fisherwomen with these ceremonies. Some ceremonies welcome non-Indian people to witness the proceedings, and these witnesses are typically served salmon dinners. This welcoming of non-Indian people to be present at salmon ceremonies is an effort to engage more of the region's residents in sharing responsibility for the salmon and for the habitat.
- *Naming ceremonies.* Naming ceremonies require that traditional meals, including salmon, be served. These are common throughout the area.
- *Giveaways and feast.* Giveaways and feasts feature traditional foods, including salmon, and are held frequently.
- *Funerals.* Indian funerals in the region are large gatherings that are typically attended by at least 100 people and often many more. Funerals are accompanied by traditional meals that include salmon. Meals take several days of preparation. Those who cook and serve must be fed as well. The death of a tribal member is marked by remembrances or memorials a year later. Burnings are held to feed the deceased at other times. All of these events require the use of traditional foods, including salmon (Lane et al. 2004).

The subsistence value of salmon to Indian people is not only traditionally and economically important, reducing ongoing food costs, but is also important to the health of tribal members. As discussed and documented in Meyer Resources Inc. (1999), the peoples of the regional tribes cope with overwhelming levels of poverty, unemployment that is between 3 and 13 times higher than for the region's non-Indians, and rates of death that are from 20 percent higher to more than twice the death rate for residents of Washington, Oregon, and Idaho as a whole.

Salmon and steelhead produced in the Columbia River Basin contribute to ceremonial and subsistence harvest for Columbia River tribes, but they do not account for a large part of the ceremonial and subsistence catch of tribes outside the Columbia River Basin (L. Lestelle, email comm., Biostream Environmental, Fisheries Biologist, April 8, 2009). This is because Columbia River fish account for a relatively small percentage of tribal harvest in areas outside of the Columbia River Basin where ceremonial and subsistence fishing occurs (L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, April 8, 2009). Within the Columbia River Basin, harvest of salmon for tribal ceremonial and subsistence uses occurs both in the basin's mainstem and terminal areas of the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions. No quantitative levels of ceremonial and subsistence harvest are believed to occur in the lower Columbia River economic impact region.

Although ceremonial and subsistence harvest can include coho salmon, steelhead, and summer and fall Chinook salmon, harvest typically focuses on spring Chinook salmon. Subsistence fishing in the Columbia River Basin occurs throughout the year. Also, some limited commercial fishing often occurs before the spring ceremonial fishing. Some tribes also use surplus hatchery fish for cultural purposes (funerals, etc.) (B. P. Lumley, pers. comm., CRITFC, Executive Director, December 3, 2010).

Ceremonial and subsistence harvests generally do not vary a great deal from year to year because tribes take fish to meet the needs of a given number of people for fresh fish. Hence, subsistence fish are, in practice, the priority fish taken by a tribe (L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, March 28, 2012).

Considerable uncertainty exists regarding levels of ceremonial and subsistence harvests by tribes in the Columbia River Basin (L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, March 28, 2012). No comprehensive harvest data for past ceremonial and subsistence catch in the Columbia River mainstem (Zone 6) are available. In an attempt to collect data on ceremonial and subsistence catch, the Mitchell Act Fishery Modeling Team contacted CRITFC and was told that no estimates of total ceremonial and subsistence catch in the mainstem Columbia River are available (S. Ellis, pers. comm., CRITFC, Management Biologist, October 25, 2011, cited in L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, March 28, 2012). CRITFC's harvest monitoring system maintains weekly estimates of total catch (commercial, plus ceremonial and subsistence, catch) of all species, but does not keep track of the final disposition of fish. As a result, CRITFC was unable to provide an estimate of the size of the tribes' ceremonial and subsistence catch relative to their overall catch.

Despite the lack of comprehensive data on ceremonial and subsistence harvests in the Columbia River mainstem, the Mitchell Act Fishery Modeling Team estimated average annual ceremonial and subsistence catch by tribes in the mainstem Zone 6 (mid Columbia River economic impact region) fishery (L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, March 28, 2012). These estimates are shown in Table 3-26. Because of data limitations, actual ceremonial and subsistence harvest is likely substantially greater than the estimates in Table 3-26. As a result, the estimates in this table should be considered minimums. These estimates were developed based on data sources and assumptions described in the Socioeconomic Impact Methods (Appendix J).

Considered together, ceremonial and subsistence catch from mainstem and terminal areas is estimated, at a minimum, to total 19,630 fish annually in the mid Columbia River region, with Chinook salmon accounting for 92 percent of the catch (Table 3-26). In the upper Columbia River region, ceremonial and subsistence catch is estimated to total 2,876 fish. In the lower Snake River region, ceremonial and subsistence catch is estimated at 6,033 fish. The ceremonial and subsistence harvests shown in Table 3-26 are numbers of fish in addition to the commercial tribal harvest estimates described in Section 4.3.4, Harvest and Economic Value. Further, no monetary value has been assigned to tribal ceremonial and subsistence harvests, which, from a tribal perspective, have important and distinct religious, social, and cultural values different from the economic value of tribal commercial fisheries.

3.4.4.1.3 Tribal Salmon Fishing and Hatchery Program Revenue

Estimates of revenues from the tribal commercial salmon harvest[4] are presented in Table 3-15 (Columbia River Basin) and Table 3-18 (Pacific Ocean and Puget Sound area); these estimates are based on ex-vessel values. Tribal revenues are highest in the mid Columbia River economic impact region ($2,761,765) followed by the Puget Sound/Strait of Juan de Fuca region ($2,726,685), and the Washington coast economic impact region ($1,537,124). These three economic impact regions account for about 98 percent of the total revenues from commercially harvesting salmon and steelhead by tribes (Table 3-16 and Table 3-19).

[4] These estimated tribal commercial salmon harvest revenues likely underestimate, to some unknown, but presumed relatively minor, extent, the actual total ex-vessel value because some portion of the catch is sold directly to the public at somewhat higher prices than the wholesale price.

TABLE 3-26. ESTIMATED MINIMUM[1] AVERAGE ANNUAL CEREMONIAL AND SUBSISTENCE HARVESTS IN THE COLUMBIA RIVER BASIN[2].

	MID COLUMBIA RIVER			UPPER COLUMBIA RIVER			LOWER SNAKE RIVER
SPECIES	MAINSTEM	TERMINAL AREAS	TOTAL	MAINSTEM	TERMINAL AREAS	TOTAL	MAINSTEM AND TERMINAL AREAS
Spring Chinook	11,300	4,558	15,858	0	1,260	1,260	6,030[3]
Summer Chinook	900	5	905	0	1,610	1,610	0
Fall Chinook	500	734	1,234	0	0	0	1
Coho	420	877	1,297	0	0	0	2
Steelhead	0	336	336	0	6	6	0
Total	13,120	6,510	19,630	0	2,876	2,876	6,033

Source: L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, March 28, 2012; and G. Blair, pers. comm., ICF International, Senior Fisheries Biologist, May 9, 2012. Refer to information in the Socioeconomics Impact Methods Appendix (pages 6 and 7, Appendix J) for estimation details, including data sources and assumptions.

[1] Because of data limitations, actual ceremonial and subsistence harvest is likely greater than the estimates of harvest in this table. As a result, the estimates in this table should be considered as minimums.

[2] No quantifiable estimates of ceremonial and subsistence harvests are assumed to occur in the lower Columbia River region.

[3] Includes spring and summer Chinook salmon.

Estimated costs associated with smolt production at hatcheries operated by the Yakama Nation, Nez Perce Tribe, and Confederated Tribes of the Colville Reservation total an estimated $3.3 million annually. This total does not include smolt production costs associated with hatchery programs that are jointly operated with other entities (e.g., Washington Department of Fish and Wildlife and Oregon Department of Fish and Game). Smolt production costs include employee salaries and operations and maintenance costs (details for estimating smolt production costs are presented in Appendix J, Socioeconomics Impact Methods.

3.4.4.2 Non-tribal User Groups of Concern

The analysis of potential environmental justice effects on non-tribal user groups considered effects on both commercial fishers and recreational anglers. Because of limitations on available data at the local or regional level, the analysis of potential effects on recreational anglers had to be conducted at the state level. This statewide analysis demonstrated that the groups of recreational anglers in Washington, Oregon, Idaho, and California do not qualify as environmental justice groups of concern based on consideration of minority or low-income thresholds. As a result, recreational anglers were not carried forward as a group subject to further environmental justice analysis.

The analysis of potential environmental justice effects on non-tribal groups, therefore, focused on commercial fishers operating from port communities along the coast, as well as in the mainstem Columbia River and its tributaries in the lower Columbia River economic impact region. Based on community-level data, commercial fishers in 11 port and fishing communities were identified as environmental justice user groups of concern based on minority and/or low-income criteria (Table 3-27). Of these, four user groups are located in the California coast economic impact region, three user groups in the Washington coast economic impact region, and two user groups each in the Oregon coast and lower Columbia River economic impact regions (Table 3-27).

3.4.4.3 Other Communities of Concern

Counties are designated as fishing communities of concern if 2010 Census population statistics indicate that a county exceeds any of the environmental justice thresholds for either low-income or minority populations identified in Table 3-25 (Section 3.4.3.2, Environmental Justice Thresholds). As shown in Table 3-28, 37 counties qualify as communities of concern (based on either low-income or minority population thresholds), and 7 communities qualify as both low-income and minority communities of concern).

Table 3-27. Summary of Environmental Justice User Groups of Concern (Commercial Fishers).

Economic Impact Region/Community	Non-white (%)	Native American (%)	Hispanic (%)	Poverty Rate (%)	Per Capita Income ($)	Fishing Net Revenues ($)
Washington Coast						
Ilwaco	10.1	2.1	5.7	8.3	22,620	25,656
La Push[1,2]	87.0	80.4	6.7	N/A[3]	N/A[3]	91,889
Neah Bay	87.9	77.1	7.3	27.3	16,550	37,224
Westport	13.0	2.9	7.3	27.6	19,620	202,455
Oregon Coast						
Astoria	10.8	0.1	9.8	16.1	24,300	231,385
Brookings	7.8	0.1	6.6	10.5	24,620	0[4]
Coos Bay	12.9	2.6	7.6	18.5	20,900	0[4]
Newport	15.9	2.1	15.3	16.7	26,220	0[4]
Tillamook	13.5	1.5	17.2	29.1	17,590	0[4]
California Coast						
Crescent City	33.9	4.8	30.6	31.1	9,390	0[4]
Eureka	20.7	3.7	11.6	21.9	22,570	0[4]
Fort Bragg	25.2	2.2	31.8	25.4	17,510	0[4]
Monterey	21.7	0.5	13.7	10.1	35,530	0[4]
San Francisco	51.5	0.5	15.1	11.5	44,370	0[4]
Lower Columbia River						
Astoria (OR)	10.8	0.1	9.8	16.1	24,300	478,240
Clatskanie (OR)	7.1	2.0	3.7	10.2	20,760	10,043
Dodson[5] (OR)	9.9	3.9	6.2	N/A[3]	N/A[3]	95,648
St. Helens-Rainier (OR)	9.3	1.6	5.8	11.9	22,010	85,605
Cathlamet (WA)	5.3	0.9	3.4	13.9	20,760	163,558
Ilwaco (WA)	10.1	2.1	5.7	8.3	22,620	439,981
Kalama (WA)	8.7	1.3	4.9	7.8	24,260	5,739
Longview (WA)	14.0	1.7	9.7	20.9	22,660	89,909
Skamania County (WA)	7.2	1.6	5.0	7.8	22,893	38,259
Skamokawa[6] (WA)	5.7	0.2	2.2	N/A[3]	N/A[3]	123,386
Vancouver (WA)	19.1	1.0	10.4	14.6	25,290	95,648

Sources: Sources: U.S. Census Bureau, 2010 Census, Table DP-1: Profile of General Population and Housing Characteristics—2010 Demographic Profile; U.S. Census Bureau, 2005-2009 American Community Survey, Table B17001: Poverty Status in the Past 12 Months by Sex by Age, Table B19301: Per Capita Income in the Past 12 Months (in 2009 Inflation Adjusted Dollars).

[1] Shading represents those communities that exceed the threshold for a low-income or minority community, making them a user group of concern.

[2] Represents U.S. Census data for Zip Code 98350. Poverty rate and per capita income data were not available from the 2010 U.S. Census or American Community Survey database; however, La Push qualified as an environmental justice low-income user group of concern based on 2000 U.S. Census data.

[3] N/A means information not available for these communities.

[4] Columbia River salmon are not commercially harvested south of Astoria; thus, no fishing net revenues have been estimated for communities south of Astoria, including those in Oregon and California.

[5] Represents U.S. Census data for Zip Code 97014. Poverty rate and per capita income data were not available from the 2010 U.S. Census or American Community Survey database; however, Dodson qualified as an environmental justice low-income user group of concern based on 2000 U.S. Census data.

[6] Represents U.S. Census data for Zip Code 98647. Poverty rate and per capita income data were not available from the 2010 U.S. Census or American Community Survey database. Skamokawa did not qualify as an environmental justice low-income user group of concern based on 2000 U.S. Census data.

1 **TABLE 3-28. SUMMARY OF ENVIRONMENTAL JUSTICE COMMUNITIES OF CONCERN.**

ECONOMIC IMPACT REGION/COUNTY[2]	NON-WHITE (%)	NATIVE AMERICAN (%)	HISPANIC (%)	POVERTY RATE (%)	PER CAPITA INCOME ($)
Lower Columbia River					
Benton Co. (OR)[1]	12.9	0.9	6.4	19.1	25,620
Clackamas Co. (OR)	11.8	0.8	7.7	8.9	31,750
Clatsop Co.[3] (OR)	9.1	1.0	7.7	12.6	25,020
Columbia Co. (OR)	7.5	1.3	4.0	8.9	24,450
Lane Co. (OR)	11.7	1.2	7.4	16.2	23,260
Linn Co. (OR)	9.4	1.3	7.8	14.9	22,250
Marion Co. (OR)	21.8	1.6	24.3	15.4	21,980
Multnomah Co. (OR)	23.5	1.1	10.9	15.5	28,500
Polk Co. (OR)	14.1	2.1	12.1	12.9	23.780
Washington Co. (OR)	23.4	0.7	15.7	9.8	30,020
Yamhill Co. (OR)	14.6	1.5	14.7	12.9	23,930
Clark Co. (WA)	14.6	0.9	7.6	10.5	27,380
Cowlitz Co. (WA)	11.1	1.5	7.8	15.8	22,680
Lewis Co. (WA)	10.3	1.4	8.7	13.4	21,690
Pacific Co. (WA)[3]	12.6	2.3	8.0	16.5	21,870
Wahkiakum Co. (WA)	6.0	1.3	2.7	9.0	22,970
Mid Columbia River					
Crook Co. (OR)	7.3	1.4	7.0	13.6	21,920
Deschutes Co. (OR)	7.8	0.9	7.4	8.9	28,000
Gilliam Co. (OR)	4.8	1.0	4.7	10.8	25,350
Grant Co. (OR)	5.0	1.2	2.8	14.4	22,080
Hood River Co. (OR)	16.9	0.8	29.5	11.2	22,760
Jefferson Co. (OR)	31.0	16.9	19.3	16.9	18,890
Morrow Co. (OR)	22.3	1.2	31.3	16.8	18,980
Sherman Co. (OR)	6.6	1.6	5.6	21.0	20,310
Umatilla Co. (OR)	20.9	3.5	23.9	15.5	19,680
Wasco Co. (OR)	13.9	4.4	14.8	15.8	21,770
Wheeler Co. (OR)	7.6	1.2	4.3	15.2	22,290
Benton Co. (WA)	17.6	0.9	18.7	12.4	26,250
Franklin Co. (WA)	39.5	0.7	51.2	20.5	18,670
Grant Co. (WA)	27.2	1.2	38.3	19.0	19,200
Klickitat Co. (WA)	12.3	2.4	10.7	19.8	20,480
Skamania Co. (WA)	7.2	1.6	5.0	7.8	22,890
Walla Walla Co.(WA)	15.5	1.0	19.7	18.8	21,780
Upper Columbia River					
Chelan Co. (WA)	20.7	1.0	25.8	11.9	23,340
Douglas Co. (WA)	20.4	1.1	28.7	14.3	22,520
Kittitas Co. (WA)	10.7	1.0	7.6	22.8	24,450
Okanogan Co. (WA)	26.1	11.4	17.6	19.6	19,370
Yakima Co. (WA)	36.3	4.3	45.0	20.8	18,560
Lower Snake River					
Adams Co. (ID)	3.9	1.0	2.4	11.6	22,920
Clearwater Co. (ID)	6.1	2.2	3.1	11.5	21,700
Custer Co. (ID)	3.6	0.6	4.0	11.9	22,680

TABLE 3-28. SUMMARY OF ENVIRONMENTAL JUSTICE COMMUNITIES OF CONCERN (CONTINUED).

ECONOMIC IMPACT REGION/COUNTY[2]	NON-WHITE (%)	NATIVE AMERICAN (%)	HISPANIC (%)	POVERTY RATE (%)	PER CAPITA INCOME ($)
Idaho Co. (ID)	6.2	3.0	2.6	18.6	18,300
Latah Co. (ID)	7.2	0.6	3.6	22.9	19,200
Lemhi Co. (ID)	3.6	0.7	2.3	16.0	21,300
Lewis Co. (ID)	9.7	4.7	3.3	14.2	18,580
Nez Perce Co. (ID)	9.9	5.6	2.8	14.4	23,130
Shoshone Co. (ID)	4.6	1.4	3.0	17.6	18,670
Valley Co. (ID)	4.2	0.7	3.9	16.2	27,380
Union Co.(OR)	6.9	1.1	3.9	15.1	22,010
Wallowa Co. (OR)	4.0	0.6	2.2	10.7	24,890
Asotin Co. (WA)	5.7	1.4	3.0	15.3	22,640
Columbia Co. (WA)	7.0	1.4	6.2	15.2	25,330
Garfield Co. (WA)	6.2	0.3	4.0	12.3	21,110
Whitman Co. (WA)	15.4	0.7	4.6	29.1	18,550
Washington Coast					
Clallam Co.	13.0	5.1	5.1	14.1	24,210
Grays Harbor Co.	15.1	4.6	8.6	15.9	21,290
Jefferson Co.	9.0	0.8	2.8	12.8	27,260
Pacific Co.[3]	12.6	2.3	8.0	16.5	21,870
Oregon Coast					
Clatsop Co.[3]	9.1	1.0	7.7	12.6	25,020
Coos Co.	10.2	2.5	5.4	16.5	21,680
Curry Co.	8.0	1.9	5.4	13.7	23,560
Lincoln Co.	12.3	3.5	7.9	17.3	23,470
Tillamook Co.	8.5	1.0	9.0	15.4	22,040
California Coast					
Del Norte Co.	26.3	7.8	17.8	19.4	19,020
Humboldt Co.	18.3	5.7	9.8	18.2	23,500
Mendocino Co.	23.5	4.9	22.2	16.3	24,100
Monterey Co.	44.4	1.3	55.4	13.3	25,340
San Francisco Co.	51.5	0.5	15.1	11.5	44,373

Sources: U.S. Census Bureau, 2010 Census, Table DP-1: Profile of General Population and Housing Characteristics—2010 Demographic Profile; U.S. Census Bureau, 2005-2009 American Community Survey, Table B17001: Poverty Status in the Past 12 Months by Sex by Age, Table B19301: Per Capita Income in the Past 12 Months (in 2009 Inflation Adjusted Dollars).

[1] Shading represents those counties that exceed the threshold for a low income or minority, making them communities of concern.

[2] Includes all counties within economic impact regions, together with those with identified low-income and minority communities of concern.

[3] Included in two economic impact regions.

3.4.4.3.1 Low-income Communities of Concern

Counties were identified as low-income if the poverty rate and/or per capita income level for the county was below threshold levels established for the applicable statewide reference area (Table 3-25). Nineteen counties in the area that includes the four economic impact regions in the Columbia River Basin and three coastal economic impact regions in California, Oregon, and Washington qualify as low-income communities (Table 3-27). Across the seven economic impact regions, seven counties qualify as low-income communities of concern within the mid Columbia

River economic impact region (Jefferson, Morrow, Sherman, Umatilla, Franklin, Grant, and Klickitat), five counties within the lower Snake River economic impact region (Idaho, Latah, Shoshone, Valley, and Whitman), three counties within the upper Columbia River economic impact region (Kittitas, Okanogan, and Yakima), two counties within the California coast economic impact region (Del Norte and Humboldt), and one county each within the lower Columbia River (Benton) and the Oregon coast economic impact region (Lincoln) (Table 3-28).

3.4.4.3.2 Minority Communities of Concern

Three categories were used to determine if a particular county was considered a minority community of concern: percentage of county residents that were non-white, percentage that were Native American, and percentage that were Hispanic. Counties were determined to be minority communities of concern if the percentage in any category exceeded the threshold levels established for the applicable statewide reference area (Table 3-25).

Twenty-nine counties were determined to be minority communities of concern (Table 3-28). Of these 29 minority communities, 9 counties are located in the mid Columbia River economic impact region (Hood, Jefferson, Morrow, Umatilla, Wasco, Benton, Franklin, Grant, and Walla Walla), five counties within the California coast region (Del Norte, Humboldt, Mendocino, Monterey, and San Francisco), four counties each within the upper Columbia River economic impact region (Chelan, Douglas, Okanogan, and Yakima) and the lower Snake River economic impact region (Clearwater, Idaho, Lewis, and Nez Perce), three counties within the lower Columbia River economic impact region (Marion, Multnomah, and Washington), and two counties each in the Washington coast region (Clallam and Grays Harbor) and the Oregon coast region (Coos and Lincoln) (Table 3-28). Eleven of the 29 counties also are considered low-income communities of concern (e.g., Jefferson and Morrow Counties in the Oregon coast region).

3.4.5 Public Outreach

The goal of public outreach activities is to inform local community members of the project and to solicit input about community-based concerns regarding the proposed action and its potential environmental and socioeconomic effects. In the context of environmental justice, the public outreach process can be used to help locate environmental justice populations of concern throughout the affected economic impact regions. Public outreach also provides a forum to obtain information on potential effects on specific environmental justice groups or communities of concern, including Native American tribes.

Throughout the EIS process, NMFS has attempted to ensure that the requirements of E.O. 12898 regarding environmental justice are implemented, including the conduct of appropriate tribal consultation activities. As part of the public scoping process for this EIS, NMFS directly notified non-tribal commercial and recreational fishers to consult on the proposed action. NMFS sent a letter to Columbia River, Puget Sound/Strait of Juan de Fuca, and Washington coastal tribes asking them to participate in an EIS scoping meeting. Non-tribal commercial and recreational fishing groups also were contacted by phone and/or by email to invite them to participate in an EIS scoping meeting. Additional notices were published in local newspapers and regional electronic newsletters. Emails were also sent to individuals who NMFS was able to identify as non-tribal commercial, recreational, or tribal fishers. All groups notified during scoping are included on the EIS distribution list and received direct information about commenting on the draft and final EISs. In this way, a diverse population, located over a broad geographic area, was identified and reached during the scoping process, was also notified during the review period for the draft EIS, and will be notified when the final EIS is published.

3.5 Wildlife

3.5.1 Introduction

Hatchery operations have the potential to affect wildlife by changing the total abundance of salmon and steelhead in aquatic and marine environments. Changes in the abundance of salmon and steelhead can affect wildlife through predator/prey interactions. In addition, hatcheries could affect wildlife through transfer of toxic contaminants or pathogens from hatchery-origin fish to wildlife, operation of weirs (which could block or entrap wildlife), or predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities). Key wildlife groups of concern are 1) ESA-listed aquatic, marine, and terrestrial wildlife species, 2) non-listed birds, 3) non-listed marine mammals, and 4) other non-listed aquatic, marine, and terrestrial wildlife species. This section describes current baseline conditions and key factors affecting the distribution and abundance of each of the wildlife groups. Baseline conditions were developed from existing literature for wildlife species, reflecting best available science on species life history (including habitats, prey choice, and availability), that may be affected by the EIS alternatives.

3.5.2 Analysis Area

The analysis area for fish in this EIS is the same as the project area as described in Section 2.2 (Description of Project Area). Information in Section 3.5 (Wildlife) and Section 4.5 (Wildlife) is organized according to species, although some species are grouped when appropriate. Some wildlife species are found throughout the analysis area, while others are only found in part of the analysis area (Table 3-29, Table 3-30, and Table 3-31).

3.5.3 ESA-listed Species

Anadromous salmon provide a rich, seasonal food resource that directly affects the ecology of both aquatic and terrestrial consumers and indirectly affects the entire food web that knits the water and land together. Wildlife species have likely had a very long, and probably co-evolutionary, relationship with salmon in the Pacific Northwest (Cederholm et al. 2001).

Two ESA-listed wildlife species (Southern Resident killer whale, and marbled murrelet) occur within the analysis area and may feed on salmon and steelhead produced within the Columbia River Basin (Table 3-29). Although the grizzly bear is ESA-listed as threatened in the contiguous United States, its presence is limited to the North Cascades population within the analysis area. In this area, it feeds primarily on plants. In the North Cascades, less than 10 percent of the grizzly bear's diet is meat (winterkill deer and elk) (Western Wildlife Outreach 2014). Thus, the grizzly bear is not discussed further in this EIS. Two additional ESA-listed species (spotted owl and Canada lynx) occur in the analysis area, but they rarely interact with salmon and steelhead and are not discussed further in this EIS.

Production of salmon and steelhead (including hatchery-origin and natural-origin fish) could affect distribution and abundance of Southern Resident killer whale and marbled murrelet through effects on prey abundance and distribution, as well as by transfer of toxins and pathogens from fish to wildlife species. Because none of the listed wildlife species feeds on hatchery-origin fish while the fish are in the hatchery facility, practices implemented at the hatcheries to control predators would not affect listed wildlife species. Other Federal- and state-listed amphibian and invertebrate (insect) species and their relationship with salmon and steelhead are discussed in Section 3.5.6, Other Aquatic and Terrestrial Wildlife.

3.5.3.1 Distribution of ESA-listed Species and Their Food Resources

Salmon and steelhead from the Columbia River Basin provide a source of prey for Southern Resident killer whales and marbled murrelets. Most of the consumption of salmon and steelhead by these ESA-listed species occurs in ocean waters outside the analysis area, but some consumption occurs in the Columbia River estuary (Watson et al. 1991; Krahn et al. 2002; McShane et al. 2004; NMFS 2008a).

3.5.3.1.1 Killer Whale (Southern Resident DPS)

There are three forms, or ecotypes, of killer whales that occur along the Pacific coastline and associated inland areas ("resident," "transient," and "offshore" killer whales). The resident killer whales in the North Pacific include the Southern Residents, Northern Residents, Southern Alaska Residents, and the Western Alaska Residents, of which only the Southern Resident killer whale stock is listed under ESA. The three pods of the Southern Resident killer whale (ESA-listed as endangered and protected under the Marine Mammal Protection Act [MMPA]) have been observed in ocean waters from Southeast Alaska to Monterey Bay, California, and inland marine waters including the Strait of Juan de Fuca, the Georgia Basin, and Puget Sound (Hanson and Emmons 2011; NMFS 2008b; Ford et al. 2012; Hanson et al. 2013). Southern Resident killer whales have seasonal patterns of occurrence in inland marine waters of Washington and British Columbia, which has been documented since 1974 (McCluskey 2006; Hauser et al. 2007; Hanson and Emmmons 2011; Center for Whale Research 2014).

TABLE 3-29. STATUS, DISTRIBUTION, ASSOCIATIONS, AND TRENDS FOR ESA-LISTED WILDLIFE IN THE ANALYSIS AREA POTENTIALLY AFFECTED BY THE EIS ALTERNATIVES.

SPECIES	FEDERAL (F) AND STATE (S) STATUS[1]	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA	OCCURRENCE AT, AND ASSOCIATION WITH, COLUMBIA RIVER BASIN HATCHERY FACILITIES[2]	ASSOCIATION WITH HATCHERY-ORIGIN AND NATURAL-ORIGIN SALMON IN ANALYSIS AREA[3]	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[4]	LIFE STAGE OR HABITAT WHERE INTERACTIONS OCCUR[5]	TRENDS IN ABUNDANCE
Southern Resident killer whale	F: Endangered S: Endangered in Washington	Occasionally occur in mouth of the Columbia River.	Do not occur at Columbia River Basin hatchery facilities.	Occasionally forage on salmon in the mouth of the Columbia River (Zamon et al. 2007, Hanson et al. 2010).	Strong	Saltwater habitats	Periods of increasing, as well as decreasing, population trends over the last several decades; current population estimate is 80 individuals as of June 2014 (E. Heydenreich, pers. comm., Center for Whale Research, Senior Staff, June 23, 2014).
Marbled murrelet	F: Threatened S: Threatened in Washington and Oregon	Rarely forage in Columbia River estuary (McShane et al. 2004). Areas of mature and old-growth forest near lower Columbia River provide potential nesting habitat.	No hatchery facility properties contain mature or old-growth forest to support the birds. No documented nesting or foraging at hatcheries.	Generally, murrelets forage on salmon in saltwater and freshwater rearing areas (Cederholm et al. 2001). However, foraging marbled murrelets are rarely observed within the Columbia River estuary, and there is no evidence that murrelets forage in freshwater habitats in the analysis area (Varoujean and Williams 1995, McShane et al. 2004, U.S. Forest Service [USFS] 2008).	Recurrent	Saltwater, freshwater	Declining in both Washington and Oregon (McShane et al. 2004).

[1] For state status, if a state is not listed, either the species does not occur in the area, or the species has no state listing status.

[2] Hatchery facilities include acclimation ponds.

[3] Refers to entire analysis area, including, but not limited to, fish-rearing areas and release sites.

[4] Definitions from Cederholm et al. (2001): "Strong" relationship means that salmon play an important role in this species' distribution, viability, abundance, and/or population status. "Recurrent" relationship means that the relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas. "Rare" relationship means that salmon play a very minor role in the diet of these species.

[5] Definitions from Cederholm et al. (2001): "Saltwater" means smolt or, subadult, adult.

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TABLE 3-30. STATUS, DISTRIBUTION, HABITAT ASSOCIATIONS, AND TRENDS FOR BIRD SPECIES IN THE ANALYSIS AREA THAT PREY ON SALMON.

SPECIES[1]	FEDERAL (F) AND STATE (S) STATUS[2]	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA[3]	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[5]	LIFE STAGE OR HABITAT WHERE INTERACTIONS OCCUR[5]	USGS BREEDING BIRD SURVEY, WASHINGTON 1983 TO 2007 (SAUER ET AL. 2008)[6]	USGS BREEDING BIRD SURVEY, OREGON 1983 TO 2007 (SAUER ET AL. 2008)[6]	USGS BREEDING BIRD SURVEY, IDAHO 1983 TO 2007 (SAUER ET AL. 2008)[6]	OTHER TREND INFORMATION
Gulls and Terns								
Gulls (glaucous-winged, ring-billed, California, and western)	F: none S: for California gulls	Common throughout analysis area. Large nesting colony of glaucous-winged/western gulls on Rice Island and East Sand Island in the Columbia River estuary; ring-billed and California gull colonies above Dalles Dam.	Strong	Incubation, freshwater rearing, saltwater, spawning, carcass	Decreasing trend for California gulls. No trend for any other species	Decreasing trend for ringed-billed gulls. No trend for any other species	No data for western gull and glaucous-winged gull. No trend for ring-billed gull and California gull	
Caspian tern	F: none S: monitor in Washington	Large nesting population in the Columbia River estuary. Population in estuary is being managed to reduce predation on salmon. Large colony on East Sand Island; also colonies on other small islands in the Columbia River Basin.	Strong	Freshwater rearing, saltwater	Increasing trend	No trend	No trend	Increasing in Washington (Shuford and Craig 2002)
Cormorant Species								
Double-crested cormorant	F: none S: none	Occurs year-round in the Columbia River estuary and around reservoirs in the mid Columbia River. Large nesting colonies on islands in the estuary and upstream from McNary Dam.	Strong	Freshwater rearing, saltwater	No trend	No trend	No trend	
Brandt's cormorant	F: none S: candidate in Washington	Occurs year-round in Columbia River estuary. Small colony on East Sand Island in the estuary.	Recurrent	Freshwater rearing, saltwater	No trend	No data	N/A[8]	
Pelagic cormorant	F: none S: none	Occurs year-round in Columbia River estuary.	Recurrent	Freshwater rearing, saltwater	No trend	No data	N/A[8]	
Loon Species								
Common loon	F: none S: sensitive in Washington	Fairly common migrant, winter resident on Columbia and Snake Rivers (especially reservoirs) and in the Columbia River estuary. Rare in summer in analysis area.	Recurrent	Freshwater rearing, saltwater[7]	No data	No data	No data	No apparent trend for wintering common loons in Washington (Richardson et al. 2000)
Red-throated loon	F: none S: none	Rare migrant and winter resident throughout analysis area.	Recurrent	Freshwater rearing, saltwater	N/A[7]	N/A[7]	N/A[7]	
Pacific loon	F: none S: none	Present during fall and spring migration; rare in winter along Columbia River and Snake River and the Columbia River estuary.	Recurrent	Saltwater	N/A[7]	N/A[7]	N/A[7]	
Grebe Species								
Western grebe	F: none S: candidate in Washington	Common winter resident in Columbia River estuary; uncommon in Columbia River Basin in winter. Breeds on large ponds and reservoirs in Columbia River Basin.	Recurrent	Freshwater rearing, saltwater	No data	No data	No data	
Clark's grebe	F: none S: monitor in Washington	Common breeder along Snake River. Rare migrant and winter resident in reservoirs and the Columbia River estuary.	Recurrent	Saltwater	N/A[7]	N/A[7]	No data	
Red-necked grebe	F: none S: monitor in Washington	Rare migrant along Columbia River and rare winter resident in the Columbia River estuary.	Rare	Spawning, carcass	Declining trend	No data	No trend	
Pied-billed grebe	F: none S: none	Uncommon to common year-round resident in wetlands and other shallow areas throughout analysis area.	Recurrent	Freshwater rearing	Increasing trend	No trend	No trend	
Duck Species								
Harlequin duck	F: species of concern S: none	Winter resident in the Columbia River estuary. Breeds in fast flowing, mountain streams in the upper Columbia and Snake River Basins.	Strong; however, not documented in Columbia River Basin	Incubation, saltwater	No data	No data	No data	

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TABLE 3-30. STATUS, DISTRIBUTION, HABITAT ASSOCIATIONS, AND TRENDS FOR BIRD SPECIES IN THE ANALYSIS AREA THAT PREY ON SALMON (CONTINUED).

SPECIES[1]	FEDERAL (F) AND STATE (S) STATUS[2]	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA[3]	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[4]	LIFE STAGE OR HABITAT WHERE INTERACTIONS OCCUR[4]	USGS BREEDING BIRD SURVEY, WASHINGTON 1983 TO 2007 (SAUER ET AL. 2008)[5]	USGS BREEDING BIRD SURVEY, OREGON 1983 TO 2007 (SAUER ET AL. 2008)[5]	USGS BREEDING BIRD SURVEY, IDAHO 1983 TO 2007 (SAUER ET AL. 2008)[5]	OTHER TREND INFORMATION
Common goldeneye	F: none S: none	Common winter resident and migrant along major streams in the Columbia River Basin.	Recurrent	Incubation, spawning, carcass	No data	No data	No data	
Barrow's goldeneye	F: none S: none	Common winter resident and migrant in the estuary and along mainstem of Columbia and Snake Rivers. Some breeding birds occur on Snake River.	Recurrent	Incubation, spawning, carcass	No trend	No data	No data	
Common merganser	F: none S: none	Common winter resident in the estuary and major streams in the Columbia River Basin; uncommon breeder on eastside of Cascades. Breeds in lakes and rivers on Westside of Cascades.	Strong	Carcass	No trend	Increasing trend	No trend	
Red-breasted merganser	F: none S: none	Present in winter in the Columbia River estuary; uncommon migrant along the mainstem Columbia River.	Strong;[4] however, not documented in Columbia River Basin	Incubation, freshwater rearing, saltwater	N/A[7]	N/A[7]	N/A[7]	
Other Fish-eating Bird Species								
Bald eagle	F: protected under Bald Eagle and Golden Eagle Protection Act S: sensitive in Washington	Nests, forages, and winters along analysis area rivers and in Columbia River estuary. No recorded nesting at hatchery facilities.	Strong	Freshwater; carcasses, saltwater	Increasing trend	Increasing trend	Increasing trend	
Great blue heron	F: none S: monitor in Washington	Common resident of shorelines and shallow waters in the analysis area, associated with hatchery facilities.	Recurrent	Freshwater rearing, saltwater	No trend	No trend	No trend	
Belted kingfisher	F: none S: none	Year-round resident in the Columbia River estuary and along the tributaries in the Columbia River Basin.	Recurrent	Freshwater rearing, saltwater	No trend	No trend	No trend	
Osprey	F: none S: monitor in Washington	Fairly common breeder in the analysis area, particularly where large shoreline trees and artificial structures are available.	Strong,[4] but salmon as a prey source not documented in Columbia River Basin	Freshwater rearing, saltwater, spawning	Increasing trend	Increasing trend	No trend	
American white pelican	F: none S: endangered in Washington	Breeds on Badger Island on the mid Columbia River.	Recurrent	Freshwater rearing	No trend	No trend	No trend	
Brown pelican	F: delisted S: endangered in Washington and Oregon	Occur in the Columbia River estuary, where a large roosting site is present at East Sand Island.	Rare	Saltwater	No trend	No Trend	N/A[7]	
American/ northwestern crow	F: none S: none	Common year-round resident throughout analysis area.	Recurrent	Freshwater rearing,[8] carcass	No trend	Increasing trend for American crow. No data for northwestern crow	No trend for American crow. No information for northwestern crow	
Common raven	F: none S: none	Common year-round resident throughout much of analysis area.	Recurrent	Freshwater rearing,[8] carcass	Increasing trend	No trend	Increasing trend	

[1] Species include those that regularly occur within the analysis area or nearby coastal waters and that have a strong, consistent or recurrent relationship with salmon, as identified by Cederholm et al. (2001).
[2] For state status, if a state is not listed, either the species does not occur in the area, or the species has no state listing status.
[3] Sources: Opperman (2003), Christmas Bird Count (2004), Portland Audubon Society (2008), United States Department of the Interior and BLM (2007), USFWS (2007a,b).
[4] Source: Cederholm et al. (2001). If data are not available for the Columbia River Basin, the relationship is listed as *not documented in Columbia River Basin.*
[5] Trends are indicated if P < 0.1.
[6] Definitions from Cederholm et al. (2001): "Strong" relationship means that salmon play an important role in this species' distribution, viability, abundance, and/or population status. "Recurrent" relationship means that the relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas. "Rare" means that salmon play a very minor role in the diet of these species. "Incubation" means egg and alevin; "freshwater rearing" means fry, fingerling, or parr; "saltwater" means smolt or, subadult, adult.
[7] Not applicable because species does not breed in the state (Marshall et al. 2006:, Smith et al. 1997).
[8] Crows and ravens prey on juvenile salmon that are stranded in shallow water.

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TABLE 3-31. STATUS, DISTRIBUTION, HABITAT ASSOCIATIONS, AND TRENDS FOR MARINE MAMMALS.

SPECIES	FEDERAL (F) AND STATE (S) STATUS	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[1]	TRENDS IN ABUNDANCE
California sea lion	F: MMPA S: none	Occurs in Columbia River estuary and Columbia River up to the Bonneville dam primarily during the non-breeding season (September to May) (NMFS 1997). Large haul-out at the South Jetty on the Columbia River (Jeffries et al. 2000).	Strong; saltwater, spawning	The population off the west coast of the United States has shown an overall increasing trend since the mid-1970s, with an average annual rate of increase of over 12 percent (NMFS 2011a).
Steller sea lion	F: MMPA S: threatened in Washington, sensitive in Oregon	Present year-round in Columbia River estuary and river up to Bonneville Dam (NMFS 2008a). Haul-out site present at the South Jetty on the Columbia River (Jeffries et al. 2000).	Forage on salmon along lower Columbia River and estuary (NMFS 2008d).	Increasing population trend exists with a 12 percent annual growth rate (Allen and Angliss 2012).
Harbor seal	F: MMPA S: monitor in Washington; none in Oregon	Present year-round in the Columbia River estuary and the lower Columbia River to Bonneville Dam (NMFS 2008f). Numerous haul-out sites, and also pupping sites, in the estuary (Jeffries 1986; Jeffries et al. 2000).	Recurrent; saltwater, spawning, carcass	The harbor seal population on the Oregon/Washington coast is stable and very close to carrying capacity (NMFS 2011b).
Harbor Porpoise	F: MMPA S: none	Occurs in coastal waters of Oregon and Washington.	Rare: saltwater	Estimates of abundance for the Northern Oregon/Washington coast stock in 1997 and 2002 were not significantly different, although the survey area in 1997 was slightly larger than in 2002 (NMFS 2011c)

[1] Definitions from Cederholm et al. (2001): "Strong" relationship means that salmon play an important role in this species' distribution, viability, abundance, and/or population status. "Recurrent" relationship means that the relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas. "Rare" relationship means that salmon play a very minor role in the diet of these species. "Saltwater" means smolt or, subadult, adult.

All three Southern Resident pods occur in Puget Sound (including the vicinity of the San Juan Islands and Gulf Islands, the Strait of Juan de Fuca, and the Georgia Basin) with the greatest frequency from May to October. Their frequency of occurrence in inland marine waters declines starting in October and remains low through May, with variations among the three pods. From November through December, Southern Resident killer whales, and J pod in particular, are more frequently detected in Puget Sound than in the Georgia Basin and San Juan Islands, although overall frequency of occurrence is much lower than in summer months (Hanson and Emmons 2011). Occurrence of Southern Resident killer whales in inland marine waters has been relatively low from January to April since 2003. Recent efforts to determine their winter distribution using passive acoustic recorders, ocean-class vessel surveys, a coastal observer network, and satellite tagging have established that Southern Resident killer whales are present in the coastal waters of Washington, Oregon, and California, the west coast of Vancouver Island, and the Strait of Juan de Fuca during winter and early spring months (Ford et al. 2000; NMFS 2008b; Hanson et al. 2013).

Transient killer whales are not listed under ESA, and available information on their diet indicates that marine mammals are their primary prey (NMFS 2008b). Although the Northern and Alaska resident killer whale populations feed on schooling fish (including salmon and steelhead), these stocks do not occur near the Columbia River. Offshore killer whales feed primarily on fish, though they have been documented to feed on sharks (Ford et al. 2011). They are most often found several miles offshore, but they also occasionally visit coastal and inshore waters.

Because this EIS is focused on salmon and steelhead hatchery production effects on wildlife in the Columbia River Basin, only the Southern Resident killer whale stock is discussed further in this EIS. As of June 2014, there were 80 Southern Resident killer whales counted in the annual census (E. Heydenreich, pers. comm., Center for Whale Research, Senior Staff, June 23, 2014). Considering the analysis area, Southern Resident killer whales have been detected in ocean waters near the mouth of the Columbia River during winter and early spring months (Ford et al. 2000; Wiles 2004; NMFS 2008b,c; Hanson et al. 2013). Moreover, Southern Resident killer whales have been observed feeding near the Columbia River estuary during winter months at the time of spring Chinook salmon migration (Zamon et al. 2007).

Most of the information on the diet of the Southern Resident killer whale is based on studies conducted in the summer months in inland waters of Washington and British Columbia. Diets of Southern Resident killer whales that were determined from scales, tissue, and fecal samples collected near the San Juan Islands and the Strait of Juan de Fuca show that the whales primarily consume large Chinook salmon from May to October even when other salmon species are more abundant (Ford and Ellis 2006; Hanson et al. 2010) (Table 3-32). Southern Resident killer whales spend a large proportion of their time during these months in inland marine waters, including, in particular, the west side of San Juan Island, the Strait of Georgia, and the Strait of Juan de Fuca (Ford and Ellis 2006; Hauser et al. 2007; Hanson and Emmons 2011). During this period, their diet consists of more than 83 percent Chinook salmon and 14 to 15 percent other salmon species (steelhead, chum salmon, sockeye salmon, and coho salmon) (Hanson et al. 2010). Ford and Ellis (2006) found that killer whales captured older (i.e., larger) than average Chinook salmon. Despite the greater abundance of pink salmon and sockeye salmon compared to Chinook salmon, these two species were rare in samples of Southern Resident killer whale prey remains (Hanson et al. 2010; Hanson 2011).

TABLE 3-32. SUMMARY OF IMPORTANT SOUTHERN RESIDENT KILLER WHALE PREY.

MONTH(S)	IMPORTANT PREY SPECIES (%)	SAMPLE LOCATION(S)	CITATION
May to October	Chinook salmon (71)[1]	Southeast Vancouver Island	Ford and Ellis 2006; Ford et al. 2010
May to September	Chinook salmon (83)[2]	San Juan Islands; Strait of Juan de Fuca	Hanson et al. 2010
October to January	Chinook salmon (52)[2] Chum salmon (47)[2]	Puget Sound	Hanson 2011; Hempelmann et al. 2012
February to April	Chinook salmon Chum salmon Steelhead	Strait of Georgia Strait of Juan de Fuca Washington coast	Hanson 2011; Ford 2012 Northwest Fisheries Science Center 2013

[1] Percent of salmon prey (scales and tissues) identified to species.
[2] Percent determined by quantitative DNA cloning (percent of DNA in sample; all species).

Genetic studies indicate that Fraser River Chinook salmon stocks are an important component of the Southern Resident killer whale summer diet near the San Juan Islands and the western Strait of Juan de Fuca, British Columbia (NMFS 2008b; Hanson et al. 2010). Of the Chinook salmon prey remains sampled by Hanson et al. (2010) in these areas from May to September, 80 to 90 percent were inferred to have originated from the Fraser River and 6 to 14 percent were inferred to have originated from Puget Sound rivers. Thus, during the summer months, Southern Resident killer whales forage primarily on Chinook salmon stocks that are entering the Strait of Juan de Fuca or the Georgia Strait en route to spawning streams in the Fraser River system and streams that drain into Puget Sound (Hilborn et al. 2012).

Southern Resident killer whale feeding events were sampled from October to January in Puget Sound from Tacoma to northern Admiralty Inlet (Hanson 2011; Hempelmann et al. 2012). During this period, chum salmon comprised a larger portion of the diet than during summer months (Table 3-32). There is little information about diet composition and selectivity in winter to early spring months when Southern Resident killer whales are more often present in the Pacific Ocean (Hilborn et al. 2012). Two Southern Resident killer whale prey samples collected during March on the Washington coast were Columbia River Chinook salmon (Hanson 2011); samples obtained during February and March in the Strait of Georgia were Chinook salmon, and one sample obtained in April in the Strait of Juan de Fuca was a steelhead (Ford 2012). Preliminary results of a 2013 winter Southern Resident killer whale and ecosystem cruise study (performed in March 2013 by the Northwest Fisheries Science Center) indicate that the whales preyed primarily on Chinook salmon, but they also fed on steelhead and chum salmon (Northwest Fisheries Science Center 2013). Chinook salmon prey originated from multiple stocks including Klamath River, Lower Columbia Springs, Middle Columbia Tule, Upper Columbia Summer/Fall, and North and South Puget Sound.

The extent to which Southern Resident killer whales depend on specific salmon runs or populations throughout their range over the course of the year is not known, and it is likely to vary depending on fish availability. At different times of the year, Southern Resident killer whales may consume Chinook salmon that originate in the Fraser River, Puget Sound, Washington and Oregon coastal streams; the Columbia River, and central California streams (Hanson et al. 2010; Hanson 2011; Ford et al. 2012), but data are insufficient to identify the proportion of different Chinook salmon populations in their year-round diet. In addition to data obtained from prey remains described above, observations of Southern Resident killer whales in various parts of their range suggest that they may be exploiting locally available prey. For example, sightings of Southern Resident killer whales off Westport, Washington, and in the mouth of the Columbia River may coincide with the spring Chinook salmon run in the Columbia River (Krahn et al. 2004; Zamon et al. 2007; NMFS 2008b). Additional indirect evidence from contaminant signatures in blubber of some killer whales suggests that fish from California waters form a significant portion of their diet (Krahn et al. 2007, 2009).

The relationship between availability of salmon species and the nutritional condition, fecundity, and survival of Southern Resident killer whales was reviewed recently by an independent science panel convened by National Oceanic and Atmospheric Administration (NOAA) Fisheries and Fisheries and Oceans Canada (Hilborn et al. 2012). The panel acknowledged correlations between overall Chinook salmon abundance and Southern Resident killer whale survival rates and fecundity (Ford et al. 2009; Ward et al. 2013). However, the panel cautioned against assuming that there is a simple linear causative relationship between Chinook salmon abundance and the status of Southern Resident killer whales.

The association of Southern Resident killer whales with Chinook salmon in inland marine waters during summer months, even when other salmon species are more abundant, has been well documented. Recent studies establish the importance of chum salmon from October through January. Predation on Chinook salmon and chum salmon from February through April is less well documented, but it appears to be consistent with preferences observed in other months. There is no evidence that Southern Resident killer whales distinguish between hatchery-origin and natural-origin salmon (NMFS 2008c). Partial compensation by hatcheries for declines in natural-origin salmon populations may have benefitted Southern Resident killer whales (NMFS 2008b).

Although Chinook salmon and chum salmon are selected with much greater frequency than other prey species of Southern Resident killer whales, other salmon and steelhead are also prey items during specific times of the year. Thus, all species of hatchery-origin salmon and steelhead may contribute to the diet of Southern Resident killer whales throughout the year.

3.5.3.1.2 Marbled Murrelet

Marbled murrelets range along the Pacific coast from Alaska to California. The southern end of their breeding range is central California (USFWS 1997). Most recent population estimates in 2008 were 18,000 birds distributed throughout their range (USFWS 2009). Marbled murrelets are less abundant near the Columbia River than in other parts of coastal Oregon and Washington and inland waters of Puget Sound (Thompson 1999; McShane et al. 2004).

Marbled murrelets are opportunistic feeders that consume a wide variety of fishes in marine habitats (Burkett 1995). The diet of marbled murrelets includes forage fish (such as immature Pacific herring, sand lance, northern anchovy, capelin, and eulachon species), squid, and large pelagic crustaceans (such as euphausiids, mysids, and amphipods) (Burkett 1995; Ostrand et al. 2004). Salmon smolts (not identified to species), immature rockfish, and eulachon are also taken, but no information was found specific to marbled murrelet prey base within the Columbia River Basin. McShane et al. (2004) reviewed evidence of predation on salmonids in freshwater habitats, but the examples cited were not in the Columbia River Basin, and there is no evidence indicating that marbled murrelets forage in freshwater habitats in the analysis area. Varoujean and Williams (1995) observed fewer than 10 marbled murrelets during aerial surveys in the saltwater Columbia estuary, and USFS (2008) does not indicate the presence of marbled murrelets within the Columbia River Basin in their mapping of populations in Washington and northern Oregon.

3.5.3.2 Transfer of Toxic Contaminants and Pathogens

Wildlife that consumes salmonid and steelhead could be affected by the transfer of toxics and/or pathogens from the fish. Use of disinfectants, therapeutic chemicals, anesthetics, and pesticides at hatchery facilities is regulated by the Food and Drug Administration (FDA) and EPA and is subject to permit approval. As described in Section 3.6, Water Quality and Quantity, and Section 3.7, Human Health, safety measures specific to these chemical products, along with Federal and state Occupational Safety and Health Administration regulations, serve to limit human exposure to potentially hazardous concentrations. By extension, exposure of wildlife species to chemicals used in hatchery facilities is also minimized.

There is considerable evidence of bioaccumulation of persistent organic pollutants, including dichlorodiphenyltrichloroethane (DDT; and its metabolite 4,4'-dichlorodiphenyldichloroethylene [4,4'-DDE]) and polychlorinated biphenyls (PCBs), in fish-eating birds and other wildlife that use the Columbia River estuary. Birds containing these substances include bald eagles and osprey (Anthony et al. 1993; Henney et al. 2003; Buck et al. 2005). High levels of PCBs and DDT are also documented in Southern Resident killer whales (Ross et al. 2000; Ylitalo et al. 2001), which are at the top of the food chain and have a long life expectancy. Available information does not indicate that fish hatcheries introduce these contaminants into the environment, but hatchery-origin, as well as natural-origin, salmon and steelhead may pass contaminants on to wildlife predators (Lower Columbia River Estuary Partnership [LCREP] 2005). Both hatchery-origin and natural-origin salmon ingest contaminants that occur in rivers (LCREP 2005), and several stream segments in the Columbia River Basin are on the Washington, Oregon, and Idaho state 303(d) lists for dieldrin, total PCBs, mercury, DDT, and other contaminants. See the following websites for additional information:

- http://www.ecy.wa.gov/programs/wq/303d/index.html
- http://www.deq.state.or.us/wq/assessment/assessment.htm
- https://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx (Section 3.6.3.2.1, Federal Regulations)

PCBs, dieldrin, and mercury have been found in fish tissue collected in river segments of the Columbia River Basin (Section 3.6, Water Quality and Quantity). Direct uptake of organic contaminants from water to fish is a minor accumulation pathway, and the major source of contamination in salmon and steelhead is probably their diet (NMFS 1993). In a recent study, contaminants in prey of out-migrant juvenile Chinook salmon in the Columbia River estuary appear to have contributed substantially to levels of DDT and PCBs (Johnson et al. 2007). The prey base for natural-origin salmonid and steelhead would be the same as for hatchery-origin fish following release. There is some potential for elevated contaminant loads to occur in hatchery-origin fish prior to their release due to their ingestion of fish feed; however, data are insufficient to determine if fish feed increases contaminant loading in hatchery-origin fish compared to natural-origin salmonids (Johnson et al. 2007).

Diseases in hatchery-origin fish are caused by viral, bacterial, and parasite pathogens that are also present in natural-origin salmonid populations (McVicar et al. 2008). Little information was found in the literature indicating that fish diseases injure or kill wildlife, although some fish diseases or parasites use wildlife as intermediate disease hosts or vectors (McVicar et al. 2008). One exception is salmon poisoning disease, a rickettsial disease borne by salmonids that sickens dogs, wild canids, and possibly other carnivores that ingest infected raw fish (Ettinger and Feldman 1995). Hatchery facilities and hatchery practices have not been identified as contributing to this disease.

3.5.4 Non-listed Birds

A variety of birds (bald eagles, gulls and terns, cormorants, loons, grebes, ducks, and other fish-eating birds) forages on salmon and steelhead in various life stages, including salmon carcasses, along the Columbia River and in the Columbia River estuary (Table 3-30). Some species (such as the double-crested cormorant) are year-round residents, while others (such as the common goldeneye) occur primarily during winter and migration. Trends in abundance for these birds vary by species (Table 3-30). With regard to hatchery operations, factors that affect distribution and abundance of non-listed bird species include prey sources and distribution of food resources, transfer of toxins and pathogens, and hatchery predator control programs.

3.5.4.1 Distribution of Non-listed Birds and Their Food Resources

Hatchery-origin fish provide a source of prey to avian predators, particularly in areas where the fish congregate, including release sites, tailraces of dams, and the Columbia River estuary. Some of the consumption of hatchery-origin salmon by predators occurs in ocean waters outside the analysis area, but much of the consumption occurs in the Columbia River estuary and interior regions. Within hatcheries, hatchery-origin fish are protected from predators by a variety of methods (e.g., bird netting and electric wires) (Section 3.5.4.3, Hatchery Predator Control Programs and Weirs).

3.5.4.1.1 Bald Eagle

Bald eagles (protected under the Bald Eagle and Golden Eagle Protection Act) are common along the Washington and Oregon coasts and freshwater rivers and streams at lower elevations (Marshall et al. 2006; Smith et al. 1997). Bald eagles that breed along the lower Columbia River are year-round residents and do not migrate. These bald eagles exhibited low reproductive success characteristic of a declining population in a study Anthony conducted in 1993 (Anthony et al. 1993). High contaminant concentrations (DDE, PCBs, and dioxins) were thought to account for this population's low productivity (Anthony et al. 1993). Nonetheless, the resident population has recently increased, likely as a result of recruitment of new adults from other areas (Watson et al. 2002). In addition to the resident population, migrant bald eagles from other regions overwinter on the lower Columbia River.

Breeding bald eagles are uncommon in eastern Washington, Oregon, and Idaho, although scattered pairs nest along lakes, reservoirs, and rivers (Stinson et al. 2007; Pacific Biodiversity Institute 2008). In winter, migrant bald eagles move into the region, focusing on salmon spawning streams and waterfowl wintering areas. In eastern Washington and Idaho, the reservoirs and major tributaries of the Columbia River and Snake River are important wintering habitats (Stinson et al. 2001).

The diet of bald eagles is diverse, in part because eagles can be active predators, scavengers, and carrion feeders, and they often steal prey from other predators (Stinson et al. 2007). Their diet can also vary by season and geographic location. Information on bald eagle prey within the Columbia River estuary is sparse, but one study found that prey delivered to nests consisted primarily of fish, of which suckers, American shad, carp, and salmonids were the most common items (Watson et al. 1991). Evidence of bald eagle predation on juvenile salmonids (not identified to the species level) during June coincided with juvenile outmigration through the estuary. Historically, bald eagles fed on salmon carcasses near the mouth of the Columbia River in late summer and fall, but it is unknown which species were consumed (Stinson et al. 2007).

Information on bald eagle diet in Interior Columbia River Basin is also limited, but available studies indicate bald eagles take a diverse array of fish, birds, and mammals. Prey delivered to nests at Lake Roosevelt consisted primarily of fish, including suckers, hatchery-origin rainbow trout, and kokanee (Stinson et al. 2001). Food habits of wintering bald eagles at reservoirs on the Columbia River from John Day Dam to the confluence of the Yakima River consisted primarily of waterfowl and gallinaceous birds, carrion, and a variety of mostly non-salmonid fish (Knight et al. 1979; Fielder 1982). Salmon carcasses may, however, be consumed when available (Fitzner et al. 1980; Fitzner and Hanson 1979).

Salmon carcasses are likely to be an important bald eagle food source on spawning streams. In addition to natural-origin salmon and hatchery-origin salmon that die in streams in the analysis area, hatchery operators also distribute hatchery-origin salmon carcasses from their hatchery facilities. In Washington State, hatchery employees annually distributed salmon carcasses to upstream river reaches starting in 1996. Over the next 15 years, the program distributed more than 808,000 carcasses into streams across the state (WDFW 2014). Oregon hatchery program employees have also placed hatchery-origin salmon carcasses in Oregon streams. For example, ODFW placed 34,277 carcasses in Oregon streams from 2006 to 2007 (ODFW 2007). However, out-planted hatchery-origin carcasses comprise a small proportion of the total available carcasses in freshwater streams.

3.5.4.1.2 Other Birds

Glaucous-winged gulls, western gulls, California gulls, and ring-billed gulls are predators of salmon (Roby and Collis 2008; Cederholm et al. 2001). Gull species are common throughout the analysis area. They nest on islands in the Columbia River estuary where they consume substantial numbers of juvenile salmon and steelhead, with proportions in their diet apparently a function of the nesting location (Collis et al. 2001). Glaucous-winged gulls and western gulls nesting on Rice Island (RM 21) consumed mostly non-salmonid riverine fishes, but they also consumed salmonids (11 percent of their diet in the late 1990s). Gulls nesting on East Sand Island consumed primarily marine fishes and a smaller percentage of salmon and steelhead smolts (4.2 percent of the diet in the late 1990s). California gulls and ring-billed gulls are more numerous in the mid Columbia region than in the Columbia River estuary, and they outnumber other colonial piscivorous birds (such as Caspian terns and double-crested cormorants) on or near the mid and upper Columbia River above the Dalles Dam (Collis et al. 2001). However, these gulls consume few fish and fewer juvenile salmonids compared to Caspian terns or double-crested cormorants nesting along the mid Columbia River (Roby and Collis 2012).

Caspian terns and double-crested cormorants are the most important avian predators of salmon and steelhead in the Columbia River Basin, both in terms of the number of juvenile fishes consumed and the proportions they comprise in the predators' diets. Most information on their diet comes from studies of Caspian terns and double-crested cormorants nesting on islands in the Columbia River estuary and the mid Columbia River (reviewed in LCFRB 2004; Roby and Collis 2008, 2011, 2012). While Caspian terns are not an ESA-listed species, they are of concern because breeding Caspian terns are concentrated at relatively few sites, and they consume large proportions of outmigrating juvenile salmon and steelhead in the Columbia River (LCFRB 2004; Roby and Collis 2008). The Caspian tern colony on East Sand Island in the Columbia River estuary (RM 5) is the largest nesting colony of Caspian terns in the world. The colony consisted of approximately 10,000 breeding pairs in 2007 and 2008 (Portland Audubon Society 2008; NW Fishletter 2009) and declined to about 7,000 breeding pairs in 2011 (Roby and Collis 2012). The Caspian tern colony on East Sand Island did not produce fledglings in 2011, likely due to disturbance by bald eagles and associated gull predation on eggs and chicks (Roby and Collis 2012). Smaller colonies located on islands farther upstream in the Columbia River plateau region include Crescent Island (McNary Pool) and Goose Island on Potholes Reservoir with fewer than 500 pairs for each colony (Roby and Collis 2008, 2011, 2012) and Rock Island (John Day Pool) with less than 100 pairs (Roby and Collis 2008).

Breeding Caspian terns eat almost exclusively fish, including anchovy, herring, salmonids, shiner perch, sand lance, sculpins, eulachon, and flatfish (Roby and Collis 2008). The proportion of salmon and steelhead in their diet varies depending on location of the nesting colony. Juvenile salmon and steelhead comprised about 30 percent of prey items taken by East Sand Island terns from 2000 to 2010 (Roby and Collis 2012), and the remainder of the diet typically included marine forage fishes, such as northern anchovy, shiner perch, and Pacific herring (Roby and Collis 2008). In 2011, Caspian terns nesting on East Sand Island consumed an estimated 4.8 million juvenile salmonids, which is lower than the 11-year average, but not significantly different from smolt consumption estimates from the previous 2 years (Roby and Collis 2012). Predation rates on steelhead were 2 to 12 times higher than those for other salmon species and run types. In comparison, salmon and steelhead juveniles accounted for 74 percent of the diet of a similar-size Caspian tern nesting colony on Rice Island (RM 21) (Collis et al. 2002). This colony was relocated in 1999/2000 through habitat removal to reduce predation intensity on outmigrating salmon and steelhead.

The smaller Caspian tern colony on Crescent Island in the McNary Pool (RM 318) also consumed a large proportion of juvenile salmon and steelhead: 63 and 69 percent of identified prey items were salmonid smolts in 2006 and 2007, respectively (Roby and Collis 2008). Caspian terns nesting in the mid and lower Columbia River show a strong relationship with juvenile salmon and steelhead in terms of numbers of juveniles consumed and the proportion of salmon in their diet.

In 2008, USACE began implementation of a program to disperse the Columbia River estuary nesting population on East Sand Island to alternate nesting sites in California and Oregon with the objective of reducing the predation impact on Columbia River salmon and steelhead stocks (USACE 2008). Since early 2008, eight new islands were constructed as alternative nesting sites in interior Oregon and the Upper Klamath Basin of northeastern California (Roby and Collis 2012).

Double-crested cormorants are also important avian predators of salmon and steelhead on the Columbia River considering the number of juvenile fishes consumed. The double-crested cormorant colony on East Sand Island consisted of about 13,770 breeding pairs in 2007 and has remained at about 13,000 breeding pairs in 2010 and 2011, making it the largest known nesting concentration of this species in the world (Portland Audubon Society 2008). Prey items identified at this colony included a variable portion of salmonids (ranging as high as 25 percent in 1999, but lower than 20 percent in subsequent years); marine forage fish (northern anchovy) and estuarine resident fish (sculpin, flounder) comprised over 50 percent of the diet. Double crested cormorants nesting on East Sand Island consumed approximately 20 million juvenile salmonids in 2011, the highest annual estimate of smolt consumption for this colony. All species of anadromous salmonids from all run types (fall, winter, summer, and spring) and all tagged ESUs were represented in the prey of the East Sand Island cormorant colony in proportion to their relative availability (Roby and Collis 2008).

Brandt's cormorants and pelagic cormorants are residents within the Columbia River estuary and are believed to feed on salmon and steelhead in this area (Cederholm et al. 2001), but the importance of salmon and steelhead has not been established for these species. During the past 2 years, smolt consumption by double-crested cormorants nesting on East Sand Island was significantly greater than smolt consumption by Caspian terns at that site. Agencies and tribal fisheries staff are developing a management plan to control cormorant predation in the Columbia River estuary (Roby and Collis 2012).

Smaller cormorant colonies above McNary Dam on the mid Columbia River and at the Potholes Reservoir in eastern Washington also consumed salmon smolts. Diet data for Foundation Island (RM 323) in McNary Pool from 2005 to 2010 indicated that about 50 percent of their diet was juvenile salmonids during May (the peak of smolt out-migration), while less than 10 percent of their diet was salmonids during early April, June, and July (Roby and Collis 2012). The diet of overwintering cormorants in the upper Columbia River Basin (including the Snake River) is less well known. Juvenile salmonids comprised about 12 percent of the diet of overwintering cormorants that forage at dams on the lower Snake River (Roby and Collis 2008).

A more recent study found that overall diet composition of cormorants varied highly and changed as winter progressed (Roby and Collis 2012). Although a relatively small proportion of fall Chinook salmon were consumed (3.4 percent by mass), the bulk of the diet of over-wintering cormorants consisted of non-native fishes that compete with or depredate juvenile salmonids (Roby and Collis 2012). Nesting double-crested cormorants have a strong relationship with juvenile salmon and steelhead in the lower and mid Columbia River in terms of numbers of juvenile salmon consumed, but over-wintering cormorants in the upper basin probably do not have this relationship.

Predation on salmon and steelhead smolts by American white pelicans nesting on Badger Island in the mid Columbia River was relatively minor compared to predation rates of Caspian terns and double-crested cormorants in the mid Columbia region (Roby and Collis 2012). This predator does not appear to have a close association with salmon and steelhead.

Non-breeding brown pelicans occur along the Pacific Northwest coast from June to October. In Washington, their numbers are highest at communal migration roosts near the mouth of the Columbia River, including East Sand Island, and on the ocean coastline in Washington (Opperman 2003; Seattle Audubon Society 2005). Their diet on the West coast consists of schooling anchovies, eulachon, herring, Pacific mackerel, minnow, and sardines (Monterey Bay Aquarium 2003; Seattle Audubon Society 2005; NatureServe 2008).

Other predators on juvenile salmon and steelhead include loons, grebes, and ducks. Cederholm et al. (2001) considered that harlequin ducks have a strong relationship with salmonid eggs, alevins, and smolts, although available information on the Columbia River Basin did not indicate that salmon and steelhead were an important component of their diet. This migratory species breeds in fast-flowing mountain streams in the upper Columbia and Snake River Basins, where most prey consists of aquatic insects, although some alevins and salmon eggs are also eaten (Robertson and Goudie 1999). Their winter range includes the Columbia River estuary where their prey is benthic invertebrates.

Although Cederholm et al. (2001) indicated that goldeneyes have a recurrent relationship with salmon, no additional information on the proportion of salmon and steelhead in their diet has been published. Common and red-breasted mergansers are considered important predators of salmon and steelhead, based on studies in British Columbia (Cederholm et al. 2001); however, the importance of salmon and steelhead in the diet of mergansers within the Columbia River Basin has not been well documented. Salmon and steelhead comprised 20 percent of common merganser prey on the Yakima River only in fall and winter; in spring, common mergansers consumed primarily sculpin and chiselmouth (Phinney et al. 1998).

Osprey nest in large shoreline trees and other tall artificial structures that occur along the lower Columbia River in spring and summer, feeding almost exclusively on fish in proportion to their availability. In the lower Columbia and Willamette Rivers, largescale suckers and northern pikeminnow accounted for approximately 90 percent of the biomass in the osprey diet (Henny et al. 2003; LCFRB 2004). Other predators of salmon and steelhead consist of great blue herons, which are residents of shorelines and shallow waters (including fish hatcheries), as well as resident belted kingfishers, crows, and ravens that occur throughout the analysis area and have a recurrent relationship with salmon and steelhead (Cederholm et al. 2001).

Numbers of avian predators of salmon and steelhead have increased as a result of nesting habitat and feeding opportunities created by dredge spoil deposition in or near estuaries (which creates nesting habitat), reservoir impoundments, and tailrace bypass outfalls associated with hydroelectric projects (NMFS 2008a). Because the birds' breeding seasons coincide with outmigrating juvenile salmon, the birds can easily exploit this prey base. Stream-type juvenile salmon, especially yearling smolts from spring-run populations, are vulnerable to bird predation in the estuary because they tend to use the deeper, less turbid water over the channel, which is located near habitat preferred by piscivorous birds (Fresh et al. 2005). Recent research shows that subyearlings from the Lower Columbia River Chinook Salmon ESU are especially subject to tern predation, probably because of their long estuarine resident time (Ryan et al. 2003). Hatchery-origin yearling Chinook salmon and steelhead are more vulnerable to tern predation than their natural-origin counterparts in some years because they tend to reside closer to the water surface where terns forage (Collis et al. 2001).

3.5.4.2 Transfer of Toxic Contaminants and Pathogens

The potential for transfer of toxins and pathogens to avian predators is the same as described for ESA-listed species (Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens).

3.5.4.3 Hatchery Predator Control Programs and Weirs

The primary avian predators associated with operation of hatchery facilities are bald eagles, great blue herons, kingfishers, gulls, mergansers, and cormorants (ODFW 1992; Price and Nickum 1995; U.S. Department of Agriculture 1997). To minimize predation on fish at hatcheries, operators employ techniques to deter and control predators. These techniques include non-lethal, passive, exclusionary-type devices (such as bird netting and electric wires). In some cases, harassment of the birds using pyrotechnics or a trained falcon is also employed. These control programs are used at hatchery rearing ponds and net pens where predator control is needed, and their use is at the discretion of hatchery operators. Records of the number of injuries and deaths to other avian predators from control measures at the hatcheries are not available.

In addition to avian predators, river otters and mink are common predators at hatchery facilities (J. Kerwin, pers. comm., WDFW, Wildlife Biologist, February 18, 2004; USFWS 2011). The hatcheries employ non-lethal, passive, exclusionary-type devices (e.g., otter fencing), as well as trapping, to inhibit or prevent these predators from taking hatchery salmon. Effective predator control devices at hatcheries result in lost foraging opportunities for individual predators at the hatcheries, but it has not been demonstrated that these devices impact overall wildlife populations in the analysis area.

Weirs and fish-ladder trap combinations associated with barriers (such as dams) are used to block upstream migration to collect hatchery broodstock and to separate hatchery-origin fish from natural-origin fish to meet management objectives. Weirs and traps used for broodstock collection may be seasonal or permanent, and their effects on non-target fish and aquatic species would depend on the timing of their use in streams. For example, weirs may delay migration or block the movements of other aquatic wildlife species, isolating formerly connected areas and potentially fragmenting populations.

The distribution of predators may be affected by changes in the occurrence of aquatic prey populations in streams affected by weirs and traps. Weirs may alter streamflow, streambed, and riparian habitat, and they may affect habitat availability for non-target fish, amphibians, and aquatic invertebrates. Weirs may facilitate predation by mammals and birds on salmon and steelhead by blocking fish passage and concentrating fish into confined areas. The effects of weirs and traps on non-target aquatic wildlife species may be advantageous to wildlife that preys on fish and detrimental to those aquatic wildlife species that travel along the stream corridor where the weirs are located. However, no studies have been conducted to date demonstrating that weirs are negatively impacting wildlife populations.

3.5.5 Marine Mammals

In addition to the Southern Resident killer whale (Section 3.5.3, ESA-listed Species), three other marine mammal species, Steller sea lions, California sea lion, and harbor seal, forage on salmon in the analysis area (Table 3-31). A fourth marine mammal species, the harbor porpoise, occurs in the analysis area, but because no information was found in the literature indicating that the harbor porpoise feeds on salmon and steelhead, the species is not discussed further in this EIS.

Trends in abundance indicate that California sea lion, Steller sea lion, and harbor seal populations have increased overall in recent years (Table 3-31). Relevant to hatchery operations, factors that affect distribution and abundance of California sea lions and harbor seals include prey resources and distribution of food resources, transfer of toxins and pathogens, and hatchery predator control programs.

3.5.5.1 Distribution of Marine Mammals and Their Food Resources

Salmon benefit California sea lions, Steller sea lions, and harbor seals by providing a source of prey. Marine mammals are known to change their distribution in response to salmon abundance and distribution. Similar to other species that prey on salmon, foraging success of California sea lions, Steller sea lions, and harbor seals is expected to be particularly high where fish congregate, such as dam tailraces and estuaries.

3.5.5.1.1 Steller Sea Lion

The eastern stock of Steller sea lions, a species protected under MMPA and recently delisted under ESA, is resident year-round on the coasts of Oregon and Washington and from the mouth of the Columbia River up to Bonneville Dam (NMFS 2008d, e). No Steller sea lion rookeries (i.e., mating areas) exist near the Columbia River, but individuals use the South Jetty at the mouth of the river as a haul-out site year-round (Jeffries et al. 2000). Numbers vary seasonally, with peak counts of approximately 1,000 Steller sea lions during fall and winter months (NMFS 2008a).

Historically, eastern stock Steller sea lions were rarely observed upstream of the mouth of the Cowlitz River (Columbia RM 70), but in recent years, they have appeared in increasing numbers at Bonneville Dam (RM 146) from January to May. First observed in the dam's tailrace in 2003, numbers of Steller sea lions have gradually increased from 3 individuals observed in 2003 to as many as 89 individuals observed during the 2011 peak year. The annual counts of individuals were lower in 2012 (73 individuals) (Stansell et al. 2012) and 2013 (over 80 individuals) (Stansell et al. 2013) but, nonetheless, remain high relative to the early 2000s. The maximum daily estimated number of Steller sea lions present at Bonneville Dam peaked in 2010 at over 50 animals on a given day and has been lower, but still above pre-2010 numbers, in subsequent years.

Steller sea lions forage opportunistically on a wide variety of fish species in response to seasonal abundance. For example, Steller sea lions prey on white sturgeon, adult Chinook salmon, and Pacific lamprey in the tailrace of Bonneville Dam on the Columbia River (Stansell et al. 2012), where migrating fish are concentrated and likely more easily consumed than in a natural setting. From foraging studies in the lower Columbia River and at Pacific Northwest coastal sites, authors describe a variety of Steller sea lion prey species, including Pacific whiting, rockfish, eulachon, Pacific hake, anchovy, Pacific herring, staghorn sculpin, salmonids, octopus, and lamprey (Jeffries 1984; NMFS 2008e). From another study, adult salmon and steelhead remains were found in 25 percent of Steller sea lion scat samples, American shad were found in 25 percent of samples, and white sturgeon were found in 50 percent of samples (NMFS 2008f).

White sturgeon were the most commonly observed prey of Steller sea lions prior to the appearance of spring Chinook salmon in April, after which Chinook salmon appeared to become the preferred prey (Stansell et al. 2011, 2012). Steelhead were taken in smaller numbers throughout the observation period. The estimated number of adult salmon and steelhead consumed by pinnipeds altogether increased overall through 2010, with declines in California sea lion consumption and increases in Steller sea lion consumption in subsequent years. At the peak of pinniped consumption of adult salmon passing through Bonneville Dam in 2007, they collectively consumed an estimated 4.7 percent of all salmon and steelhead. Steller sea lions were estimated to have consumed 0.6 percent and 0.8 percent of the adult salmon and steelhead runs from January 1 to May 31 in 2011 and 2012, respectively, compared to 1.2 percent California sea lions consumed in 2011 and 0.6 percent they consumed in 2012 (Stansell et al. 2011, 2012).

The increasing numbers and salmon and steelhead predation by sea lions at Bonneville Dam are a management concern with respect to natural-origin salmon populations (Pinniped-Fishery Interaction Task Force 2007; NMFS 2008f). While current trends indicate lower numbers of California sea lions at this site since 2010 due to management action and other factors discussed in Section 3.5.5.1.1, California Sea Lion, overall salmon predation by pinnipeds may remain high if Steller sea lion predation replaces predation by California sea lions.

3.5.5.1.2 California Sea Lion

California sea lions (protected under MMPA) range from the Pacific coast of central Mexico north to British Columbia, Canada. Their primary breeding range is from the Channel Islands in southern California to central Mexico (Lowry and Forney 2005). California sea lions do not breed within the Columbia River; during the breeding season, they leave the river and move south to breeding grounds in California. California sea lions have increased in abundance and distribution in the Columbia River since the 1980s (NMFS 2008f; Carretta et al. 2012). Male sea lions (and a few non-breeding females) appear in the river seasonally from January through late May, ranging upriver as far as Bonneville Dam at RM 146. A 2006 survey WDFW conducted estimated up to

1,200 California sea lions in the lower Columbia River, and as many as 104 individuals have been estimated during a single season (2003) at the Bonneville Dam tailrace (Stansell et al. 2012). California sea lion numbers and salmon consumption have declined at Bonneville Dam since removal was authorized in 2008; 54 animals were removed through 2012. Annual estimates of California sea lion individuals have declined at Bonneville Dam since 2008: an estimated 54 individuals were present in 2011, 39 individuals in 2012, and approximately 60 individuals in 2013 (Stansell et al. 2011, 2012, 2013). The highest maximum daily estimated number of California sea lions peaked in 2007 at over 50 individuals and has been fewer than 30 individuals per day since 2009.

California sea lions are opportunistic feeders, and consumption of salmon by these pinnipeds varies by location, season, and year (NMFS 1997). NMFS (2008c) has summarized recent information on the diet of California sea lions in the Columbia River as follows. The diet of California sea lions in the estuary includes 10 to 30 percent salmonids and a variety of marine and estuarine prey, including squid, eulachon, herring, flatfish, perch, Pollock, hake, and rockfish. During spring migrations of eulachon, lamprey, salmon, and steelhead, California sea lions commonly follow prey upriver as far as Bonneville Dam. At the tailrace of Bonneville Dam, direct observations from 2002 to 2007 indicated that close to 79 percent of the fish that pinnipeds (primarily California sea lions) preyed upon were salmon, with the remainder consisting of lamprey (9.3 percent), sturgeon (4 percent), shad (1.2 percent), and unknown prey (6.6 percent) (NMFS 2008f).

At their peak of consumption on adult salmon passing through the Bonneville Dam in 2007, pinnipeds (primarily California sea lion) were estimated to have consumed 4.7 percent of all salmonids. The Pinniped-Fishery Interaction Task Force recommended implementation of management measures, including hazing programs and lethal or non-lethal removal, with the objective of reducing predation to 1 percent or less (Pinniped Fisheries Interaction Task Force 2007). The Task Force recommended removal of up to 85 California sea lions per year. In its 3-year review of the program, the Task Force acknowledged that predation rates had declined (1.8 percent in 2011 and 1.4 percent in 2012; reported by Stansell et al. 2012), while noting that fewer animals (40 individuals) were removed during the 3 years of implementation (2008 through 2010) (Pinniped Fisheries Interaction Task Force 2010). The Task Force concluded that factors other than removal of individuals influence the impact of sea lion predation. These factors are uncertain, fluctuate over time, and/or are outside the control of the program. Examples of such factors include fish-run size, the ratio of hatchery-origin fish to natural-origin fish; and other impacts limiting salmon abundance (e.g., hydropower operations, harvest, and habitat) and their relative contributions to recovery. The primary factor was the variation in run size from year to year. Nonetheless, the Task Force recommended maintaining the current authority to remove California sea lions under Section 120 of MMPA and strengthening the level of resources in the short term, while pursuing other longer term and effective strategies.

3.5.5.1.3 Harbor Seal

Harbor seals are abundant, year-round residents of coastal and estuarine waters in Washington and Oregon. They are present in the lower reaches of the Columbia River up to the Bonneville Dam year-round (Jeffries 1984). Harbor seal populations in Washington and Oregon have recovered from low levels in the 1960s following removal of the harbor seal bounty program and passage of MMPA. The current population estimate for the Oregon/Washington coast stock of harbor seals is 24,732 harbor seals (Carretta et al. 2007).

Harbor seals are nomadic and move from estuaries to coastal areas in response to seasonally abundant prey. Haul-out sites are located on sandbars and intertidal flats from the mouth of the Columbia River to as far inland as the Cowlitz River at Longview, Washington (RM 57) (Jeffries et al. 2000). Rookeries are in coastal estuaries, including the Columbia River estuary. Peak numbers of harbor seals are present at haul-out sites in the Columbia River from mid-December to April (Jeffries et al. 2000). These numbers and movements appear correlated with spawning runs of eulachon (LCFRB 2004). By May, use of most upriver haul-out ceases, and harbor seals return to the estuary and marine coastal areas.

Similar to the California sea lion, the diet of harbor seals in the Columbia River varies by season, including eulachon in the winter, and anchovy, Pacific herring, staghorn sculpin, starry flounder, and lamprey at other times of the year (Beach et al. 1985; Riemer and Brown 1997; NMFS 1997; Browne et al. 2002). NMFS (1997) summarized food habits studies in the Columbia River as follows: "Salmonids appear to be targeted as prey by harbor seals primarily in the spring and fall, possibly because they are abundant and available in the river at the time in contrast to the winter when eulachon are much more abundant." Juvenile Chinook salmon were taken in the spring (Reimer and Brown 1997; Browne et al. 2002), and Reimer and Brown (1997) also found that juvenile Chinook salmon were taken in the fall. Numerically, about 1 percent of the harbor seal diet was composed of salmon based on data in an older study along the Oregon coast, although total biomass would be about 10 percent because salmon are larger than other prey species (Park 1993).

In studies on the Columbia River, most salmonids consumed by harbor seals were juvenile Chinook salmon taken during the spring (the frequency of occurrence in samples was 19 percent), and adult salmon were consumed during the fall to a lesser extent (the frequency of occurrence in samples was 10 percent) (Browne et al. 2002). During summer months, the frequency of occurrence of adult and juvenile salmon in harbor seal scat samples was 4 percent and 5 percent, respectively. Like California sea lions, harbor seals follow prey upriver as far as the Bonneville Dam (NMFS 2008f).

3.5.5.2 Transfer of Toxic Contaminants and Pathogens

The potential for transfer of toxins and pathogens to marine mammals is the same as described for ESA-listed wildlife species (Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens).

3.5.6 Other Aquatic and Terrestrial Wildlife

In addition to the listed species and other birds and marine mammals discussed in the sections above, other wildlife species interact with salmon and steelhead (Table 3-32). Some of these animals (river otter and mink) are predators of salmon and steelhead, while others (marine invertebrates and insects) are prey. Some wildlife species are not direct predators or prey of salmon, but may be affected by prey availability and hatchery practices through effects on water quality, stream flow, nutrient and salmon carcass availability, or other factors.

Relevant to hatchery operations, factors that affect distribution and abundance of other aquatic and terrestrial wildlife include prey resources and distribution of food resources and hatchery predator control programs.

3.5.6.1 Distribution of Other Aquatic and Terrestrial Wildlife and Their Food Resources

As described for listed species, avian predators, and marine mammals, hatcheries may benefit other salmon predators by providing a source of prey, particularly where hatchery-origin fish congregate outside of the hatchery facilities (e.g., release sites, dam tailraces, and estuaries). At the hatcheries, predation success is expected to be generally low, due to implementation of predator control measures (Section 3.5.4.3, Hatchery Predator Control Programs and Weirs). Listed amphibians and invertebrates (Table 3-33) have not been cited as having a relationship with salmon and steelhead. Although salmon prey studies have not demonstrated salmon consumption of snails, there is anecdotal information that snails could be part of the diet of salmon, although minor, if occurring at all.

TABLE 3-33. STATUS AND HABITAT ASSOCIATIONS OF OTHER WILDLIFE IN THE ANALYSIS AREA WITH DIRECT OR INDIRECT RELATIONSHIPS WITH HATCHERY-ORIGIN SALMON.

	STATUS	HABITAT[1]			RELATIONSHIP WITH SALMON[2]		
SPECIES	FEDERAL (F) AND STATE (S) STATUS	FRESHWATER	ESTUARINE/ MARINE	RIPARIAN	PREDATOR	PREY	SCAVENGER
River otter	F: none S: none	√	√		√		
Mink	F: none S: none	√	√		√		√
Amphibians (e.g., salamanders)	Varies by species[3]	√		√	√		
Aquatic/terrestrial/ riparian zone invertebrates[3] (e.g., insects)	N/A	√	√	√		√	√
Marine invertebrates (e.g., zooplankton)[4]	F: none S: varies by species		√			√	

Source: Cederholm et al. (2001).

[1] Includes those habitats most relevant for evaluating interactions with salmon; does not include all habitats used by each species.

[3] Applicable listed species include federally listed frogs (Columbia spotted frog, *Rana luteiventris,* (Federal species of concern); Oregon spotted frog, *Rana pretiosa* (Federal species of concern and Washington State endangered species); large mountain salamander, *Plethodon larselli* (Federal species of concern and Washington State endangered species); northern leopard frog, *Rana pipiens* (Federal species of concern); western pond turtle, *Actinemys marmorata* (Federal species of concern).

[4] Applicable listed species include federally listed snails (Bliss Rapids snail, *Taylorconcha serpenticola*, (Federal threatened species); Banbury Springs lanx, *Lanx* sp., (Federal endangered species); Idaho springsnail, *Pyrgulopsis idahoensis* (Federal endangered species); Snake River physa snail, *Physa natricina* (Federal endangered species); Utah valvata, *Valvata utahensis* (Federal endangered species).

The river otter is a top predator of a wide variety of aquatic food chains from marine environments to montane lakes. It is found throughout the analysis area (LCFRB 2004). Otter prey vary seasonally, but the species is heavily dependent on a wide variety of fish, including salmonids (Melquist 1997; Hansen 2003). Cederholm et al. (2001) considered river otters to have a strong relationship with juvenile salmon, spawning salmon, and salmon carcasses. Mink also occur throughout the analysis area (Maser 1998). Mink consume salmon and steelhead, but they also consume other prey, and they are less specialized as fish predators than are otters (Melquist 1997).

Cederholm et al. (2001) identified two salamander species (which are amphibians) as having a recurrent relationship with salmonids in freshwater. The Pacific giant salamander is a common predator in its larval stage in headwater and mid-size streams in western Washington and Oregon, consuming invertebrates, larval amphibians, and small fish, which may include salmonid fry (Cederholm et al. 2001). Cope's giant salamander, a species that spends its entire life in small, steep-gradient streams in the Olympic Peninsula and southwestern Washington, may also prey on salmonids. Pacific giant salamanders have been found in small streams with juvenile coho salmon and steelhead, but their relationship (predator/prey or competitor) is unknown (Roni 2002). Neither species is a Federal or state listed species (Table 3-32).

Marine invertebrates that occur in the Columbia River estuary are consumed by juvenile salmon to an extent determined by each species' life history. For example, subyearling Chinook salmon have a long residence time in the Columbia River estuary (with peak numbers from May through September) and, thus, would be important predators on marine invertebrates. While in the estuary, Chinook salmon consume emergent insects, epibenthic crustaceans (e.g., mysids and amphipods), and freshwater pelagic zooplankton (Pearcy 1992; Bottom et al. 2005). These species are not either Federal or state listed species (Table 3-33).

Aquatic insects and terrestrial insects (which are invertebrates) are prey of salmon fry. Upon emergence from stream gravels, all species of salmon fry actively feed on dipterans, and chum salmon and Chinook salmon fry feed on stonefly and mayfly nymphs. Coho salmon fry are suspension and surface feeders whose diet is predominately terrestrial insects. In turn, aquatic insects (such as caddisflies, stoneflies, and midges) feed on salmon carcasses.

Macroinvertebrate communities in streams with salmon runs can increase in response to spawning activity because substrate disturbance during spawning opens niche space for blackflies, stonefly nymphs, and midge larvae, all of which are potential prey items for salmon. Nutrient enrichment from carcasses (Cederholm et al. 2001) and increases in aquatic invertebrate density from the introduction of salmon carcasses support feeding by early life stages of salmon species (Cederholm et al. 2001).

3.5.6.2 Transfer of Toxic Contaminants and Pathogens

The potential for transfer of toxins and pathogens to other aquatic and terrestrial wildlife is the same as described for ESA-listed wildlife species (Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens).

3.5.6.3 Hatchery Predator Control Programs

In addition to the avian predators discussed in previous sections, river otters and mink are common predators at hatchery facilities (J. Kerwin, pers. comm., WDFW, Wildlife Biologist, February 18, 2004; USFWS 2011). The hatcheries employ non-lethal, passive, exclusionary devices (e.g., otter fencing), as well as trapping, to inhibit or prevent these predators from taking hatchery-origin salmon (see Section 3.5.4.3, Hatchery Predator Control Programs and Weirs).

3.5.6.4 Hatchery Facility Effects

Hatchery facilities may indirectly alter water quality and quantity in streams where hatchery facilities are located. Hatchery operations may affect water volume and flow, particularly in bypass areas. Depending on existing habitat and the timing and degree of water flow alterations, habitat availability for stream-breeding amphibians (e.g., giant salamanders), crustaceans, and aquatic insects could be influenced by hatchery operations. Water diversions and water quality are regulated by water right permits, NMFS screening criteria, and NPDES permitting (Section 1.7.8, Clean Water Act).

Most hatchery facilities contain ponds for fish rearing or other purposes with asphalt or other lined walls that do not provide amphibian habitat. While amphibians can enter these ponds, in some instances, the animals may not be able to escape from the ponds, and they may eventually drown. Susceptibility of amphibians to mortality in hatchery ponds depends on the occurrence of the animals in the hatchery vicinity, the mobility of the species, the configuration of the pond walls, and the elevation of the pond water relative to the height of the walls. In addition, the presence of dense concentrations of fish makes these ponds generally unsuitable for breeding amphibians because of predation on larval amphibians.

Other potential sources of amphibian mortality at the hatchery facilities could include entrapment in fish screens and other exclusionary devices. Apart from ponds, hatcheries generally do not create slow-moving or still-water areas that could support native (e.g., rough-skinned newt and red-legged frog) and/or non-native (i.e., bullfrog), pond-breeding amphibians. The effects of hatchery ponds on amphibian populations, therefore, are minimal.

3.5.6.5 Nutrients/Distribution of Salmon Carcasses

Research in Pacific Northwest coastal streams indicates the importance of anadromous salmon and steelhead to freshwater and terrestrial food webs and ecosystem function (Kline et al. 1990; Willson et al. 1998; Cederholm et al. 2001; Gende et al. 2002; Hilderbrand et al. 2004). In addition to live salmon and steelhead consumed by wildlife predators, salmon carcasses provide a carrion food source for wildlife and a source of nutrients for other aquatic and terrestrial species through the decomposition of carcasses. The annual influx of anadromous fish transports energy and nutrients of marine origin to freshwater communities, where decomposer communities (algae, fungi, and bacteria) develop on salmon carcasses and provide food for freshwater invertebrates and insects, which in turn, are prey for juvenile fishes and their predators (Willson et al. 1998). The input of marine-derived nutrients, such as phosphorus and nitrogen, into streams is thought to substantially enhance productivity of many nutrient-poor coastal streams (reviewed by Willson et al. 1998) and riparian vegetation communities (reviewed by Hilderbrand et al. 2004). Because of the long migrations of some stocks of Pacific salmon, the link between marine and terrestrial production may be extended hundreds of miles inland; as salmon enter small tributaries to spawn, they are dispersed throughout watersheds (Gende et al. 2002).

Salmon-derived nutrients are distributed into the adjacent landscape by consumers such as scavenging birds and mammals and insects, as well as through surface and streambed-subsurface zone flows in streams. Ecological consequences of marine-derived nutrients vary among streams depending on nutrient limitations and heterogeneity in habitats and stream geomorphology. Truncation of marine-derived nutrient influx by dams and habitat destruction in the Columbia and Snake River Basins and reductions in numbers of spawning salmon and steelhead have likely impacted productivity historically in many freshwater and terrestrial systems (Gende et al. 2002).

Distributing hatchery-origin salmon carcasses to upstream river reaches can replace some of the nutrients in nutrient-deficient areas where spawning salmon and steelhead are limited or lacking. Hatchery operators obtain permits, as required, to out-plant salmon carcasses, the amount of which is based on hatchery production and other factors (Salmonid Enhancement and Habitat Advisory Board 2014). As mentioned above, hatcheries distribute approximately 160,000 to 180,000 salmon carcasses annually to upstream river reaches in Washington State (WDFW 2008). Similar practices also occur in Oregon, where carcasses are placed in a large number of Columbia River tributaries each year (ODFW 2007), as well as in Idaho (NMFS 2008b).

3.6 Water Quality and Quantity

3.6.1 Introduction

Successful operation of Federal, state, and tribal hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in the hatchery facility, is discharged to adjacent receiving environments. Operation of hatchery facilities may affect water quality parameters (e.g., temperature, pH, and nutrients) (Section 3.6.3.1, Water Quality Parameters) and/or the diversion and consumption of water (Section 3.6.4, Water Quantity). This section describes 1) the water quality parameters that could be affected by hatchery operations, 2) applicable water quality regulations for hatchery facilities, and 3) how hatchery operations could affect surface and groundwater near hatchery facilities.

3.6.2 Analysis Area

The analysis area for water quality and quantity is the same as the project area (Section 2.2, Description of Project Area). Information presented in Section 3.6, Water Quality and Quantity, is organized according to issue.

3.6.3 Water Quality

3.6.3.1 Water Quality Parameters

Hatchery production could affect several water quality parameters in the aquatic system. Concentrating large numbers of fish within hatcheries could produce effluent with elevated temperature, ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand (BOD), pH, and solids levels (Sparrow 1981; Washington State Department of Ecology [Ecology] 1989; Kendra 1991; Cripps 1995; Bergheim and Åsgård 1996; Michael 2003). Chemical use within hatcheries could result in the release of antibiotics (therapeutic medications), fungicides, and disinfectants into receiving waters (Boxall et al. 2004; Pouliquen et al. 2009; Martinez-Bueno et al. 2009). Other chemicals and organisms that could potentially be released by hatchery operations are PCBs, DDT and its metabolites (Missildine et al. 2005; HSRG 2009), pathogens (HSRG 2005; HSRG 2009), steroid hormones (Kolodziej et al. 2004), anesthetics, pesticides, and herbicides. Hatchery production could also affect stream flow near facilities through removal and release of existing water resources.

Each of the following sections describes the water quality parameters, explains how the parameter is transported from hatcheries into the aquatic system, and discusses potential effects on receiving waters. The water quality parameters discussed apply to water that could be transported from hatcheries to the aquatic system through discharges from operations (referred to as effluent), decomposition of hatchery-origin salmon carcasses placed in streams to enhance nutrient levels, and releases of large numbers of hatchery-origin salmon into receiving streams. Discharges from hatchery facilities are regulated under the CWA, as discussed later in this section. Planting carcasses and releasing hatchery-origin fish into streams are not regulated activities under the CWA.

Hatchery facility waste products include uneaten food, fecal matter, soluble metabolites (e.g., ammonia), algae, parasitic microorganisms, drugs, and other chemicals (Kendra 1991; Bergheim and Åsgård 1996; Idaho Department of Environmental Quality [IDEQ] 2008). Fish hatchery facility wastewater commonly includes suspended solids and settleable solids (those that settle out of suspension), as well as nutrients, such as various forms of nitrogen (e.g., ammonia) and phosphorus (Michael 2003). Effluent water quality could affect the health and productivity of receiving waters. Some of the chemical or physical parameters having the greatest potential to impact receiving waters are temperature, nitrogen, phosphorus, dissolved oxygen, pH, and solids, as described below (IDEQ 2002).

Some water quality parameters could also be affected by decomposition of salmon carcasses. Spawned-out salmon could occur either directly at the facility site (from hatchery-origin adults that return to a hatchery facility or net pen, but are not collected) or indirectly away from the facility site (from hatchery-origin adults that spawn naturally or hatchery-origin carcasses that are deliberately placed in streams by hatchery operators). The direct placement of spawned-out carcasses in a watershed is, in part, a response to research demonstrating that carcass-derived nutrients historically represented a critical contribution of marine-derived nutrients (particularly phosphorus) to the overall productivity of both aquatic and terrestrial components of the ecosystem (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs on Salmon and Steelhead Species, Section 3.5.6.5, Nutrients/Distribution of Salmon Carcasses) (Cederholm et al. 2001).

3.6.3.1.1 Temperature

The temperature of receiving waters adjacent to hatcheries could be affected by the discharge of warmer or colder water from these facilities. Salmon and steelhead require specific temperatures for growth, maintenance, and reproduction at the hatcheries. Water temperatures that fluctuate dramatically or move beyond the optimal range for each salmon life stage can cause stress, thereby reducing production efficiency, increasing disease susceptibility, and altering waste generation within the facility (IDEQ 2002). Thus, hatcheries may release water with a temperature that is optimum for hatchery operations, but differs from the receiving environment.

In addition, some hatchery facility effluents are diverted to settling basins before discharge to receiving waters. With little or no flow, water temperature within these settling basins could be increased by solar insulation before discharge (Kendra 1991). The amount of increase would depend on the retention time of water in the basin. When these hatchery facility effluents are released into nearby water bodies, there may be effects on the receiving water bodies if the effluent is warmer than the receiving water. The extent of the effect would depend on the absolute temperature difference, the volume of effluent released, and the size (water volume) of the receiving water body. To minimize this effect, if temperature of the receiving water is a concern, effluent discharge permits for hatcheries may specify effluent temperature limits, either just before discharge, or at the downstream end of a mixing zone in the receiving water. Recent monitoring of several hatcheries in Washington indicated that effluent from hatchery facilities would not have a reasonable potential to exceed water quality standards for temperature (Ecology 2010a).

3.6.3.1.2 Nutrients

Nutrients, such as various forms of nitrogen and phosphorus, are commonly recognized constituents of hatchery facility wastewater (Michael 2003). Nitrogen and phosphorus are recognized as potential limiting factors in many aquatic systems (Michael 2003); the quantity of these nutrients in an aquatic system could determine the amount of aquatic plant growth. Elevated levels of these nutrients encourage the growth of aquatic plants, which then changes the habitat. In addition, the growth of aquatic plants results in oxygen consumption that fish and other native plants need to survive (IDEQ 2008; Kendra 1991). An increase in nutrients could also change macrobenthic (e.g., insect) communities (species presence and/or abundance) downstream from effluent discharges, potentially affecting the availability of preferred prey resources (Camargo 1992).

In addition to nutrient concentrations in discharged effluent, nutrient levels in the receiving environment could also be affected through the release of organic matter (uneaten food, feces, and dead fish) in hatchery facility effluent, as well as the decomposition of spawned-out or deliberately placed salmon carcasses. As this organic matter decomposes, it consumes oxygen in the process and releases additional nutrients (nitrogen [as nitrate-nitrite and ammonia] and phosphorus) to the environment. Ammonia forms ammonium ion and un-ionized ammonia, which could be harmful or lethal to aquatic organisms. This toxic, un-ionized fraction varies with pH, temperature, and salinity, and it increases as the pH and temperature increase (IDEQ 2002). The decomposition of spawning salmon carcasses also results in the release of nutrients (primarily phosphorus) (WDFW 2004); however, such releases are considered beneficial because they are gradual, spread out over larger areas, and only occur around the spawning season (Cederholm et al. 2001). In contrast, hatcheries operate throughout the year, and the effluent discharge typically occurs at a single location. Thus, there are temporal and spatial components to natural delivery of these nutrients by spawning fish that nutrient delivery through wastewater does not duplicate (Michael 2003).

Most of the nutrients of concern in hatchery facility effluent are associated with solids (i.e., they are the result of organic matter from uneaten food and feces) in the effluent (Ecology 2010a). Investigations of treatment options have identified the process of settling solids (which allow removal of such solids) as the most cost-effective method to reduce the amount of nutrients in the effluent to an acceptable level (McLaughlin 1981; Michael 2003). Hatchery facilities typically use settling ponds to reduce the solids in their discharge effluent. With adequate removal of solids, there is a low risk of water quality violations from nutrients (Ecology 2010a). However, the risk of nutrient impairment from effluent discharged into a stream also depends on the physical and chemical characteristics of that stream.

3.6.3.1.3 Dissolved Oxygen

By far, oxygen is the most important dissolved gas in an aquatic environment because it is necessary to support life. Depleted dissolved oxygen levels could adversely affect receiving waters by reducing the productivity and usable habitat for aquatic species. Tolerances for dissolved oxygen conditions vary widely by aquatic species. While most aquatic organisms could survive brief periods at low oxygen levels, prolonged exposure could have adverse effects on organisms not adapted for such conditions (IDEQ 2002). Reduced dissolved oxygen could cause stress, making organisms less competitive and productive and, in severe cases, could result in direct mortality (Ecology 2005a).

Dissolved oxygen levels in an aquatic system could be reduced directly through the release of nutrients (nitrogen and phosphorus) from organic matter into the water column (Piedrahita et al. 1996). Indirectly, dissolved oxygen could be reduced by the decomposition of organic matter in hatchery facility effluent discharged into receiving waters or through the decomposition of salmon carcasses. The decomposition process uses oxygen, which is typically referred to as BOD. While not a specific compound, BOD is a measure of the amount of oxygen consumed by this biological process. It is used in modeling to assess the potential reduction of dissolved oxygen caused by effluent discharge into receiving water (Ecology 2010a).

Ecology initiated specific monitoring for dissolved oxygen in hatchery facility effluent and concluded that hatchery facilities do not have a reasonable potential to exceed water quality standards for dissolved oxygen (Ecology 2010a). Subsequent changes in Washington's NPDES permit requirements include individual BMPs and waste handling plans that, when complied with, help ensure that water quality criteria for dissolved oxygen are not exceeded. Similarly, Idaho and Oregon NPDES permits for hatcheries no longer include limits for dissolved oxygen.

3.6.3.1.4 pH

pH is a measure of hydrogen ion concentration. It is important because aquatic organisms could be harmed when conditions lead to pH levels outside their normal tolerance range in their environment (IDEQ 2002). Changes in pH likely arise from primary production (algal growth via photosynthesis) within hatcheries (Kendra 1991). Release of excess nutrients in effluent can also cause excess growth of periphyton (attached algae) in streams (Ecology 2009). Effluent with a lower pH than the receiving water is more acidic, while effluent with a higher pH is more basic than the receiving water. Decreases in pH can lead to increased toxicity of certain chemicals, including ammonia and nitrite. However, all hatcheries in the Columbia River basin must comply with specific Federal, state, and or tribal water quality regulations that include pH in hatchery facility effluent. All hatchery facilities in the analysis area are currently in compliance with these regulations (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance).

3.6.3.1.5 Sediment (Turbidity, Total Suspended Solids, and Settleable Solids)

Sediment in streams is assessed by turbidity, which is the measure of light blocked and scattered by particles (cloudiness) in the water column. In effluent, sediment is measured as total suspended solids (TSS), the amount (mass) of particles suspended in the water column, and settleable solids, the amount of particles that fall out of suspension and accumulate at the bottom of the water column (sedimentation). Effluent discharged from the operation and maintenance of hatcheries could increase sediments in downstream water (turbidity), as well as sedimentation rates, by flushing uneaten feed, feces, and dead fish when cleaning raceways and holding ponds to the downstream receiving environment (Kendra 1991; Williams et al. 2003).

Settling solids (i.e., allowing them to fall to the bottom of a holding basin) has been shown to be an effective method to reduce solids in effluent (Michael 2003). Hatcheries typically use settling ponds to reduce the settleable solids and TSS levels in their discharge effluent. Relative to the dissolved components of waste, such as phosphorus and ammonia, solids are much easier to capture and remove from the aquaculture operation before effluent discharge (IDEQ 2002).

Offline settling basins are used to capture particles of organic matter and prevent such releases into receiving waters.

3.6.3.1.6 PCBs and DDTs (Fish Tissue)

While in the marine environment, salmon could ingest PCBs and store them in their body fats (BPA and CTCR 2007). NMFS (2001) indicated that juvenile salmon could accumulate toxicants, including PCBs and DDTs, during downstream migration and smolting. Feed or supplements used by hatcheries may also be a source of PCBs and DDTs (Maule et al. 2007; Maule 2009), and USGS and USFWS are conducting research to confirm this association (USGS 2012). Distribution of hatchery-origin carcasses in streams could result in the release of PCBs and DDTs into the freshwater aquatic system as the carcasses decompose (Missildine et al. 2005). However, the likelihood of PCB and DDT release from salmon carcasses would be similar between hatchery-origin and natural-origin salmon and steelhead since these fish would be exposed to the same toxicants in river, estuary, and ocean environments. Section 3.7, Human Health, provides a detailed discussion of toxic contaminants in hatchery-origin fish, including PCBs and DDTs.

3.6.3.1.7 Pathogens

While hatcheries conduct regular screening for pathogens and diseases (parasites, viruses, and bacteria) and follow prescriptive measures to control their spread, some pathogens are released in hatchery facility effluent or from the inadvertent release of affected fish. Pathogens that are potentially harmful to human health are discussed in Section 3.7, Human Health. Fish pathogens include infectious pancreatic necrosis virus, infectious hematopoietic necrosis virus, viral hemorrhagic septicemia virus, furunculosis (*Aeromonas salmonicida*), enteric redmouth (*Yersinia ruckeri*), whirling disease (*Myxobolus cerebralis*), salmonid ceratomyxosis (*Ceratomyxa shasta*), and *Renibacterium salmoninarum* (causative agent of bacterial kidney disease) (Naylor et al. 2005; Northwest Indian Fisheries Commission [NWIFC] et al. 2006).

Salmon carcasses could also result in the introduction of pathogens into the aquatic system (USFWS 1999; LaPatra 2003; Naylor et al. 2005; HSRG 2005, 2009), although little evidence is available to demonstrate that this is a common occurrence (USWFS 1999; LaPatra 2003). Salmon carcasses with pathogens may increase the susceptibility of salmon to a variety of diseases (Pearsons et al. 2003). However, as discussed above, outside of the hatchery facility, hatchery-origin and natural-origin salmon would be exposed to the same pathogens; thus, the likelihood of pathogens being in hatchery-origin carcasses would be about the same as that which occurs in natural-origin carcasses. Additionally, hatchery-origin carcasses comprise a small proportion of the total available carcasses compared to naturally spawning salmon in freshwater streams.

3.6.3.1.8 Steroid Hormones

Hatchery facility effluent may also contribute steroid hormones to receiving waters. Like other vertebrate animals, salmon naturally produce and excrete steroid hormones, and wastewater treatment practices employed by most aquaculture facilities are unlikely to remove these hormones (Kolodziej et al. 2004). Kolodziej et al. (2004) detected the endogenous steroids estrone, testosterone, and androstenedione in the raceways and effluents of three fish hatcheries at concentrations near 1 milligram per liter. Such concentrations may be high enough to affect fish behaviors in the hatcheries (Colman et al. 2009). However, there are no data that suggest these hormones would affect water quality of the receiving waters. As a result, there are no current effluent discharge limits or water quality standards for steroid hormones.

3.6.3.1.9 Chemicals Used in Hatchery Programs

Fish hatcheries use a broad spectrum of chemicals such as commercial antibiotics, fungicides, and disinfectants for the control of bacterial and fungal disease agents associated with fish aquaculture. The types and amounts of chemicals used at a hatchery facility depend on site-specific conditions, fish culture practices, species of fish, and types of parasites or disease organisms being treated. For more information on hatchery facility use of antibiotics, fungicides, and disinfectants, refer to Section 3.7, Human Health.

The discharge of treated waters in raceways to receiving environments could result in the release of these chemicals into downstream receiving waters. Several of the antibiotics used in aquaculture have been detected in receiving waters and sediment downstream of fish farms (Boxall et al. 2004; Pouliquen et al. 2009; Martinez-Bueno et al. 2009). Although concentrations observed in the water column usually are well below those that are toxic to fish and invertebrates, they could be toxic to naturally occurring algae and bacteria (Boxall et al. 2004). Additionally, there are some reports of antibiotic resistance and other problems in river systems with high inputs of these compounds, as discussed in Section 3.7, Human Health. As discussed in Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance, several Federal agencies have approved hatchery facilities to use a broad spectrum of commercial antibiotics, fungicides, and disinfectants. The use of these federally regulated products requires hatchery personnel to follow manufacturer-identified conditions under which the product is expected to be effective and safe.

3.6.3.2 Applicable Hatchery Facility Regulations and Compliance

Hatchery facilities must comply with all applicable Federal, state, and tribal water quality standards for effluent discharges and Federal and state regulations on the use of chemicals and fish food. This section discusses the Federal, state, and tribal regulations applicable to water quality and describes how hatcheries in the Columbia River basin (i.e., analysis area) comply with these regulations.

3.6.3.2.1 Federal Regulations

EPA regulates direct discharge of hatchery facility effluent under the CWA through NPDES permits. For discharges from hatcheries not located on Federal or tribal lands within Oregon and Washington, EPA has delegated its regulatory oversight to the states. Oregon also administers the NPDES program for Federal hatchery facilities, but not tribal hatchery facilities. Oregon, Washington, and Idaho are all responsible for certifying that NPDES-permitted projects not located on Federal or tribal lands comply with state water quality standards. Washington is also responsible for certifying that NPDES-permitted projects located on Federal lands (but not tribal lands) comply with state and Federal water quality regulations, while Idaho certifies all permits written by EPA. This is accomplished through CWA Section 401 water quality certification. As a result of this certification, hatcheries that are in compliance with water quality standards and, thus, their NPDES permits are considered not to cause or contribute to a violation of water quality standards.

NPDES permits are typically renewed on a 5- or 10-year basis, and permit limits may be revised to reflect changes in water quality standards or treatment technologies. New or modified permits may be required at other times if a permitted facility expands, increases production, or modifies processes so that pollutant discharges increase or the nature of the discharged pollutants changes. A new or modified permit may also be required if a facility is located within a watershed for which one or more pollutant limits are established. These pollutant limits, or total daily maximum loads (TMDLs), are discussed below.

EPA issued a general NPDES permit for Federal aquaculture facilities and aquaculture facilities on tribal lands within the boundaries of the state of Washington, which became effective August 1, 2009 (EPA 2009). This permit was closely based on Washington's previous upland fin-fish hatchery and rearing general permit, which was effective from June 1, 2005, through July 31, 2010 (Ecology 2005a). Washington's general permit is discussed in detail in Section 3.6.3.2.2, State Regulations.

For TSS and settleable solids, EPA's general permit for Washington includes the same discharge limits and sampling frequencies as Washington's general permit. EPA's general permit also includes limits on total residual chlorine for all discharge types, while Washington's general permit only includes a limit on total residual chlorine for discharges of rearing vessel disinfection water (these limits only apply when chlorine is being used).

Since EPA has not previously issued a general permit in Washington for Federal and tribal aquaculture facilities in Washington, additional requirements were included to support future analyses of water quality effects for development of subsequent issuances of its general permit. Additional discharge monitoring requirements include disinfectants (other than chlorine), copper (or other antifouling agents, when used), and hardness (only when copper monitoring is required) in hatchery effluent and ammonia, temperature, and pH in offline settling basin discharges to receiving waters that are impaired for ammonia or total nitrogen. Surface water monitoring requirements include ammonia, pH, and temperature immediately upstream of offline settling basins that discharge directly to surface waters, as well as copper and hardness when copper compounds are applied.

PCBs have recently been found in several hatcheries, including Leavenworth National Fish Hatchery in eastern Washington. EPA is concerned that PCBs in paint or caulk may be an issue in other Washington aquaculture facilities (EPA 2008). To address this concern, EPA's general permit for Washington requires hatcheries to include information on painted and caulked surfaces that regularly contact process water when they apply for general permit coverage.

EPA issued an NPDES permit for cold-water aquaculture facilities not subject to waste load allocations (TMDLs), which became effective December 1, 2007. This permit (IDG-131000) contains effluent limits and monitoring requirements for cold-water raceways and associated full-flow, settling basin discharges. Idaho General Permit IDG-130000 applies to aquaculture facilities subject to waste load allocations. Idaho's general NDPES permits for cold-water aquaculture facilities in the state contain provisions for monitoring groundwater diversions, but no specific requirements for the protection of groundwater quality.

The current aquaculture facility NPDES permits for Idaho require monitoring of effluent flow, TSS, and total phosphorus, as well as pH, temperature, and total ammonia as nitrogen for those hatchery facilities that discharge directly from offline settling basins, but do not require monitoring for dissolved oxygen or BOD (EPA 2007a). Idaho hatcheries within the project area that are discharging under waste load allocations assigned as part of receiving environment

TMDL programs are required to monitor effluent flow, TSS, net TSS, net total phosphorus, copper (when used), and hardness (only when copper monitoring is required) (EPA 2007b).

Oregon (Oregon Department of Environmental Quality [ODEQ]) and Washington (Ecology) are also responsible for issuing and enforcing NPDES permits. In Idaho, EPA is responsible for issuing and enforcing NPDES permits. EPA administers NPDES permits for all projects on Federal lands in Washington and Idaho and tribal lands in Oregon, Washington, and Idaho; however, Native American tribes may adopt their own water quality standards for permits on tribal lands. State and tribal water quality standards are discussed separately below. EPA (2004) designates salmon hatchery programs as concentrated aquatic animal production facilities, and it established national effluent limitation guidelines for these facilities that address the discharge of TSS, BOD, and nutrients (69 Fed. Reg. 51891, August 23, 2004). It determined that narrative guidelines were most appropriate and chose not to establish nationwide quantitative limits. This decision, in part, was to allow greater flexibility for states that had already adopted suspended sediment and BOD limits for hatchery operations. Additionally, EPA chose not to establish numeric discharge limits for any antibiotics, fungicides, or disinfectants used in hatchery operations, choosing instead to require concentrated aquatic animal production facilities to follow existing Federal and state guidance concerning the safe handling and storage of these materials.

Fish hatcheries are approved by several Federal agencies to use a broad spectrum of commercial antibiotics, fungicides, and disinfectants to control bacterial and fungal disease agents associated with fish aquaculture. As stated earlier, the use of these federally regulated products requires hatchery personnel to follow manufacturer-identified conditions under which the product could be expected to be effective and safe. Labels for approved products describe uses allowed by law. Any departure from the directions and conditions on the product label or on special state labels could be a legal violation. The use of hatchery treatment chemicals is closely regulated by EPA, and each hatchery operation has reporting requirements concerning their use. Additional discussion about regulation of hatchery treatment chemicals is provided in Section 3.7, Human Health. State-specific water quality standards for hatchery treatment chemicals are discussed below.

As part of administering elements of the CWA, Washington, Oregon, and Idaho must assess water quality in streams, rivers, and lakes. These assessments are published in what are referred to as the 305(d) report and the 303(d) list (the numbers referring to the relevant sections of the original CWA text). The 305(d) report reviews the quality of all waters of the state, while the 303(d) list identifies specific water bodies considered impaired (based on a specific number of exceedances of state water quality criteria in a specific segment of a water body). For water bodies that fail to meet state water quality standards, Federal law requires the state to identify sources of pollution to those water bodies and develop a Water Quality Improvement Report to address those pollutants. The Water Quality Improvement Project establishes limits on the pollutants (TMDLs) that can be discharged to a water body while still meeting state standards.

Of the specific parameters impairing water quality in segments of the Columbia and Snake Rivers, several are potentially associated with hatchery production (Table 3-34). As stated above, hatcheries that are in compliance with their NPDES permits, and thus water quality standards, are considered not to cause or to contribute to a violation of water quality standards. However, the amounts of these chemicals being discharged into receiving waters from hatcheries do contribute to the total pollutant loads of those receiving waters and downstream waters. Although all hatchery facilities are in compliance with their NPDES permits (Table 3-6), periodic permit limit exceedances do occur. A review of compliance with Washington's general permit during the previous permit period (January 2006 to January 2010) showed that the most common exceedances were for TSS limits from offline settling basins due to high inflow volumes that flushed influent solids through the system without allowing them to settle (Ecology 2010a).

Additionally, any hatchery facility covered by an older NPDES permit may have discharge limits that do not address current water quality conditions or treatment technologies, possibly resulting in higher pollutant loads being discharged to receiving waters than would be allowed under a new permit.

3.6.3.2.2 State Regulations

The states of Washington, Oregon, and Idaho each have primary responsibility for the health and protection of their state's water quality. Each state has established water quality standards, which consist of 1) designated uses for the water body, 2) water quality criteria (numeric pollutant concentrations and narrative requirements) to protect designated uses, 3) an antidegradation policy, and 4) general policies addressing implementation issues, such as low flows, mixing zones, and variances. While these states depend primarily on EPA to develop and promulgate proposed water quality standards, the states' water quality standards differ, both qualitatively (narrative standards) and quantitatively (numeric standards).

TABLE 3-34. 303(D) WATER QUALITY PARAMETERS POTENTIALLY AFFECTED BY HATCHERY FACILITIES IN THE COLUMBIA AND SNAKE RIVERS.

IMPAIRING POLLUTANT[1]	POTENTIALLY ASSOCIATED WITH HATCHERY FACILITIES?	
	NO	YES
4,4'-DDD		X
4,4'-DDE		X
4,4'-DDT		X
Beryllium	X	
Aldrin	X	
Algae		X
Alpha-BHC	X	
Ammonia		X
Arsenic	X	
Bacteria	X	
Chlordane	X	
Cadmium	X	
Chlorine		X
Chromium	X	
Copper	X	X
Dieldrin (fish tissue)	X	
Dissolved oxygen		X
Dioxin	X	
Fecal coliform	X	
Flow alteration		X
Iron	X	
Lead	X	
Manganese	X	
Mercury	X	
Mercury (fish tissue)	X	
Nickel	X	
Nutrients		X
Oil and grease	X	
PAHs	X	
Particle distribution (embeddedness)	X	
Pathogens		X
Pesticides	X	
pH		X
Sediment (suspended solids)		X
Sedimentation (settleable solids)		X
Silver	X	

Table 3-34. 303(d) Water Quality Parameters Potentially Affected by Hatchery Facilities in the Columbia and Snake Rivers (continued).

Impairing Pollutant[1]	Potentially Associated with Hatchery Facilities? No	Yes
Temperature		X
Thallium	X	
Total dissolved gas	X	
Total PCBs (fish tissue)		X
Total phosphorus		X
Zinc	X	

[1] Identified from monitored river segments in the watersheds draining into the lower Columbia, mid Columbia, upper Columbia, lower Snake, and mid Snake Rivers, as reported in Ecology (2010b), ODEQ (2010), IDEQ (2011).

DDD: dichlorodiphenyldichloroethane; DDE: dichlorodiphenyldichloroethylene; DDT: dichlorodiphenyltrichloroethane; PAHs: polycyclic aromatic hydrocarbons.

The following sections provide Washington-, Oregon-, and Idaho-specific information regarding individual NPDES permits, including criteria, monitoring requirements, and compliance. For all three states, there are currently no specific water quality criteria for steroid hormones. In general, none of the states has specific water quality criteria for hatchery treatment chemicals and considers applications following manufacturer and Federal guidelines as meeting water quality objectives. All hatcheries within the Columbia River Basin are currently in compliance with their NPDES permits.

Washington

Ecology reissued its Upland Fin-Fish Hatching and Rearing NPDES Waste Discharge General Permit effective August 1, 2010 (Ecology 2010c). This permit covers every upland finfish hatching or rearing facility within Ecology's jurisdiction and sets specific limits on days of operation and pounds of fish produced per year. This general permit established monthly averages and instantaneous maxima for settleable solids and TSS in the rearing ponds, raceway discharges, and any offline settling basin discharges.

The Upland Fin-Fish Hatching and Rearing Permit does not allow violation of the state's groundwater standards (Chapter 173-200 WAC). Ecology has determined that a properly operated upland finfish hatching and rearing facility poses little potential to impact state groundwater quality standards; however, this permit does not authorize a violation of these standards. Ecology may require facilities with the potential to violate these standards to obtain coverage under an individual permit, require additional sampling and groundwater monitoring, and/or require rearing and pollution abatement ponds to be lined, if necessary (Ecology 2010a).

Washington has adopted surface water quality standards for turbidity, temperature, ammonia, dissolved oxygen, and pH. The numeric standards (both upper and lower in the case of pH) have been revised for these parameters in the last 10 years to be more protective of salmonids. Nutrient standards are primarily narrative and are aimed at minimizing production of algae when excess nitrates and phosphorus are present. Washington also regulates settleable solids and TSS in hatchery facility effluent discharges. For water bodies identified as having impaired water quality, Washington requires discharge permittees, including hatchery operators, to comply with state water quality standards for each pollutant considered to be causing a violation of water quality. For a facility that discharges to an impaired water body with a TMDL or other control plan for a pollutant with an effluent limitation in the general permit, individual NPDES permit coverage may be required if the general permit does not provide the level of protection required by the TMDL or control plan.

Washington requires effluent monitoring, recording, and reporting for each hatchery facility to verify that its treatment process is functioning correctly, and effluent limitations are being achieved. In a 1988 survey of 19 trout and salmon hatchery facilities, Ecology found levels of BOD that sometimes exceeded state water quality standards. This survey spurred modifications of the general upland NPDES permit under which these facilities operate (Ecology 2005a; Ecology 2005b), resulting in the application of effluent limits for solids (both settleable solids and TSS), to reduce the levels of organic matter introduced to the environment and minimize the downstream BOD levels. Due to concerns raised by this study (Ecology 1989; Kendra 1991), Ecology initiated specific monitoring for temperature and dissolved oxygen in hatchery facility effluent. The results of this additional monitoring showed that these facilities do not have reasonable potential to exceed water quality standards for these parameters (Ecology 2010a). This led Ecology to drop temperature and dissolved oxygen as monitoring requirements for subsequent NPDES permits (Ecology 2005b, 2010a).

Ecology's current NPDES permit does require monitoring of TSS (Ecology 2010c). Effects from hatchery facility effluent discharges on the downstream macrobenthic community have been observed in other salmon and trout rearing facilities in the United States and internationally (Kendra 1991; Camargo 1992; Selong and Helfrich 1998). Partly in response to these types of studies, investigations of treatment options have identified settling solids as the most cost-effective method to improve effluent quality to acceptable levels (McLaughlin 1981; Michael 2003). Most of the nutrients of concern are associated with solids, which are effectively removed in settling ponds. Washington's NPDES permits have instituted requirements for controlling sediment discharges, believing that solids in effluent are the best indication of how well a facility is complying with its permit (Ecology 2010a).

The type and amount of salmon carcasses that could be placed in the environment are under the control of specific state programs independent of hatchery program funding and management. In Washington, WDFW has a specific nutrient supplementation program aimed at placing salmon carcasses in selected streams based on historical levels of salmon escapement (WDFW 2004). While this program establishes guidelines for carcass distribution, the actual number distributed is independent of individual hatchery program production.

Oregon

Oregon's General NPDES Permit 300J (fish hatcheries) establishes waste discharge limitations for TSS, temperature, and pH (both monthly averages and daily maxima) for normal and cleaning operations at upland hatcheries. This general permit sets minimum monitoring and reporting requirements for effluent discharges, receiving streams, and influent supply water.

Like Washington, Oregon has adopted surface water quality standards for temperature, ammonia, dissolved oxygen, and pH, and the numeric standards for these parameters have been revised in the last 5 years to be more protective of salmonids. Nutrient standards are primarily narrative and are aimed at minimizing production of algae when excess nitrates and phosphorus are present. Oregon also regulates turbidity and TSS in hatchery facility effluent discharges; however, limits for TSS are basin-specific.

Oregon's NPDES Permit 300J does not authorize any discharges from fish hatcheries to groundwater, including discharges to an underground injection control system. ODEQ administers a number of groundwater protection programs, and Oregon hatcheries are required to comply with these programs in their operations (ODEQ 2009).

ODEQ regulates salmon carcass distribution as a discharge to waters of the state. It requires a separate NPDES permit with stream chemistry monitoring before these distributions can occur (Oregon Plan 1999).

ODFW's Fish Health Management Policy describes measures that minimize the impact of fish diseases on the state's fish resources (ODFW 2003). In addition to supporting the primary objective of producing healthy smolts, ODFW has implemented both disease control and disease prevention programs at all of its hatchery facilities to prevent the introduction, amplification, or spread of fish pathogens that might negatively affect the health of both hatchery-origin and natural-origin reproducing stocks.

Idaho

The Idaho Water Quality Standards and Wastewater Treatment Requirements (Title 1, Chapter 2) regulate aquaculture waste management and the protection of designated or existing uses of state waters, which IDEQ determined under the state Water Quality Act (Idaho Code 39-3601 *et seq.).* A BMP plan, as outlined in the Idaho Waste Management Guidelines for Aquaculture Operations (IDEQ 2002), is required for a facility to be covered under Idaho's general NPDES permit for aquaculture (IDEQ 2008).

As Washington and Oregon have done, Idaho has adopted standards for temperature, ammonia, dissolved oxygen, and pH, and the numeric standards have been revised for these parameters in the last 10 years to be more protective of salmonids. Nutrient standards are primarily narrative and are aimed at minimizing production of algae when excess nitrates and phosphorus are present. Idaho regulations state that "surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths" (Idaho Administrative Procedures Act 58, Title 01, Chapter 02). Idaho's water quality standards also include limits on turbidity. Additionally, each Idaho fish hatchery facility must comply with the conditions of the Idaho Administrative Rule 58.01.11 – Ground Water Quality Rule (http://adm.idaho.gov/adminrules/rules/idapa58/0111.pdf).

Regarding distribution of salmon carcasses, Idaho is currently developing new measures for improving fish habitats, including nutrient supplementation and fish supplementation measures, to incorporate into the Northwest Power and Conservation Council's Fish and Wildlife Program (IDFG 2008). As is the case for Washington and Oregon, this program establishes guidelines for carcass distribution, but the actual number distributed is independent of individual hatchery program production.

The Fisheries Management Plan 2007-2012 (IDFG 2006) describes Idaho's fisheries management on a statewide basis, including department policies and fisheries management programs. This plan incorporates goals, objectives, and strategies from IDFG's strategic plan (IDFG 2005), which includes a goal to eliminate the effects of fish and wildlife diseases on fish and wildlife populations, livestock, and humans. Plan strategies to accomplish this goal include monitoring fish and wildlife populations for disease; ensuring that propagation, stocking, and translocation of fish and wildlife do not contribute to the introduction or transmission of diseases; enhancing and enforcing laws to protect fish and wildlife populations from disease; reducing or eliminating the risk of transmission of disease between captive and free-ranging fish and wildlife; developing risk assessment, public information, and response strategies for fish and wildlife disease threats; and collaborating with other agencies and educational institutions on disease control, prevention, and research.

3.6.3.2.3 Tribal Water Quality Standards

Five Native American tribes manage hatcheries and satellite facilities located within the Columbia River basin: the Yakama Indian Nation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Confederate Tribes of the Warm Springs Reservation of Oregon, and Confederated Tribes of the Colville Reservation. Of these, the Confederated Tribes of the Umatilla Indian Reservation (2001) have set water quality standards that are the same as Oregon state standards, and the Confederated Tribes of the Colville Reservation (2005) have adopted water quality standards set by EPA.

The Tribal Fish Health Manual (NWIFC 2006), which includes *The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (NWIFC et al. 2006), provides guidance to tribal hatchery staff for producing healthy, quality fish and reducing the discharge of pollutants (solids, drugs, and chemicals) in tribal hatchery effluent.

3.6.4 Water Quantity

By their very nature and function, hatcheries use large quantities of water. This requirement often influences hatchery facility site selection, in terms of quality of the resource (particularly the temperature and dissolved oxygen) and availability and hydrology of the source. Hatchery facility use of water is both consumptive and nonconsumptive, depending on the following: 1) the manner in which the water is withdrawn and returned to the environment and 2) whether water is stored over time in the hatchery facility (such as a pond) where evaporative losses could occur. Hatchery facilities that divert water from an adjacent stream to flow through the hatchery facility or pond system, and then return that water to the source at some location downstream of its diversion point, are considered a consumptive use, requiring a water right, since some portion of the source river is dewatered (has less water between the point of diversion and discharge return to the river).

3.6.4.1 Surface Water Diversion and Consumption

Water use by hatchery facilities consists of filling and maintaining ponds and raceways (static) or flow-through (dynamic) systems. As mentioned above, static ponds and offline settling basins require storing water over time with a subsequent loss of water to local surface water from evaporation or infiltration. Streams, lakes, and groundwater could also be affected through the construction, operation, and maintenance of diversion structures (weirs, intake pipes, and wells) that would remove or divert water into hatcheries or rearing ponds.

Washington State uses the location of hatchery facility discharge relative to the intake point to determine whether a water use is considered consumptive and requires a water right to guarantee year-round operations (Washington Water Resources Program Policy 1020). Under this interpretation, withdrawing and discharging water at the same location (intake = outflow) is not a consumptive use and does not require a water right (a special allowance is made for one-time filling of the system over a short period). Similarly, withdrawal of well water that is allowed to percolate back into the soil at the point of extraction is not considered a consumptive use.

For both Oregon (Water Resources 536.295) and Idaho (House Bill 636), any use of water resulting in a substantial return of the diverted stream to the waters of the state is considered a non-consumptive use and does not require a water right. Water diversions or wells that do not meet this criterion would be considered consumptive uses and would require a water right.

Diversion of water from streams for use in hatchery operations, as well as in-water structures such as weirs, could alter stream flow between the points of withdrawal and discharge when they are not at the same location. Flow alteration, either between intake and outflow locations or from diversion to discharge location, could affect both water quantity and quality, thereby potentially affecting aquatic species. The volume of water in a flow-altered stream segment could be reduced, resulting in the potential for larger changes in temperature (due to shallower water and slower flow) and reduced ability to dilute chemicals introduced from discharged effluent.

Use of surface water for hatchery operations is typically non-consumptive, with water being returned to approximately the same location at which it was withdrawn. Consequently, any stream segment in the analysis area potentially affected by such a diversion would likely be small. Additionally, where states have established low-flow limits (minimum required flows during summer months), hatchery facilities cannot divert water in amounts that would result in a violation of those limits.

3.6.4.2 Groundwater Diversion and Consumption

Hatchery operations may affect the quantity of underlying groundwater through withdrawal of well water for use. This would be considered a consumptive water use, requiring a water right. As for surface water diversions, hatcheries cannot divert groundwater in amounts that would contribute to violations of any low-flow limits set for specific river segments.

3.7 Human Health

3.7.1 Introduction

Hatchery facilities routinely use chemicals in the management of their facilities. These chemicals include therapeutics (e.g., antibiotics), fungicides, disinfectants, anesthetics, pesticides, and herbicides (Section 3.6.3.1, Water Quality Parameters). These chemicals are not considered hazardous to human health when safety precautions and regulations are followed (Section 3.7.3, Safe Handling of Hatchery Chemicals). However, some chemicals (e.g., antibiotics) do not have established water quality criteria. If discharged to surface waters near hatchery facilities, these chemicals may pose a threat to human health (Section 3.7.4.2, Therapeutics).

Hatchery facility workers may also be exposed to diseases while handling fish. A number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species (Section 3.7.6, Relevant Disease Vectors and Transmission). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Section 3.7.6, Relevant Disease Vectors and Transmission). Concerns have also been raised that farm- or hatchery-raised fish may contain toxic contaminants that pose a health risk to consumers (Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish).

This section summarizes the following topics: safe handling of hatchery chemicals, common chemicals used in hatchery programs, potentially toxic contaminants in hatchery-origin fish, and potential viruses/bacteria transmitted from handling hatchery-origin fish. The human health issues addressed in the following sections are considered representative of all hatchery facilities and are not specific to a particular hatchery facility.

3.7.2 Analysis Area

The analysis area for human health is the same as the project area (Section 2.2, Description of Project Area). Information presented in Section 3.7, Human Health, is organized according to issue.

3.7.3 Safe Handling of Hatchery Chemicals

Hatchery facilities typically follow Occupational Safety and Health Administration (OSHA) regulations and institute chemical control programs to protect their employees. Employers must train employees regarding the potential hazards (e.g., chemical or physical) that are present at the site. Typically, hazard communication programs are implemented to train employees to recognize hazards, to use protective measures (e.g., personal protective equipment), and to perform proper actions during an emergency. Medical surveillance may be necessary if overexposure to chemicals becomes apparent. Chemical safety and handling are also addressed by maintaining and applying the following: 1) a general, reduced-chemical-use policy, 2) current chemical information, 3) first aid training and materials, 4) symptom awareness training, and 5) proper procedures for chemical storage and disposal. Specific state and Federal programs or rules developed for worker safety or use of chemicals protect hatchery facility workers from exposure to chemicals at potentially hazardous concentrations. Therefore, chemicals described in the following sections are not considered hazardous to human health when safety precautions and regulations are followed.

3.7.4 Chemicals Used in Hatchery Facilities

Hatchery facilities use a variety of chemicals to maintain a clean environment for the production of disease-free fish. Common chemical classes include disinfectants, therapeutics, anesthetics, pesticides/herbicides, and feed additives. The production of these chemicals for the protection of public health and the environment is governed by EPA (through the Federal Insecticide, Fungicide, and Rodenticide Act) and FDA (through the Federal Food, Drug, and Cosmetic Act). Use of chemical products in the workplace is not considered a threat to human health when label warnings and directions are followed as established by EPA or FDA. Chemicals used in hatcheries typically are disposed of according to label requirements or discharged as effluents to receiving waters according to established water quality guidelines developed through Federal or state regulations. However, some chemicals (e.g., antibiotics) do not have established water quality criteria and, therefore, may be discharged to surface waters near hatchery facilities. A brief description of commonly used chemicals in hatchery facilities is provided below.

3.7.4.1 Disinfectants

Disinfectants are primarily used to clean equipment throughout the hatchery facility and may also be used to treat diseases. Hatchery facility workers typically would be exposed to these chemicals through skin contact or inhalation during cleaning. However, Federal and state occupational health and safety programs (e.g., OSHA, Washington State Industrial Safety and Health Act, Oregon OSHA) ensure a safe workplace and require personal protective equipment and procedures (e.g., gloves, use of proper ventilation procedures, and/or respiratory protection in enclosed spaces, etc.). Following product label use directions and using other hatchery-specific safety measures result in reduced chemical exposure to a safe level.

Some common disinfectants used in aquaculture are described below and in Table 3-35.

- **Chlorine (Sodium Hypochlorite).** Hypochlorite is used for cleaning tanks and equipment and is the active component in chlorine. This compound may also be used to destroy fry that are infected with a disease.
- **Chloramine T.** Chloramine T is used for disinfecting tanks and equipment and to treat bacterial gill diseases in salmonids. The active component is chlorine.
- **Formalin.** Formalin is a saturated aqueous solution of formaldehyde. It is used as a general disinfectant and is effective against fungal or parasitic infections.
- **Hydrogen peroxide.** Hydrogen peroxide is used as a general disinfectant. It is effective against fish parasites (e.g., sea lice).
- **Iodophor.** Iodophor is a form of stabilized iodine employed as a general disinfectant. It is used to disinfect fish eggs and is effective against some bacteria and viruses.
- **Quaternary ammonium compounds (Hyamine).** Ammonium compounds or topical disinfectants are used to remove parasites from fish. They have detergent and antibacterial properties.

TABLE 3-35. PROPERTIES OF CHEMICALS COMMONLY USED AT HATCHERY FACILITIES.

CHEMICAL	HAZARD RANK[1]	LD_{50} (MG/KG)[2]	SKIN OR LUNG IRRITANT	CARCINOGENIC RATING[3]
DISINFECTANTS				
Chloramine T	1	935_{rat}	Corrosive to skin and respiratory irritant	N/A -- N/A[4]
Formalin	2	100_{rat}	Skin and respiratory irritant	1 -- B1
Hydrogen Peroxide	1	$>2{,}000_{mouse}$	Mildly irritating to skin or lungs	3 -- N/A
Iodophor	0	$10{,}000_{rabbit}$	Skin irritant	N/A -- N/A
Quaternary Ammonia (Hyamine)	2	350_{rat}	Skin and respiratory irritant	N/A -- N/A
Chlorine (Sodium Hypochlorite)	0	$5{,}800_{mouse}$	Skin and respiratory irritant	3 -- N/A
THERAPAUTICS				
Amoxicillin	N/A	N/A	Skin irritant	N/A -- N/A
Erythromycin	0	$9{,}272_{rat}$	Mild skin, eye, and respiratory irritant	N/A -- N/A
Florfenicol	1	800_{rat}	Mild skin, eye, and respiratory irritant	N/A -- N/A
Oxytetracycline (terramycin)	0	$7{,}200_{mouse}$	Mild skin, eye, and respiratory irritant	N/A -- N/A
Penicillin	N/A	N/A	Skin irritant	N/A -- N/A

TABLE 3-35. PROPERTIES OF CHEMICALS COMMONLY USED AT HATCHERY FACILITIES (CONTINUED).

CHEMICAL	HAZARD RANK[1]	LD_{50} (MG/KG)[2]	SKIN OR LUNG IRRITANT	CARCINOGENIC RATING[3]
Potassium Permanganate	1	750$_{rat}$	Skin, eye, and respiratory irritant	N/A -- N/A
Romet®	1	665$_{rat}$	Skin, eye, and respiratory irritant	N/A -- N/A
Sulfamethoxazole Trimethoprim	0	5,513$_{mouse}$	Skin irritant	N/A -- N/A
ANESTHETICS				
Benzocaine	N/A	N/A	NA	N/A -- N/A
Tricaine Methanesulfonate (MS-222)	N/A	N/A	Skin, eye, and respiratory irritant	N/A -- N/A
PESTICIDES/HERBICIDES				
2,4-Dichlorophenoxyacetic Acid	2	275$_{rat}$	Skin, eye, and respiratory irritant	2B -- N/A
2-Butoxyethyl 2,4-Dichlorophenoxy Acetate	1	831$_{rat}$	Skin, eye, and respiratory irritant	2B -- N/A
Chelated Copper	N/A	N/A	Skin, eye, and respiratory irritant	N/A -- N/A
Dichlobenil	1	2,126$_{rat}$	Mild skin and respiratory irritant	N/A -- N/A
Diquat	2	130$_{rat}$	Skin, eye, and respiratory irritant	N/A -- N/A
Endothall	3	>38$_{rat}$	Skin, eye, and respiratory irritant	N/A -- N/A
Fluridone	0	>10,000$_{rat}$	Mild skin and respiratory irritant	N/A -- N/A
Glyphosate	1	1,568$_{mouse}$	Skin, eye, and respiratory irritant	N/A -- D
Rotenone	2	60$_{rat}$	Skin, eye, and respiratory irritant	N/A -- N/A
MISCELLANEOUS				
Alcohol Anhydrous (ethyl alcohol)	1	3,450$_{mouse}$	Skin, eye, and respiratory irritant	N/A -- N/A
Lime (calcium hypochlorite)	1	850$_{rat}$	Skin, eye, and respiratory irritant	3 -- N/A
Salt (NaCl)	1	3,000$_{rat}$	Mild eye, irritant	N/A -- N/A
Sodium Thiosulfate	N/A	N/A	Skin, eye, and respiratory irritant	N/A -- N/A

Source: Information in this table was compiled from the Hazardous Substance DataBank (2014) and supplemented by EPA (2014), Eka Chemicals (2011), PHARMAQ AS (2006), Spectrum Chemicals and Laboratory Products (2013), and Western Chemical (2010).

[1] Hazard ranking based on oral toxicity (LD50) as follows: 0-non-hazardous (LD50>5,000), 1-Practically non-hazardous (LD50=500-5,000), 2-Slightly hazardous (LD50=50-500), 3-Moderately hazardous (LD50=5-50), and 4-Highly hazardous (LD50<=5) (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection [GESAMP] 1997).

[2] LD50 means median lethal dose, concentration that results in mortality of 50 percent of the animals tested after exposure to one oral dose. Typically reported for mammalian species.

[3] Potential for exposure to result in the development of cancer based on 1) International Agency for Research on Cancer (1 - carcinogenic to humans, 2A - Probably carcinogenic to humans, 2B - Possibly carcinogenic to humans, 3 - Unclassifiable (insufficient information), 4 - Probably not carcinogenic to humans) or 2) EPA's Integrated Risk Information System (Group A - Human carcinogen, Group B - Probable human carcinogen, B1 - Indicates limited human evidence, B2 - Indicates sufficient evidence in animals and inadequate or no evidence in humans, Group C - Possible human carcinogen, Group D - Not classifiable as to human carcinogenicity, Group E - Evidence of noncarcinogenicity for humans).

[4] N/A means data not available to assess hazard ranking or carcinogenic potential.

3.7.4.2 Therapeutics

Therapeutics consist of chemicals or veterinary medicines that are designed to be effective against parasitic, bacterial, or viral infections in fish. The most commonly used therapeutics in salmonid aquaculture are listed below:

- **Amoxicillin.** Amoxicillin is generally used as a veterinary antibiotic.
- **Erythromycin.** Erythromycin is generally used as a veterinary antibiotic.
- **Florfenicol.** Florfenicol is generally used as a veterinary antibiotic.
- **Oxytetracycline (Terramycin).** Oxytetracycline is widely used as an antibiotic. It may be applied orally in fish feed or as a bath and is effective against a wide range of bacteria.
- **Potassium permanganate.** Potassium permanganate is primarily used as a bath treatment for fungal infections of finfish. It may also be used to alleviate acute oxygen shortage and to remove organic contaminants in fish ponds.
- **Penicilllin.** Penicillin is generally used as a veterinary antibiotic.
- **Romet.** Romet is typically applied in fish feed and is used to control a variety of bacterial infections.
- **Sulfamethazole trimethoprim.** Sulfamethazole trimethoprim is generally used as a veterinary antibiotic.
- **Vaccines.** Vaccines are generally used to treat viral diseases. Various vaccines are available to treat animals in aquaculture. Salmonids may be given vaccines to treat furunculosis, vibriosis, or yersiniosis. These vaccines are generally not considered a potential risk for human health since viral diseases of fish are typically not pathogenic to humans (World Health Organization [WHO] 1999), and the potential for exposure is minimal. The primary exposure pathway tends to be through accidental needle-stick injury (Douglas 1995; Leira and Baalsrud 1997).

Therapeutics typically are only applied when a fish health specialist has determined that a disease is present in the fish stocks. Human exposure to these chemicals typically would occur through skin contact during application of the compound or through accidental needle pricks during vaccinations. However, state and Federal occupational safety regulations (e.g., Occupational Safety and Health Act of 1970 [29 United States Code [USC] 651 *et seq.])* are in place to prevent these types of accidents.

Outside of the use of therapeutic chemicals in the workplace, there are two primary environmental concerns with the use of therapeutics in salmon aquaculture:

1. Therapeutic substances are not 100 percent absorbed by the fish and may be excreted into the holding water (Texas Agricultural Extension Service 1994; GESAMP 1997; Milewski 2001). Government agencies typically do not regulate disposal of chemicals in fish waste products; therefore, there is a potential for these chemicals to enter the environment surrounding the hatcheries (Texas Agricultural Extension Service 1994; GESAMP 1997; Milewski 2001). Clean Water Act and state surface water regulations (Table 3-35) prevent the discharge of chemicals at concentrations that may pose a threat to human health. However, water quality regulations currently do not exist for all veterinary products, medicines, or their by-products when incompletely metabolized. The environmental persistence of therapeutic substances varies, and some may degrade in a few hours to a few months (GESAMP 1997). Antibiotics used by hatcheries have been detected in receiving waters downstream of aquaculture operations (Boxall et al. 2004; Pouliquen et al. 2009; Martinez-Bueno et al. 2009). Moreover, recent studies suggest these compounds may persist in sediments (Pouliquen et al. 2009; Martinez-Bueno et al. 2009).

   Therapeutics typically are applied infrequently and at low doses (GESAMP 1997). FDA governs the use of therapeutics through the Animal Medicinal Drug Use Clarification Act of 1994 (21 Code of Federal Regulations [CFR] 530), which does not permit extra-label use of a drug that is administered through feed (MacMillan et al. 2006).

   Currently, the volume of therapeutics released from hatcheries and the potential risks associated with these releases are unknown. Concentrations that have been reported in receiving waters near fish farms and hatcheries in other parts of the United States and in Europe are usually well below those toxic to fish and invertebrates (Boxall et al. 2004). It is expected that limited use of veterinary medicines following label instructions in U.S. fish hatcheries poses minimal risk to human health and the environment (GESAMP 1997; MacMillan et al. 2006), although locally high concentrations could arise depending on the nature of the receiving environment.

2. The use of antibiotics may increase the potential for the development of resistance in certain strains of bacteria (GESAMP 1997; Burka et al. 1997; WHO 1999). Therefore, overuse of antibiotics could render them ineffective for some bacteria. Resistant bacteria that infect fish have the potential to transfer resistant genetic material to bacteria that

infect non-fish organisms (e.g., humans). Genetic bacterial resistance may occur by the movement of plasmids (i.e., genetic elements independent of the chromosome) between bacteria. This type of transfer has been demonstrated in a number of microorganisms (GESAMP 1997; Burka et al. 1997; WHO 1999; Cabello 2006). Therefore, the improper use of antibacterials may cause resistance in bacterial pathogens that can infect humans (GESAMP 1997; Burka et al. 1997; WHO 1999; Cabello 2006). FDA governs the use of therapeutics through the Animal Medicinal Drug Use Clarification Act of 1994 (21 CFR 530), which prohibits therapeutics for uses not specified in the drug's label (MacMillan et al. 2006). Adhering to this regulation and drug label recommendations minimizes the potential for the development of antibiotic resistance.

3.7.4.3 Anesthetics

Anesthetics commonly are used to immobilize brood fish during egg or milt collection, to calm fish during transportation, or during treatment with other therapeutics. They typically are applied or used at low concentrations and, thus, represent a low risk to human health (GESAMP 1997) when handled using general safety precautions (i.e., Federal or state OSHA regulations) and following label requirements. Some common anesthetics used in aquaculture are listed below:

- **Benzocaine.** Benzocaine is used during egg or milt stripping or during preparation for transport.
- **Tricaine methanesulfonate (MS-222).** Tricaine methanesulfonate is used as a general sedative and applied as a bath in the holding tanks.

3.7.4.4 Pesticides/Herbicides

Globally, various pesticides and herbicides are used in aquaculture to protect fish stocks from parasites and remove nuisance organisms, weeds, or algae. Due to their toxicity, many of these chemicals are not approved for use in the United States. For hatcheries, pesticides and herbicides typically are highly toxic, and they are used in small concentrations to control algae growth or aquatic weed growth. Commonly used algaecides approved in the United States may contain various forms of copper. Some common aquatic herbicides include dichlobenil, diquat, endothall, fluridone, glyphosate, 2,4-dichlorophenoxyacetic acid, and 2-butoxyethyl ester. These products may be hazardous to human health if prolonged or accidental exposure (i.e., inhalation, ingestion, or dermal contact) occurs because they may be toxic at certain concentrations. Some of these products have bacteria as the active ingredient (e.g., Microbe Lift and Liquid Live Micro-organism) rather than a chemical ingredient to reduce the growth of pests. These products are typically less toxic to human health than synthetic chemicals. Safety measures on the product label and the material safety data sheet provide directions for proper use and applications. These safety measures, along with Federal and state OSHA regulations, serve to limit human exposure to potentially hazardous concentrations. Chemical properties of pesticides and herbicides are provided in Table 3-35.

3.7.4.5 Feed Additives

Hatcheries may provide their stock with feed supplemented with a variety of dietary additives. Fish raised in hatcheries are fed supplements only while they are juveniles, which differs from farm-raised fish that consume feeds and additives throughout their life. These additives may consist of artificial or natural pigments, fish oils, and/or vitamins. For example, astaxanthin and canthaxanthin are carotenoids commonly used to color the flesh of salmonids artificially during the later stages of growth. Vitamin C and Vitamin E are widely used to enhance the disease resistance of fish stocks. Exposure to feed additives from hatchery-origin fish is considered to be a low risk to human health because the concentrations used in hatcheries typically are below levels that would result in adverse health effects (GESAMP 1997).

In comparison, Hites et al. (2004) found that farm-raised salmon contained substantially more chemical pollutants than fish caught in the wild. Their study suggested that these pollutants were originating from fish pellets that contain the dried and compressed body parts and toxins from several whole fish, which they compared to a natural-origin salmon that eats a few bites of a single fish. In recent studies Johnson et al. (2007a,b), high concentrations of both PCBs and DDTs, comparable to those observed in farmed salmon, were found in hatchery-origin Chinook salmon. The authors attributed this effect to high body fat levels in hatchery-reared juveniles, which facilitate the uptake of lipid soluble contaminants. They concluded that contaminant concentrations in different lots of feed and in fish from different hatcheries were too variable to determine how fish feed affects hatchery-origin fish. The authors stated that more comprehensive sampling of fish and feed from hatcheries is needed to determine the extent of the problem in the Pacific Northwest (which includes this analysis area) (Box 3-1).

Box 3-1. What is the difference between hatchery-origin and farm-raised salmon?

Farm-raised salmon spend their entire lives in captivity compared to hatchery-origin salmon, which are reared in hatchery facilities as juveniles (generally for periods less than 1 year) and then released into the wild where they spend the remainder of their lives. When in captivity, both hatchery-origin and farm-raised salmon are fed pellets of concentrated fish products (that may contain high levels of chemical toxins); however, hatchery-origin fish are exposed to these chemicals for a shorter time than are farm-raised fish.

In a more recent study (Johnson et al. 2010), which sampled subyearling Chinook salmon from eight hatcheries that release juvenile salmon into the Columbia River, concentrations of PCBs and DDTs were lower than in the fish sampled earlier (i.e., in Johnson et al. 2007a,b) and generally comparable to levels observed in juvenile salmon from minimally contaminated rural estuaries. Contaminant concentrations were higher in the Chinook salmon from the earlier study, in part, because those fish were older and larger than those sampled in Johnson et al. (2010), but the differences could also be related to differences in contaminant concentrations in feed or in the hatchery environment.

3.7.4.6 Miscellaneous Chemicals

Various other chemicals typically are used at salmonid hatcheries. Some of these chemicals are described below and in Table 3-35. These chemicals are practically nonhazardous (see Table 3-35) and, when used within the product label requirements and following OSHA regulations, are not expected to pose a risk to human health.

- **Anhydrous (ethyl) alcohol.** Anhydrous alcohol is one of two chemicals used in a solution used to check the fertilization of eggs.
- **Lime (type S).** Lime is widely used to neutralize acidity and increase total alkalinity of grow-out ponds.
- **Salt (NaCl).** Salt can be used to remove parasites or prevent stress during transport of fish.
- **Sodium thiosulfate.** Sodium thiosulfate is used to neutralize chlorine and iodophor prior to discharging wastewater.

3.7.5 Toxic Contaminants in Hatchery-origin Fish

Seafood consumption by humans is generally promoted due to the nutritional value of fish products. For example, fish contain elevated levels of omega-3 fatty acids, which are considered beneficial to the cardiovascular system (Mayo Clinic 2014). However, concerns have been raised that farm-raised and hatchery-origin fish may contain toxic contaminants (WHO 1999; Jacobs et al. 2002a,b; Easton et al. 2002; Hites et al. 2004) that pose a health risk to consumers. Sources of contaminants in the fish include chemicals or therapeutics, contamination of the nutritional supplements or feeds, and/or contamination of the environment where the fish are reared or released (Jacobs et al. 2002a,b; Easton et al. 2002; Hites et al. 2004; Carlson and Hites 2005; Johnson et al. 2007b; Maule et al. 2007; Kelly et al. 2008; Johnson et al. 2010). The contaminants of primary concern are those that are persistent in the environment and are known to accumulate in the tissues of fish (e.g., methylmercury, dioxins, DDTs, or PCBs) (Jacobs et al. 2002a,b; Easton et al. 2002; Hites et al. 2004; Johnson et al. 2007b; Maule et al. 2007; Kelly et al. 2008; Johnson et al. 2010).

While in the hatchery facilities, hatchery-origin fish are fed with commercial diets containing fish oil and fish meal that can be derived from anywhere in the world. These feeds are known sources of toxic contaminants (Jacobs et al. 2002a; Carlson and Hites 2005). As described above, contaminant concentrations (e.g., pesticides, PCBs) measured in farmed fish are higher than in natural-origin fish (Hites et al. 2004; Hamilton et al. 2005). The use of commercial feed in hatchery facilities may also contribute to higher concentrations of organic pollutants in hatchery-reared fish compared to their natural-origin counterparts (Johnson et al. 2007b).

Recent investigations examined the amount of organic contaminants in commercial fish feeds and found elevated levels of PCBs, polychlorinated aromatic hydrocarbons, and pesticides (Jacobs et al. 2002a,b; Easton et al. 2002; Hites et al. 2004; Neergaard 2004; Carlson and Hites 2005). USGS and USFWS completed a study of contaminants in fish feeds used in National Fish Hatcheries (NFHs) (Maule et al. 2007) and also found contaminants in these feeds, although generally at lower concentrations than those reported by the investigators cited above. USGS and USFWS have continued studying contaminants in fish feed and in fish at several USFWS hatcheries in the Pacific Region to (1) evaluate and compare overall contaminant levels, (2) identify temporal differences in contaminant levels found in various feed forms, (3) evaluate contaminant levels and bioaccumulation rates of different commercial diets in various life-stage history classes, (4) assess the redistribution of contaminants during smoltification, and

(5) simulate the release of fish from a hatchery by fasting fish and monitoring the mobilization and redistribution of contaminants (USGS 2012).

While hatchery-origin fish may contain chemicals of concern, the risk from consuming contaminants in hatchery-origin fish remains uncertain. The potential for human exposure to contaminants in fish is tied directly to the frequency of consuming fish (EPA 1999). Thus, groups that consume large amounts of fish may have a higher potential for exposure to contaminants. Current information on consumption patterns suggests that some populations may consume greater quantities of fish than the general population (often termed 'subsistence consumers') (EPA 1999). However, information is not available to determine what proportion of the diet of subsistence consumers comes from hatchery-origin or farm-raised fish. In addition, not all the contaminants in hatchery-origin fish are derived from the hatchery facility.

Migrating salmonids encounter and accumulate additional contaminants in the rivers, estuaries, and oceans that they inhabit (Missildine et al. 2005; Johnson et al. 2007a,b). Therefore, it is unknown what proportion of contaminants present in hatchery-origin fish originates from hatcheries or what proportion accumulates after release. It is also unknown whether those contaminant levels pose a risk to human health.

One recent study (Johnson et al. 2010) suggested that, for juvenile salmon that feed and rear in urban areas, contaminants accumulated after release account for the majority of their body burdens, although hatcheries could be a primary source for fish reared only in uncontaminated rural areas. However, contaminants taken up during hatchery rearing would probably contribute very little to body concentrations of adult, returning salmon, since concentrations would be diluted so much by growth of the fish. Some recent studies suggest that, for returning adult salmon, most of their contaminant body burden was acquired during their time at sea (Kelly et al. 2007; Cullon et al. 2009; O'Neill and West 2009).

Another potential source of contaminants for hatchery-origin fish includes construction materials found within hatcheries. In one recent event, PCBs were identified in fish from the Leavenworth NFH and were found to be related to the paint lining fish tanks (Cornwall 2005). Some hatchery facilities were constructed in the early to mid-1900s and may contain chemicals in historical building materials (e.g., paint) that are banned in current materials. Testing of other NFHs for toxic substances is ongoing (Cornwall 2005), and EPA's NPDES general permit for Federal and tribal aquaculture facilities requires hatcheries to include information on painted and caulked surfaces that regularly contact process water when they apply for general permit coverage (EPA

2008). While there is a potential for exposure to contaminants in building materials, these are likely isolated as further incidents have not been reported.

3.7.6 Relevant Disease Vectors and Transmission

A number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species (Durborow 1999; Leira and Baalsrud 1997; Lehane and Rawlin 2000). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Leira and Baalsrud 1997; Durborow 1999; Lehane and Rawlin 2000).

Some common bacterial or viral species transmittable to humans through contact with fish include the following (Durborow 1999):

- Mycobacterium marinum
- Streptococcus iniae
- Vibrio species
- Aeromonas species
- Erysipelothirx rhusiopathiae
- Cryptosporidosium

The transmission of fish-borne pathogens to humans is rare and can be controlled with the proper safety measures (i.e., wearing protective clothing when handling fish and thoroughly cooking fish). In addition, FDA regulations (21 CFR 123) require processors of fish and fishery products to develop and implement Hazard Analysis Critical Control Point systems for their operations to prevent and limit the potential for exposure and spread of pathogens and contaminants. Safety precautions that limit the spread of disease include the following:

- Using gloves when handling animals
- Covering cuts and sores with bandages before working
- Immediately washing cuts/abrasions with soap and water and/or an antiseptic
- Keeping work areas clean with detergents or disinfectants
- Ensuring hygienic disposal of effluent or wastes

Compliance with safety programs, applicable rules and regulations, and the use of personal protective equipment limits the spread of parasites, viruses, or bacteria.

Science, Service, Stewardship

Chapter 4

Environmental Consequences

4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

The six alternatives being evaluated in this environmental impact statement (EIS) are described in Section 2.5, Alternatives Analyzed in Detail. The alternatives are based on goals and principles that form a policy direction. To evaluate the effects of these alternatives meaningfully, relative to baseline conditions, specific implementation scenarios for each alternative were developed and are identified in Section 4.1.3, Implementation Scenarios. Each implementation scenario is meant to represent one generalized example of how each of the alternate policy goals (i.e., alternatives) could be implemented.

Baseline conditions for the six resources (fish, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health) that may be affected by the proposed action and alternatives are described in Chapter 3, Affected Environment. This chapter provides an analysis of the direct and indirect environmental effects of the alternatives on these six resources. Section 4.8, Summary of Resource Effects, presents a summary table of environmental effects by resource and alternative. Cumulative effects are presented in Chapter 5, Cumulative Effects. The specific section sequence for Chapter 4 is as follows:

- Introduction (Section 4.1)
- Fish (Section 4.2)
- Socioeconomics (Section 4.3)
- Environmental Justice (Section 4.4)
- Wildlife (Section 4.5)
- Water Quality and Quantity (Section 4.6)
- Human Health (Section 4.7)
- Summary of Resource Effects (Section 4.8)

4.1.1 Analysis Area

As discussed in Section 3.1, Introduction, the analysis area varies by resource and is defined at the beginning of each resource discussion in Chapter 3.

4.1.2 Mitigation

Mitigation includes actions that avoid the potential impact, minimize the impact, rectify the impact, reduce or eliminate the impact, and/or compensate for the impact by replacing or providing substitute resources (40 Code of Federal Regulations [CFR] 1508.20).

Risks to salmon and steelhead species and habitat from hatchery operations are described in Section 3.2.3, Salmon and Steelhead. Hatchery operators throughout the basin have been applying some mitigation measures under Alternative 1 (No Action). The measures address the effects of these risks by implementing changes to hatchery programs and facility operations over time as new developments in hatchery science occur, i.e., through various hatchery review processes (Section 1.5.2, Other Reviews of Columbia River Basin Hatchery Programs). These mitigation measures have typically taken the form of both operational and physical facility measures. Below is a list of commonly applied measures that help mitigate for the risks of hatchery programs:

- Reduce the number of juveniles released.
- Release hatchery-origin smolts so that when they return as adults, they will return to the hatchery facility and not to natural spawning areas.
- Operate weirs to trap and remove hatchery-origin fish before they spawn naturally.
- Minimize hatchery facility failure through 24-hour-per-day staffing and onsite residence by hatchery facility personnel to allow for rapid response to power or facility failures.
- Use backup generators to respond to power loss.
- Design hatchery facilities to be non-consumptive regarding water resources. That is, water used in the hatchery facility can be returned near the point where it was withdrawn from its source to minimize effects on natural-origin fish and other aquatic fauna.
- Operate all hatchery facilities within the limits established in National Pollutant Discharge Elimination System (NPDES) permits (if required).
- Operate hatchery facilities to allow all migrating species of all ages to bypass or pass through hatchery-related structures.
- Operate hatcheries so that hatchery-origin fish are reared to sufficient size, and smoltification occurs within nearly the entire population.
- Release smolts in river areas below the upstream areas used for natural-origin salmon and steelhead rearing.

- Time hatchery fish releases to minimize ecological risks.
- Maintain low densities of fish in hatchery facilities to reduce fish stress.
- Have a fish health specialist conduct monthly and prerelease checks of hatchery-origin salmon and steelhead.

4.1.3 Implementation Scenarios [This section was moved from Section 2.7, Implementation Scenarios, in the draft EIS.]

4.1.3.1 Identifying an Implementation Scenario

The policy directions that are associated with each of the action alternatives (Section 2.5, Alternatives Analyzed in Detail) are goal-oriented and do not identify specific actions that would be taken under each alternative. This is because the National Marine Fisheries Service (NMFS) understands that specific hatchery actions should be determined on a hatchery-program-by-hatchery-program basis. To analyze, illustrate, and compare the potential environmental effects of each alternative, however, an implementation scenario was developed for the policy direction under each alternative.

Each implementation scenario is one example of how each hatchery program could be operated to meet the policy direction of the alternative. There are, however, different potential implementation scenarios that managers could apply and still remain consistent with each alternative policy direction. NMFS does not advocate for any of the implementation scenarios evaluated in this EIS over any other potential scenarios that managers could use, and the analysis may show that implementing some components of a scenario may be unreasonable. For example, some components of these implementation scenarios may or may not be viewed as consistent with commitments in the *United States (U.S.) v Oregon* Management Agreement (Section 1.7.4, *U.S. v. Oregon),*or other current congressional mitigation agreements. The EIS does not make a determination that an alternative or its implementation scenario is or is not consistent with the *U.S. v. Oregon* Management Agreement or other mitigation agreements, and no such assertion is made (Section 1.7, Relationship to Other Plans, Regulations, Agreements, Laws, and Executive and Secretarial Orders). Likewise, the programs developed through the alternative implementation scenarios should not be viewed as necessarily being consistent with application of the Endangered Species Act (ESA). ESA determinations will be made during program-specific consultations with NMFS when hatchery managers seek ESA authorizations.

4.1.3.2 Performance Metrics

To enable an informative and consistent analysis of effects between the baseline condition (Alternative 1, No Action) and the alternatives, specific performance metrics (i.e., measurements of performance) were identified for each performance goal (Section 2.4.2, Alternative Performance Goals) (Table 4-1) (Box 4-1). The performance metrics included four measurements:

- Natural-origin spawner abundance. The level of natural-origin spawners available to contribute to the next generation of a population is an important indicator of population viability.
- Mean adjusted productivity of population. The productivity of a population (recruits per spawner) is an indication of growth rate potential of the population. The EIS uses the mean adjusted productivity estimates produced by the All-H analyzer.
- Proportionate natural influence (PNI). PNI of a population, which is a measure of the natural environment's influence on the genetic diversity of a population, as a whole, is a function of both the proportion of hatchery-origin spawners (pHOS) in the natural escapement and the proportion of natural-origin broodstock (pNOB) incorporated into the hatchery program.
- pHOS. The pHOS that joins natural-origin adults on spawning ground is a measure of the potential effect of the hatchery on genetic diversity of the natural-origin population.

As described in the draft EIS and reiterated in Section 1.3.1, Preferred Alternative Formulated and Identified in the final EIS, and Section 2.8, Selection of the Preferred Alternative, NMFS utilized the public review process to develop a preferred alternative that combines elements of the alternatives analyzed in the draft EIS and in the final EIS. During the public comment period, it became clear to NMFS that hatchery operators throughout the Columbia River Basin had varying approaches to realizing benefits from and minimizing or reducing the potential risks of their hatchery programs on natural-origin salmon and steelhead populations. Thus, the implementation scenario for the Preferred Alternative (Alternative 6) applies these varying approaches to increase the benefits to and minimize the potential risks of hatchery programs on natural-origin salmon and steelhead populations instead of applying one standardized set of performance metrics to every hatchery program in the basin.

TABLE 4-1. PERFORMANCE METRICS FOR EACH HATCHERY PERFORMANCE GOAL USED TO MEASURE THE EFFECTS TO NATURAL-ORIGIN POPULATIONS FOR ALTERNATIVE 1 THROUGH ALTERNATIVE 6[1].

HATCHERY PERFORMANCE GOAL[2]	PERFORMANCE METRICS FOR AFFECTED POPULATIONS
Intermediate Performance Goal	Abundance – Maintained or increased abundance of natural-origin spawners over baseline
	Productivity – Maintained or increased productivity of population over baseline
	Diversity – Percent of integrated populations maintain a PNI greater than or equal to 0.50
	Diversity – Percent of isolated, natural-origin populations maintain a pHOS less than or equal to 0.10
Stronger Performance Goal	Abundance – Increased abundance of natural-origin spawners over baseline
	Productivity – Increased productivity of population over baseline
	Diversity – Percent of integrated populations maintain a PNI greater than or equal to 0.67
	Diversity – Percent of isolated, natural-origin populations maintain a pHOS less than or equal to 0.05

[1] Genetic Diversity Performance Metrics (PNI/pHOS) were actively utilized as goals in developing hatchery programs under the implementation scenarios for Alternative 2 through Alternative 5. The performance metrics were used to analyze the effects to diversity (genetic) from all Implementation scenarios (Alternative 1 through Alternative 6).
[2] Definitions of Alternative Performance goals can be found in Section 2.4.2.1, Performance Goals Defined.

Box 4-1. What is the difference between a hatchery performance goal and a performance metric?

In this EIS, performance goals are identified within each alternative (Section 2.4.2, Alternative Performance Goals). These goals refer to how hatchery programs will be operated to reduce risks to or produce benefits for the natural salmon and steelhead populations they affect. There are two performance goals: stronger and intermediate. Both performance goals would likely reduce the risks hatchery programs impose on salmon and steelhead populations compared to the baseline conditions. Additionally, the stronger performance goals for programs designed as conservation or both (conservation/harvest) would likely benefit natural-origin salmon and steelhead populations compared to the baseline conditions.

Performance metrics are identified in this section so that the effects of alternative implementation scenarios on salmon and steelhead populations can be compared. Performance metrics apply to the natural populations that are being affected by the hatchery programs. Performance metrics include four measurements: natural-origin spawner abundance, population mean adjusted productivity, PNI, and pHOS.

Although NMFS uses these performance metrics in this EIS, no determination has been made regarding their adequacy under ESA. NMFS is not advocating the use of any particular performance metric. Reviewers are encouraged to understand the dynamics of the population that affect its abundance, productivity, PNI, and pHOS values, particularly in an integrated population. In some cases, the favorable values of an integrated population may disguise underlying risks. For example, if the naturally spawning component of the integrated population is small, then it may be necessary to maintain a high number of natural-origin fish in the hatchery broodstock to maintain a high overall PNI value. This overuse of the natural-origin population could maintain its PNI, but increase genetic and demographic risks to the population as a whole.

4.1.3.3 Implementation Measures

Implementation scenarios for Alternative 2 through Alternative 6 include implementation measures that would reduce, where necessary, risks from hatchery programs on salmon and steelhead populations. However, these implementations measures may also affect other resources within the analysis area (Table 4-2).

A description of *how* these measures can affect performance metrics is found in Box 4-2.

After identifying measures (i.e., implementation measures) that could be taken under each alternative to help meet performance metrics (Section 4.1.3.2, Performance Metrics), a computer spreadsheet model, the All-H Analyzer, was used to develop and model the implementation scenario. The All-H Analyzer is a Microsoft Excel-based application that evaluates salmon management options in the context of the four “Hs” that affect salmon populations (habitat degradation, hydroelectric system passage, harvest, and hatchery effects) (Appendix G, Overview of the All-H Analyzer). The All-H Analyzer allows users to input data reflecting habitat productivity/capacity, harvest rates, and hatchery operations. Data inputs for hatchery operations include production levels, hatchery program strategies (integrated or isolated), use of weirs and/or selective fisheries, and the proportion of natural-origin fish in the broodstock.

The All-H Analyzer produces outputs in terms of the resulting number of hatchery-origin and natural-origin fish returning both to the habitat and to the hatchery facility, the number of hatchery-origin and natural-origin fish harvested, the resulting mean adjusted productivity and abundance of the population, and the resulting PNI and pHOS of a population. Input data used in the All-H Analyzer, for baseline conditions (Alternative 1 [No Action]), were obtained from hatchery operators and reflect 2010 hatchery conditions.

TABLE 4-2. RESOURCES THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

Implementation Measures Incorporated in One or More of the Alternatives' Implementation Scenarios	Resources That May Be Affected					
	Fish	Socioeconomics	Environmental Justice	Wildlife	Water Quality and Quantity	Human Health
Change production levels in hatchery programs.	X	X	X	X	X	X
Update water intake screens at hatchery facilities.	X	X				
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	X	X				
Correct water quality issues at hatchery facilities.	X	X		X	X	X
Install new seasonal weirs.	X	X		X	X	
Install new permanent weirs.	X	X		X	X	
Establish new selective fisheries in terminal areas.	X	X	X			
Change hatchery program goals (i.e., harvest or conservation).	X					
Change hatchery program's operational strategy (i.e., isolated or integrated).	X					
Establish new hatchery programs.	X	X	X	X	X	X
Terminate hatchery programs that only support harvest if they fail to meet performance goals.	X	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources.

Box 4-2. How can measures at, or associated with, hatchery programs and facilities be used to meet performance metrics?

The following examples illustrate measures that could be taken to help meet performance metrics:

- Reducing production would result in fewer hatchery-origin fish spawning naturally. This would reduce pHOS and increase PNI.
- Increasing the number of natural-origin fish used in the hatchery broodstock would generally increase the PNI of an integrated population.

Box 4-2. How can measures at, or associated with, hatchery programs and facilities be used to meet performance metrics? (continued)

- Using adult traps and weirs to reduce the number of hatchery-origin fish returning to a stream's natural spawning ground would decrease pHOS.
- Changing a hatchery program's operational strategy from isolated to integrated, or from integrated to isolated, could help a program meet performance goals. For example, if managers cannot successfully segregate hatchery program fish from the naturally spawning population, they may choose to implement an integrated hatchery program with the natural-spawning population to reduce the genetic risk. On the other hand, an integrated program may be difficult to operate properly because of the program size relative to the natural-origin population. If the hatchery program is intended to meet mitigation objectives, the program may have to take actions to increase the segregation of the hatchery program fish from the natural-origin population.
- Relocating a hatchery program to areas removed from natural-origin populations would reduce pHOS.
- Although not necessarily associated with hatchery operations, selective fisheries can be used to target hatchery-origin fish and potentially reduce pHOS in natural spawning areas. Fisheries can be selective through a variety of means, including the time and area within which they are conducted. If hatchery-origin fish are externally mass-marked (Box 2-4), fishing techniques that require release of natural-origin fish are selective. One effect of selective fisheries discussed in the EIS is similar to the intended effect of weirs, reducing pHOS. However, one potential benefit of using selective fisheries instead of weirs is that the catch of hatchery-origin fish could contribute to recreational, commercial, or treaty harvests rather than being removed by the operation of a weir. To help illustrate the potential effects of mark-selective fisheries generally, Alternative 4 and Alternative 5 in the EIS assume increased harvest rates on hatchery-origin fish in "terminal" areas, i.e., the tributaries into which adult fish return, when necessary to meet the alternative performance goal. These additional fisheries are modeled to maintain harvest limits on the natural-origin fish and achieve identified escapement goals.

The All-H Analyzer was chosen for this EIS based on its capability to model all of the Columbia River Basin hatchery programs at one time and to allow the hatchery program fish to interact with all natural-origin populations. The All-H Analyzer facilitates the comparison of potential effects to salmon and steelhead resources across the alternatives. The All-H Analyzer was designed to allow fish managers to compare alternative management scenarios and understand how each scenario might perform relative to other scenarios. It is not a tool that was designed to predict the exact numbers of hatchery-origin or natural-origin fish that would result from different management actions. Results from the All-H Analyzer should be considered in the context of general qualitative, rather than quantitative, change that might be expected from substantial hatchery program adjustments. For a detailed review of the All-H Analyzer see Appendix I.

In some cases, when applying the All-H Analyzer to the implementation scenario for each alternative, a salmon or steelhead population was not projected to meet its performance metrics even after use of all available measures (i.e., even with reduction in production, changes to a hatchery program's operational strategy, and installation of weirs). In these cases, the hatchery program was assumed to be terminated within that implementation scenario with the following two exceptions:

- Conservation hatchery programs were not assumed to be terminated. This was the case for 70 percent of the hatchery programs that were not assumed to be terminated, even though they prevented a population from meeting target performance metrics.
- Hatchery programs were not assumed to be terminated if they affected a population with such low abundance that the population's status would not improve, even if the hatchery program were terminated. This was the case for 30 percent of the hatchery programs that were not assumed to be terminated, even though they prevented a population from meeting target performance metrics.

4.1.3.4 Comparison of Implementation Scenarios

A no-action alternative and five action alternatives are analyzed in detail in this EIS. One implementation scenario has been identified for each alternative so that the effects can be understood and compared. Implementation scenarios are compared in this section using the following categories:

- Measures that could be implemented to meet the alternative metrics (Table 4-3)
- Combined production levels by species for the entire Columbia River Basin, as well as the portion of production funded under the Mitchell Act (Table 4-4)

- Terminated hatchery programs (Table 4-5)
- New hatchery programs (Table 4-5)
- Weirs (Table 4-6)
- Number of populations that meet and do not meet intermediate or stronger performance metrics by alternative (Table 4-7)
- Harvest contribution (Table 4-8)
- Subbasins where hatchery fish would not be released (Table 4-9)

Some of the alternative effects, particularly those that affect natural-origin fish populations, are presented in this summary. The full discussion of all environmental impacts is found in Chapter 4, Environmental Consequences.

4.1.4 Implementation Scenario for Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations (baseline conditions) with no policy changes and is referred to as baseline conditions operations in this EIS. Although salmon and steelhead populations fluctuate annually due to environmental effects outside of hatcheries, Alternative 1 assumes that future salmon and steelhead population sizes would be similar to those under existing conditions.

Under the implementation scenario for Alternative 1, no new policy direction would be adopted. NMFS would disburse Mitchell Act funds, subject to annual funding availability, to agencies and tribes as in 2010, and hatchery production in the Columbia River Basin would continue at current levels (Table 2-3). In this EIS, the 2010 data from the most recent year available were used for the modeling analysis and represent baseline conditions for hatchery operations. Production levels in 2010 were similar to current production levels (2013). No performance goals would be established. The No-action Alternative assumes that no additional implementation measures, other than those already occurring under baseline conditions, would be assumed to be taken to reduce adverse effects on natural-origin fish (Table 4-3).

More than 140 million smolts would continue to be produced by existing Columbia River hatchery programs, with 46 percent coming from hatchery programs funded through the Mitchell Act (Table 4-4). Under Alternative 1, Chinook salmon represent the highest number of hatchery fish produced for all hatchery programs combined (75 percent of the total) (Table 4-4). Sixty-six percent of the coho salmon hatchery production would be funded through the Mitchell Act followed by 46 percent of Chinook salmon hatchery production (Table 4-4). Approximately

13 percent of the nearly 15 million hatchery-origin steelhead released under Alternative 1 would be produced by Mitchell Act-funded hatchery programs (Table 4-4). Relatively few sockeye would be produced under Alternative 1 by Mitchell Act-funded hatchery programs, and no chum salmon would be produced (Table 4-4). Details on the operation of individual hatchery programs under Alternative 1 can be found in Appendix C through Appendix F.

TABLE 4-3. COMPARISON OF IMPLEMENTATION MEASURES FOR EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

	ALTERNATIVE (IMPLEMENTATION SCENARIO)					
IMPLEMENTATION MEASURES	**1**	**2**	**3**	**4**	**5**	**6***
Change production levels in hatchery programs.	No	Yes	Yes	Yes	Yes	Yes
Update water intake screens at hatchery facilities.	No	Yes	Yes	Yes	Yes	Yes
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	No	Yes	Yes	Yes	Yes	Yes
Correct water quality issues at hatchery facilities.	No	Yes	Yes	Yes	Yes	Yes
Install new seasonal weirs.	No	No	Yes	Yes	Yes	No
Install new permanent weirs.	No	No	No	Yes	Yes	No
Establish new selective fisheries in terminal areas.	No	No	No	Yes	Yes	No
Change hatchery program goals (i.e., harvest or conservation).	No	No	No	Yes	Yes	Yes
Change hatchery program's operational strategy (i.e., isolated or integrated).	No	No	No	Yes	Yes	Yes
Establish new hatchery programs.	No	No	No	Yes	Yes	Yes
Terminate hatchery harvest programs that only support harvest if they fail to meet performance goals.	No	Yes	Yes	Yes	Yes	Yes
Terminate conservation or dual-role hatchery programs if they fail the meet performance goals.	No	No	No	No	No	No

*Preferred Alternative.

TABLE 4-4. HATCHERY PRODUCTION LEVELS BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO WHEN IMPLEMENTATION MEASURES ARE USED TO MEET PERFORMANCE METRICS (ROUNDED TO THE NEAREST 1,000 FISH).

		CHINOOK SALMON	STEELHEAD	COHO SALMON	CHUM SALMON	SOCKEYE SALMON	TOTAL
Alternative 1	All hatchery programs	105,624	14,616	19,741	250	362	140,593
	Mitchell Act-funded hatchery programs	48,893	1,935	12,944	0	150	63,922
	Non-Mitchell Act-funded hatchery programs	56,731	12,681	6,797	250	212	76,671
Alternative 2	All hatchery programs	40,409	11,416	6,097	171	212	57,981
	Mitchell Act-funded hatchery programs	0	0	0	0	0	0
	Non-Mitchell Act-funded hatchery programs	40,409	11,092	6,097	171	212	57,981
Alternative 3	All hatchery programs	85,728	12,994	15,158	171	362	114,413
	Mitchell Act-funded hatchery programs	39,598	1,878	8,912	0	150	50,538
	Non-Mitchell Act-funded hatchery programs	46,130	11,116	6,246	171	212	63,875
Alternative 4	All hatchery programs	89,411	12,866	15,744	676	362	119,059
	Mitchell Act-funded hatchery programs	40,292	1,793	9,974	50	150	52,258
	Non-Mitchell Act-funded hatchery programs	49,119	11,074	5,770	626	212	66,801
Alternative 5	All hatchery programs	88,693	14,475	15,588	171	712	119,639
	Mitchell Act-funded hatchery programs	45,823	2,589	8,981	0	751	58,143
	Non-Mitchell Act-funded hatchery programs	48,750	12,611	6,676	171	212	68,421
Alternative 6 (Preferred Alternative)	All hatchery programs	104,671	15,160	17,407	350	712	138,299
	Mitchell Act-funded hatchery programs	41,796	1,928	10,473	100	500	54,796
	Non-Mitchell Act-funded hatchery programs	62,875	13,232	6,934	250	212	83,503

Table 4-5. Number of Hatchery Programs Assumed to be Terminated and Hatchery Programs Assumed to be Initiated under Each Alternative's Implementation Scenario.

	Alternative 1 (Baseline)	Alternative 2			Alternative 3			Alternative 4			Alternative 5			Alternative 6 (Preferred Alternative)		
Ecological Province	Total Number of Hatchery Programs	Total Hatchery Programs Assumed Terminated (Mitchell Act Programs Assumed Terminated)	Hatchery Programs Assumed Initiated	Total Number of Remaining Hatchery Programs	Hatchery Programs Assumed Terminated	Hatchery Programs Assumed Initiated	Total Number of Remaining Hatchery Programs	Hatchery Programs Assumed Terminated	Hatchery Programs Assumed Initiated	Total Number of Remaining Hatchery Programs	Hatchery Programs Assumed Terminated	Hatchery Programs Assumed Initiated	Total Number of Remaining Hatchery Programs	Hatchery Programs Assumed Terminated	Hatchery Programs Assumed Initiated	Total Number of Remaining Hatchery Programs
Columbia Estuary	16	13 (11)	0	**3**	2	0	**14**	0	3	**19**	2	0	**14**	0	2	**18**
Lower Columbia	57	32 (31)	0	**27**	4	2	**55**	11	13	**59**	4	2	**55**	4	4	**57**
Columbia Gorge	14	12 (12)	0	**2**	2	1	**13**	2	1	**13**	5	2	**11**	5	2	**11**
Columbia Plateau	24	6 (6)	0	**18**	1	0	**23**	1	0	**23**	1	1	**24**	1	0	**24**
Columbia Cascade	20	0 (0)	0	**20**	0	0	**20**	0	0	**20**	1	3	**22**	2	7	**24**
Blue Mountain	14	0 (0)	0	**14**	0	0	**14**	0	0	**14**	0	1	**15**	0	1	**15**
Mountain Snake	32	5 (2)	0	**27**	2	0	**30**	2	0	**30**	0	3	**35**	0	5	**37**
Grand Total	**177**	**68 (62)**	**0**	**111**	**11**	**3**	**169**	**16**	**17**	**178**	**13**	**12**	**176**	**12**	**21**	**186**

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TABLE 4-6. NEW WEIRS BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO AND ECOLOGICAL PROVINCE.

		ALTERNATIVE					
RECOVERY DOMAIN	**ECOLOGICAL PROVINCE**	**1**	**2**	**3**	**4**	**5**	**6***
Willamette/ Lower Columbia	Columbia Estuary	0	0	6	7	6	0
	Lower Columbia	0	0	2	2	1	0
	Columbia Gorge	0	0	1	1	1	0
Interior Columbia	Columbia Gorge	0	0	0	0	0	0
	Columbia Plateau	0	0	2	0	2	0
	Columbia Cascade	0	0	0	0	1	0
	Blue Mountain	0	0	1	0	0	0
	Mountain Snake	0	0	2	1	1	0
Total		**0**	**0**	**9**	**11**	**12**	**0**

* Preferred Alternative.

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TABLE 4-7. NUMBER OF POPULATIONS THAT WOULD MEET GENETIC DIVERSITY PERFORMANCE METRICS (PNI AND pHOS) UNDER EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

Recovery Domain		Alternative 1 (No Action)			Alternative 2			Alternative 3			Alternative 4			Alternative 5			Alternative 6 (Preferred Alternative)		
		PNI ≥ 0.67; pHOS ≤ 0.05 (Stronger)	PNI ≥ 0.50; pHOS ≤ 0.10 (Intermediate)	PNI < 0.50; pHOS > 0.10 (Weaker than Intermediate)	PNI ≥ 0.67; pHOS ≤ 0.05 (Stronger)	PNI ≥ 0.50; pHOS ≤ 0.10 (Intermediate)	PNI < 0.50; pHOS > 0.10 (Weaker than Intermediate)	PNI ≥ 0.67; pHOS ≤ 0.05 (Stronger)	PNI ≥ 0.50; pHOS ≤ 0.10 (Intermediate)	PNI < 0.50; pHOS > 0.10 (Weaker than Intermediate)	PNI ≥ 0.67; pHOS ≤ 0.05 (Stronger)	PNI ≥ 0.50; pHOS ≤ 0.10 (Intermediate)	PNI < 0.50; pHOS > 0.10 (Weaker than Intermediate)	PNI ≥ 0.67; pHOS ≤ 0.05 (Stronger)	PNI ≥ 0.50; pHOS ≤ 0.10 (Intermediate)	PNI < 0.50; pHOS > 0.10 (Weaker than Intermediate)	PNI ≥ 0.67; pHOS ≤ 0.05 (Stronger)	PNI ≥ 0.50; pHOS ≤ 0.10 (Intermediate)	PNI < 0.50; pHOS > 0.10 (Weaker than Intermediate)
Willamette/Lower Columbia																			
Primary Populations	Target		No Targets Set (No Action)			67			67			67			67			67	
	Result	39	7	21	61	3	3	55	7	5	62	0	5	54	8	5	45	5	17
Contributing Populations	Target		No Targets Set (No Action)			33			33			33			33			33	
	Result	11	2	20	26	5	2	13	8	12	14	6	13	13	8	12	13	2	18
Stabilizing Populations	Target		No Targets Set (No Action)			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status	
	Result	3	0	18	15	2	4	4	1	16	4	2	15	4	1	16	3	0	18
Interior Columbia																			
Primary Populations	Target		No Targets Set (No Action)			76			76			76			76			76	
	Result	50	5	21	63	10	3	59	13	4	59	13	4	71	1	4	57	9	10
Contributing Populations	Target		No Targets Set (No Action)			22			22			22			22			22	
	Result	12	0	10	16	2	4	15	4	3	15	4	3	16	3	3	12	3	7
Stabilizing Populations	Target		No Targets Set (No Action)			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status	
	Result	2	1	22	6	0	19	3	1	21	3	1	21	3	1	21	2	0	23

[4] Number of populations that would meet or exceed target performance metrics, for each alternative's implementation scenario, is in green. Number of populations that would not meet target performance metrics is in red. Note that this EIS does not evaluate habitat improvements or other measures unrelated to hatchery programs that could contribute improved conditions for these or any populations.

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TABLE 4-8. TOTAL NUMBER OF COLUMBIA RIVER FISH HARVESTED UNDER EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

	ALTERNATIVE					
	1	2	3	4	5	6*
Chinook Salmon	496,500	285,109	466,905	487,569	493,210	548,332
Steelhead	199,295	159,229	184,387	183,830	198,893	205,701
Coho Salmon	245,881	64,319	171,699	192,578	177,495	197,152
Chum Salmon	370	352	352	466	352	389
Sockeye Salmon	2,479	2,274	2,472	2,472	2,934	2,934
Total	944,525	511,283	825,815	866,915	872,884	954,508

These harvest numbers reflect the number of Columbia River Basin salmon and steelhead harvested in all fisheries (California, Oregon, Washington, British Columbia, and Southeast Alaska).
* Preferred Alternative.

TABLE 4-9. COLUMBIA RIVER SUBBASINS OR MAJOR WATERSHEDS WITHIN A SUBBASIN WHERE HATCHERY FISH ARE NOT RELEASED BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6*
Asotin	Asotin	Asotin	Asotin	Asotin	Asotin
Chinook	Big Creek	Chinook	Chinook	Chinook	Chinook
Clatskanie	Chinook	Clatskanie	Clatskanie	Clatskanie	Clatskanie
Fifteenmile	Clatskanie	Fifteenmile	Fifteenmile	Fifteenmile	Fifteenmile
John Day	Clackamas	John Day	John Day	John Day	John Day
Middle Fork Salmon	Coweeman	Middle Fork Salmon	Middle Fork Salmon	Middle Fork Salmon	Middle Fork Salmon
Mill-Abernathy -Germany	Elochoman	Mill-Abernathy-Germany	Mill-Abernathy-Germany	Mill-Abernathy-Germany	Mill-Abernathy-Germany
Scappoose	Fifteenmile	Scappoose	Scappoose	Scappoose	Scappoose
	Gnat Creek			White Salmon	White Salmon
	Grays				
	John Day				
	Kalama				
	Klickitat				
	Little White Salmon				
	Middle Fork Salmon				
	Mill-Abernathy-Germany				
	Sandy				
	Scappoose				
	Toutle				
	Washougal				
	White Salmon				
	Wind				

These subbasins do not represent those with populations that are entirely free of hatchery influence because several receive hatchery-origin influence from nearby hatchery programs (e.g., the Asotin has documented steelhead returns from Lyons Ferry Hatchery releases) (A. Appleby, pers. comm., to the Hatchery Scientific Review Group [HSRG] 2009).
* Preferred Alternative.

No new hatchery programs would be initiated, nor would existing hatchery programs be terminated under Alternative 1 (Table 4-5). No new weirs would be installed in the Willamette/Lower Columbia Recovery Domain (Lower Columbia and Columbia Gorge) or the Interior Columbia Recovery Domain (Columbia Plateau, Columbia Cascade, Blue Mountain, and Mountain Snake)[1] (Table 4-6).

While performance metrics would not be applied under Alternative 1, under this baseline conditions alternative, 39 (53 percent) of the 67 primary populations in the Willamette/Lower Columbia Recovery Domain meet the stronger genetic diversity performance metrics for pHOS (less than 0.05 for naturally spawning populations) or PNI (greater than 0.67 for integrated populations). Seven (10 percent) of the populations reflect the intermediate genetic diversity performance metrics for pHOS (greater than 0.05 but less than 0.10) or PNI (greater than 0.50 but less than 0.67). Twenty-one (31 percent) of the populations have either a pHOS greater than 0.10 or a PNI less than 0.50 (Table 4-7). Of the 33 contributing populations, 33 percent of the populations reflect the stronger genetic diversity performance metrics, 6 percent reflect the intermediate genetic diversity performance metrics, and 61 percent of the populations either have a pHOS greater than 0.10 or a PNI less than 0.50. Of the 21 stabilizing populations in the Willamette/Lower Columbia Recovery Domain, 14 percent reflect the stronger genetic diversity performance metrics, 0 percent reflect the intermediate genetic diversity performance metrics, and a majority of the populations (86 percent) either had a pHOS greater than 0.10 or a PNI less than 0.50 (Table 4-7).

In the Interior Columbia Recovery Domain, nearly 67 percent of the 76 primary populations reflect the stronger genetic diversity performance metrics for pHOS or PNI, nearly 7 percent reflect the intermediate genetic diversity performance metrics, and 28 percent had a pHOS greater than 0.10 or a PNI less than 0.50 (Table 4-7). Of the 22 contributing populations in the Interior Columbia Recovery Domain, 55 percent reflect the stronger genetic diversity performance metrics, 0 percent reflect the intermediate genetic diversity performance metrics, and 45 percent have a pHOS greater than 0.10 or a PNI less than 0.50. Of the 25 stabilizing populations in the Interior Columbia Recovery Domain, only 8 percent reflect the stronger genetic diversity performance metrics, one of the populations (4 percent) reflect the intermediate metrics, and most populations (88 percent) have a pHOS greater than 0.10 or a PNI less than 0.50 (Table 4-7).

[1] Weirs discussed within these alternatives are intended, generally, to aid in the removal of hatchery fish from natural spawning grounds. The weirs are not considered part of the Mitchell Act Screens and Fishways Program that focuses on structures to bypass fish around dams and irrigation diversions (Section 1.1.1, The Mitchell Act).

Again, while useful for comparison purposes, performance metrics were not applied to stabilizing populations under Alternative 1.

The number of fish harvested under Alternative 1 would be approximately 602,368 salmon and steelhead (Table 4-8). These fish are coho salmon (37 percent), Chinook salmon (46 percent), steelhead (22 percent), sockeye salmon (less than 1 percent), and chum salmon (less than 1 percent) (Table 4-8). Nine subbasins would not receive direct releases of hatchery fish under Alternative 2 (Table 4-9).

4.1.5 Implementation Scenario for Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, hatchery programs currently funded through the Mitchell Act would be assumed to be terminated. Hatchery programs that receive partial funding through Mitchell Act sources would also be assumed to be terminated. This includes hatchery programs that rely on fish provided by Mitchell Act-funded hatchery programs. Remaining Columbia River Basin hatchery programs would be operated to achieve intermediate performance metrics (Table 4-1). As shown in Table 4-3, measures implemented to achieve performance metrics vary under each implementation scenario so that their environmental effects can be compared and contrasted. Under the implementation scenario for Alternative 2, implementation measures would include reductions in production levels and/or changes in the proportion of natural-origin fish in the broodstock to help meet target performance metrics (Table 4-3). Facility best management practices (BMPs) would be implemented so that screens on the water intakes would be updated, and any water quality issues would be addressed.

Under the implementation scenario for Alternative 2, two noteworthy measures would *not* be implemented to meet performance metrics. First, no new weirs would be installed to help control the number of hatchery fish spawning naturally. This exception is made so that the reviewer may isolate and compare effects when new weirs would be installed (as planned under the implementation scenarios for Alternative 3 through Alternative 5) from effects when new weirs would not be installed (under the implementation scenario for Alternative 2 and Alternative 6). Second, no new selective fisheries would be implemented in tributaries (known as *terminal area fisheries*) to reduce the number of hatchery adults returning to spawn. Again, the purpose of this exception is to allow the reader to isolate and compare effects when such fisheries would be implemented (under the implementation scenarios for Alternative 4 and Alternative 5) with effects when they would not be implemented (implementation scenario for Alternative 2).

Production under the implementation scenario for Alternative 2 would represent about 41 percent of production levels under Alternative 1 with Mitchell Act funded hatcheries representing zero percent of total production (Table 4-4). Under the implementation scenario for Alternative 2, Chinook salmon would represent 70 percent of all hatchery fish produced, steelhead 20 percent, and coho salmon 10 percent (Table 4-4). All 62 hatchery programs that rely on Mitchell Act funds (either entirely or because those hatchery programs rely on fish provided by Mitchell Act-funded hatchery programs) would be assumed to be terminated (Table 4-5). Another four harvest hatchery programs would be assumed to be terminated to achieve the target performance metrics (Table 4-5). Table 4-10 (found at the end of Section 4.1, Introduction) lists the hatchery programs assumed to be terminated under the implementation scenario for Alternative 2. No new hatchery programs would be assumed to be initiated.

Under the implementation scenario for Alternative 2, intermediate genetic diversity performance metrics would be achieved or exceeded for 95 percent of the primary and contributing populations in the Willamette/Lower Columbia Recovery Domain and 93 percent of the populations in the Interior Columbia Recovery Domain (Table 4-7). Despite eliminating 68 hatchery programs (Table 4-5) and reducing many others, some hatchery programs would be retained, even though intermediate genetic diversity performance metrics would not be achieved for 13 populations affected by the hatchery programs (Table 4-7). In the Willamette/Lower Columbia Recovery Domain, hatchery programs would be retained, even though they would affect three primary and two contributing populations that would not achieve target genetic diversity performance metrics (Table 4-7). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the North Santiam River.
2. **Clatskanie Creek Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program to meet the conservation goal in the Grays River.
3. **Hood River Summer Steelhead (Primary).** Maintain steelhead conservation hatchery programs nearby and in upper Columbia. This is a small population, so few out-of-basin hatchery fish exceed metrics.
4. **White Salmon Spring Chinook Salmon (Contributing).** Population abundance is zero. The population was designated contributing by the Lower Columbia Fish Recovery Board (LCFRB) (2012) in anticipation of removal of Condit Dam.

5. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the Middle Fork Willamette River.

In the Interior Columbia Recovery Domain, eight hatchery programs would be maintained, even though three primary and five contributing populations would not achieve target genetic diversity performance metrics. These populations and the reasons for retaining the associated hatchery programs are as follows:

1. **Clearwater Upper Selway River Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the upper Selway River.
2. **Entiat Summer Steelhead (Primary).** Population abundance is very low (fewer than 100 fish) and influenced by a small number of out-of-basin conservation hatchery fish.
3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the Okanogan River.
4. **Umatilla River Fall Chinook Salmon (Contributing).** Maintain fall Chinook salmon conservation hatchery program to meet the conservation goal in the Umatilla River.
5. **Clearwater Lower Selway River Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the lower Selway River.
6. **South Fork Clearwater/Crooked River Summer Steelhead (Contributing).** Maintain summer steelhead conservation hatchery programs to meet the conservation goal in the South Fork Clearwater River.
7. **Yakima Marion Drain fall Chinook Salmon (Contributing).** Maintain fall Chinook hatchery programs in the Yakima River Basin, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of hatchery-origin fish.
8. **South Fork Clearwater/Crooked River Summer Steelhead (Contributing).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the South Fork Clearwater River.

The number of fish harvested under the implementation scenario for Alternative 2 would be about 55 percent of fish harvested under Alternative 1 (No Action) (Table 4-8). Most of this decrease would be due to substantial reductions in Chinook salmon, steelhead, and coho salmon

(Table 4-8). Twenty-two subbasins would not receive direct releases of hatchery-origin fish under the implementation scenario for Alternative 2 (Table 4-9). Most of these would be within the Willamette/Lower Columbia Recovery Domain.

4.1.6 Implementation Scenario for Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, Mitchell Act-funded hatchery programs and non-Mitchell Act-funded hatchery programs would be operated to achieve intermediate performance metrics (Table 4-1) for primary and contributing (Box 1-5) salmon and steelhead populations. Measures implemented under the implementation scenario for Alternative 3 to help hatchery programs meet performance metrics would include all of the measures under the implementation scenario for Alternative 2, plus the installation of new seasonal weirs (Table 4-3). The use of additional weirs under the implementation scenario for Alternative 3 would reduce the number of hatchery-origin fish spawning with natural-origin fish compared to the implementation scenarios for Alternative 1 and Alternative 2 (Box 4-3) and would improve PNI and pHOS (genetic diversity performance metrics) for affected salmon and steelhead populations.

Hatchery production levels under the implementation scenario for Alternative 3 would be approximately 81 percent of hatchery production levels under Alternative 1 with Mitchell Act-funded hatchery programs producing 44 percent of the total hatchery production (Table 4-4). To meet the performance metrics for both Mitchell Act and non-Mitchell Act funded hatchery programs, hatchery production levels would be reduced by 26.2 million juvenile fish from Alternative 1 levels (Table 4-4). However, 114 million juvenile fish (about 81 percent of production levels under Alternative 1) would continue to be produced in Columbia River Basin hatchery programs (Table 4-4). Similar to Alternative 1, most of the hatchery production under the implementation scenario for Alternative 3 would be Chinook salmon (75 percent), followed by approximately 11 percent steelhead and 13 percent coho salmon, with less than 1 percent of both chum and sockeye salmon (Table 4-4). Eleven hatchery programs would be assumed to be terminated because they would not meet performance metrics through available implementation measures (Box 4-4) (Table 4-5). For more details on hatchery programs assumed to be terminated, see Table 4-11 at the end of Section 4.1, Introduction.

Box 4-3. What are weirs, and how can they be operated to manage for performance metrics?

Weirs are structures in streams designed to block the migration of adult fish, but allow passage of water, juvenile fish, debris, and, in some cases, boats. Fish collection facilities often use weirs to collect broodstock and, if marked, to separate hatchery-origin from natural-origin fish (Box 2-4). This capability allows operators to manage the number of hatchery fish spawning in the natural environment or collect the appropriate proportion of natural-origin broodstock to maintain an integrated hatchery program. Decreasing pHOS and/or increasing pNOB may be required for a hatchery program to meet performance metrics. Although fish mortality from weir operation is generally considered to be low (McLean et al. 2004), weirs can present other biological risks, including juvenile or adult migration delay, isolating formerly connected populations, limiting movement of non-target species, increasing predation by concentrating fish, and altering habitat conditions upstream and downstream of the weir (Recovery Implementation Science Team [RIST] 2009) (Appendix I). Weirs can also affect boat passage or other recreational activities and degrade the scenic qualities of a river. Weirs can be expensive to construct and operate.

While this EIS does not intend to fulfill any required environmental review or assessment associated with weir installation or operation, it does evaluate how the use of a weir under reasonable assumptions could result in environmental effects on the hatchery programs analyzed in the alternatives. For instance, while not being specific in the design and operation of any particular weir, the EIS considers two broad types of weirs for analysis in the alternatives: permanent weirs and seasonal (temporary) weirs.

Permanent weirs are substantial structures relative to the size of streams within which they are built, and they can withstand a wide spectrum of water flow throughout the year. This is true even though they may be operated only during certain times to target a particular run. Permanent weirs efficiently capture fish, but do not generally catch every fish targeted for removal. For this reason, this analysis assumes that a permanent weir would be operated with the trapping efficiency necessary to achieve performance goals, but not greater than 95 percent of the fish targeted for removal would be removed.

Seasonal weirs are installed during certain times of the year to capture adults of a particular run. The weirs are usually built to withstand only the flow levels expected during their use. When the weir is not needed, it may be removed to allow for fish passage or recreational activities. This removal also prevents destruction by high flows.

Box 4-3. What are weirs and how can they be operated to manage for performance metrics? (continued)

Even so, seasonal weirs are more prone to partial or total physical failure compared to permanent weirs because of the inherent constraints of constructing a portable structure (which is less costly) versus a permanent structure. Thus, this analysis assumes that a seasonal weir would be operated with the trapping efficiency necessary to achieve the performance goal, but not greater than 60 percent of the fish targeted for removal would be removed.

Because of its lower efficiency (maximum of 60 percent), the use of a seasonal weir is sometimes not sufficient to remove enough hatchery-origin fish to achieve performance metrics. If not replaced by a higher efficiency weir (such as a permanent weir), the number of hatchery-origin fish produced may have to be reduced to decrease the number of hatchery-origin adults that return to the spawning grounds.

To illustrate the effects of different weir efficiencies, this EIS assumes the use of permanent weirs (maximum efficiency of 95 percent) if their efficiency is necessary to meet performance metrics in the Willamette/Lower Columbia Recovery Domain under Alternative 4. Under Alternative 5, this EIS assumes the use of permanent weirs if their efficiency is necessary to meet performance metrics in the Interior Columbia Recovery Domain. For comparison, seasonal weirs are assumed to be used at all other times, including under Alternative 3.

For more information on weirs, including costs and their usage in salmon management, see Johnson et al. (2007) and Appendix I. Again, this final EIS is not intended to fulfill requirements for environmental review, if any, for weir installation or operations.

Under the implementation scenario for Alternative 3, no new hatchery programs would be assumed to be initiated (Table 4-5). To minimize the number of hatchery fish that spawn in the wild, the implementation scenario for Alternative 3 would include the installation of nine new weirs in addition to the existing weirs under Alternative 1 (baseline level) (Table 4-6). Most of the new weirs (89 percent) would be placed in the Willamette/ Lower Columbia Recovery Domain (Table 4-6). Weirs would be placed where, based upon their assumed efficiency, they would be expected to allow primary or contributing populations to meet performance metrics (Box 4-3).

Box 4-4. Why terminate hatchery programs to meet performance metrics?

In general, most hatchery programs currently fall short of intermediate or stronger performance goals. This occurs because hatchery programs individually or cumulatively result in a high number of hatchery-origin spawners on natural spawning grounds.

In circumstances where hatchery programs cumulatively lead to high pHOS levels, more than one hatchery program may produce fish that spawn in the same subbasin, thus affecting the same natural-origin salmon or steelhead population. In these cases, there are two ways to meet the performance goals:

1. Reduce the level of production, or close one of the hatchery programs affecting the natural-origin salmon or steelhead population. This action would reduce the total number of hatchery-origin spawners.
2. Reduce production in more than one hatchery program (if not all hatchery programs) affecting the natural-origin salmon or steelhead population.

When considering the widest range of options for achieving performance goals, the implementation scenarios for different alternatives have diverse approaches to achieving performance goals. For example, hatchery-origin spring Chinook salmon from the Middle Fork Willamette River program return into the McKenzie, South Santiam, and North Santiam Rivers and affect populations in each of these rivers. In addition, hatchery programs operating in the above rivers also produce hatchery-origin fish that interact with these populations. Under the implementation scenario for Alternative 2, all hatchery programs would remain, but would be reduced considerably to achieve performance goals. Under the implementation scenario for Alternative 3, the Middle Fork Willamette hatchery program would be terminated, as it was estimated to be the largest contributor of hatchery-origin spawners, but other hatchery programs would be maintained at current levels.

There are two circumstances in this EIS where hatchery programs would not be closed, even though affected populations would not meet performance metrics. The first is when the purpose of the hatchery program is conservation of a salmon or steelhead population listed under ESA, and elimination of the program would put the natural population at further risk. The second is when the affected population is small, is dominated by spawning hatchery-origin fish, and habitat productivity is so low that it cannot sustain a naturally spawning population.

For primary populations, the intermediate performance metrics would be achieved or exceeded for more than 83 percent of the populations in the Willamette/Lower Columbia Recovery Domain and 93 percent of the populations in the Interior Columbia Recovery Domain (Table 4-7).

While implementing the actions previously described and reducing juvenile releases from many others, hatchery programs would be retained, even though the intermediate genetic diversity performance metrics would not be achieved for 24 affected populations in the Willamette/Lower Columbia and Interior Columbia Recovery Domains (Box 4-4). In the Willamette/Lower Columbia Recovery Domain, hatchery programs would be retained, although 5 affected primary populations and 12 contributing populations would not achieve target genetic diversity performance metrics. These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the North Santiam River.
2. **Columbia Gorge Tributaries Coho Salmon (Washington) (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 25 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
3. **Clatskanie Creek Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program to meet the conservation goal in the Grays River.
4. **Hood Fall Chinook Salmon (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 100 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
5. **Chinook River Coho Salmon (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 100 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
6. **Chinook River Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
7. **Big Creek Fall Chinook Salmon (Contributing).** Maintain out-of-basin hatchery programs in the lower Columbia River, population abundance is low and is heavily influenced by a small number of out-of-basin hatchery fish.

8. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the Middle Fork Willamette River.

9. **Hood Coho Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 10 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

10. **Fifteenmile Creek Coho Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

11. **Columbia Gorge Tributaries Coho Salmon (Oregon) (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by small number of out-of-basin hatchery fish.

12. **White Salmon Spring Chinook Salmon (Contributing).** The population was designated contributing by LCFRB (2012) in anticipation of removal of Condit Dam.

13. **White Salmon Fall Chinook Salmon (Contributing).** The population was designated contributing by LCFRB (2012) in anticipation of removal of Condit Dam.

14. **Clackamas Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is low and is heavily influenced by small number of out-of-basin hatchery fish.

15. **Columbia Gorge Tributaries Fall Chinook Salmon (Oregon) (Contributing).** Maintain out-of-basin programs, population abundance is low (fewer than 150) and is heavily influenced by out-of-basin hatchery fish.

16. **Little White Salmon Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 25 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

17. **Wind River Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is low and is heavily influenced by small number of out-of-basin hatchery fish.

In the Interior Columbia Recovery Domain, four primary and three contributing populations would not achieve target genetic diversity performance metrics (Table 4-7). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Clearwater Upper Selway River Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the upper Selway River.
2. **Entiat Summer Steelhead (Primary).** Population abundance is very low (fewer than 100 fish) and is influenced by out-of-basin, conservation, hatchery-origin fish.
3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the Okanogan River.
4. **Salmon River (Redfish Lake) Sockeye Salmon (Primary).** Maintain sockeye salmon conservation hatchery program to meet the conservation goal in the Salmon River.
5. **Clearwater Lower Selway River Spring Chinook salmon (Contributing).** Maintain spring Chinook salmon hatchery conservation program to meet the conservation goal in the lower Selway River.
6. **Yakima Marion Drain Fall Chinook (Contributing).** Population abundance is very low (fewer than 100 fish) and heavily influenced by a small number of hatchery-origin fish.
7. **South Fork Clearwater/Crooked River Summer Steelhead (Contributing).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the South Fork Clearwater River.

The number of fish harvested under the implementation scenario for Alternative 3 would be approximately 87 percent of the fish harvested under Alternative 1 (No Action) (Table 4-8). Most of this decrease would be due to a 30 percent reduction in the number of coho salmon harvested (Table 4-8). The number of subbasins not receiving direct releases of hatchery fish under the implementation scenario for Alternative 3 would be the same as under Alternative 1 (No Action) (Table 4-9).

4.1.7 Implementation Scenario for Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, hatchery programs in the Willamette/Lower Columbia Recovery Domain would be operated to allow primary and contributing salmon and steelhead populations to meet stronger genetic diversity performance metrics (Table 4-1). Hatchery programs in the Interior Columbia Recovery Domain would be operated to allow primary and contributing salmon and steelhead populations to meet intermediate genetic diversity performance metrics (Table 4-1). Under the implementation scenario for Alternative 4, several additional measures would be implemented (when compared to the implementation scenarios for Alternative 1 through Alternative 3) in the Willamette/Lower Columbia Recovery Domain to help programs meet performance metrics (Table 4-1). Weirs would be installed, the purpose or type of hatchery programs could be changed, and new selective terminal fisheries would be added to control the number of hatchery fish on the spawning ground (Table 4-3).

Under the implementation scenario for Alternative 4, production would be about 85 percent of production levels under Alternative 1 with Mitchell Act-funded hatchery programs producing 44 percent of total hatchery production (Table 4-4). More than 119 million fish would continue to be produced by hatcheries. Similar to the implementation scenarios for Alternative 1, Alternative 2, and Alternative 3, most fish production (75 percent) under the implementation scenario for Alternative 4 would be Chinook salmon, while 11 percent, 13 percent, less than 1 percent, and less than 1 percent would be of steelhead, coho salmon, chum salmon, and sockeye salmon, respectively (Table 4-4).

Sixteen new hatchery programs would be assumed to be initiated in the Columbia Estuary and Lower Columbia Ecological Provinces under the implementation scenario for Alternative 4 (Table 4-5). Eight of these new hatchery programs would support conservation objectives, while two new hatchery programs would support harvest, and six hatchery programs would support both conservation and harvest (Table 4-5). For more details on hatchery programs that would be assumed to be initiated under the implementation scenario for Alternative 4, see Table 4-15 at the end of Section 4.1, Introduction.

More hatchery programs would be assumed to be terminated under the implementation scenario for Alternative 4 than under the implementation scenarios for Alternative 3 and Alternative 5 (Table 4-5). These assumed eliminations would occur in both the Willamette/Lower Columbia and Interior Columbia Recovery Domains (Table 4-5). Eliminations would occur because programs would prevent salmon and steelhead populations from meeting target performance metrics. For more details on assumed-to-be-terminated programs, see Table 4-12 at the end of Section 4.1, Introduction.

To minimize the number of hatchery-origin fish that spawn naturally, the implementation scenario for Alternative 4 includes the installation of 11 new weirs (Table 4-6). Six weirs would be permanent structures, and four would be seasonal in the Willamette/Lower Columbia Recovery Domain. One new weir would be seasonal in the Interior Columbia Recovery Domain (Box 4-3).

Stronger genetic diversity performance metrics would be achieved for 93 percent of the primary populations in the Willamette/Lower Columbia Recovery Domain (Table 4-7). Hatchery programs would continue operating in the implementation scenario for Alternative 4, even though this would result in two primary populations not achieving stronger genetic diversity performance metrics (Table 4-7). Of the 33 contributing populations, 14 (42 percent) would achieve target performance metrics. Some hatchery programs in the Willamette/Lower Columbia Recovery Domain would continue operating, even though they would affect 5 primary and 19 contributing populations that would not meet target genetic diversity performance metrics (Table 4-7). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the North Santiam River.
2. **Hood Fall Chinook Salmon (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 100 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
3. **Columbia Gorge Tributaries Coho Salmon (Washington) (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 25 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
4. **Chinook River Coho Salmon (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 100 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
5. **Clatskanie Creek Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program to meet the conservation goal in the Grays River.
6. **Chinook River Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
7. **Big Creek Fall Chinook Salmon (Contributing).** Maintain out-of-basin hatchery programs in the lower Columbia River, population abundance is low and is heavily influenced by a small number of out-of-basin hatchery fish.

8. **Kalama River Chum Salmon (Contributing).** New chum salmon conservation hatchery programs implemented in the Lower Columbia River.
9. **White Salmon Spring Chinook Salmon (Contributing).** The population was designated contributing by LCFRB (2012) in anticipation of removal of Condit Dam.
10. **White Salmon Fall Chinook Salmon (Contributing).** The population was designated contributing by LCFRB (2012) in anticipation of removal of Condit Dam.
11. **Columbia Gorge Tributaries Fall Chinook Salmon (Oregon) (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 150) and is heavily influenced by out-of-basin hatchery fish.
12. **Little White Salmon Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 25 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
13. **Wind River Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is low and is heavily influenced by small number of out-of-basin hatchery fish.
14. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the Middle Fork Willamette River.
15. **Clackamas Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is low and is heavily influenced by small number of out-of-basin hatchery fish.
16. **Hood Coho Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 10 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
17. **Fifteenmile Creek Coho Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.
18. **Columbia Gorge Tributaries Coho Salmon (Oregon) (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by small number of out-of-basin hatchery fish.

19. **Kalama River Fall Chinook Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved and maintain a smaller fall Chinook hatchery program in the Kalama River.

20. **Mill-Abernathy-Germany Coho Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved with a weir and maintain nearby hatchery programs.

21. **Washougal River Coho Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved with a weir and maintain a coho hatchery program.

22. **Washougal River Coho Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved with a weir and maintain an integrated coho hatchery program.

23. **Kalama River Coho Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved with a weir and maintain an integrated coho hatchery program.

24. **North Fork Lewis Type S Coho Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved and maintain nearby coho hatchery programs.

In the Interior Columbia Recovery Domain, four primary and three contributing populations would not achieve target genetic diversity performance metrics (Table 4-7). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Upper Selway River Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the upper Selway River.

2. **Entiat Summer Steelhead (Primary).** Population abundance is low (fewer than 100 fish) and is influenced by out-of-basin, conservation hatchery fish.

3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the Okanogan River.

4. **Salmon River (Redfish Lake) Sockeye Salmon (Primary).** Maintain sockeye salmon conservation hatchery program to meet the conservation goal in the Salmon River.

5. **Clearwater Lower Selway River Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the lower Selway River.

6. **Yakima Marion Drain Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 100 fish) and heavily influenced by a small number of hatchery-origin fish.

7. **South Fork Clearwater/Crooked River Summer Steelhead (Contributing).** Maintain summer steelhead conservation hatchery programs to meet the conservation goal in the South Fork Clearwater River.

The number of fish harvested under the implementation scenario for Alternative 4 would be approximately 92 percent of fish harvested under Alternative 1 (No Action) (Table 4-8). Most of this decrease would result from a 28 percent reduction in the number of coho salmon harvested (Table 4-8). Slightly fewer Chinook salmon, steelhead, and sockeye salmon would be harvested. The number of subbasins not receiving direct releases of hatchery fish under the implementation scenario for Alternative 4 would be similar to Alternative 1 (No Action) but would additionally include the White Salmon Subbasin (Table 4-9).

4.1.8 Implementation Scenario for Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, hatchery programs in the Interior Columbia Recovery Domain would be operated to allow primary and contributing populations to achieve stronger performance metrics (Table 4-1). Programs in the Willamette/Lower Columbia Recovery Domain would be operated to allow primary and contributing populations to achieve intermediate performance metrics (Table 4-1).

Under the implementation scenario for Alternative 5, new opportunities would be identified to support harvest opportunities above Bonneville Dam, including the tribal commercial fisheries. Because some existing hatchery production levels would be reduced under the implementation scenario for Alternative 5 to ensure that hatchery programs could meet performance metrics, opportunities would be explored for increasing hatchery production in other existing hatchery facilities while still meeting target performance metrics.

Unlike the implementation scenarios for Alternative 2 and Alternative 3, hatchery programs would be operated to achieve stronger performance metrics in the Interior Columbia Recovery Domain under the implementation scenario for Alternative 5 (Table 4-1). In addition, hatchery programs within the Willamette/Lower Columbia Recovery Domain would be operated to achieve intermediate performance metrics (Table 4-1). Under the implementation scenario for Alternative 5, several additional measures would be implemented (when compared to Alternative 1, Alternative 2, and Alternative 3) in the Interior Columbia Recovery Domain. These measures would aid programs in meeting target performance metrics (the same as under the implementation scenario for Alternative 4) (Table 4-3). Permanent weirs could be installed to help meet performance metrics, the purpose or type of hatchery programs could be changed, and new terminal selective fisheries could be added to control the number of hatchery fish on the spawning ground (Table 4-3).

Under the implementation scenario for Alternative 5, 12 new hatchery programs would be assumed to be initiated, with 8 occurring in the Interior Columbia Recovery Domain, and 4 initiated in the Willamette/Lower Columbia Recovery Domain (Table 4-5). For more details on new hatchery programs that would be assumed to be initiated under the implementation scenario for Alternative 5, see Table 4-15 at the end of Section 4.1, Introduction.

Hatchery production levels under the implementation scenario for Alternative 5 would be 85 percent of the production levels under Alternative 1 (No Action) with Mitchell Act-funded hatchery production representing 43 percent of total hatchery production (Table 4-4). More than 119 million juvenile fish would continue to be produced in Columbia River Basin hatchery programs. Chinook salmon, steelhead, and coho salmon would represent 74 percent, 12 percent, and 13 percent, respectively, of total hatchery production under the implementation scenario for Alternative 5 (Table 4-4). Chum and sockeye salmon would represent less than 1 percent each, of the total production under the implementation scenario for Alternative 5 (Table 4-4).

At least one hatchery program would be assumed to be terminated in all ecological provinces, except the Mountain Snake and Blue Mountain Ecological Provinces (Table 4-5). These terminations would occur because of the inability of the programs to meet target performance goals (Table 2-4) (Table 4-1). For more details on terminated hatchery programs, see Table 4-13 at the end of Section 4.1, Introduction.

There would be 12 new weirs under the implementation scenario for Alternative 5 (Table 4-6). New weirs would be placed in all ecological provinces except the Columbia Gorge and Blue Mountain Ecological Provinces (Table 4-6). These weirs would be a combination of seasonal and permanent structures (as necessary) in the Interior Columbia Recovery Domain and all seasonal structures in the Willamette/Lower Columbia Recovery Domain (Box 4-3). Weirs would be located where they could achieve the desired benefits for primary or contributing populations.

The stronger genetic diversity performance metrics would be achieved for 71 of the 76 primary populations (93 percent) in the Interior Columbia Recovery Domain (Table 4-7). Hatchery programs would be maintained in the implementation scenario for Alternative 5, even though four affected primary populations would not achieve the intermediate genetic diversity performance metrics (Table 4-7). Of the 22 contributing populations, 16 populations (73 percent) would achieve stronger genetic diversity performance metrics (Table 4-7). Some hatchery programs would be maintained under the implementation scenario for Alternative 5, even though six contributing populations would not achieve target genetic diversity performance metrics (Table 4-7). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Entiat Summer Steelhead (Primary).** Population abundance is low (fewer than 100 fish) and is influenced by out-of-basin, conservation, hatchery-origin fish.
2. **Twisp Summer Steelhead (Primary).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved and maintain summer steelhead conservation hatchery program in the Twisp River.
3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the Okanogan River.
4. **Clearwater Upper Selway River Spring Chinook (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the upper Selway River.
5. **Salmon River (Redfish Lake) Sockeye Salmon (Primary).** Maintain sockeye salmon conservation hatchery program to meet the conservation goal in the Salmon River.
6. **Clearwater Lower Selway River Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the lower Selway River.
7. **South Fork Clearwater/Crooked River Summer Steelhead (Contributing).** Maintain summer steelhead conservation hatchery program to meet the conservation goal in the South Fork Clearwater River.
8. **Clearwater Lolo River Summer Steelhead (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved and maintain summer steelhead conservation hatchery programs in the Lolo River.

9. **Umatilla River Fall Chinook Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved and maintain fall Chinook conservation hatchery program in the Umatilla River.

10. **Yakima River Fall Chinook Salmon (Contributing).** Unable to realistically meet stronger performance metrics. Intermediate performance metrics achieved and maintain fall Chinook conservation hatchery program in the Yakima River.

11. **Yakima Marion Drain Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 100 fish) and heavily influenced by a small number of hatchery-origin fish.

In the Willamette/Lower Columbia Recovery Domain, hatchery programs would be maintained in the alternative, even though 5 primary and 12 contributing populations would not achieve target genetic diversity performance metrics (Table 4-7). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the North Santiam River.

2. **Hood Fall Chinook Salmon (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 100 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

3. **Columbia Gorge Tributaries Coho Salmon (Washington) (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 25 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

4. **Chinook River Coho Salmon (Primary).** Maintain out-of-basin programs, population abundance is very low (fewer than 100 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

5. **Clatskanie Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program to meet the conservation goal in the Grays River.

6. **Chinook River Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

7. **Big Creek Fall Chinook Salmon (Contributing).** Maintain out-of-basin hatchery programs in the lower Columbia River, population abundance is low and is heavily influenced by a small number of out-of-basin hatchery fish.

8. **White Salmon Spring Chinook Salmon (Contributing).** The population was designated contributing by LCFRB (2012) in anticipation of removal of Condit Dam.

9. **White Salmon Fall Chinook Salmon (Contributing).** The population was designated contributing by LCFRB (2012) in anticipation of the removal of Condit Dam.

10. **Columbia Gorge Tributaries Fall Chinook Salmon (Oregon) (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 150) and is heavily influenced by out-of-basin hatchery fish.

11. **Little White Salmon Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 25 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

12. **Wind River Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is low and is heavily influenced by small number of out-of-basin hatchery fish.

13. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program to meet the conservation goal in the Middle Fork Willamette River.

14. **Clackamas Fall Chinook Salmon (Contributing).** Maintain out-of-basin programs, population abundance is low and is heavily influenced by small number of out-of-basin hatchery fish.

15. **Hood Coho Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 10 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

16. **Fifteenmile Creek Coho Salmon (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by a small number of out-of-basin hatchery fish.

17. **Columbia Gorge Tributaries Coho Salmon (Oregon) (Contributing).** Maintain out-of-basin programs, population abundance is very low (fewer than 50 fish) and is heavily influenced by small number of out-of-basin hatchery fish.

The number of fish harvested under the implementation scenario for Alternative 5 would be about 92 percent of those harvested under Alternative 1 (No Action) (Table 4-8). Most of this decrease would be due to a 28 percent reduction in the number of coho salmon harvested (Table 4-8). The number of subbasins that would not receive direct releases of hatchery fish under the implementation scenario for Alternative 5 would increase by one (White Salmon) over Alternative 1 (No Action) (Table 4-9).

4.1.9 Implementation Scenario for Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, hatchery programs in both the Interior Columbia Recovery Domain and the Willamette/Lower Columbia Recovery Domain would be operated to achieve stronger performance goals. Unlike under the implementation scenarios for Alternative 2 through Alternative 5, all hatchery programs in the Columbia River Basin that affect primary or contributing populations would be operated to achieve stronger performance goals (Table 2-4).

Under the implementation scenario for Alternative 6, new opportunities would be identified to support harvest opportunities. Because some existing hatchery production levels would be reduced under the implementation scenario for Alternative 6 to ensure that hatchery programs could meet performance metrics, opportunities would be explored for increasing hatchery production in other existing hatchery facilities while still meeting target performance metrics.

The implementation scenario for Alternative 6 does not include the installation of new weirs above baseline levels (Table 4-6). Under the implementation scenario for Alternative 6, 21 new hatchery programs would be assumed to be initiated throughout the Columbia Basin (Table 4-5). At least one new program would be assumed to be initiated in each of the seven ecological provinces (Table 4-5). For more details on new hatchery programs that would be assumed to be initiated under the implementation scenario for Alternative 6, see Table 4-15 at the end of Section 4.1, Introduction

Hatchery production levels under the implementation scenario for Alternative 6 would be 98 percent of the production levels under Alternative 1, with Mitchell Act-funded hatchery production representing 40 percent of total hatchery production (Table 4-4). More than 138 million juvenile fish would continue to be produced in Columbia River Basin hatchery programs. Chinook salmon, steelhead, and coho salmon would represent 76 percent, 11 percent, and 13 percent of total hatchery production under the implementation scenario for Alternative 6, respectively (Table 4-4). Chum and sockeye salmon would represent less than 1 percent of the total production under the implementation scenario for Alternative 6 (Table 4-4).

Twelve hatchery programs would be assumed to be terminated under the implementation scenario for Alternative 6 (Table 4-5). These programs would be eliminated due to initiation of a replacement program with a different operational strategy, i.e., a former isolated harvest program may be terminated and replaced with an integrated strategy harvest or conservation program. For more details on terminated hatchery programs, see Table 4-14 at the end of Section 4.1, Introduction.

The stronger genetic diversity performance metrics would be achieved for 45 of the 67 primary populations (67 percent) and 13 of the 33 contributing populations (39 percent) in the Willamette/Lower Columbia Recovery Domain (Table 4-7). The stronger genetic diversity performance metrics would be achieved for 57 of the 76 primary populations (75 percent), and 12 of 22 of the contributing populations (56 percent) in the Willamette/Lower Columbia Recovery Domain (Table 4-7).

Though not the performance goal for Alternative 6, the intermediate genetic diversity performance metrics would be achieved for 5 of the 67 primary populations (8 percent) and 2 of the 33 contributing populations (6 percent) in the Willamette/Lower Columbia Recovery Domain (Table 4-7). The intermediate genetic diversity performance metrics would be achieved for 9 of the 76 primary populations (12 percent), and 3 of the 22 contributing populations (14 percent) in the Willamette/Lower Columbia Recovery Domain (Table 4-7).

The number of fish harvested under the implementation scenario for Alternative 6 would be about 101 percent of fish harvested under Alternative 1 (No Action) (Table 4-8). Harvest of all species would increase slightly, compared to Alternative 1, with the exception of coho salmon. The harvest of coho salmon would be 80 percent of the amount harvested under the implementation scenario for Alternative 1 (Table 4-8). The number of subbasins that would *not* receive direct releases of hatchery fish under the implementation scenario for Alternative 6 would be the same as under Alternative 1 (No Action) (Table 4-9).

1 **TABLE 4-10. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE**
2 **IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2.**

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Columbia River Estuary	Columbia Estuary	Big Creek Fall Chinook Salmon (Tules-Hatchery)	Hatchery program depends on Mitchell Act. funds.
			Big Creek Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Gnat Creek Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Big Creek Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Youngs Bay Tributary Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Youngs Bay Coho Salmon (Bonneville and Sandy Hatcheries)	Hatchery program depends on Mitchell Act funds.
			Deep River Fall Chinook Salmon (Washougal Hatchery)	Hatchery program depends on Mitchell Act funds.
			Deep River Coho Salmon (Early Type S Toutle Hatchery)	Hatchery program depends on Mitchell Act funds.
			Youngs Bay Fall Chinook Salmon (Rogue Upriver Brights-Select Area Fishery Enhancement)	Hatchery program adversely affects primary fall Chinook salmon populations in Clatskanie and Elochoman Rivers.
		Elochoman	Elochoman/Beaver Creek Summer Steelhead (Merwin Hatchery)	Hatchery program depends on Mitchell Act funds.
			Elochoman/Beaver Creek Winter Steelhead (Early)	Hatchery program depends on Mitchell Act funds.
			Grays Winter Steelhead (Early/Elochoman-Beaver Creek Hatchery)	Hatchery program depends on Mitchell Act funds.
		Grays	Grays River Coho Salmon	Hatchery program adversely affects primary coho salmon population in Grays River.
			Bonneville Fall Chinook Salmon (Tule/Spring Creek Hatchery)	Hatchery program depends on Mitchell Act funds.

TABLE 4-10. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia (continued)	Lower Columbia	Columbia Lower	Bonneville Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Salmon Creek Winter Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Toutle Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
		Cowlitz	Cowlitz-Coweeman Winter Steelhead (Early/Elochoman Hatchery)	Hatchery program depends on Mitchell Act funds.
			North Fork Toutle Summer Steelhead	Hatchery program depends on Mitchell Act funds.
			Toutle Coho Salmon (Early/Type S)	Hatchery program depends on Mitchell Act funds.
			South Fork Toutle Summer Steelhead	Hatchery program depends on Mitchell Act funds.
			Kalama Winter Steelhead (Early)	Hatchery program depends on Mitchell Act funds.
		Kalama	Kalama Coho Salmon (Natural)	Hatchery program depends on Mitchell Act funds.
			Kalama Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Kalama Summer Steelhead	Hatchery program depends on Mitchell Act funds.
			Kalama Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Kalama Winter Steelhead (Late)	Hatchery program depends on Mitchell Act funds.
			Kalama Coho Salmon (Early/Type S)	Hatchery program depends on Mitchell Act funds.
			Kalama Spring Chinook Steelhead	Hatchery program depends on Mitchell Act funds.
			East Fork Lewis Winter Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.

TABLE 4-10. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia (continued)	Lower Columbia (continued)	Lewis	North Fork Lewis Winter Steelhead (Merwin Hatchery)	Hatchery program adversely affects primary and contributing steelhead populations in the East Fork and North Fork Lewis River.
			East Fork Lewis Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Sandy Winter Steelhead (Late)	Hatchery program depends on Mitchell Act funds.
		Sandy	Sandy Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Sandy Summer Steelhead (South Santiam Hatchery)	Hatchery program depends on Mitchell Act funds.
			Sandy Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Washougal Winter Steelhead (Early/ Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
		Washougal	Washougal Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Washougal Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Washougal Coho Salmon	Hatchery program depends on Mitchell Act funds
			Clackamas Summer Steelhead	Hatchery program depends on Mitchell Act funds.
		Willamette	Clackamas Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Clackamas Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Clackamas-Eagle Creek Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Clackamas-Eagle Creek Winter Steelhead (Early)	Hatchery program depends on Mitchell Act funds.

TABLE 4-10. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia (continued)	Lower Columbia (continued)		White Salmon Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			White Salmon Winter Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Big White Salmon	Gorge Fall Chinook Salmon (Spring Creek Tules)	Hatchery program depends on Mitchell Act funds.
			Klickitat Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
		Columbia Gorge	Klickitat Coho Salmon (Washougal)	Hatchery program depends on Mitchell Act funds.
		Klickitat	Klickitat Fall Chinook Salmon (Upriver Brights)	Hatchery program depends on Mitchell Act funds.
			Klickitat Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Klickitat Coho Salmon (Lewis Hatchery)	Hatchery program depends on Mitchell Act funds.
			Little White Salmon Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Little White Salmon Fall Chinook Salmon (Tule Spring Creek Hatchery)	Hatchery program depends on Mitchell Act funds.
		Little White Salmon	Little White Salmon Fall Chinook Salmon (Upriver Brights)	Hatchery program depends on Mitchell Act funds.
			Wind Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Mainstem Columbia Summer Steelhead (Wells Hatchery)	Hatchery program depends on Mitchell Act funds.
		Wind	Walla Walla Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.

TABLE 4-10. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Interior Columbia	Columbia Plateau	Columbia Lower Middle	Umatilla Coho Salmon	Hatchery program depends on Mitchell Act funds.
		Walla Walla	Yakima Coho Salmon (Upper Yakima-Naches)	Hatchery program depends on Mitchell Act funds.
		Umatilla	Yakima Coho Salmon (Hatchery)	Hatchery program depends on Mitchell Act funds.
		Yakima	Yakima Fall Chinook Salmon (Hatchery)	Hatchery program depends on Mitchell Act funds.
			Clearwater Coho Salmon	Hatchery program depends on Mitchell Act funds.
			East Fork Salmon Summer Steelhead (B–run/Hatchery)	Hatchery program adversely affects primary steelhead population in the East Fork Salmon River.
	Mountain Snake	Clearwater	East Fork Salmon Summer Steelhead (A–run/Hatchery)	Hatchery program adversely affects primary steelhead population in the East Fork Salmon River.
		Salmon	Lemhi Summer Steelhead (A-run/Hatchery)	Hatchery program adversely affects primary steelhead population in the Lemhi River.
			Redfish Lake Sockeye Salmon Captive Brood Program	Hatchery program depends on Mitchell Act funds.

TABLE 4-11. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 3.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Columbia River Estuary	Columbia Estuary	Deep River Fall Chinook Salmon (Washougal Hatchery)	Hatchery program adversely affects primary fall Chinook salmon populations in Grays and Elochoman Rivers.
			Youngs Bay Fall Chinook Salmon (Rogue Upriver Brights/Select Area Fisheries)	Hatchery program adversely affects primary fall Chinook salmon populations in Clatskanie and Elochoman Rivers.
	Lower Columbia	Kalama	Kalama Coho Salmon (Early/Type S)	Hatchery program adversely affects contributing coho population in the Kalama River.
		Lewis	North Fork Lewis Winter Steelhead (Merwin Hatchery)	Hatchery program adversely affects primary and contributing steelhead populations in the East Fork and North Fork Lewis River.
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Klickitat	Klickitat Coho Salmon (Washougal Hatchery)	This hatchery program would be assumed to be discontinued because of effects on primary and contributing populations outside of the Klickitat basin (mainly the Washougal River). A portion of this production would be assumed to be replaced with an in-basin, isolated hatchery program.
Interior Columbia	Columbia Plateau	Yakima	Yakima Fall Chinook Salmon (Hatchery)	Hatchery program adversely affects contributing fall Chinook population in the Yakima River. A portion of this lost production would be replaced with an integrated program in the Yakima River.
	Mountain Snake	Salmon	East Fork Salmon Summer Steelhead (B−run/Hatchery)	Hatchery program adversely affects primary steelhead population in the East Fork Salmon River.
			East Fork Salmon Summer Steelhead (A−run/Hatchery)	Hatchery program adversely affects primary steelhead population in the East Fork Salmon River.

TABLE 4-12. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 4.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Lower Columbia	Cowlitz	Lower Cowlitz Winter Steelhead (Early-Hatchery)	Hatchery program adversely affects contributing steelhead population in the Cowlitz River. A portion of this program would be assumed to be replaced with an integrated steelhead program.
			Lower Cowlitz Winter Steelhead (Late-Hatchery)	Hatchery program adversely affects contributing steelhead population in the Cowlitz River. A portion of this program would be assumed to be replaced with an integrated steelhead program.
		Kalama	Kalama Coho Salmon (Early/Type S)	Hatchery program adversely affects contributing coho salmon population in the Kalama River.
			Kalama Winter Steelhead (Early)	Hatchery program adversely affects primary winter steelhead population in the Kalama River.
		Lewis	East Fork Lewis Winter Steelhead (Skamania Hatchery)	Hatchery program adversely affects primary winter steelhead population in the East Fork Lewis River. A portion of this program would be assumed to be replaced with an integrated steelhead program.
			East Fork Lewis Summer Steelhead (Skamania Hatchery)	Hatchery program adversely affects primary summer steelhead population in the East Fork Lewis River. A portion of this program would be assumed to be replaced with an integrated steelhead program.
			North Fork Lewis Winter Steelhead (Merwin Hatchery)	Hatchery program adversely affects primary and contributing steelhead populations in the East Fork and North Fork Lewis River.
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Klickitat	Klickitat Coho Salmon (Washougal Hatchery)	This hatchery program would be assumed closed because of effects on primary and contributing populations outside of the Klickitat Basin (mainly the Washougal River). A portion of this production would be assumed to be replaced with an in-basin isolated hatchery program.

TABLE 4-12. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 4 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Interior Columbia	Columbia Plateau	Yakima	Yakima Fall Chinook Salmon (Hatchery)	Hatchery program adversely affects fall Chinook population in the Yakima River. A portion of this lost production would be assumed to be replaced with an integrated program in the Yakima River.
Interior Columbia	Mountain Snake	Salmon	East Fork Salmon Summer Steelhead (B‑run/Hatchery)	Hatchery program adversely affects primary steelhead population in the East Fork Salmon River.
			East Fork Salmon Summer Steelhead (A‑run/Hatchery)	Hatchery program adversely affects primary steelhead population in the East Fork Salmon River.

TABLE 4-13. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 5.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Columbia River Estuary	Columbia Estuary	Deep River Fall Chinook Salmon (Washougal Hatchery)	Hatchery program adversely affects fall Chinook salmon populations in Grays and Elochoman Rivers.
		Columbia Estuary	Youngs Bay Fall Chinook Salmon (Rogue Upriver Brights/ Select Area Fisheries)	Hatchery program adversely affects primary fall Chinook salmon populations in Clatskanie and Elochoman Rivers.
	Lower Columbia	Kalama	Kalama Coho Salmon (Early/ Type S)	Hatchery program adversely affects contributing coho salmon population in the Kalama River.
		Lewis	North Fork Lewis Winter Steelhead (Merwin Hatchery)	Hatchery program adversely affects primary and contributing steelhead populations in the East Fork and North Fork Lewis River.
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Klickitat	Klickitat Coho Salmon (Washougal Hatchery)	This hatchery program would be assumed to close because of effects to primary and contributing populations outside of the Klickitat Basin (mainly the Washougal River). A portion of this production would be assumed to be replaced with an in-basin isolated hatchery program.
		Klickitat	Klickitat Summer Steelhead (Skamania Hatchery)	Hatchery program adversely affects primary steelhead population in the Klickitat River. This lost production would be assumed to be replaced with a larger integrated steelhead hatchery program in the Klickitat River.
		White Salmon	White Salmon Summer Steelhead (Skamania Hatchery)	Hatchery program adversely affects primary and contributing steelhead populations in the Columbia Gorge.
		White Salmon	White Salmon Winter Steelhead (Skamania Hatchery)	Hatchery program adversely affects primary and contributing steelhead populations in the Columbia Gorge.

TABLE 4-13. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 5 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Interior Columbia	Columbia Cascade	Okanogan	Okanogan Summer Steelhead (Wells Hatchery)	Hatchery program adversely affects steelhead population in the Yakima River. This lost production would be replaced with an integrated program in the Okanogan River.
	Columbia Plateau	Yakima	Yakima Fall Chinook Salmon (Hatchery)	Hatchery program adversely affects contributing fall Chinook population in the Yakima River. A portion of this lost production would be assumed to be replaced with an integrated program in the Yakima River.

TABLE 4-14. HATCHERY PROGRAMS ASSUMED TO BE TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 6.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Lower Columbia	Sandy	Sandy Spring Chinook Program	Replaced with Isolated Program
Interior Columbia	Columbia Cascade	Columbia mainstem	Wells Coho Program	Discontinued isolated coho program.
		Okanogan	Okanogan Summer Steelhead (Wells stock)	Discontinued isolated STHD program, increased integrated program.
	Columbia Plateau	Yakima	Yakima Coho Program	Discontinued isolated coho salmon program.
		Klickitat	Klickitat Coho (Lewis stock) Program	Discontinued isolated coho salmon program.
		Klickitat	Klickitat Coho (Washougal) Program	Discontinued isolated coho salmon program.
		Klickitat	Klickitat Summer STHD (Skamania Hatchery)	Discontinued isolated hatchery program.
		White Salmon	White Salmon Summer STHD (Skamania)	Discontinued program due to Condit Dam removal.
		White Salmon	White Salmon winter STHD (Skamania)	Discontinued program due to Condit Dam removal.

TABLE 4-15. NEW HATCHERY PROGRAMS ASSUMED TO BE INITIATED UNDER ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

ECOLOGICAL PROVINCE	HATCHERY PROGRAM	PURPOSE	INITIATED UNDER THE FOLLOWING ALTERNATIVES					
			1	2	3	4	5	6*
Columbia Estuary	Big Creek Chum Salmon	Conservation						X
	Klaskanine Creek Fall Chinook (Tules-Hatchery)	Harvest						X
	Elochoman Chum Salmon	Conservation				X		
	Mill, Abernathy, Germany Creek Chum Salmon	Conservation				X		
	Grays Fall Chinook Salmon	Harvest and Conservation				X		
Lower Columbia River	Lower Cowlitz River Winter Steelhead (Late)	Harvest and Conservation				X		X
	Tilton River Winter Steelhead (Late)	Conservation				X		X
	East Fork Lewis River Summer Steelhead	Harvest and Conservation				X		
	East Fork Lewis River Winter Steelhead	Harvest and Conservation				X		
	Sandy Winter Steelhead (Hatchery)	Harvest			X	X	X	X
	Sandy Spring Chinook (Hatchery)	Harvest						X
	North Fork Lewis River Spring Chinook	Harvest and Conservation				X		
	Washougal Summer Steelhead	Harvest				X		
	Lower Columbia Duncan Creek Chum Salmon	Conservation				X		
	Sandy Chum Salmon	Conservation				X		
	Lewis Chum Salmon	Conservation				X		
	Washougal Chum Salmon	Conservation				X		
	Washougal Coho	Harvest and Conservation			X	X	X	
	Coast Fork Spring Chinook Salmon	Conservation				X		

TABLE 4-15. NEW HATCHERY PROGRAMS ASSUMED TO BE INITIATED UNDER ONE OR MORE OF THE ALTERNATIVE IMPLEMENTATION SCENARIOS (CONTINUED).

ECOLOGICAL PROVINCE	HATCHERY PROGRAM	PURPOSE	INITIATED UNDER THE FOLLOWING ALTERNATIVES					
			1	2	3	4	5	6*
Columbia Gorge	Klickitat Summer-Winter Steelhead	Harvest and Conservation					X	X
	Klickitat Coho (Hatchery)	Harvest			X	X	X	X
Columbia Plateau	Ringold Hatchery Spring Chinook Salmon	Harvest					X	
Columbia Cascade	Columbia River Mainstem Summer Steelhead (Wells Hatchery)	Harvest						X
	Methow Summer Steelhead (Hatchery)	Harvest					X	X
	Entiat River Summer/Fall Chinook Salmon (Hatchery)	Harvest						X
	Okanogan River Summer Chinook (Chief Joseph Hatchery)	Harvest					X	X
	Okanogan River Spring Chinook Salmon	Conservation						X
	Okanogan River Spring Chinook Salmon (Hatchery)	Harvest						X
	Wenatchee/Nason Creek Spring Chinook Salmon	Conservation						X
	Wenatchee Summer Steelhead (Hatchery)	Harvest					X	
Blue Mountain	Imnaha Spring/Summer Chinook Salmon	Harvest					X	X
	Lower Selway River Summer Chinook Salmon	Harvest and Conservation						X
	South Fork Salmon River Summer Chinook Salmon	Harvest and Conservation					X	X
	Pahsimeroi Summer Steelhead (Hatchery)	Harvest						X
	Pahsimeroi Summer Chinook Salmon	Harvest and Conservation					X	X
Mountain Snake	Upper Salmon River Spring Chinook Salmon	Harvest and Conservation					X	X

* Preferred Alternative.

4.2 Fish

4.2.1 Introduction

This section presents the expected effects on fish resources as a result of implementing any of the six EIS alternatives. This section first analyzes hatchery effects on salmon and steelhead related to the categories of effects that are generally associated with hatchery operations (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species). The analysis of effects on salmon and steelhead is followed by an analysis of the effects of the alternatives on other fish species that have a relationship with salmon and steelhead in the analysis area (Section 3.2.4, Other Fish Species that Have a Relationship with Salmon and/or Steelhead).

Hatchery production can have benefits to fish resources, including salmon, steelhead, and other fish species with a relationship to the salmon and steelhead. Hatchery operations can also pose risk to salmon and steelhead, as well as the other fish species that depend on them for food or that are negatively impacted by the hatchery production.

As described in Section 4.1.3, Implementation Scenarios, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 4-3). Table 4-16 shows the implementation measures that may affect fish species. Each implementation measure is expected to affect one or more species of fish. All implementation measures are expected to affect salmon and steelhead.

As described in Section 3.2.2, Analysis Area, the analysis area for fish in this EIS is the same as the project area, as described in Section 2.2, Description of Project Area. Information presented in Section 3.2, Fish, and Section 4.2, Fish, is organized according to species. For salmon and steelhead species, the analysis is further subdivided by evolutionarily significant unit (ESU) and distinct population segment (DPS) (Box 1-1). The boundaries of each salmon ESU and steelhead DPS cover several subbasins and one or more ecological provinces (Section 2.2, Description of Project Area). Maps of the ESU and DPS boundaries can be found at http://www.westcoast.fisheries.noaa.gov/maps_data/species_population_boundaries.html.

TABLE 4-16. FISH SPECIES THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

	FISH SPECIES THAT MAY BE AFFECTED					
IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	SALMON AND STEELHEAD	OREGON CHUB, LAKE CHUB, PYGMY WHITEFISH	BULL TROUT, COASTAL CUTTHROAT TROUT, LAMPREY, RAINBOW TROUT, WESTSLOPE CUTTHROAT TROUT	EULACHON, LEOPARD DACE, UMATILLA DACE, MARGINED SCULPIN, MOUNTAIN SUCKER	GREEN STURGEON	NORTHERN PIKE-MINNOW
Change production levels in hatchery programs.	X	X	X	X	X	X
Update water intake screens at hatchery facilities[1]	X	X		X		
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	X					
Correct water quality issues at hatchery facilities.	X	X	X	X		X
Install new seasonal weirs.	X		X			
Install new permanent weirs.	X	X				
Establish new selective fisheries in terminal areas.	X					
Change hatchery program goals (i.e., harvest or conservation).	X					
Change hatchery program's operational strategy (i.e., isolated or integrated).	X					
Establish new hatchery programs.	X	X	X	X	X	X
Terminate hatchery programs that only support harvest if they fail to meet performance goals.	X	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources. Implementation measures that were not applied under any of the alternatives were not included in this table.

[1] Screens on water intakes to the hatchery facilities are generally designed to prevent juvenile, natural-origin salmon and steelhead from being pulled into the hatchery facility. Updated water intake screens will benefit salmon and steelhead and may also benefit other fish species, depending on their size.

4.2.2 Methods for Analyzing Effects

Two analytical tools are used to estimate effects on salmon and steelhead from implementation scenarios associated with the action alternatives, the All-H Analyzer (AHA) (Appendix G) and the Hatchery Program Viewer (HPV) (Appendix H) (Section 4.1.3.3, Implementation Measures). The All-H Analyzer is a tool for evaluating individual hatchery programs in the context of harvest rates, habitat conditions, and fish passage through the Columbia River hydroelectric system. The

All-H Analyzer allows users to input data reflecting current habitat productivity/capacity, harvest rates, and hatchery program operations. Outputs from the All-H Analyzer are used to make relative comparisons of viable salmonid population (VSP) effects across the alternatives (Table 4-17).

TABLE 4-17. METHODS USED TO ESTIMATE EFFECTS ON SALMON AND STEELHEAD.

	General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species						
Method for Evaluation	**VSP Effects**	**Hatchery Facility Risks**	**Risks from Competition and Predation**	**Masking Risks**	**Fisheries Related Risks[1]**	**Nutrient Cycling Benefits**	**Disease Transfer Risks**
Model (AHA)	X		X				
Model (HPV)		X					
Ratios of hatchery-origin to natural-origin smolts			X				
Qualitative comparison				X	X	X	X
Analyzed in basin-wide summary	X	X	X	X	X	X	X
Analyzed by ESU/DPS	X		X				

[1] Exploitation rates on natural-origin fish would not vary among the implementation scenarios for alternatives.

The All-H Analyzer was chosen for this EIS based on its capability to model all of the Columbia River Basin hatchery programs at one time and to allow the hatchery program fish to interact with all natural-origin populations. The All-H Analyzer facilitates the comparison of potential effects on salmon and steelhead resources across the alternatives. The All-H Analyzer was designed to allow fish managers to compare alternative management scenarios and understand how each scenario might perform relative to other scenarios. It is not a tool that was designed to predict the exact numbers of hatchery-origin or natural-origin fish that would result from different management actions. Results from the All-H Analyzer should be considered in the context of general qualitative, rather than quantitative, change that might be expected from substantial hatchery program adjustments. For a detailed review of the All-H Analyzer see Appendix I)

Most assumptions and data used in the All-H Analyzer have been obtained from Columbia River fish managers and from readily available documents. Assumptions and information sources are summarized below:

- Habitat conditions are assumed to represent the current (2010) situation in each subbasin. For most subbasins, characterization of current habitat conditions has been completed by the region's fish managers, using the Ecosystem Diagnosis and Treatment model (http://ecosystems.icfi.com/ebp/Ecosystems/EDT.aspx), and reported in individual subbasin plans prepared for the Northwest Power and Conservation Council (http://www.nwcouncil.org/fw/subbasinplanning/Default.htm).
- Fish passage conditions in the Columbia River hydroelectric system represent those described in the 2008 Supplement to the Federal Columbia River Power System (FCRPS) Biological Opinion (http://www.westcoast.fisheries.noaa.gov/fish_passage/fcrps_opinion/federal_columbia_river_power_system.html). Survival numbers from the 2008 FCRPS Biological Opinion were drawn from the most current fish passage conditions when EIS modeling occurred.
- A harvest model was developed for this EIS (Appendix K). The harvest model relies on datasets that are used by the Pacific Fisheries Management Council (PFMC) (http://www.pcouncil.org/salmon/background) and in the Pacific Salmon Commission (www.psc.org) models (http://www.pcouncil.org/salmon/background/document-library/fishery-regulation-assessment-model-fram-documentation/) to characterize stock-specific fishery exploitation (total harvest percentage) patterns. Additionally, the EIS harvest model has been updated to reflect the current Columbia River fisheries management, as agreed to in the 2008 to 2017 *U.S. v. Oregon* Management Agreement (Appendix B).

The HPV is used in this analysis to determine adherence to the BMPs identified by the HSRG for a given hatchery facility (Appendix H). Outputs from the HPV are used to make relative comparisons of hatchery facility effects (e.g., facility failure, juvenile entrainment in hatchery water intake facilities, blocked passage of natural-origin fish, and hatchery effluent discharge) between alternatives. A list of facility BMPs can be found in Appendix H. For the purposes of this EIS, only the BMPs related to hatchery facility effects are included in the implementation scenarios (Table 3-6 and Table 4-16).

One category of hatchery effects (fisheries-related risks) is described in Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species. It is not analyzed in

Chapter 4 because effects would remain the same across alternatives since exploitation rates on all natural-origin populations would be held constant. The following sections provide additional information on the methods used to assess effects from and on VSP, competition, and predation.

Effects from fish collection, masking effects, nutrient cycling effects, and fish health effects are evaluated on a Columbia River basinwide scale (i.e., the effects on all ESUs and DPSs are combined). The ESU/DPS-level analysis focuses on VSP effects and competition and predation effects.

4.2.2.1 Methods for Determining Effects on VSP for Salmon and Steelhead

The All-H Analyzer is used to compare the alternatives' effects on abundance, productivity, diversity, and spatial structure for each ESU/DPS. In this EIS, these parameters are similar but not identical to those defined by NMFS in Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units (McElhaney et al. 2000) (Section 3.2.3.1.1, Effects on the Viable Salmonid Population Concept). For this EIS analysis, the parameters are expressed as follows:

- Abundance is expressed as the average number of adult natural-origin spawners based on the last 80 generations of the All-H Analyzer simulation.
- Productivity is expressed in terms of changes to the Beverton-Holt productivity parameter (Beverton and Holt 1957), which quantifies the maximum possible adult recruitment rate (adult produced per spawner) in the absence of density-dependent effects.
- Diversity (genetic) is expressed as the proportion (percent) of populations, within each ESU/DPS, meeting each of the diversity performance metric categories: stronger (PNI higher than 0.67 or pHOS lower than 0.05), intermediate (PNI higher than 0.50 or pHOS lower than 0.10), and weaker than Intermediate (Table 4-7).
- Spatial structure is indexed by two different metrics: the change in the proportion of populations within an ESU for which adjusted productivity is greater than 1.0 and the change in the proportion of populations with mean abundance greater than 500 natural-origin spawners. The Interior Columbia Technical Recovery Team (ICTRT) does not consider any population with fewer than 500 individuals to be viable, regardless of its productivity (ICTRT 2007). A necessary (but not sufficient) condition for the rebuilding of a population is that each spawner produces at least one returning adult in the next generation. If such populations are considered marginally viable, a comparison across

alternatives of the proportion of populations meeting these standards within an ESU is a coarse index of spatial structure.

The numbers shown in tables and figures are, for the most part, raw model output numbers and should not be viewed as specific predictions; they should only be used for comparison purposes among alternatives. The All-H Analyzer is not a tool designed to predict the number of fish that will result from different management actions. Instead, it was designed to allow fish managers to make relative comparisons of alternative management scenarios and understand how each scenario would perform relative to other scenarios.

For more background information on methods, assumptions, and application of the model, refer to the All-H Analyzer User Guide (Appendix G). The All-H Analyzer datasets for individual populations are provided at http://hatcheryreform.us/hrp/tools/aha/welcome_show.action.

4.2.2.2 Methods for Determining Competition and Predation Effects on Salmon and Steelhead

This EIS considers effects from competition and predation in two analyses. One analysis computes the ratio of hatchery-origin juveniles that would be released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS. A higher ratio may indicate greater competition for food or habitat or greater predation caused by hatchery-origin fish. Ratios do not consider several important factors such as the capacity of the habitat, spatial and temporal overlap of hatchery-origin and natural-origin fish, and the status of natural-origin populations. The exact form of interaction (i.e., competition or predation) depends on the hatchery-origin species released and the natural-origin species in question. For example, predation is more likely than competition when considering the effects of larger hatchery-origin coho salmon on smaller natural-origin chum salmon fry. Competition would be more likely among populations of the same species because they would be more likely to occupy the same macro and microhabitats and compete for the same food resources (Section 3.2.3.1.4, Risks from Competition with Hatchery-origin Fish). The potential form of interaction and the magnitude of its effect on the conservation of natural-origin populations are discussed in more detail in each ESU section.

In the second analysis, ecological interactions are assessed by considering the ratio of natural-origin and hatchery-origin smolts (as provided by the All-H Analyzer) that emigrate through the Columbia River estuary. These ratios, along with a consideration of the spatial and temporal overlap of salmon and steelhead smolts in the estuary, roughly indicate the cumulative risk of hatchery programs to salmon and steelhead in the Columbia River Basin (Section 3.2.3.1.4, Risks from Competition with Hatchery-origin Fish). These results are reported on a basinwide scale instead of by ESU/DPS. An additional and broader assessment of the cumulative effects of the proposed action can be found in Chapter 5 (Cumulative Effects).

4.2.3 Effects on Salmon and Steelhead

The analysis of effects on salmon and steelhead is separated into two sections. The sections are 1) Section 4.2.3.1, Basinwide Effects on Salmon and Steelhead, and 2) Section 4.2.3.2, Effects on Salmon ESUs and Steelhead DPSs (Table 4-18).

4.2.3.1 Basinwide Effects on Salmon and Steelhead

As described in Chapter 2, Alternatives, the implementation scenarios for each alternative incorporate measures (i.e., implementation measures) that would allow Columbia River Basin hatchery programs to be operated consistent with the goals of each alternative (Section 2.5, Alternatives Analyzed in Detail). The application of implementation measures varies across alternatives (Table 4-3). That is, the implementation scenarios differ in the implementation measures that are used to meet goals of each alternative. For example, new weirs can be installed under the implementation scenarios for Alternative 3 through Alternative 5, but they are not part of the implementation scenarios for Alternative 2 and Alternative 6. By varying the implementation measures used within the implementation scenarios, this EIS presents an evaluation of a greater range of options for operating hatchery programs in the Columbia River Basin than if the same implementation measures were used under all six implementation scenarios.

The following discussion compares the effects of the alternatives on salmon and steelhead. These effects are organized into categories consistent with Section 3.2.3.1, General Risks and Benefits of Hatchery Programs on Salmon and Steelhead Species. For this analysis, however, effects from competition and predation are combined into one section. As described in Section 4.2.2, Methods for Analyzing Effects, fisheries-related effects were described in Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species, but are not analyzed in Chapter 4, Environmental Consequences, because effects would not vary across alternatives since exploitation rates would be held constant. Therefore, the anticipated effects from fisheries-related risks would be the same as under baseline conditions described in Section 3.2.3.1.10, Risks Associated with Fisheries that Target Hatchery-origin Fish.

TABLE 4-18. SALMON AND STEELHEAD INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE ALTERNATIVE IMPLEMENTATION SCENARIOS	SALMON AND STEELHEAD INDICATORS THAT MAY BE AFFECTED					
	VSP EFFECTS	HATCHERY FACILITY RISKS	RISKS FROM COMPETITION AND PREDATION	MASKING RISKS	NUTRIENT CYCLING BENEFITS	DISEASE TRANSFER RISKS
Change production levels in hatchery programs.	X	X	X	X	X	X
Update water intake screens at hatchery facilities		X				
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.		X			X	
Correct water quality issues at hatchery facilities.		X				
Install new seasonal weirs.	X		X	X	X	
Install new permanent weirs.	X		X	X	X	
Establish new selective fisheries in terminal areas.	X		X	X	X	
Change hatchery program goals (i.e., harvest or conservation).	X					
Change hatchery program's operational strategy (i.e., isolated or integrated).	X		X			
Establish new hatchery programs.	X	X	X	X	X	X
Terminate hatchery programs that only support harvest if they fail to meet performance goals.	X	X	X	X	X	X

4.2.3.1.1 Effects on the Viable Salmonid Population Concept

McElhany et al. (2000) developed the VSP concept as a way to evaluate the conservation status of Pacific salmon and steelhead. A key part of this approach was the identification of four measurable indicators of population health that should be considered in performing conservation status assessments. These indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins). See each ESU/DPS section for a discussion of effects of the alternatives on VSP.

Effects on Abundance and Productivity

As discussed in Section 3.2.3.1.1.1, Effects on Abundance and Productivity, one main benefit conferred by hatchery programs is an increase in the total abundance of a salmon population that returns to spawn naturally. Freshwater, habitat-related factors limiting the survival and productivity of a natural-origin population can be circumvented by spawning, incubating, rearing, and releasing fish from the population in a hatchery facility. In the situation where the hatchery stock is the same genetic population as the natural-origin population, the hatchery may also act as protection for the population against catastrophic environmental conditions. Short-term success in increasing the number of naturally spawning, natural-origin fish has been demonstrated for some hatchery programs (e.g., Hood Canal summer chum salmon and Snake River fall Chinook salmon supplementation and reintroduction hatchery programs). However, the long-term success in recovering a self-sustaining, naturally spawning population is yet to be demonstrated and may be difficult without commensurate improvements in the condition of natural habitat. Productivity may also be increased if the hatchery-origin fish improve the condition of the spawning gravel or add nutrients to the system.

Effects on Genetic Diversity

As discussed in Chapter 2, Alternatives, stronger and intermediate hatchery performance goals are applied to the action alternatives to reduce genetic risks to natural-origin salmon and steelhead from operating hatchery programs. Table 4-1 identifies performance metrics for each hatchery performance goal. As shown in Table 4-3, the following implementation measures would be used under one or more of the alternative implementation scenarios to reduce genetic risks and to meet target performance goals:

- Change production levels in hatchery programs.
- Install new seasonal weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Change hatchery program goals (i.e., harvest or conservation).

- Change hatchery program’s operational strategy (i.e., isolated or integrated).
- Establish new hatchery programs.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

Three of these implementation measures would change production levels: change production levels in hatchery programs, establish new hatchery programs, and terminate hatchery programs that only support harvest if they fail to meet performance goals. Three additional implementation measures would reduce the number of hatchery-origin salmon and steelhead spawning naturally: install new seasonal weirs, install new permanent weirs, and establish new selective fisheries in terminal areas. The two remaining implementation measure would change a hatchery program’s operational strategy (isolated or integrated) or a program’s goal (conservation, harvest, or both). All of these implementation measures can be used under one or more implementation scenarios to increase PNI and/or reduce pHOS, where necessary, which would reduce genetic risks compared to baseline conditions (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. No additional implementation measures would be taken to reduce negative effects on natural-origin salmon and steelhead (Section 4.1.3.4, Comparison of Implementation Scenarios, Implementation Scenario for Alternative 1). Baseline abundance and productivity are estimated for each of the 17 salmon and steelhead ESUs/DPSs (Table 4-19). As under baseline conditions, the percentage of populations within each of the 17 Columbia River ESUs/DPSs meeting the stronger performance metrics[2] for genetic diversity ranges from a low of 0 percent (four ESUs/DPSs) to a high of 100 percent (Deschutes Summer/fall-run Chinook salmon ESU) (Table 4-19). The percentage of populations within each of the 17 Columbia River ESUs/DPSs meeting the intermediate performance metrics[1] for genetic diversity ranges from a low of 0 percent (two ESUs/DPSs) to a high of 100 percent (Deschutes Summer/fall-run Chinook salmon ESU) (Table 4-19). No additional weirs would be installed compared to baseline conditions (Table 4-20).

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[1] The terms “stronger performance metrics,” “intermediate performance metrics,” and “weaker than intermediate performance metrics” are deliberately phrased as relative indices to avoid a determination of their adequacy or inadequacy under ESA or other legal standards. A determination as to whether a specific hatchery program meets ESA requirements will be made in a separate NMFS review upon a request for ESA authorization (Section 4.1.3, Implementation Scenarios).

Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, 14 of the 17 salmon and steelhead ESUs/DPSs would have increases in abundance of natural-origin spawners (stronger performance metric), while three ESUs/DPSs would have decreased abundance (weaker than intermediate performance metric) relative to Alternative 1 (Table 4-19). Fifteen of the 17 salmon and steelhead ESUs/DPSs would have increases in mean adjusted productivity (stronger performance metric), while two would have stable productivity (intermediate performance metric), relative to baseline (Table 4-19). Under the implementation scenario for Alternative 2, 13 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the stronger genetic diversity performance metrics, while 4 of the 17 salmon and steelhead ESUs/DPSs would have no change in the percentage of populations meeting the stronger genetic diversity performance metrics (Table 4-19).

Overall, under the implementation scenario for Alternative 2, 15 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the intermediate or stronger genetic diversity performance metrics (Table 4-19), which would likely reduce the genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. No new weirs would be installed under the implementation scenario for Alternative 2 (Table 4-20), so there would be no additional weir effects compared to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, 13 of the 17 salmon and steelhead ESUs/DPSs would have increases in the abundance of natural-origin spawners (stronger performance metric), while 4 ESUs/DPSs would have decreased abundance (weaker than intermediate performance metric) relative to Alternative 1 (Table 4-19). Fifteen of the 17 salmon and steelhead ESUs/DPSs would have increases in mean adjusted productivity (stronger performance metric), while 2 would have stable productivity (intermediate performance metric), relative to Alternative 1 (Table 4-19). Under the implementation scenario for Alternative 3, 10 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the stronger genetic diversity performance metrics, while 7 of the 17 salmon and steelhead ESUs/DPSs would have no change in the percentage of populations meeting the stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19).

TABLE 4-19. SUMMARY OF VSP INDICATOR EFFECTS (PERCENT CHANGE) RELATIVE TO BASELINE (ALTERNATIVE 1), FOR EACH COLUMBIA RIVER SALMON AND STEELHEAD ESU/DPS.

	Alternative 1 (baseline)				Alternative 2				Alternative 3				Alternative 4				Alternative 5				Alternative 6 (Preferred Alt)			
			% of Primary and Contributing populations meeting Genetic Diversity Metrics				Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics				Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics				Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics				Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics				Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics	
ESU/DPS	Total Natural-origin Spawners (NOS) Abundance	Mean Adjusted Productivity	PNI>0.67 or pHOS <0.05 (Stronger)	Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	PNI>0.67 or pHOS <0.05 (Stronger)	Total PNI>0.50 or pHOS <0.10 (Intermediate +)	%Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	PNI>0.67 or pHOS <0.05 (Stronger)	Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	PNI>0.67 or pHOS <0.05 (Stronger)	Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	PNI>0.67 or pHOS <0.05 (Stronger)	Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	PNI>0.67 or pHOS <0.05 (Stronger)	Total PNI>0.50 or pHOS <0.10 (Intermediate +)
Lower Columbia River Chinook Salmon	58,943	3.3	21%	32%	+21%	+48%	+68%	+61%	+15%	+24%	+40%	+36%	+17%	+39%	+43%	+36%	+15%	+24%	+36%	36%	+9%	+3%	+15%	+11%
Mid-Columbia River Spring-run Chinook Salmon	16,666	4.0	60%	70%	+3%	+15%	+30%	+30%	+2%	+13%	+20%	+30%	+2%	+13%	+20%	+30%	+2%	+15%	+40%	+30%	-1%	+7.5%	+20%	+10%
Deschutes River Summer/Fall-run Chinook Salmon	8,925	2.4	100%	100%	+24%	+21%	N/C[1] 100%	N/C 100%	+6%	+4%	N/C 100%	N/C 100%	+6%	+4%	N/C 100%	N/C 100%	+1%	+4%	N/C 100%	N/C 100%	+11%	+13%	N/C 100%	N/C 100%
Upper Columbia River Spring-run Chinook Salmon	2,332	2.6	0%	17%	+14%	+46%	+50%	+83%	+14%	+46%	+50%	+83%	+14%	+46%	+50%	+83%	+26%	+58%	+100%	+83%	+3%	+40%	+17%	+66%
Upper Columbia River Summer/Fall-run Chinook Salmon	74,573	2.4	33%	33%	+34%	N/C	+34%	+34%	+27%	+17%	+17%	+50%	+27%	+17%	+17%	+50%	20%	+8%	+17%	+50%	+20%	+8%	+17%	+50%
Upper Willamette River Chinook Salmon	24,775	3.7	40%	40%	+4%	+8%	N/C	+20%	+3%	+5%	N/C	+20%	+2%	+5%	N/C	+20%	+3%	+5%	N/C	+20%	+2%	+5%	N/C	+20%
Snake River Spring/Summer-run Chinook Salmon	20,699	2.1	76%	76%	+5%	+5%	+7%	+17%	+5%	+5%	+7%	+17%	+5%	+5%	+7%	+17%	+11%	+10%	+17%	+17%	+6.1%	+5%	+14%	+17%
Snake River Fall-run Chinook Salmon	2,437	0.97	0%	0%	-25%	+70%	+100%	+100%	-30%	+55%	N/C 0%	+100%	-30%	+55%	N/C 0%	+100%	-12%	+67%	+100%	+100%	-23%	N/C	N/C 0%	N/C 0%
Lower Columbia River Steelhead	16,988	3.2	75%	85%	+8%	+13%	+5%	N/C	+1%	+3%	+5%	+15%	+3%	+9%	+20%	+15%	+1%	+3%	+5%	+15%	-<1%	N/C	N/C	-5%

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TABLE 4-19. SUMMARY OF VSP INDICATOR EFFECTS (PERCENT CHANGE) RELATIVE TO BASELINE (ALTERNATIVE 1), FOR EACH COLUMBIA RIVER SALMON AND STEELHEAD ESU/DPS (CONTINUED).

	Alternative 1 (baseline)				Alternative 2				Alternative 3				Alternative 4				Alternative 5				Alternative 6 (Preferred Alt)			
ESU/DPS	Total Natural-origin Spawners (NOS) Abundance	Mean Adjusted Productivity	% of Primary and Contributing populations meeting Genetic Diversity Metrics: PNI>0.67 or pHOS <0.05 (Stronger)	% of Primary and Contributing populations meeting Genetic Diversity Metrics: Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: PNI>0.67 or pHOS <0.05 (Stronger)	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: Total PNI>0.50 or pHOS <0.10 (Intermediate +)	%Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: PNI>0.67 or pHOS <0.05 (Stronger)	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: PNI>0.67 or pHOS <0.05 (Stronger)	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: PNI>0.67 or pHOS <0.05 (Stronger)	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: Total PNI>0.50 or pHOS <0.10 (Intermediate +)	% Change in Total Natural-origin Spawners (NOS) Abundance	% Change in Mean Adjusted Productivity	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: PNI>0.67 or pHOS <0.05 (Stronger)	Change in % of Primary and Contributing populations meeting Genetic Diversity Metrics: Total PNI>0.50 or pHOS <0.10 (Intermediate +)
Middle Columbia River Steelhead	28,570	3.0	81%	94%	+10%	+10%	+13%	+6%	+10%	+10%	+13%	+6%	+10%	+10%	+13%	+6%	+13%	+10%	+19%	+6%	+2%	N/C	+7%	-6%
Snake River Basin Steelhead	21,031	2.4	77%	77%	+4%	+8%	+14%	+19%	+2%	+8%	+9%	+17%	+2%	+8%	+9%	+17%	+4%	+8%	+14%	+19%	+<1%	N/C	+13%	+1%
Southwest Washington Steelhead	3,165	4.5	86%	86%	+8%	+18%	+14%	+14%	+<1%	+2%	N/C	+14%	+3%	+9%	+14%	+14%	+1%	+2%	N/C	+14%	+<1%	+2%	N/C	N/C
Upper Columbia River Steelhead	2,093	1.0	0%	20%	+11%	+20%	N/C	+40%	+11%	+20%	N/C 0%	+40%	+11%	+20%	N/C 0%	+40%	-3%	+30%	+40%	+40%	+2.3%	+10%	+20%	+20%
Upper Willamette River Steelhead	9,255	5.4	75%	75%	+13%	+13%	+25%	+25%	+13%	+13%	+25%	+25%	+13%	+13%	+25%	+25%	+13%	+13%	+25%	+25%	+13%	+13%	+25%	+25%
Lower Columbia River Coho Salmon	32,851	1.8	27%	45%	+10%	+50%	+59%	+55%	-1%	+22%	+23%	+32%	+1%	+22%	+32%	+32%	-1%	+22%	+23%	+32%	-3.5%	+11%	+14%	+10%
Columbia River Chum Salmon	19,304	1.9	86%	86%	+1%	N/C	N/C	+7%	-1%	N/C	N/C	+7%	+4%	N/C	N/C	N/C	-1%	N/C	N/C	+7%	+<1%	N/C	N/C	N/C
Snake River Sockeye Salmon	165	0.13	0%	0%	-100%	+100 %	+100%	+100%	-25%	N/C	N/C 0%	N/C 0%	-25%	N/C	N/C 0%	N/C 0%	+144%	N/C	N/C 0%	N/C 0%	+144%	N/C	N/C 0%	N/C 0%

[1] N/C = no change.

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TABLE 4-20. NEW WEIRS BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO AND ECOLOGICAL PROVINCE.

Recovery Domain	Ecological Province	Alternative 1 (No Action)	2	3	4	5	6
Willamette/ Lower Columbia	Columbia Estuary	0	0	6	7	6	0
	Lower Columbia	0	0	1	2	1	0
	Columbia Gorge	0	0	1	1	1	0
Interior Columbia	Columbia Gorge	0	0	0	0	0	0
	Columbia Plateau	0	0	0	0	2	0
	Columbia Cascade	0	0	0	0	1	0
	Blue Mountain	0	0	0	0	0	0
	Mountain Snake	0	0	1	1	1	0
Total		**0**	**0**	**9**	**11**	**12**	**0**

Overall, under the implementation scenario for Alternative 3, 15 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the intermediate or stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19). This would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. Nine new seasonal weirs would be installed under the implementation scenario for Alternative 3 when compared to Alternative 1 (Table 4-20), which would increase the following weir effects relative to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, entrainment or impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased out-of-basin fish presence due either to trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries from limiting free stream passage (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, 15 of the 17 salmon and steelhead ESUs/DPSs would have increases in abundance of natural-origin spawners (stronger performance metric), while 2 ESUs/DPSs would have decreases in natural-origin abundance (weaker than intermediate performance metric), relative to Alternative 1 (Table 4-19). Fifteen of the 17 salmon and steelhead ESUs/DPSs would have increases in mean adjusted productivity (stronger performance metric), while 2 would have stable productivity (intermediate performance metric) relative to Alternative 1 (Table 4-19). Under the implementation scenario for Alternative 4, 11 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the stronger genetic diversity performance metrics, while 6 of the 17 salmon and steelhead ESUs/DPSs would have no change in the percentage of populations meeting the stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19).

Overall, under the implementation scenario for Alternative 4, 14 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the intermediate or stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19). This increase would likely reduce the genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. Eleven new seasonal and permanent weirs would be installed under the implementation scenario for Alternative 4 when compared to Alternative 1 (Table 4-20), which would increase the following weir effects relative to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, entrainment or impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased out-of-basin fish presence due either to trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries from limiting free stream passage (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, 13 of the 17 salmon and steelhead ESUs/DPSs would have increases in abundance of natural-origin spawners (stronger performance metric), while 4 ESUs/DPSs would have decreases in abundance (weaker than intermediate performance metric) relative to Alternative 1 (Table 4-19). Fifteen of the 17 salmon and steelhead ESUs/DPSs would have increases in mean adjusted productivity (stronger performance metric), while 2 would have stable productivity (intermediate performance metric) relative to Alternative 1 (Table 4-19). Under the implementation scenario for Alternative 5, 12 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the stronger genetic diversity performance metrics, while 5 of the 17 salmon and steelhead ESUs/DPSs would have no change in the percentage of populations meeting the stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19).

Overall, under the implementation scenario for Alternative 5, 15 of the 17 salmon and steelhead ESUs/DPSs would have increases the percentage of populations meeting the intermediate or stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19), which would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. Twelve new seasonal and permanent weirs would be installed under the implementation scenario for Alternative 3 when compared to Alternative 1 (Table 4-20). This would increase the following weir effects relative to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, entrainment or impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased out-of-basin fish presence due either to trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries from limiting free stream passage (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, 13 of the 17 salmon and steelhead ESUs/DPSs would have increases in abundance of natural-origin spawners (stronger performance metric), while 4 ESUs/DPSs would have decreased abundance (weaker than intermediate performance metric) relative to Alternative 1 (Table 4-19). Eleven of the 17 salmon and steelhead ESUs/DPSs would have increased in mean adjusted productivity (stronger performance metric), while six would have stable productivity (intermediate performance metric) relative to Alternative 1 (Table 4-19). Under the implementation scenario for Alternative 6, 10 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the stronger genetic diversity performance metrics, while 7 of the 17 salmon and steelhead ESUs/DPSs would have no change in the percentage of populations meeting the stronger genetic diversity performance metrics relative to Alternative 1 (Table 4-19).

Overall, under the implementation scenario for Alternative 6, 10 of the 17 salmon and steelhead ESUs/DPSs would have increases in the percentage of populations meeting the intermediate or stronger genetic diversity performance metrics (Table 4-19), which would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. However, 2 of the 17 salmon and steelhead ESUs/DPSs would have a decrease in the percentage of populations meeting the intermediate or stronger genetic diversity performance metrics (Table 4-19), which would likely increase genetic risks of hatchery programs on those natural-origin salmon and steelhead populations relative to Alternative 1. No new seasonal and permanent weirs would be installed under the implementation scenario for Alternative 6 when compared to Alternative 1 (Table 4-20). No additional effects on salmon and steelhead from weirs would be expected, relative to Alternative 1.

4.2.3.1.2 Hatchery Facility Risks

Potential risks to natural-origin salmon and steelhead associated with the operation of hatchery facilities include the following:

1. Hatchery facility failure (power or water loss leading to catastrophic fish losses)
2. Hatchery facility water intake effects (stream dewatering and fish entrainment)
3. Hatchery passage (blocking upstream or downstream fish passage)
4. Hatchery facility effluent discharge effects (deterioration of downstream water quality)

The first risk affects natural-origin fish being held in the hatchery facility; the second, third, and fouth affect natural-origin fish in the stream (Section 3.2.3.1.3, Current Approaches for Reducing Hatchery Facility Risks). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios and would affect risks on natural-origin salmon and steelhead as result of operating hatchery facilities (Table 4-3):

1. Change production levels in hatchery programs.
2. Update water intake screens at hatchery facilities.
3. Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.
4. Correct water quality issues at hatchery facilities.
5. Install new seasonal weirs.
6. Install new permanent weirs.
7. Establish new hatchery programs.
8. Terminate hatchery programs that only support harvest if they fail to meet performance goals.

Five of these implementation measures may affect water quality and quantity: change production levels in hatchery programs, update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures, correct water quality issues at hatchery facilities, establish new hatchery programs, and terminate hatchery programs that only support harvest if they fail to meet performance goals. Although reductions in water quantity and quality are a hatchery facility risk (i.e., there may be effluent discharge effects), they are not discussed here because they are analyzed in Section 4.6, Water Quality and Quantity. Effects of weirs are discussed in Section 4.2.3.1.1, Effects on the Viable Salmonid Population Concept, Effects on Genetic Diversity. As a result, the analysis in this section focuses on water intake effects and hatchery facility failure (Section 3.2.3.1.3, Current Approaches for Reducing Hatchery Facility Risks).

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. No additional implementation measures would be applied (Section 4.1.3.4, Implementation Scenario for Alternative 1), and the same percentage of hatchery programs within the analysis area would meet BMPs aimed at reducing facility failure effects, water intake effects, facility passage effects, and water quality effects as under baseline conditions (Table 3-6 and Table 4-21). As a result, hatchery facility risks related to screening, passage, water quality, and hatchery facility failure would be the same as under baseline conditions.

Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, all hatchery programs in the analysis area would meet BMPs aimed at facility effects reduction (Table 4-21). As a result, hatchery facility risks related facility failure effects, water intake effects, facility passage effects, and water quality effects would be reduced compared to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, all hatchery programs in the analysis area would meet BMPs aimed at facility effects reduction (Table 4-21). As a result, hatchery facility risks related facility failure effects, water intake effects, facility passage effects, and water quality effects would be reduced compared to Alternative 1.

TABLE 4-21. COMPARISON OF THE PERCENTAGE OF HATCHERY PROGRAMS WITHIN THE ANALYSIS AREA MEETING BMPS TO MINIMIZE HATCHERY FACILITY EFFECTS.

BMP	ALTERNATIVE (PERCENT [%] OF HATCHERY PROGRAMS)					
	1 (NO ACTION)	2	3	4	5	6
Hatcheries are operated to allow all migrating species of all ages to bypass or pass through hatchery-related structures.	71	100	100	100	100	100
Screens on water intakes would be compliant with Integrated Hatchery Operations Team (IHOT), NMFS, or other agency standards.	53	100	100	100	100	100
Water supplies would be protected by alarms and backup power generators. Staff are notified of emergencies through the use of alarms, auto-dialers, and/or pagers.	66	100	100	100	100	100
All facilities operate within the limits established in NPDES permits. Should production from the facility fall below the minimum production requirements for an NPDES permit, the facility would operate in compliance with state or Federal regulations for discharge.	100	100	100	100	100	100

A list of facility BMPs can be found in Appendix H, and individual HPV files for each hatchery program can be found at http://hatcheryreform.us/hrp/tools/hpv/welcome_show.action.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, all hatchery programs in the analysis area would meet BMPs aimed at facility effects reduction (Table 4-21). As a result, hatchery facility risks related facility failure effects, water intake effects, facility passage effects, and water quality effects would be reduced compared to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, all hatchery programs in the analysis area would meet BMPs aimed at facility effects reduction (Table 4-21). As a result, hatchery facility risks related facility failure effects, water intake effects, facility passage effects, and water quality effects would be reduced compared to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, all hatchery programs in the analysis area would meet BMPs aimed at facility effects reduction (Table 4-21). As a result, hatchery facility risks related facility failure effects, water intake effects, facility passage effects, and water quality effects would be reduced compared to Alternative 1.

4.2.3.1.3 Risk of Competition with and Predation from Hatchery-origin Fish

Competition between hatchery-origin and natural-origin fish may result from direct interactions, in which hatchery-origin fish interfere with access to limited resources by natural-origin fish, or indirect interactions, as when utilization of a limited resource by hatchery-origin fish reduces the amount available for natural-origin fish (Section 3.2.3.1.5, Current Approaches for Reducing Risks from Competition with Hatchery-origin Fish). The same situations that lead to competition between hatchery-origin and natural-origin juveniles can cause predation risk. Direct predation occurs when hatchery-origin fish eat natural-origin fish; indirect predation occurs when predation from other sources increases as a result of the increased abundance of juvenile salmon and steelhead (Section 3.2.3.1.6, Risks of Predation from Hatchery-origin Fish). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios that may reduce competition and predation risks compared to baseline conditions (Table 4-3):

- Change production levels in hatchery programs.
- Install new seasonal weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

These five implementation measures may reduce pHOS relative to baseline conditions: change production levels in hatchery programs, install new seasonal weirs, install new permanent weirs, establish new selective fisheries in terminal areas, and terminate hatchery programs that only support harvest if they fail to meet performance goals. If pHOS is reduced compared to baseline conditions, then competition between adult hatchery-origin and natural-origin salmon and steelhead for mates and spawning sites may be reduced compared to baseline conditions. Two of these implementation measures may reduce the number of hatchery-origin fish released from the hatchery facilities compared to baseline conditions: change production levels in hatchery programs and terminate hatchery programs that only support harvest if they fail to meet performance goals. If the number of hatchery-origin fish being released from the hatchery facilities is reduced, then competition between hatchery-origin and natural-origin juveniles for food and space may be reduced compared to baseline conditions in areas where they co-occur. Likewise, any predation on natural-origin juveniles from hatchery-origin juveniles may also be reduced.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. Production levels would remain the same as under baseline conditions, and no additional implementation measures would be used (Section 4.1.3.4, Implementation Scenario for Alternative 1). As under baseline conditions, almost 126 million salmon and steelhead smolts would emigrate through the estuary (83 percent of those smolts would be of hatchery-origin) (Table 4-22). As a result, the risks of predation on and competition with natural-origin salmon and steelhead would be the same under Alternative 1 as under baseline conditions.

TABLE 4-22. NUMBERS AND PERCENTAGES OF NATURAL-ORIGIN AND HATCHERY-ORIGIN SALMON AND STEELHEAD EMIGRATING THROUGH THE COLUMBIA RIVER ESTUARY BY ALTERNATIVE.

	ALTERNATIVE					
	1 (NO ACTION)	2	3	4	5	6
Hatchery-origin Fish in the Estuary						
Number of Fish	105,620,359	32,696,218	85,478,650	90,399,167	87,768,927	98,613,520
Percent (%)	83	58	79	79	79	81
Natural-origin Fish in the Estuary						
Number of Fish	21,289,959	23,853,096	23,327,233	23,897,356	23,277,130	23,159,916
Percent (%)	17	42	21	21	21	19
TOTAL (Number of Fish)	**126,910,319**	**56,549,749**	**108,805,882**	**114,296,523**	**111,046,057**	**121,773,436**
Percent (%) Reduction Compared to Alternative 1		**55**	**14**	**10**	**13**	**4**

Source: All-H Analyzer

Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, production levels would be reduced by 59 percent relative to Alternative 1 (Table 4-4), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 55 percent relative to Alternative 1 (Table 4-22). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 19 percent relative to Alternative 1 (Table 4-4), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 14 percent relative to Alternative 1 (Table 4-22). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, production levels would be reduced by 15 percent relative to Alternative 1 (Table 4-4), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 10 percent relative to Alternative 1 (Table 4-22). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, production levels would be reduced by 15 percent relative to Alternative 1 (Table 4-4), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 13 percent relative to Alternative 1 (Table 4-22). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, production levels would be reduced by two percent relative to Alternative 1 (Table 4-4), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 4 percent relative to Alternative 1 (Table 4-22). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would be reductions in hatchery-origin adults on the spawning grounds, a reduction in competition for mates and spawning sites would also be expected compared to Alternative 1.

4.2.3.1.4 Risks of Masking

Unidentifiable adult hatchery-origin fish returning to natural spawning areas confound NMFS' ability to determine the status of the population. Abundance and productivity of the natural-origin population can be overestimated, and the productivity and capacity of the habitat can be imprecisely assessed. The abundance and productivity of the natural-origin fish and the condition of the habitat that sustains these fish are, therefore, masked by the continued infusion of hatchery-origin fish (Section 3.2.3.1.8, Risks Associated with Masking). In recent years, the masking problem has been greatly alleviated by the implementation of mass marking, the marking of a hatchery program's entire release (Box 2-4). However, several implementation measures that may further reduce the chances of masking by reducing the number of hatchery-origin salmon and steelhead on the spawning grounds would be incorporated under one or more of the alternatives' implementation scenarios (Table 4-3):

- Change production levels in hatchery programs.
- Install new seasonal weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. Production levels would remain the same as under baseline conditions, and no additional implementation measures would be used (Section 4.1.3.4, Implementation Scenario for Alternative 1). As a result, the risks of masking would be the same under Alternative 1 as under baseline conditions.

Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, production levels would be reduced by 59 percent relative to Alternative 1 (Table 4-4). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 19 percent relative to Alternative 1 (Table 4-4). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 15 percent relative to Alternative 1 (Table 4-4). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 15 percent relative to Alternative 1 (Table 4-4). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, production levels would be reduced by approximately 2 percent relative to Alternative 1 (Table 4-4). These production reductions, though minor, may slightly reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

4.2.3.1.5 Benefits of Nutrient Cycling

Salmon and steelhead are major vectors for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Experiments have shown that carcasses of hatchery-produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Section 3.2.3.1.12, Benefits of Nutrient Cycling). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios and would affect the number of salmon and steelhead returning to the spawning ground and contributing nutrients to the freshwater system (Table 4-3):

- Change production levels in hatchery programs.
- Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.
- Install new seasonal weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Establish new hatchery programs.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

Three of these implementation measures would affect hatchery production levels: change production levels in hatchery programs, establish new hatchery programs, and terminate hatchery programs that only support harvest if they fail to meet performance goals. Four of these implementation measures would affect the proportion of fish that escape to the spawning grounds: update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures, install new seasonal weirs, establish new permanent weirs, and establish new selective fisheries in terminal areas. Changing hatchery production and/or the proportion of fish returning to the spawning grounds would change the contribution of nutrients from salmon and steelhead to the freshwater system. A reduction in the number of salmon and steelhead carcasses may negatively affect juvenile salmon since hatchery carcasses are an important source of nutrients for them (Section 3.2.3.1.12, Benefits of Nutrient Cycling).

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. Production levels would remain the same as under baseline conditions, and no additional implementation measures would be used (Section 4.1.3.4, Implementation Scenario for Alternative 1). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be the same under Alternative 1 as under baseline conditions.

Alternative 2 (No Mitchell Act Funding)

There would be an 11 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 2 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

There would be a 5 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 3 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

There would be a 3 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 4 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

There would be a 6 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 5 relative to

Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

There would be a 3 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 6 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

4.2.3.1.6 Risks Associated with Disease Transfer

Interactions between hatchery-origin fish and natural-origin fish in the environment may result in the transmission of pathogens, if either the hatchery-origin or natural-origin fish are harboring fish disease (Section 3.2.3.1.13, Risks Associated with Disease Transfer). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios and would affect risks associated with disease transfer from hatchery-origin to natural-origin salmon and steelhead (Table 4-3). The following implementation measures could be used to reduce risks associated with disease transfer:

- Change production levels in hatchery programs.
- Establish new hatchery programs.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

These implementation measures would affect the number of fish being reared in the hatchery facilities. Reducing production levels may reduce the number of diseased hatchery-origin fish that are released into the natural environment.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. As under baseline conditions, hatchery facilities would continue following fish health guidelines, but no additional implementation measures would be taken to reduce the transfer of disease from hatchery-origin to natural-origin salmon and steelhead (Section 4.1.3.4, Implementation Scenario for Alternative 1). As a result, the risks for transfer of disease from hatchery-origin to natural-origin fish would be the same under Alternative 1 as under baseline conditions.

Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, production levels would be reduced by 58 percent relative to Alternative 1 (Table 4-4), Reducing production levels 58 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment, which may reduce the risks associated with disease transfer, relative to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 19 percent relative to Alternative 1 (Table 4-4). Reducing production levels 19 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment, which may reduce the risks associated with disease transfer, relative to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 15 percent relative to Alternative 1 (Table 4-4). Reducing production levels 15 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment, which may reduce the risks associated with disease transfer, relative to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 3, production levels would be reduced by 15 percent relative to Alternative 1 (Table 4-4). Reducing production levels 15 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment, which may reduce the risks associated with disease transfer, relative to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 2, production levels would be reduced by 2 percent relative to Alternative 1 (Table 4-4). Reducing production levels 2 percent relative to

Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment, which may reduce the risks associated with disease transfer, relative to Alternative 1.

4.2.3.2 Effects on Salmon ESUs and Steelhead DPSs under All Alternatives

Basinwide effects on salmon and steelhead are discussed in Section 4.2.3.1, Basinwide Effects on Salmon and Steelhead. This section evaluates effects specific to each ESU or DPS. Conditions under Alternative 1 are expected to be the same as under current conditions, so this analysis focuses on the effects of Alternative 2 through Alternative 6 relative to the effects of Alternative 1. The analysis includes a comparison of effects on VSP (abundance, productivity, and diversity) and competition and predation risks. A summary of effects to VSP by alternative is presented in Table 4-19. Effects on other categories of risks (e.g., masking) are the same at an ESU and DPS level as described in the basinwide analysis (Section 4.2.3.1, Basinwide Effects on Salmon and Steelhead).

4.2.3.2.1 Lower Columbia River Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Abundance of natural-origin spawners in the Lower Columbia River Chinook Salmon ESU would increase under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 due to reduced genetic, predation, and competition risks (Table 4-23). Abundance would be highest under the implementation scenario for Alternative 2 compared to the other alternatives.

Mean adjusted productivity would also increase under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 due to reduced genetic, predation, and competition risks (Table 4-23). Productivity would be highest under the implementation scenario for Alternative 2, compared to the other alternatives, because genetic risks would be reduced more under the implementation scenario for Alternative 4 when compared to the others. Strategies would be implemented to control the number of hatchery-origin fish spawning naturally (i.e., weirs), and hatchery programs would be better integrated (i.e., there would be a higher proportion of pNOB and/or lower pHOS).

TABLE 4-23. MEAN PERCENT CHANGE IN ADJUSTED PRODUCTIVITY ($PROD_{ADJ}$) AND IN ABUNDANCE OF NATURAL-ORIGIN SPAWNERS (NOS) PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	3.3	58,943	N/A[1]	N/A
2	4.9	71,346	49	21
3	4.1	68,072	26	15
4	4.6	68,779	42	17
5	4.1	67,854	25	15
6	3.4	64,255	4	9

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS (Section 2.4, Alternative Development).

The number and percent of primary and contributing populations that would have adjusted productivity greater than 1.0, and 500 or more NOS would increase under the implementation scenarios for Alternatives 2 through 6 when compared to Alternative 1, suggesting that spatial structure would be greater under Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-24).

TABLE 4-24. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ} > 1.0$	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ} > 1.0$	PERCENT OF POPULATIONS WITH $PROD_{ADJ} > 1.0$	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ} > 1.0$ AND NOS > 500
1 (No Action)	23	16	15	82	57	54
2	27	18	18	96	64	64
3	24	17	17	86	61	61
4	24	17	17	86	61	61
5	24	17	17	86	61	61
6	24	16	16	86	57	57

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS (Section 2.4, Alternative Development).
The symbol “>” = “greater than.”

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 21 percent of primary and contributing Chinook salmon populations for the Lower Columbia River Chinook Salmon ESU would meet stronger metrics for genetic diversity, and 68 percent would meet weaker than intermediate metrics for genetic diversity. The number of populations meeting stronger metrics for genetic diversity would improve under the implementation scenarios for Alternative 2 through Alternative 6, with the highest percentage of populations meeting stronger metrics for genetic diversity under the implementation scenario for Alternative 2 (Table 4-25). Thus, genetic risks described in Section 3.2.3.1.1.2, Effects on Genetic Diversity, would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 through application of measures such as changing production levels, installing seasonal and permanent weirs, establishing selective fisheries in terminal areas, changing program goals or type, and terminating programs that fail to meet performance criteria. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-25. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	6	3	19	21	11	68
2	25	1	2	89	4	7
3	17	2	9	61	7	32
4	18	1	9	64	4	32
5	16	3	9	57	11	32
6	10	2	16	36	7	57

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS (Section 2.4, Alternative Development).

No new weirs would be installed under the implementation scenarios for Alternative 1, Alternative 2, or Alternative 6, but five new weirs would be installed under the implementation scenarios for Alternative 3 and Alternative 5, and seven new weirs would be installed under the implementation scenario for Alternative 4 to achieve PNI and pHOS objectives (Table 4-26). As a result, the following weir effects may be greater under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1.2, Effects on Genetic Diversity). Six of the seven weirs under the implementation scenario for Alternative 4 would be permanent structures necessary to achieve high effectiveness and presumably would have greater effects on native-origin fish species compared to effects from seasonal (seasonal) weirs under implementation scenarios for Alternative 3 and Alternative 5.

TABLE 4-26. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Clatskanie	Clatskanie Fall Chinook Salmon	0	0	50	95	50	0
Scappoose	Scappoose Fall Chinook Salmon	0	0	50	95	50	0
Grays	Grays Fall Chinook Salmon	0	0	50	95	50	0
Mill-Abernathy-Germany	Mill-Abernathy-Germany Fall Chinook Salmon	0	0	0	95	0	0
Elochoman	Elochoman Fall Chinook Salmon	0	0	50	95	50	0
Washougal	Washougal Fall Chinook Salmon	0	0	50	50	50	0
Lewis	East Fork Lewis Fall Chinook Salmon (Tule)	0	0	0	95	0	0

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new or upgraded weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-27 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-27. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	10.2	0.7	3.0	0.0
2	0.9	0.3	0.7	0.0
3	7.0	0.5	1.8	0.0
4	7.4	0.5	1.9	0.1
5	7.0	0.5	1.9	0.0
6	8.1	0.6	2.3	0.1

Source: Appendix C

Ratios generally would be reduced under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to other alternatives, suggesting that competition with and predation on natural-origin salmon and steelhead would be lowest under the implementation scenario for Alternative 2.

4.2.3.2.2 Mid-Columbia River Spring-run Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity in the Mid-Columbia Spring-run Chinook Salmon ESU would increase under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-28). Abundance would be highest under the implementation scenario for Alternative 2 compared to the other alternatives. Abundance would both increase and decrease under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1. Abundance would decrease slightly under the implementation scenario for Alternative 6 when compared to Alternative 1 due to improved integration of hatchery programs in the Deschutes, Walla Walla, and Umatilla subbasins, which would require more natural-origin fish to be taken into the hatchery broodstock. Abundance would increase under the implementation scenarios for Alternative 2 though Alternative 5 compared to Alternative 1 due to reduced genetic, competition, and predation risks.

TABLE 4-28. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	4.0	16,666	N/A[1]	N/A
2	4.6	17,111	13	3
3	4.5	16,954	11	2
4	4.5	16,954	11	2
5	4.6	16,982	15	2
6	4.3	16,463	7	-1

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the Columbia River Basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 was equal under the implementation scenarios for Alternative 2 through Alternative 6, suggesting that spatial structure would improve slightly for Alternative 2 through Alternative 6, when compared to Alternative 1 (Table 4-29). The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 would increase under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-29). This suggests that structure would improve under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. The higher NOS would result from an increase in NOS abundance for Klickitat spring Chinook salmon due to improved broodstock management (i.e., improving integration by including more natural-origin adults in the broodstock).

TABLE 4-29. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	10	7	7	100	70	70
2	10	8	8	100	80	80
3	10	8	8	100	80	80
4	10	8	8	100	80	80
5	10	8	8	100	80	80
6	10	8	8	100	80	80

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 60 percent of primary and contributing Chinook salmon populations would meet stronger metrics for genetic diversity, 10 percent would meet intermediate metrics for genetic diversity, and 30 percent would meet weaker than intermediate metrics for genetic diversity (Table 4-30). The implementation scenarios for Alternative 2 through Alternative 6 would increase the number of primary and contributing populations meeting either the stronger or intermediate metrics for genetic diversity compared to Alternative 1, and all primary and contributing populations in this ESU would meet either the stronger or intermediate metrics for genetic diversity under the implementation scenarios for Alternative 2 through Alternative 5. As a result, genetic risks described in Section 3.2.3.1.1.2, Effects on Genetic Diversity, would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1. Reductions would occur through application of measures such as changing production levels, installing seasonal and permanent weirs, establishing selective fisheries in terminal areas, changing program goals or type, and terminating programs that fail to meet performance criteria. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-30. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	6	1	3	60	10	30
2	9	1	0	90	10	0
3	8	2	0	80	20	0
4	8	2	0	80	20	0
5	10	0	0	100	0	0
6	8	0	2	80	0	20

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

As described in Section 3.2.3.1.1.2, Effects on Genetic Diversity, weir effects include isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries. No new weirs would be required to meet PNI and pHOS objectives for any of the alternatives, although existing weirs in the Deschutes and upper Yakima Rivers would have to be maintained (Table 4-31). As a result, weir effects would be the same under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-32 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-31. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Deschutes	Deschutes Spring Chinook Salmon	50	50	50	50	50	50
Yakima	Upper Yakima Spring Chinook Salmon	95	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new or upgraded weir.

TABLE 4-32. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	72.0	2.5	18.0	0.0
2	22.0	2.0	0.0	0.0
3	68.4	2.4	9.6	0.0
4	68.4	2.4	9.6	0.0
5	69.0	2.4	9.6	0.0
6	73.3	2.3	9.7	0.0

Source: Appendix C

Ratios of hatchery-origin to natural-origin fish would generally be reduced under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. The ratio of hatchery-origin to natural-origin Chinook salmon would increase slightly under Alternative 6, however, suggesting that for most species, under most alternatives, competition and predation risks would be lower under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. Ratios of hatchery-origin to natural-origin fish would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks on the Mid-Columbia River Spring-run Chinook Salmon ESU would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

4.2.3.2.3 Deschutes River Summer/Fall-run Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity and abundance would be greater under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-33). Intraspecific competition and predation would be slightly reduced under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1. This reduction may lead to increases in abundance and productivity. However, differences in abundance and productivity among the alternatives would probably be more affected by differences in the genetic risk posed by hatchery-origin Chinook salmon straying into the Deschutes River from outside the Deschutes River Basin. There are no direct releases of summer/fall Chinook salmon into the Deschutes River.

TABLE 4-33. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE DESCHUTES RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.44	8,925	N/A[1]	N/A
2	2.94	11,065	20	24
3	2.54	9,497	4	6
4	2.54	9,497	4	6
5	2.46	9,007	1	1
6	2.70	9,900	11	11

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number and percent of primary and contributing populations that would have an adjusted productivity of greater than 1.0 and 500 or more NOS did not vary among implementation scenarios for the alternatives. This suggests that spatial structure would not vary among implementation scenarios for the alternatives (Table 4-34).

Table 4-34. Number and Percent of Primary and Contributing Populations Comprising the Deschutes River Summer/Fall-run Chinook Salmon ESU that Would Have a $PROD_{ADJ}$ Greater than 1.0, 500 or More NOS, or Both.

Alternative	Number of Populations with $PROD_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with Both NOS > 500 and $PROD_{ADJ}$ > 1.0	Percent of Populations with $PROD_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with Both $PROD_{ADJ}$ > 1.0 and NOS > 500
1 (No Action)	1	1	1	100	100	100
2	1	1	1	100	100	100
3	1	1	1	100	100	100
4	1	1	1	100	100	100
5	1	1	1	100	100	100
6	1	1	1	100	100	100

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

There is only one primary or contributing population in this ESU, and it would meet the stronger metrics for genetic diversity under implementation scenarios for all of the alternatives (Table 4-35). Therefore, there would be no expected differences in genetic effects between alternatives. Weirs would not be required in any of the alternatives' implementation scenarios to achieve PNI and pHOS objectives, so weir effects would not vary among the alternatives. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-36 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-35. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE DESCHUTES RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	1	0	0	100	0	0
2	1	0	0	100	0	0
3	1	0	0	100	0	0
4	1	0	0	100	0	0
5	1	0	0	100	0	0
6	1	0	0	100	0	0

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

TABLE 4-36. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE DESCHUTES RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	1.7	0.3	0.0	0.0
2	1.5	0.2	0.0	0.0
3	1.7	0.3	0.0	0.0
4	1.7	0.3	0.0	0.0
5	1.7	0.3	0.0	0.0
6	1.5	0.2	0.0	0.0

Source: Appendix C

Ratios would be slightly lower under the implementation scenarios for Alternative 2 and Alternative 6 compared to Alternative 1 for hatchery-origin Chinook salmon to natural-origin Chinook salmon, but ratios for hatchery-origin steelhead on natural-origin Chinook salmon would be reduced under Alternative 2 and Alternative 6 compared to Alternative 1 (Table 4-36). This suggests that there would be slight reductions in intraspecific (among the same species) competition and predation risk for the Deschutes River Summer/Fall-run Chinook Salmon ESU under the implementation scenario for Alternative 2 and Alternative 6 when compared to Alternative 1.

There would not be any changes in the ratio of hatchery-origin to natural-origin salmon and steelhead smolts under implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. This suggests that competition and predation risks would be similar (Table 4-36).

4.2.3.2.4 Upper Columbia River Spring-run Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity and abundance would increase under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-37). These changes would be due to the incorporation of more natural-origin broodstock into the Methow and Wenatchee spring Chinook integrated hatchery programs, operation of the Tumwater Canyon Fish Trap in the Wenatchee to control pHOS, and a reduction in hatchery production in the Methow spring Chinook salmon hatchery program.

TABLE 4-37. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.63	2,332	N/A[1]	N/A
2	3.75	2,662	43	14
3	3.75	2,664	43	14
4	3.75	2,664	43	14
5	4.14	2,936	57	26
6	3.62	2,402	38	3

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number and percent of primary and contributing populations that would have an adjusted productivity greater than 1.0 and 500 or more NOS did vary among implementation scenarios for the alternatives. This suggests that spatial structure would not vary among implementation scenarios for the alternatives (Table 4-38).

TABLE 4-38. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ >1.0 AND NOS > 500
1 (No Action)	6	2	2	100	33	33
2	6	2	2	100	33	33
3	6	2	2	100	33	33
4	6	2	2	100	33	33
5	6	2	2	100	33	33
6	6	2	2	100	33	33

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, no primary and contributing Chinook salmon populations would meet the stronger metrics for genetic diversity, and one population would meet the intermediate metrics for genetic diversity (Table 4-39). Under the implementation scenarios for Alternative 2 through Alternative 6, more populations would meet stronger and intermediate metrics for genetic diversity compared to Alternative 1, suggesting that genetic effects would be lower under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-39). The implementation scenario for Alternative 5 would result in all primary and contributing populations meeting the stronger metrics for genetic diversity. The only population that would not meet stronger metrics for genetic diversity under the implementation scenario for Alternative 5 would be the Okanogan population, but it is classified as a stabilizing population for this analysis using terms from the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004). Thus, it is not shown in Table 4-39. As a result, the implementation scenario for Alternative 5 would likely have the fewest genetic effects, on the Okanogan population, of all of the other alternatives. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-39. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	0	1	5	0	17	83
2	3	3	0	50	50	0
3	3	3	0	50	50	0
4	3	3	0	50	50	0
5	6	0	0	100	0	0
6	1	5	0	17	83	0

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

As described in Section 3.2.3.1.1.2, Effects on Genetic Diversity, weir effects include isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due either to trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries. No new weirs would be installed under the implementation scenarios for Alternative 1 through Alternative 6, but the effectiveness of the weir in the Wenatchee River would be assumed to increase under the implementation scenarios for Alternative 2 through Alternative 6 (Table 4-40). As a result, weir effects would be greatest under the implementation scenario for Alternative 6 compared to the other alternatives' implementation scenarios and Alternative 1.

TABLE 4-40. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Wenatchee	Wenatchee (Chiwawa) Spring Chinook Salmon	30	90	90	90	90	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-41 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-41. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	16.4	3.6	5.2	0.0
2	13.8	2.3	4.8	0.0
3	13.8	2.9	4.8	0.0
4	13.8	2.9	4.8	0.0
5	16.4	2.6	4.5	0.0
6	26.0	3.6	4.0	0.0

Source: Appendix C

Ratios would generally be reduced under the implementation scenarios for Alternative 2 through Alternative 6, although the ratio of hatchery-origin to natural-origin Chinook salmon smolts would increase under the implementation scenario for Alternative 6 when compared to Alternative 1. While no one single alternative attains the lowest ratio of hatchery-origin to natural-origin Chinook salmon smolts, the implementation scenarios for Alternative 2 through Alternative 4 would result in reductions to the hatchery-origin to natural-origin Chinook salmon smolts across all of the species. This is mostly due to reductions in steelhead hatchery programs under the implementation scenarios for Alternative 2 through Alternative 4 in order to meet PNI and/or pHOS goals.

4.2.3.2.5 Upper Columbia River Summer/Fall-run Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-42). The increase for all alternatives would be the result of improving the fitness of Hanford Reach Upriver Bright population by better integrating the Priest Rapids hatchery program. This would be achieved by using a higher proportion of natural-origin adults in the broodstock. Abundance would be slightly lower under the implementation scenarios for Alternative 5 and Alternative 6 compared to the implementation scenarios for Alternative 2 through Alternative 4 because more natural-origin fish would be taken as broodstock so that hatchery production could be increased in the Okanogan River to improve harvest benefits under this alternative (Table 4-42).

TABLE 4-42. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.4	74,573	N/A[1]	N/A
2	2.9	100,253	22	34
3	2.8	94,929	18	27
4	2.8	94,929	18	27
5	2.6	89,842	11	20
6	2.6	89,631	9	20

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 would increase under the implementation scenario for Alternative 2 through Alternative 6 compared to Alternative 1. This suggests that spatial structure would increase under Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-43).

TABLE 4-43. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS >500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	3	5	3	50	83	50
2	4	4	4	67	67	67
3	4	4	4	67	67	67
4	4	4	4	67	67	67
5	4	4	4	67	67	67
6	4	5	4	67	83	67

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 33 percent of primary and contributing Chinook populations would meet stronger metrics for genetic diversity, no populations would meet the intermediate metrics for genetic diversity, and 67 percent would meet weaker than intermediate metrics for genetic diversity (Table 4-44). Under Alternative 2 through Alternative 6, more primary and contributing populations would meet stronger and intermediate metrics for genetic diversity compared to Alternative 1 (Table 4-44). The number of primary and contributing populations meeting stronger metrics for genetic diversity would improve to 67 percent for Alternative 2 through Alternative 5 (Table 4-44). In addition, 33 percent of primary and contributing populations would meet intermediate metrics for genetic diversity for Alternatives 3 through 6, compared to zero percent for Alternative 1 and Alternative 2 (Table 4-44). As a result, genetic effects would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C. One weir would be operated under the implementation scenario for Alternative 5 (Table 4-45) to help achieve PNI and pHOS objectives, so weir effects would increase under the implementation scenario for Alternative 5 compared to Alternative 1.

TABLE 4-44. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	2	0	4	33	0	67
2	4	0	2	67	0	33
3	3	2	1	50	33	17
4	3	2	1	50	33	17
5	3	2	1	50	33	17
6	3	2	1	50	33	17

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by theLCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

TABLE 4-45. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Okanagan River	Okanogan River Sum/Fall Chinook	0	0	0	0	75	0

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-46 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

Ratios for hatchery-origin Chinook to natural-origin Chinook and hatchery-origin coho to natural-origin Chinook would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 and would remain equal under Alternative 6 when compared to Alternative 1. This suggests that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

Table 4-46. Ratio of Hatchery-origin Smolt Production by Species to Natural-origin Chinook Salmon Smolt Production, by Alternative, in the Upper Columbia River Summer/Fall-run Chinook Salmon ESU.

Alternative	Hatchery-origin Chinook Salmon to Natural-origin Chinook Salmon	Hatchery-origin Steelhead to Natural-origin Chinook Salmon	Hatchery-origin Coho Salmon to Natural-origin Chinook Salmon	Hatchery-origin Chum Salmon to Natural-origin Chinook Salmon
1 (No Action)	1.9	0.1	0.1	0.0
2	0.7	0.0	0.1	0.0
3	1.6	0.0	0.1	0.0
4	1.6	0.0	0.1	0.0
5	1.7	0.0	0.1	0.0
6	1.9	0.0	0.1	0.0

Source: Appendix C

The low ratios of hatchery-origin to natural-origin fish under implementations scenarios for all alternatives would be due to the large number of natural-origin Chinook juveniles (8 to 12 million) in this ESU. The majority (around 80 percent) of the natural-origin production would be from fall Chinook originating in the Hanford Reach of the Columbia River and summer Chinook from the Wenatchee and Okanogan Rivers. No hatchery-origin chum salmon would be released in this ESU under any alternative (Appendix C).

4.2.3.2.6 Upper Willamette River Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Abundance and mean adjusted productivity would increase slightly in implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-47). Implementation scenarios for Alternative 2 through Alternative 5 would lead to fewer hatchery-origin fish on the spawning grounds compared to Alternative 1, which would likely result in greater natural-origin Chinook population productivity and abundance.

TABLE 4-47. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	3.7	24,775	N/A[1]	N/A
2	4.0	25,809	8	4
3	3.9	25,414	5	3
4	3.9	25,379	5	2
5	3.9	25,409	5	3
6	3.9	25,301	5	2

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number of populations that achieved an adjusted productivity greater than 1.0 and NOS greater than 500 was equal under all implementation scenarios. (Table 4-48). This suggests that spatial structure would remain consistent under all implementation scenarios.

TABLE 4-48. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	4	5	4	80	100	80
2	4	5	4	80	100	80
3	4	5	4	80	100	80
4	4	5	4	80	100	80
5	4	5	4	80	100	80
6	4	5	4	80	100	80

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol “>” = “greater than.”

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 40 percent of primary and contributing populations would meet stronger metrics for genetic diversity, none would meet the intermediate metrics for genetic diversity, and 60 percent would meet weaker than intermediate metrics for genetic diversity (Table 4-49). The percent of populations meeting stronger metrics for genetic diversity would be the same for all alternatives' implementation scenarios. Under the implementation scenarios for Alternative 2 through Alternative 6, however, more primary and contributing populations would meet intermediate metrics for genetic diversity, suggesting that genetic risks would be slightly reduced under the implementation scenario for Alternative 2 through Alternative 6 compared to Alternative 1.

TABLE 4-49. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	2	0	3	40	0	60
2	2	1	2	40	20	40
3	2	1	2	40	20	40
4	2	1	2	40	20	40
5	2	1	2	40	20	40
6	2	1	2	40	20	40

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

Reduced genetic risks under the implementation scenarios for Alternative 2 through Alternative 6 would be due to improved broodstock management in the South Santiam River. The two populations that would meet weaker than intermediate metrics for genetic diversity under Alternative 2 through Alternative 6 would be the Middle Fork Willamette and North Santiam River populations. Hatchery programs in these rivers would be operated primarily for conservation (gene banking) purposes, since most high-quality spring Chinook habitat is blocked by upstream dams (McElhany et al. 2003). Broodstock management in these hatchery programs could not be improved to meet intermediate or stronger metrics for genetic diversity, but this situation might change if fish passage were provided in these rivers because natural-origin abundance would likely improve compared to existing conditions. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C. No new weirs were required to meet alternative objectives (Table 4-50). However, an existing adult trap at the North Fork Dam in the Clackamas River would be used to exclude marked hatchery-origin spring Chinook salmon from the upper watershed under implementation scenarios for all alternatives. As a result, weir effects would not likely vary across the alternatives' implementation scenarios.

TABLE 4-50. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Willamette	Willamette Clackamas Spring Chinook Salmon	95	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-51 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-51. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	16.0	3.0	0.9	0.0
2	12.3	2.4	0.0	0.0
3	15.1	2.8	0.9	0.0
4	15.3	2.6	0.9	0.0
5	15.1	2.8	0.9	0.0
6	15.1	2.8	0.9	0.0

Source: Appendix C

Ratios generally would be reduced under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2, suggesting that competition and predation risks would be lowest for this alternative compared to the other alternatives. This would be due to reductions in hatchery production associated with closing hatchery programs funded through the Mitchell Act (e.g., the Eagle Creek coho salmon hatchery program) and reducing production in other hatchery programs to meet performance goals (e.g., the South Santiam spring Chinook salmon hatchery program).

4.2.3.2.7 Snake River Spring/Summer-run Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity and abundance would be greater under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-52). Increases in abundance and productivity relative to Alternative 1 would occur in multiple populations in the Salmon, Clearwater, and Grande Ronde Rivers. These increases would result from improved broodstock management (i.e., improving integration by including more natural-origin adults in the broodstock) and better control of the number of hatchery-origin adults allowed to spawn naturally in key populations when compared to management under Alternative 1.

TABLE 4-52. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.1	20,699	N/A[1]	N/A
2	2.2	21,737	5	5
3	2.2	21,768	6	5
4	2.2	21,768	6	5
5	2.3	23,000	8	11
6	2.2	21,960	6	6

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number and percent of primary and contributing populations that would have an adjusted productivity greater than 1.0 and 500 or more NOS would increase under Alternative 2 through Alternative 6. This suggests that spatial structure would increase under the implementation scenarios for the Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-53).

TABLE 4-53. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	25	15	15	86	52	52
2	27	17	17	93	59	59
3	27	17	17	93	59	59
4	27	17	17	93	59	59
5	27	16	16	93	55	55
6	27	16	16	93	55	55

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 76 percent of primary and contributing populations would meet stronger metrics for genetic diversity, 0 percent would meet the intermediate metrics for genetic diversity, and 24 percent would meet weaker than intermediate metrics for genetic diversity (Table 4-54). The number of populations meeting stronger and intermediate metrics for genetic diversity would increase under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1, suggesting that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1.

Two primary and contributing populations would meet weaker than intermediate metrics for genetic diversity under the implementation scenarios for Alternative 2 through Alternative 6, compared with seven populations under Alternative 1. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-54. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	22	0	7	76	0	24
2	24	3	2	83	10	7
3	24	3	2	83	10	7
4	24	3	2	83	10	7
5	27	0	2	93	0	7
6	26	1	2	90	3	7

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

Eight weirs currently operate within the boundaries of this ESU, and these eight weirs would continue to operate under the implementation scenario for Alternative 1 through Alternative 6 (Table 4-55). Under the implementation scenarios for Alternative 3 through Alternative 5, existing weirs in the Lostine and Imnaha Rivers would receive additional investments to improve efficiency. As a result, the following weir effects may be greater under the implementation scenario for Alternative 3 through Alterative 5 compared to implementation scenarios for Alternative 1, Alternative 2, and Alternative 6: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due either to trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

TABLE 4-55. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU.

LOCATION	POPULATION	ALTERNATIVE (PERCENT [%] EFFECTIVENESS) 1 (NO ACTION)[1]	2	3	4	5	6
Salmon River	South Fork Salmon River Summer Chinook Salmon	70	70	70	70	70	70
	East Fork-South Fork Salmon (Johnson Creek) Summer Chinook Salmon	50	50	50	50	50	50
	Pahsimeroi Summer Chinook Salmon	95	95	95	95	95	95
	Upper Salmon Mainstem Spring Chinook Salmon	95	95	95	95	95	95
Clearwater River	South Fork Clearwater Newsome Creek Spring Chinook Salmon	95	95	95	95	95	95
Grande Ronde River	Lostine Spring Chinook Salmon	50	50	90	90	90	50
	Catherine Creek Spring Chinook Salmon	55	55	55	55	55	55
Imnaha River	Imnaha Spring Chinook Salmon	20	20	70	70	70	20

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-56 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-56. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	6.0	4.3	0.4	0.0
2	5.2	3.5	0.0	0.0
3	5.2	3.5	0.4	0.0
4	5.2	3.5	0.4	0.0
5	5.6	4.0	0.4	0.0
6	6.8	4.2	0.4	0.0

Source: Appendix C

Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. However, the ratio of hatchery-origin to natural-origin smolts for Chinook salmon would increase when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks would be lowest under Alternative 2 compared to the other alternatives.

4.2.3.2.8 Snake River Fall-run Chinook Salmon ESU

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 5 and would remain the same under implementation scenarios for Alternative 6 when compared to Alternative 1 (Table 4-57). Under the implementation scenario for Alternative 1, the adjusted productivity would be lower than 1.0. The adjusted productivity would increase slightly under the implementation scenarios for Alternative 2 through Alternative 5. (Table 4-57). The implementation scenario under Alternative 2 would have the highest productivity level of all the alternatives, with an adjusted productivity of 1.65 (Table 4-57). This increase in adjusted productivity would be due to higher PNI values under the Alternative 2 implementation scenario.

Table 4-57. Mean Percent Change in $PROD_{ADJ}$ and in Abundance of NOS per Population (Primary and Contributing Populations Only) by Alternative in the Snake River Fall-run Chinook Salmon ESU.

Alternative	Mean $PROD_{ADJ}$	Total NOS Abundance	Change in Mean $PROD_{ADJ}$ from Alternative 1 (%)	Change in Total NOS Abundance from Alternative 1 (%)
1 (No Action)	0.97	2,437	N/A[1]	N/A
2	1.65	1,825	70	-25
3	1.50	1,718	54	-29
4	1.50	1,718	54	-29
5	1.62	2,150	67	-12
6	0.97	1,872	0	-23

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

Average abundance would decrease by at least 12 percent under implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-57). Although the productivity would increase under implementation scenarios for Alternative 2 through

Alternative 5 compared to Alternative 1, the abundance would decrease because more natural-origin fish would be taken into the Hells Canyon fall Chinook salmon hatchery program.

The number and percent of populations that would have an adjusted productivity greater than 1.0 and 500 or more NOS would increase under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-58), suggesting that spatial structure would be greater under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-58).

TABLE 4-58. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER FALL-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	0	1	0	0	100	0
2	1	1	1	100	100	100
3	1	1	1	100	100	100
4	1	1	1	100	100	100
5	1	1	1	100	100	100
6	0	1	0	0	100	0

Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

The Snake River Fall-run Chinook Salmon ESU consists of a single natural-origin population consisting of spawning components in the Snake River mainstem, the Clearwater River, and the lower portions of the Grande Ronde and Imnaha Rivers (Section 3.2.3.2.8, Snake River Fall-run Chinook Salmon ESU). This population would meet weaker than intermediate metrics for genetic diversity under the implementation scenario for Alternative 1 (Table 4-59). Under the implementation scenario for Alternatives 2 and 5, this population would meet stronger metrics for genetic diversity (Table 4-59). Under the implementation scenario for Alternatives 3 and 4, this population would meet intermediate metrics for genetic diversity (Table 4-59). There would be no change under the implantation scenario for Alternative 6. As a result, genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to the implementation scenario for Alternative 1, with the fewest genetic risks occurring under the implementation scenarios for Alternatives 2 and 5. Specific PNI and pHOS values for each population in the ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-59. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER FALL-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	0	0	1	0	0	100
2	1	0	0	100	0	0
3	0	1	0	0	100	0
4	0	1	0	0	100	0
5	1	0	0	100	0	0
6	0	0	1	0	0	100

[1] Source: Appendix C. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

No weirs currently exist or were needed to achieve PNI and pHOS objectives for any of the alternatives, so weir effects would not vary among the alternatives' implementation scenarios.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-60 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

For hatchery-origin Chinook salmon to natural-origin Chinook, salmon ratios would be greatly reduced under implementation scenarios for Alternative 2 through Alternative 5. These ratios would be slightly reduced under implementation scenarios for Alternative 6 compared to Alternative 1 (Table 4-60) because there would be a large reduction in the number of hatchery-origin fall Chinook released under the implementation scenarios for Alternative 2 through

Alternative 5. Ratios would be lowest under the implementation scenarios for Alternative 5 (Table 4-60), suggesting that intraspecific competition and predation risks would be lowest under the implementation scenario for Alternative 5 compared to all other alternatives.

TABLE 4-60. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SNAKE RIVER FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	15.0	22.6	2.1	0.0
2	2.5	28.4	0.0	0.0
3	2.6	29.9	3.3	0.0
4	2.6	29.9	3.3	0.0
5	1.1	29.3	2.7	0.0
6	14.7	24.8	2.2	0.0

Source: Appendix C

The ratio of hatchery-origin steelhead to natural-origin Chinook salmon would increase under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-60) because there would be decreased natural-origin production of Chinook salmon under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1. The implementation scenario under Alternative 6 would result in a smaller increase in the ratio of hatchery-origin steelhead to natural-origin Chinook salmon compared to Alternative 1. As a result, interspecific competition and predation risks would increase under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1.

The ratio of hatchery-origin coho salmon to natural-origin Chinook salmon would be reduced under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-60) because a Mitchell Act-funded coho salmon program in the Clearwater River would be terminated. However, ratios of hatchery-origin coho salmon to natural-origin Chinook would increase under the implementation scenario for Alternative 3 through Alternative 6 compared to Alternative 1 (Table 4-60). This is because natural-origin Chinook salmon production would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 because more natural-origin Chinook salmon would be taken as broodstock for the hatchery program. This suggests that interspecific competition and predation between hatchery-origin coho and natural-origin Chinook salmon would be higher under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1.

4.2.3.2.9 Lower Columbia River Steelhead DPS

Effects on Abundance and Productivity (VSP)

Average abundance and mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-61). Average abundance would slightly decrease, and mean adjusted productivity would remain constant under the implementation scenario for Alternative 6 when compared to Alternative 1 (Table 4-61). Average abundance and mean adjusted productivity would be highest under the implementation scenario for Alternative 2 when compared to the other alternatives (Table 4-61) because the Alternative 2 implementation scenario would release the fewest hatchery-origin steelhead of all the alternatives, which would lead to lower pHOS values among Lower Columbia River steelhead populations, reducing genetic risks.

TABLE 4-61. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE LOWER COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	3.2	16,988	N/A[1]	N/A
2	3.6	18,314	11	8
3	3.3	17,135	3	1
4	3.5	17,433	9	3
5	3.3	17,144	3	1
6	3.2	16,928	1	0

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 would be higher under the implementation scenarios for Alternative 2 through Alternative 5 relative to Alternative 1 because abundance would increase under each of these alternatives (Table 4-62). The results suggest that spatial structure would be greater under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 6. The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 would be similar under the implementation scenario for Alternative 6 when compared to Alternative 1 (Table 4-62), suggesting that spatial structure would be similar between these two alternatives.

TABLE 4-62. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	19	11	11	95	55	55
2	19	14	14	95	70	70
3	20	12	12	100	60	60
4	20	13	13	100	65	65
5	20	12	12	100	60	60
6	19	11	11	95	55	55

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 75 percent of primary and contributing populations would meet stronger metrics for genetic diversity, and 10 percent would meet weaker than intermediate metrics for genetic diversity (Table 4-63). The percent of primary and contributing populations meeting either stronger or intermediate metrics for genetic diversity would increase under Alternative 2 through Alternative 5 and would remain constant under Alternative 6 compared to Alternative 1 (Table 4-63). This suggests that genetic risks would be reduced under the implementation scenarios for Alternative 2 to Alternative 5 compared to Alternative 1, with the fewest genetic effects occurring under the implementation scenario for Alternative 4. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

One new weir in the Hood River would be implemented for Alternative 3 through Alternative 5 (Table 4-64) to meet PNI and pHOS objectives. The existing weirs in the Willamette, Wind, and Cowlitz Rivers would be maintained (Table 4-64). As a result, weir effects would be increased under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1.

TABLE 4-63. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	15	2	3	75	10	15
2	16	3	1	80	15	5
3	16	4	0	80	20	0
4	19	1	0	95	5	0
5	16	4	0	80	20	0
6	15	1	4	75	5	20

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

TABLE 4-64. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE LOWER COLUMBIA RIVER STEELHEAD DPS.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Willamette	Upper Clackamas Winter Steelhead (Late)	95	95	95	95	95	95
Wind	Wind Summer Steelhead	95	95	95	95	95	95
Cowlitz	Upper Cowlitz Winter Steelhead (Late)	95	95	95	95	95	95
Hood	Hood Summer Steelhead	0	0	75	75	75	0

[1] If effectiveness value is greater than 0 percent in Alternative 1, then a weir currently exists, and new weirs would not have to be constructed in the other alternatives.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-65 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-65. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE LOWER COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	14.1	201.4	55.0	0.0
2	8.3	17.9	19.9	0.0
3	12.6	152.1	38.2	0.0
4	11.9	153.8	35.2	1.4
5	12.6	152.4	40.1	0.0
6	14.0	169.7	45.6	0.0

Source: Appendix D

Ratios would generally be reduced under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. One anomaly would be the ratio of hatchery-origin chum salmon to natural-origin steelhead under the implementation scenario for Alternative 4. The ratio of hatchery-origin chum salmon to natural-origin steelhead would be 0 under the implementation scenarios for Alternative 1, Alternative 2, Alternative 3, and Alternative 5, but the ratio would increase to 1.4 under Alternative 4 (Table 4-65). However, because chum salmon would be released from hatcheries as fry and immediately migrate to the ocean, their release probably would not lead to competition with or predation on the larger natural-origin steelhead juveniles. As a result, competition and predation risks would be lower under implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1.

4.2.3.2.10 Middle Columbia River Steelhead DPS

Effects on Abundance and Productivity (VSP)

Average abundance and mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 5, with productivity remaining constant for Alternative 6, when compared to Alternative 1 (Table 4-66). Average abundance and mean adjusted productivity would be greatest under the implementation scenario for Alternative 5 when compared to implementation scenarios for the other alternatives (Table 4-66).

The number and percent of primary and contributing populations that would have an adjusted productivity greater than 1.0 and 500 or more NOS would be greatest under the implementation scenarios for Alternative 1 through Alternative 4 when compared to the implementation scenarios for all other alternatives (Table 4-67). This suggests that spatial structure would also be greatest under these alternatives compared to the other alternatives.

TABLE 4-66. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE MIDDLE COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	3.0	28,570	N/A[1]	N/A
2	3.3	31,554	13	10
3	3.3	31,350	12	10
4	3.3	31,350	12	10
5	3.3	32,354	11	13
6	3.0	28,998	2	1

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

TABLE 4-67. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MIDDLE COLUMBIA RIVER STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	16	15	15	100	94	94
2	16	15	15	100	94	94
3	16	15	15	100	94	94
4	16	15	15	100	94	94
5	16	14	14	100	88	88
6	16	14	14	100	88	88

Source: Appendix D. The abundance and productivity numbers in this table were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol “>” = “greater than.”

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 81 percent of primary and contributing steelhead populations would meet the stronger metric for genetic diversity, 6 percent would meet the intermediate metrics for genetic diversity, and 13 percent would meet the weaker than intermediate metrics for genetic diversity (Table 4-68). The number of primary and contributing populations meeting stronger metrics for genetic diversity would increase under the implementation scenarios for Alternative 2 through Alternative 6, and the number of populations meeting weaker than intermediate metrics for genetic diversity would decrease under the implementation scenarios for Alternative 2 through Alternative 5 and increase under Alternative 6. This suggests that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 and increased under Alternative 6 compared to the implementation scenario for Alternative 1. All primary and contributing populations in the Middle Columbia River Steelhead DPS would meet the stronger metric for genetic diversity under the implementation scenario for Alternative 4 (Table 4-68), suggesting that genetic risks would be lowest under this alternative's implementation scenario. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

TABLE 4-68. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MIDDLE COLUMBIA RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	13	2	1	81	13	6
2	15	1	0	94	6	0
3	15	1	0	94	6	0
4	15	1	0	94	6	0
5	16	0	0	100	0	0
6	14	0	2	88	0	13

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

No new weirs would be installed under the implementation scenarios for Alternative 1 through Alternative 4, but two new weirs would be installed under the implementation scenarios for Alternative 5 to meet PNI and pHOS goals (Table 4-69). As a result, the following weir effects may be greater under the implementation scenario for Alternative 5 compared to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due either to trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

TABLE 4-69. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE MIDDLE COLUMBIA RIVER STEELHEAD DPS.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)					
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5	6
Deschutes	Deschutes East-side Tributaries Summer Steelhead	0	0	0	0	85	0
Deschutes	Deschutes West-side Tributaries Summer Steelhead	0	0	0	0	85	0
Walla Walla	Walla Walla Summer Steelhead	95	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir under some of the alternatives.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-70 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-70. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE MIDDLE COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	1.3	37.5	3.4	0.0
2	1.0	10.6	0.0	0.0
3	1.2	33.2	3.1	0.0
4	1.2	33.2	3.1	0.0
5	1.1	32.6	3.0	0.0
6	1.2	37.7	3.3	0.0

Source: Appendix D

Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2, suggesting that competition and predation risks would be lowest for this alternative compared to the other alternatives.

4.2.3.2.11 Snake River Basin Steelhead DPS

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 5 and would remain constant under Alternative 6 when compared to Alternative 1. (Table 4-71). Abundance would also be higher under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 with the highest abundance under the implementation scenario for Alternative 2.

TABLE 4-71. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE SNAKE RIVER BASIN STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.4	21,031	N/A[1]	N/A
2	2.6	21,875	8	4
3	2.6	21,484	6	2
4	2.6	21,493	6	2
5	2.6	21,840	8	4
6	2.4	21,049	0	0

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 was higher under the implementation scenarios for Alternative 2 through Alternative 5 and the same under Alternative 6 when compared to Alternative 1 (Table 4-72). This suggests that spatial structure would be greatest under the implementation scenario for Alternative 2 and Alternative 5 compared to implementation scenarios for the other alternatives.

TABLE 4-72. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER BASIN STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	19	12	12	86	55	55
2	21	14	14	95	64	64
3	21	13	13	95	59	59
4	21	13	13	95	59	59
5	21	14	14	95	64	64
6	19	12	12	86	55	55

Source: Appendix D. The abundance and productivity numbers in this table were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol “>” = “greater than.”

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 77 percent of the primary and contributing populations would meet stronger metrics for genetic diversity, 0 percent would meet intermediate metrics for genetic diversity, and 23 percent would meet weaker than intermediate metrics for genetic diversity (Table 4-73). The highest number of primary and contributing populations would meet stronger metrics for genetic diversity under the implementation scenarios for Alternative 2 and Alternative 5 (Table 4-73), suggesting that genetic risks would be reduced under the implementation scenarios for these alternatives compared to the implementation scenarios for Alternative 1 or Alternative 6. Specific PNI and pHOS values for each population in this DPS across the alternatives’ implementation scenarios can be found in Appendix D.

TABLE 4-73. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER BASIN STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	17	0	5	77	0	23
2	20	1	1	91	5	5
3	19	2	1	86	9	5
4	19	2	1	86	9	5
5	20	1	1	91	5	5
6	14	3	5	64	14	23

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

No new weirs would be installed under the implementation scenarios for Alternative 1, Alternative 2, or Alternative 6, but one new weir would be installed in the Lemhi River under the implementation scenarios for Alternative 3 through Alternative 5 to meet PNI and pHOS goals (Table 4-74). Under the implementation scenarios for Alternative 3 and Alternative 4, these weirs would only have to capture 50 percent of the migrating fish; thus, seasonal weirs would likely be installed only during times when steelhead are actively migrating. Because the implementation scenario for Alternative 5 would have a lower target pHOS, a permanent weir would be installed in the Lemhi River. As a result, the following weir effects may be greater under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

TABLE 4-74. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE SNAKE RIVER BASIN STEELHEAD DPS.

		Alternative (percent [%] effectiveness)					
Location	Population	1 (No Action)[1]	2	3	4	5	6
Salmon	Lemhi Summer Steelhead (A-run)	0	0	50	50	95	0

[1] If effectiveness value is greater than 0 percent in Alternative 1, then a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-75 shows the ratio of hatchery-origin to natural-origin smolts by species.

TABLE 4-75. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SNAKE RIVER BASIN STEELHEAD DPS.

Alternative	Hatchery-origin Steelhead to Natural-origin Steelhead	Hatchery-origin Chinook Salmon to Natural-origin Steelhead	Hatchery-origin Coho Salmon to Natural-origin Steelhead	Hatchery-origin Chum Salmon to Natural-origin Steelhead
1 (No Action)	10.0	14.1	0.9	0.0
2	8.4	12.4	0.0	0.0
3	8.5	12.6	0.9	0.0
4	8.5	12.6	0.9	0.0
5	10.1	14.3	0.9	0.0
6	10.6	17.4	0.9	0.0

Source: Appendix D

Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 5 and increased slightly under Alternative 6 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives. This suggests that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

4.2.3.2.12 Southwest Washington Steelhead DPS

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1 (Table 4-76). Abundance would increase slightly to moderately under the implementation scenarios for Alternative 2 through Alterative 6 compared to Alternative 1 (Table 4-76).

TABLE 4-76. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE SOUTHWEST WASHINGTON STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	4.5	3,165	N/A[1]	N/A
2	5.3	3,425	17	8
3	4.6	3,176	1	0
4	4.9	3,263	7	3
5	4.6	3,186	2	1
6	4.6	3,176	2	0

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 was the same under implementation scenarios for Alternative 3, Alternative 5, and Alternative 6 compared to Alternative 1, suggesting that spatial structure would not vary among the alternatives' implementation scenarios (Table 4-77). Changing hatchery production would have relatively little effect on the spatial structure of this DPS because natural-origin productivity is high.

TABLE 4-77. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SOUTHWEST WASHINGTON STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	7	2	2	100	29	29
2	7	3	3	100	43	43
3	7	2	2	100	29	29
4	7	3	3	100	43	43
5	7	2	2	100	29	29
6	7	2	2	100	29	29

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol “>” = “greater than.”

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 86 percent of primary and contributing steelhead populations in the Southwest Washington Steelhead DPS would meet stronger metrics for genetic diversity, and 0 percent would meet intermediate metrics for genetic diversity (Table 4-78). The implementation scenarios for Alternative 2 and Alternative 4 would increase the percent of populations meeting the stronger metrics for genetic diversity to 100 percent (Table 4-78). There would be no differences in the number of populations meeting stronger and intermediate metrics for genetic diversity under the implementation scenarios for Alternative 3, Alternative 5, or Alternative 6 when compared to Alternative 1 (Table 4-78), Specific PNI and pHOS values for each population in this DPS can be found in Appendix D.

No weirs currently exist or would be installed to control the number of hatchery-origin fish returning to the spawning grounds in the Southwest Washington Steelhead DPS under implementation scenarios for any of the alternatives, so weir effects would not vary across the alternatives’ implementation scenarios.

TABLE 4-78. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SOUTHWEST WASHINGTON STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	6	0	1	86	0	14
2	7	0	0	100	0	0
3	6	1	0	86	14	0
4	7	0	0	100	0	0
5	6	1	0	86	14	0
6	6	0	1	86	0	14

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol “>” = “greater than.”

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU’s/DPS’ geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Relative to Alternative 1, only the implementation scenario for Alternative 2 would result in a substantial reduction in the proportion of hatchery-origin to natural-origin smolts, suggesting that there would be a reduction in competitive risk (Table 4-79). Under the implementation scenario for Alternative 3 through Alternative 6, the proportion of hatchery-origin to natural-origin smolts would generally be similar to or slightly lower than under Alternative 1.

The ratio of hatchery-origin Chinook salmon to natural-origin steelhead would be high for all the implementation scenarios but Alternative 2 (Table 4-79). These high ratios suggest that there would be high risk of competition for food or habitat as smolts migrate downstream. The size differences between hatchery-origin Chinook salmon and natural-origin steelhead would not be great enough for predation to occur (Section 3.2.3.1.6, Risks of Predation from Hatchery-origin Fish). The ratios between natural-origin steelhead and hatchery-origin coho salmon would decrease under implementation scenarios for Alternative 2 through Alternative 6 compared to

Alternative 1, although substantial reductions would only occur under implementation scenarios for Alternative 2, Alternative 3, and Alternative 5 (Table 4-79).

TABLE 4-79. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SOUTHWEST WASHINGTON STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	9.0	237.4	87.1	6.2
2	0.0	34.0	0.0	4.0
3	8.5	187.5	60.5	4.2
4	7.9	243.4	85.2	8.5
5	8.5	187.2	60.4	4.2
6	9.0	239.8	86.9	8.7

Source: Appendix D

4.2.3.2.13 Upper Columbia River Steelhead DPS

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1, while abundance would decrease only under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-80). The implementation scenario for Alternative 5 shows the greatest increases in mean adjusted productivity for this DPS as a result of reducing the hatchery program production compared to Alternative 1. By incorporating more natural-origin fish into the broodstock, however, abundance would be reduced under the implementation scenario for Alternative 5 compared to Alternative 1. While mean adjusted productivity would increase from 1.0 under Alternative 1 to 1.3 under Alternative 5, the mean adjusted productivity would remain low.

One population in the Upper Columbia River Steelhead DPS would have an adjusted productivity greater than 1.0 and NOS greater than 500 under the implementation scenario for Alternative 1, and the number would increase to two populations under the implementation scenarios for Alternative 2 through Alternative 6 (Table 4-81). This suggests that there would be an increase in spatial structure under the implementation scenarios for Alternative 2 through Alternative 6.

Table 4-80. Mean Percent Change in $PROD_{ADJ}$ and in Abundance of NOS per Population (Primary and Contributing Populations Only) by Alternative in the Upper Columbia River Steelhead DPS.

Alternative	Mean $PROD_{ADJ}$	Total NOS Abundance	Change in Mean $PROD_{ADJ}$ from Alternative 1 (%)	Change in Total NOS Abundance from Alternative 1 (%)
1 (No Action)	1.0	2,093	N/A[1]	N/A
2	1.2	2,325	16	11
3	1.2	2,325	16	11
4	1.2	2,325	16	11
5	1.3	2,039	30	-3
6	1.1	2,142	8	2

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

Table 4-81. Number and Percent of Primary and Contributing Populations Comprising the Upper Columbia River Steelhead DPS that Have a $PROD_{ADJ}$ Greater than 1.0, 500 or More NOS, or Both.

Alternative	Number of Populations with $PROD_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with Both NOS >500 and $PROD_{ADJ}$ > 1.0	Percent of Populations with $PROD_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with Both $PROD_{ADJ}$ > 1.0 and NOS > 500
1 (No Action)	2	2	1	40	40	20
2	3	2	2	60	40	40
3	3	2	2	60	40	40
4	3	2	2	60	40	40
5	3	2	2	60	40	40
6	3	2	2	60	40	40

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, all four of the populations in this DPS would fail to meet stronger metrics for genetic diversity and only one population would meet intermediate metrics for genetic diversity (Table 4-82). The implementation scenarios for Alternative 5 and Alternative 6 would result in two populations and one population meeting stronger metrics for genetic diversity, respectively, and one population meeting intermediate metrics for genetic diversity in each alternative. The implementation scenario for Alternative 5 would result in two populations meeting stronger metrics for genetic diversity, and Alternative 6 would result in one population meeting stronger metrics for genetic diversity, suggesting that genetic risks would be lowest under these two alternatives compared to the other alternatives. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

TABLE 4-82. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	0	1	4	0	20	80
2	0	3	2	0	60	40
3	0	3	2	0	60	40
4	0	3	2	0	60	40
5	2	1	2	40	20	40
6	1	1	3	20	20	60

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this DPS. Therefore, weir effects would not likely vary across the alternatives' implementation scenarios.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-83 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

TABLE 4-83. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	2.8	12.6	4.0	0.0
2	1.7	10.0	3.5	0.0
3	2.1	10.0	3.5	0.0
4	2.1	10.0	3.5	0.0
5	2.5	15.8	4.3	0.0
6	2.9	21.2	3.2	0.0

Source: Appendix D

Ratios of hatchery-origin fish to natural-origin fish would generally decrease under the implementation scenario for Alternative 2 through Alternative 4, but would increase under the implementation scenario for Alternative 5 through Alternative 6 compared to Alternative 1, except for a decrease in the ratio of hatchery-origin to natural-origin steelhead for Alternative 5 (Table 4-83). This suggests that overall competition and predation risks may decrease under the implementation scenarios for Alternatives 2 through 4 but likely would increase under the implementation scenarios for Alternative 5 through Alternative 6 compared to Alternative 1.

4.2.3.2.14 Upper Willamette River Steelhead DPS

Effects on Abundance and Productivity (VSP)

Mean adjusted productivity and abundance would increase under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-84). There would be no difference in the number of populations with NOS greater than 500 and a mean adjusted productivity greater than 1.0 across the alternatives' implementation scenarios (Table 4-85). All four primary and contributing populations would have an adjusted productivity greater than 1 and more than 500 natural-origin spawners (Table 4-85).

Table 4-84. Mean Percent Change in $PROD_{ADJ}$ and in Abundance of NOS per Population (Primary and Contributing Populations Only) by Alternative in the Upper Willamette River Steelhead DPS.

Alternative	Mean $PROD_{ADJ}$	Total NOS Abundance	Change in Mean $PROD_{ADJ}$ from Alternative 1 (%)	Change in Total NOS Abundance from Alternative 1 (%)
1 (No Action)	5.4	9,255	N/A[1]	N/A
2	6.1	10,465	15	13
3	6.1	10,465	15	13
4	6.1	10,465	15	13
5	6.1	10,465	15	13
6	6.1	10,460	14	13

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

Table 4-85. Number and Percent of Primary and Contributing Populations Comprising the Upper Willamette River Steelhead DPS that Would Have a $PROD_{ADJ}$ Greater than 1.0, 500 or More NOS, or Both.

Alternative	Number of Populations with $PROD_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with Both NOS > 500 and $PROD_{ADJ}$ > 1.0	Percent of Populations with $PROD_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with Both $PROD_{ADJ}$ > 1.0 and NOS > 500
1 (No Action)	4	4	4	100	100	100
2	4	4	4	100	100	100
3	4	4	4	100	100	100
4	4	4	4	100	100	100
5	4	4	4	100	100	100
6	4	4	4	100	100	100

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 75 percent of the primary and contributing populations in the Upper Willamette Steelhead DPS would meet stronger metrics for genetic diversity, and 25 would meet weaker than intermediate metrics for genetic diversity (Table 4-86). Under the implementation scenarios for Alternative 2 through Alternative 6, all of the populations would meet stronger metrics for genetic diversity. These results suggest that genetic risks would be reduced under implementation scenarios for all action alternatives relative to Alternative 1.

Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

TABLE 4-86. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	3	0	1	75	0	25
2	4	0	0	100	0	0
3	4	0	0	100	0	0
4	4	0	0	100	0	0
5	4	0	0	100	0	0
6	4	0	0	100	0	0

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this DPS. Therefore, weir effects would not likely vary across the alternatives' implementation scenarios.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-87 shows the ratio of hatchery-origin to natural-origin fish by species and the alternatives' implementation scenarios.

Ratios are reduced under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-87). This suggests that competition and predation risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1.

TABLE 4-87. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER WILLAMETTE RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	3.4	32.9	0.0	0.0
2	3.0	23.2	0.0	0.0
3	3.0	28.3	0.0	0.0
4	3.0	28.8	0.0	0.0
5	3.0	28.3	0.0	0.0
6	3.0	28.4	0.0	0.0

Source: Appendix D

All hatchery-origin steelhead released in this DPS would be summer-run steelhead. All natural-origin steelhead would be native winter-run steelhead.

4.2.3.2.15 Lower Columbia River Coho Salmon ESU

Effects Abundance and Productivity (VSP)

Mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-88). Abundance would increase under the implementation scenarios for Alternative 2 and Alternative 4, but would decrease under the implementation scenarios for Alternative 3, Alternative 5, and Alternative 6 compared to Alternative 1 (Table 4-88).

TABLE 4-88. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE LOWER COLUMBIA RIVER COHO SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.8	32,851	N/A[1]	N/A
2	2.7	36,075	45	10
3	2.2	32,531	18	-1
4	2.2	33,330	19	1
5	2.2	32,360	17	-1
6	2.0	31,701	10	-3

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The percent of populations with productivity greater than 1.0 and NOS greater than 500 would increase under the implementation scenarios for Alternative 2 through Alternative 6 compared to Alternative 1 (Table 4-89). This suggests that spatial structure may increase under the implementation scenarios for Alternative 2 through Alternative 6 when compared to Alternative 1.

TABLE 4-89. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER COHO SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	16	12	11	73	55	50
2	22	13	13	100	59	59
3	18	12	12	82	55	55
4	18	13	13	82	59	59
5	18	12	12	82	55	55
6	17	11	11	77	50	50

Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol “>” = “greater than.”

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 27 percent of the populations would meet stronger metrics for genetic diversity, 18 percent would meet intermediate metrics for genetic diversity, and 55 percent would fail to meet intermediate metrics for genetic diversity (Table 4-90). The percent of populations meeting stronger and intermediate metrics for genetic diversity would increase under the implementation scenarios for Alternative 2 through Alternative 6, with all populations meeting stronger or intermediate metrics for genetic diversity under Alternative 2 (Table 4-90). These results suggest that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 6 relative to Alternative 1, with the fewest genetic risks occurring under the implementation scenario for Alternative 2.

TABLE 4-90. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER COHO SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	6	4	12	27	18	55
2	19	3	0	86	14	0
3	11	6	5	50	27	23
4	13	4	5	59	18	23
5	11	6	5	50	27	23
6	9	3	10	41	14	45

[1] Source: Appendix D. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

No new weirs would be used under the implementation scenario for Alternative 2 or Alternative 6 compared to Alternative 1 (Table 4-91). However, two weirs would continue to be used to control the number of hatchery-origin spawners in the Clackamas and Cowlitz River coho salmon populations (Table 4-91). Under the implementation scenarios for Alternative 3 through Alternative 5, two new weirs would be installed compared to Alternative 1, and the effectiveness of the new Grays River weir would increase from 50 to 90 percent under the implementation scenario for Alternative 4 (Table 4-91). As a result, the following weir effects would be greater under the implementation scenarios for Alternative 3 through Alternative 5, with the greatest weir effects occurring under the implementation scenario for Alternative 4: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1.2, Effects on Genetic Diversity).

TABLE 4-91. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE LOWER COLUMBIA RIVER COHO SALMON ESU.

		Alternative (percent [%] effectiveness)					
Location	Population	1 (No Action)[1]	2	3	4	5	6
Elochoman	Elochoman Coho Salmon (Late-Type N)	0	0	25	50	25	0
Grays	Grays Coho Salmon (Late-Type N)	0	0	50	90	50	0
Willamette	Upper Clackamas Coho Salmon	95	95	95	95	95	95
Cowlitz	Upper Cowlitz Coho Salmon	95	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed for the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-92 shows the ratio of hatchery-origin to natural-origin fish by species and the alternatives' implementation scenarios.

Ratios are generally reduced under the implementation scenarios for Alternative 2 through Alternative 6 (Table 4-92), suggesting that competition and predation risks would be reduced under the implementation scenario for Alternative 2 through Alternative 6 compared to Alternative 1. However, there is one exception: the ratio of hatchery-origin chum salmon to natural-origin coho salmon would increase under the implementation scenario for Alternative 4 and Alternative 6 when compared to Alternative 1 (Table 4-92). Hatchery-origin chum salmon would be released as fry, and there may be competition for food and habitat between hatchery-origin chum salmon and natural-origin juvenile coho salmon. The competition risks are expected to be minor, however, because of different habitat use by the two species and because interactions would be brief. Hatchery-origin chum salmon juveniles would be too small to prey on natural-origin coho salmon juveniles, so there would be no difference in the predation risk of hatchery-origin chum salmon on natural-origin coho salmon across the alternatives' implementation scenarios.

TABLE 4-92. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE LOWER COLUMBIA RIVER COHO SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN COHO SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN COHO SALMON	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN COHO SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN COHO SALMON
1 (No Action)	18.1	4.0	62.5	0.3
2	5.3	2.2	6.5	0.2
3	13.9	4.0	52.6	0.2
4	14.2	3.7	55.3	0.8
5	14.5	4.0	52.8	0.2
6	17.5	4.4	60.6	0.5

Source: Appendix D

4.2.3.2.16 Columbia River Chum Salmon ESU

Effects Abundance and Productivity (VSP)

Mean adjusted productivity would not change under the implementation scenario for any of the alternatives (Table 4-93). Abundance would be similar under the implementation scenario for all alternatives (Table 4-93).

TABLE 4-93. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE COLUMBIA RIVER CHUM SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.9	19,304	N/A[1]	N/A
2	1.9	19,062	1	-1
3	1.9	19,062	1	-1
4	1.9	20,056	0	4
5	1.9	19,062	1	-1
6	1.9	19,313	0	0

Source: Appendix E. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

The percent of populations that would have a productivity greater than 1.0 and NOS greater than 500 would be the same under the implementation scenarios for all alternatives (Table 4-94), The percent of populations that would have a productivity greater than 1.0 and NOS greater than 500 would be the same for all alternatives (Table 4-94), suggesting that spatial structure would not change under the implementation scenario for any of the alternatives (Table 4-94).

TABLE 4-94. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE COLUMBIA RIVER CHUM SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	13	7	7	93	50	50
2	13	7	7	93	50	50
3	13	7	7	93	50	50
4	13	7	7	93	50	50
5	13	7	7	93	50	50
6	13	7	7	93	50	50

Source: Appendix E. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.
The symbol ">" = "greater than."

Effects on Genetic Diversity (VSP)

Under the implementation scenario for Alternative 1, 96 percent of the populations would meet stronger metrics for genetic diversity, 0 percent would meet intermediate metrics for genetic diversity, and 14 percent would fail to meet intermediate performance metrics for genetic diversity (Table 4-95). The percent of populations meeting stronger and intermediate metrics for genetic diversity would increase under the implementation scenarios for Alternative 2, Alternative 3, and Alternative 5 (Table 4-95), suggesting that genetic risks would be reduced under the implementation scenarios for these alternatives compared to Alternative 1. PNI and pHOS values for each Columbia River chum salmon population can be found in Appendix E.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this ESU, so weir effects would not likely vary across the alternatives' implementation scenarios.

TABLE 4-95. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE COLUMBIA RIVER CHUM SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS FOR GENETIC DIVERSITY, BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	12	0	2	86	0	14
2	12	1	1	86	7	7
3	12	1	1	86	7	7
4	12	0	2	86	0	14
5	12	1	1	86	7	7
6	12	0	2	86	0	14

[1] Source: Appendix E. Data were generated with the All-H Analyzer model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife and Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and these terms are applied in this final EIS.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-96 shows the ratio of hatchery-origin to natural-origin fish by species and the alternatives' implementation scenarios.

TABLE 4-96. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHUM SALMON JUVENILE PRODUCTION, BY ALTERNATIVE, IN THE COLUMBIA RIVER CHUM SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHUM SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHUM SALMON	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHUM SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHUM SALMON
1 (No Action)	0.1	0.7	10.8	3.1
2	0.0	0.4	1.1	0.9
3	0.0	0.6	8.4	2.2
4	0.1	0.6	8.5	2.2
5	0.0	0.6	8.4	2.3
6	0.1	0.7	9.4	2.7

Source: Appendix E

Ratios are generally reduced under the implementation scenarios for Alternative 2 through Alternative 6. However, the ratio of hatchery-origin to natural-origin chum salmon juveniles would remain consistent under the implementation scenario for Alternative 4 and Alternative 6 compared to Alternative 1 (Table 4-96), suggesting that competition and predation risks would generally be reduced under the implementation scenario for Alternative 2 through Alternative 6 compared to Alternative 1.

4.2.3.2.17 Snake River Sockeye Salmon ESU

Effects on Abundance and Productivity (VSP)

There would be minimal differences in the abundance and productivity of natural-origin spawners among implementation scenarios for the alternatives (Table 4-97). Although abundance of natural-origin spawners would increase under the implementation scenarios for Alternative 3 through Alternative 6 compared to Alternative 1, the natural-origin population abundance would remain at critically low levels. Although not shown here, the number of hatchery-origin adults in the population would increase from approximately 2,200 adults under Alternative 1 to over 7,500 adults under the implementation scenarios for Alternative 5 and Alternative 6 (Appendix F). The increase in hatchery-origin adults would be due to increased releases of hatchery-origin fish under the implementation scenarios for Alternative 3 through Alternative 6 when compared to Alternative 1.

TABLE 4-97. PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS BY ALTERNATIVE IN THE SNAKE RIVER SOCKEYE SALMON ESU.

ALTERNATIVE	$PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	0.13	165	N/A[1]	N/A
2	0.26	0	99	-100
3	0.13	124	0	-25
4	0.13	124	0	-25
5	0.13	402	0	144
6	0.13	402	0	144

Source: Appendix F. Data were generated with the All-H Analyzer model using best available data.
[1] N/A = Not applicable.

Effects on Genetic Diversity (VSP)

The Snake River Sockeye Salmon ESU consists of one population (Section 3.2.3.2.17, Snake River Sockeye Salmon ESU). This population would fail to meet intermediate metrics for genetic diversity under the implementation scenarios for all alternatives except for Alternative 2 (Appendix F). Under Alternative 2, the Redfish Lake sockeye salmon hatchery program would be eliminated because it receives Mitchell Act funding. Without the Redfish Lake hatchery program, the Snake River sockeye salmon population would meet PNI and pHOS metrics, but the ESU would likely go extinct since the number of spawners would be critically low (Appendix F). As a result, genetic risks would be greatest under Alternative 2 compared to the other alternatives.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this ESU, so weir effects would not vary across the alternatives' implementation scenarios.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Modeling was not applied to the Snake River Sockeye Salmon ESU since there are too few fish to produce meaningful results. However, because production levels would be reduced under the implementation scenario for Alternative 2 relative to Alternative 3 and Alternative 4 (which would remain at Alternative 1 levels) and Alternative 5 and Alternative 6 (which would increase production levels, compared to Alterative 1), competition and predation risks on the Snake River Sockeye Salmon ESU would likely be reduced under the implementation scenario for Alternative 2.

4.2.4 Effects on Other Fish Species that Have a Relationship to Salmon and Steelhead

Described below are other fish species that have a relationship with salmon and steelhead as discussed in Section 3.2.4, Other Fish Species that Have a Relationship with Salmon and/or Steelhead. For this section, species are combined for the analysis when they have a similar relationship with salmon and steelhead, and the effects from the alternatives would likely be the same. Qualitative analyses were conducted for the other fish species using best available science for each analysis, including those factors and threats known to limit their abundance.

4.2.4.1 Oregon Chub, Lake Chub, and Pygmy Whitefish Effects under All Alternatives

Oregon chub, lake chub, and pygmy whitefish can be prey species of salmon and steelhead (Section 3.2.4.1, Oregon Chub, Interaction with Salmon and Steelhead; Section 3.2.4.6, Lake Chub, Interaction with Salmon and Steelhead; and Section 3.2.4.12, Pygmy Whitefish, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interactions of Oregon chub, lake chub, and pygmy whitefish with salmon and steelhead under each of the alternatives. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead would also change.

Implementation measures designed to improve hatcheries may also benefit Oregon chub and pygmy whitefish by minimizing entrainment of juvenile fish at hatchery water intake screens and by improving water quality conditions in streams where hatcheries are located and these fish may reside. Critical habitat for Oregon chub is located in Polk, Benton, Linn, Marion, and Lane Counties (Section 3.2.4.1, Oregon Chub, Current Status and Trends). Some hatcheries are also located in these counties; thus, these implementation measures would help improve critical habitat conditions for Oregon chub. Lake chub do not occur near hatchery facilities.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-98). Thus, predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead would not likely change compared to baseline conditions, and hatchery improvements regarding updating hatchery water intake screens and correcting water quality conditions would not occur.

TABLE 4-98. PERCENT DECREASE IN SALMON AND STEELHEAD ABUNDANCE RELATIVE TO ALTERNATIVE 1 BY ACTION ALTERNATIVE.

	ALTERNATIVE (PERCENT [%] DECREASE RELATIVE TO ALTERNATIVE 1)				
AGE CLASS	2	3	4	5	6
Total Hatchery-origin and Natural-origin Smolts (All Species/ESUs)	49	13	10	10	-0.4
Total Hatchery-origin and Natural-origin Adult Recruits (All Species/ESUs)	26	5	3	1	-6

Note. Negative percentages represent increases in value, relative to Alternative 1.

The implementation scenarios for Alternative 2 through Alternative 5 would likely result in less predation on Oregon chub, lake chub, and pygmy white fish due to reductions in salmon and steelhead adult recruits when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 26 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits (Table 4-98) may result in a benefit to Oregon chub, lake chub, and pygmy whitefish by reducing predation on these species. Updating hatchery water intake screens and correcting water quality issues would also benefit Oregon chub and pygmy whitefish. The implementation scenario under Alternative 6 would have similar effects as Alternative 1 because the number of salmon and steelhead recruits released would be similar (Table 4-98).

The implementation scenarios for Alternative 3 through Alternative 6 would range from a 6 percent increase in salmon and steelhead adult recruits (Alternative 6) to an up to 5 percent decrease (Alternative 3 through Alternative 5) (Table 4-98). These changes may result in a benefit to Oregon chub, lake chub, and pygmy whitefish from salmon and steelhead, but the implementation scenarios under Alternative 3 through Alternative 5 would not result in as substantial a decrease as under the implementation scenario for Alternative 2 compared to Alternative 1. The benefits of updating hatchery water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 6 when compared to Alternative 1.

Although reduced predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead would likely occur under implementation scenarios for all alternatives compared to Alternative 1, predation on Oregon chub, lake chub, and pygmy whitefish by natural-origin salmon and steelhead has not been identified as a reason for Oregon chub, lake chub, and pygmy whitefish declines (Section 3.2.4.1, Oregon Chub, Limiting Factors and Threats; Section 3.2.4.6, Lake Chub, Limiting Factors and Threats; and Section 3.2.4.12, Pygmy Whitefish, Limiting Factors and Threats). Similarly, entrainment of Oregon chub, lake chub, and pygmy white fish at hatchery water intake screens and water quality conditions at operating hatcheries have not been identified as threats to these species.

Reasons for Oregon chub declines are habitat alteration and lack of available habitat from flood controls and dams; water quality degradation from runoff containing herbicides and pesticides, use of rotenone to manage recreational fisheries, and accidental chemical spills; unauthorized water withdrawals; sedimentation; and introduction of non-native fish and amphibians (Section 3.2.4.1, Oregon Chub, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. However, although none of the alternatives would have any effect on the threats to Oregon chub described here, as stated in 74 Fed. Reg. 22870 (May 15, 2009), the status of the Oregon chub has greatly improved (currently proposed for delisting [79 Fed. Reg. 7136, February 6, 2014]) since it was listed in 1993 due to implementation of its recovery plan and reestablishing and protecting Oregon chub populations (U.S. Fish and Wildlife Service [USFWS] 1998a). Action alternatives that improve predator-prey relationships among salmon and steelhead and Oregon chub enhance habitat conditions in areas designated as Oregon chub critical habitat and minimize entrainment at hatchery water intake screens.

Reasons for lake chub declines are habitat alteration, declining water quality and quantity, and the introduction of non-native species (Section 3.2.4.6, Lake Chub, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and hatchery improvement activities would have no relationship to these threat sources. It is likely that these threats would continue to affect lake chub populations negatively regardless of implementation of any alternative. Predation of lake chub by salmon and steelhead has not been cited as a threat to this species.

Reasons for pygmy whitefish declines include changing water temperature and oxygen conditions, water quality degradation, siltation, non-native fish introductions, use of pesticides, and increased development activities, including over-water and in-water structures (Section 3.2.4.12, Pygmy Whitefish, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. It is likely that these threats would continue to affect pygmy whitefish populations negatively regardless of implementation of any alternative. Predation of pygmy whitefish by salmon and steelhead has not been cited as a threat to this species.

4.2.4.2 Bull Trout Effects under All Alternatives

The primary interaction between bull trout and salmon and steelhead is that bull trout, as subadults and adults, prey on salmon and steelhead. In addition, juvenile bull trout can compete with salmon and steelhead for food resources and potentially for space and habitat, since bull trout use similar aquatic habitats as salmon and steelhead (Section 3.2.4.2, Bull Trout, Interaction with Salmon and Steelhead). Although bull trout can interbreed with brook trout, the species does not hybridize with other salmon and steelhead species. Thus, predation and interspecific competition (for prey and habitat) are the primary effects for analysis of interactions between bull trout and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation and competition would also change.

Implementation measures designed to improve hatcheries may also affect bull trout by improving water quality conditions in streams where hatcheries are located and where bull trout may pass during migration or spawn close by. However, new seasonal or permanent weirs planned under some of the action alternatives have the potential of isolating bull trout populations, limiting or delaying movement of migrating bull trout, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation of bull trout when caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize fish handling, and remove weirs when they are not needed to trap hatchery-origin fish to avoid unintentional trapping of other fish.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production and adult recruits produced compared to baseline conditions (Table 4-98). Thus, bull trout predation on salmon and steelhead and competition for prey and habitat would not likely change compared to baseline conditions. In addition, water quality conditions at hatcheries would not improve, and bull trout would not be affected by the placement of new weirs.

The implementation scenarios for all the action alternatives would likely result in a reduction in prey resources of bull trout and competition for prey resources and aquatic habitat. Under Alternative 2, the 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-98) would negatively impact an important prey resource of bull trout. However, other food sources would remain available (e.g., insects [primarily to juveniles], other fish species, frogs, snake, mice, and waterfowl), since hatchery production and activities would not affect these resources. Competition for available prey and habitat would be substantially reduced under Alternative 2 compared to Alternative 1 since fewer juvenile salmon and steelhead would compete with juvenile bull trout for prey, and there would be fewer salmon and steelhead smolts and adult recruits (49 percent and 26 percent, respectively; Table 4-98) that would compete with bull trout for habitat space. Correcting water quality issues at hatcheries would also benefit bull trout under the implementation scenario for Alternative 2 when compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 6 would also either not affect salmon and steelhead smolt production (Alternative 6), or would result in a decrease of salmon and steelhead smolt production by 10 to 13 percent (Alternative 3 through Alternative 5) compared to Alternative 1 (Table 4-98). These reductions under Alternative 3 through Alternative 5 would decrease salmon and steelhead adult recruitment by 5, 3, and 1 percent, respectively. These reductions would result in a lower impact on bull trout as described under the implementation scenario for Alternative 2. These reductions in expected risks (i.e., decreased prey base) or increases in benefits (i.e., decreases in competition for habitat and food resources) would not be as substantial under the implementation scenarios for these action alternatives as under Alternative 2. The implementation scenario under Alternative 6 would increase salmon and steelhead adult recruitment by 6 percent, which may potentially increase competition between adult bull trout and adult salmon and steelhead when compared to Alternative 1.

The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 6 when compared to Alternative 1. In contrast, new seasonal weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) have the potential of adversely impacting bull trout through habitat alteration and fragmentation, fish handling, and slowing bull trout migratory movements when compared to Alternative 1.

Bull trout are listed as threatened. Recently, additional critical habitat protecting bull trout was proposed, and it includes areas within the Columbia River Basin (Section 3.2.4.2, Bull Trout, Current Status and Trends). All the action alternatives would result in adverse effects on bull trout through reduced prey resources for subadults and adults and the potential creation of migratory barriers from new weirs; the action alternatives could also benefit bull trout through reduced competition for habitat and juvenile prey resources and improved habitat conditions.

The decrease in juvenile salmon and steelhead populations that serve as prey for bull trout has been cited as a limiting factor that affects the distribution and abundance of bull trout, while competition for prey and habitat with salmon and steelhead has not been cited as a threat to bull trout (Section 3.2.4.2, Bull Trout, Limiting Factors and Threats). In addition, instream water uses that block or restrict access to critical habitat (such as weirs) have also been cited as a threat to bull trout. Habitat degradation, introduction of non-native fish species, and restricted access to bull trout critical habitat from other sources (such as culverts, irrigation diversions, and streambed alterations) would continue under all alternatives, because these limiting factors and threats to bull trout would not be affected by hatchery production levels. In addition to these ongoing limiting factors, Alternative 2 through Alternative 5 would result in a decrease of the potential prey resource for bull trout, and Alternative 3 through Alternative 5 would result in potential adverse effects from new weirs when compared to Alternative 1. Combined, these adverse effects could continue to limit improvements in the 22 bull trout recovery units in the short term; however, improvements in habitat conditions are anticipated in the long term as a result of recovery efforts.

4.2.4.3 Eulachon Effects under All Alternatives

Newly hatched and juvenile eulachon are prey of salmon and steelhead (Section 3.2.4.3, Eulachon, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interactions between eulachon and salmon and steelhead under the implementation scenarios for each of the alternatives. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation on eulachon from these species would also change.

Implementation measures designed to improve hatcheries could benefit eulachon by minimizing entrainment of juvenile fish at hatchery water intake screens and correcting water quality conditions in streams where hatcheries occur and eulachon pass through during migration or may spawn nearby. However, their current known distribution is not near hatcheries. Therefore, entrainment and water quality benefits may be a negligible benefit for eulachon. Under the implementation scenario for Alternative 1, there would be no change in the number of hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-98). Thus, salmon and steelhead predation on eulachon would not likely change compared to baseline conditions, and hatchery improvements such as updating hatchery water intake screens and improving water quality conditions would not occur.

The implementation scenarios for all action alternatives would likely result in a decrease in eulachon predation based on reductions in salmon and steelhead adult recruits. However, these reductions in predation and the subsequent benefit to eulachon populations may be minimized by predation from other species (e.g., a wide variety of fish, marine mammals, ducks, and seabirds) that would continue under the implementation scenario for any alternative (Section 3.2.4.3, Eulachon, Background). Under the implementation scenario for Alternative 2, the 26 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits (Table 4-98) may benefit eulachon by substantially reducing predation pressure on the population from salmon and steelhead compared to Alternative 1. Updating hatchery water intake screens and correcting water quality issues would also benefit eulachon under the implementation scenario for Alternative 2 when compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 5, 3, and 1 percent, respectively (Table 4-98), which would also likely result in less predation on eulachon, but not as much of a decrease as under the implementation scenario for Alternative 2 when compared to Alternative 1. A 6 percent increase in adult salmon and steelhead recruits under the implementation scenario for Alternative 6 (Table 4-98) may result in a slight increase in salmon and steelhead predation on eulachon.

Although reduced predation on eulachon would occur under the implementation scenarios of Alternative 2 through Alternative 5 compared to Alternative 1, predation of eulachon by salmon and steelhead has not been cited as a reason for eulachon declines (Section 3.2.4.3, Eulachon, Limiting Factors and Threats). Similarly, entrainment of eulachon at hatchery water intake screens and water quality conditions at operating hatcheries have not been identified as threats to this species. Consequently, none of the alternatives, including Alternative 1, would likely change the eulachon southern DPS status as threatened (75 Fed. Reg. 13012, March 18, 2010).

The reason for recent declines in eulachon stocks within the southern DPS includes loss and modification of its habitat (particularly climate change leading to warmer water and less productive ocean regimes), commercial harvest of eulachon, bycatch of eulachon in commercial fisheries, and the potential for natural or manmade events to impact its habitat (75 Fed. Reg. 13012, March 18, 2010). Reduced salmon and steelhead adult recruits as a result of all action alternatives may help with this DPS' recovery because of reduced predation on eulachon, however, other species are known to prey on eulachon. Furthermore, other threats to the population would likely remain, such as changing ocean conditions, bycatch, and habitat degradation (Section 3.2.4.3, Eulachon, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources, except the potential for decreased salmon and steelhead harvest resulting in a lower eulachon bycatch.

It is likely that habitat conditions resulting from climate change in conjunction with other, ongoing threats described above, would continue to affect eulachon populations negatively and would be contrary to recovery efforts. Continued declines in eulachon populations would also negatively affect recreation and commercial fishing for this species, including tribal eulachon fisheries (Section 3.2.4.3, Eulachon, Background).

4.2.4.4 Green Sturgeon Effects under All Alternatives

The primary interaction between green sturgeon and salmon and steelhead is green sturgeon bycatch in salmon and steelhead fisheries (Section 3.2.4.4, Green Sturgeon, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interactions between green sturgeon and salmon and steelhead under each of the alternatives. As hatchery production and the number of salmon and steelhead adult recruits decrease under the action alternatives, harvest would likely decrease, as well as bycatch of green sturgeon.

Under the implementation scenario for Alternative 1, there would be no change in the number of hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-98). Therefore, bycatch of green sturgeon would not likely change compared to baseline conditions.

The implementation scenarios for Alternative 2 through Alternative 5 would likely result in a reduction in green sturgeon bycatch due to reductions in salmon and steelhead adult recruits when compared to Alternative 1. The implementation scenario under Alternative 2 would likely result in the greatest benefit to green sturgeon. The 26 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits (Table 4-98) would likely result in a decrease in salmon and steelhead harvest and, therefore, a decrease in bycatch of green sturgeon assuming that a harvest would decrease concurrent with the reduced hatchery production. Otherwise, if harvest does not decrease, bycatch may remain the same or increase if fishing pressure increases with decreased salmon and steelhead availability. Under the implementation scenario for Alternative 6, bycatch of green sturgeon has the potential to increase due to the 6 percent increase in salmon and steelhead adult recruits (Table 4-98).

The implementation scenarios under Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 5, 3, and 1 percent, respectively, compared to Alternative 1 (Table 4-98). Corresponding reductions in salmon and steelhead harvest would likely result in bycatch reductions of green sturgeon (assuming fishing pressure would also decrease), but not as much of a bycatch decline as the implementation scenario under Alternative 2. However, as cited by NMFS (71 Fed. Reg. 17757, April 7, 2006), the principal factor in the decline of the green sturgeon southern DPS is its limited spawning area in the Sacramento River. Consequently, none of the adult recruit decreases and subsequent expected bycatch decreases under some alternatives would likely help to recover the green sturgeon southern DPS. Additionally, existing production levels under the implementation scenario for Alternative 1 in the Columbia River Basin would not likely lead to recovery of the green sturgeon southern DPS because of the spawning habitat limitations in the Sacramento River.

In addition to spawning habitat limitations and bycatch, green sturgeon populations are threatened by other sources, including insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), potential poaching (e.g., for caviar), entrainment by water projects, influence of exotic species, small population size, impassable barriers, and elevated water temperatures (Section 3.2.4.4, Green Sturgeon, Limiting Factors and Threats). All of these threats would likely continue under any of the implementation scenarios for the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to, or effect on, these threat sources.

4.2.4.5 Coastal Cutthroat Trout Effects under All Alternatives

Coastal cutthroat trout primarily compete with salmon and steelhead in protected estuaries that support prime food and habitat resources (NMFS 1999) (Section 3.2.4.5, Coastal Cutthroat Trout, Interaction with Salmon and Steelhead). Post-spawning coastal cutthroat trout also feed on smaller salmon and steelhead in freshwater and estuarine habitats. Finally, coastal cutthroat trout hybridize with steelhead. Competition, predation, and hybridization are the primary reasons for analyzing interactions between coastal cutthroat trout and salmon and steelhead under each of the alternatives. A decrease in hatchery-origin and natural-origin salmon and steelhead smolt production would benefit coastal cutthroat trout by reducing interspecific competition for food and habitat resources in estuaries, as well as opportunities for hybridization. However, such decreases may also negatively affect coastal cutthroat trout by limiting juvenile salmon and steelhead as a prey source.

Implementation measures designed to improve hatcheries may also affect coastal cutthroat trout by correcting water quality conditions in streams where hatcheries are located, where coastal cutthroat trout may pass through during migration, or where coastal cutthroat trout spawn nearby. However, new seasonal or permanent weirs planned under some of the action alternatives may isolate coastal cutthroat trout populations, limiting or slowing migration movement, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when coastal cutthroat trout are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize fish handling, and remove weirs when they are not needed to trap hatchery-origin fish to avoid unintentional trapping of other fish.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-98). Therefore, competition, predation, and hybridization between coastal cutthroat trout and salmon and steelhead would not likely change compared to baseline conditions, and available juvenile salmon and steelhead prey would remain consistent with current availability. In addition, water quality conditions at hatcheries would not improve, and coastal cutthroat trout would not be affected by placement of new weirs.

The implementation scenarios for Alternative 2 through Alternative 5 would likely reduce interspecific competition, predation, and hybridization among coastal cutthroat trout and salmon and steelhead. Under the implementation scenario for Alternative 2, the 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-98) may result in a greater benefit to coastal cutthroat trout by reducing interspecific competition for food and habitat, predation, and hybridization when compared to Alternative 1. However, this substantial decrease in salmon and steelhead smolt production would also decrease the available juvenile prey base of salmon and steelhead for coastal cutthroat trout. This prey base decrease may be mitigated by the availability of other species upon which cutthroat prey, such as other fish and aquatic and terrestrial insects (Section 3.2.4.5, Coastal Cutthroat Trout, Background). Correcting water quality issues at hatcheries would also benefit coastal cutthroat trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 13, 10, and 10 percent, respectively, compared to Alternative 1 (Table 4-98). While this decrease in smolt production would also benefit coastal cutthroat trout by reducing interspecific competition for food and habitat resources, predation, and hybridization, it would not be as substantial a benefit as the implementation scenario for Alternative 2. Conversely, the negative effect of a reduced prey base under these alternatives would not be as substantial as the reduced prey base under the implementation scenario for Alternative 2, particularly when combined with the continued availability of other species upon which coastal cutthroat prey (e.g., other fish and insects). The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 though Alternative 6 when compared to Alternative 1. The new seasonal weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and 5) have the potential of adversely impacting coastal cutthroat trout through habitat alteration and fragmentation, fish handling, and slowing coastal cutthroat trout migratory movements when compared to Alternative 1. The implementation scenario under Alternative 6 would likely result in comparable effects on coastal cutthroat trout as the implementation scenario under Alternative 1 since the number of smolts produced would be similar, and no new weirs would be constructed under either alternative.

Genetic effects from interactions between coastal cutthroat trout, steelhead, and rainbow trout (Section 3.2.4.5, Coastal Cutthroat Trout, Limiting Factors and Threats) would likely continue under the implementation scenarios for any alternative. Other threats to coastal cutthroat trout from marine mammal predation and unfavorable ocean conditions would also continue under the implementation scenarios for all of the alternatives since hatchery production and activities would have no relationship to these threat sources (Section 3.2.4.5, Coastal Cutthroat Trout, Limiting Factors and Threats).

Reduced competition with salmon and steelhead under the implementation scenarios for Alternative 2 through Alternative 5, compared to Alternative 1, would be an overall benefit to nonmigratory, fluvial, adfluvial, and anadromous coastal cutthroat trout because of the availability of more food resources in estuary areas. However, while this benefit may occur, other limitations on the coastal cutthroat trout's prey base and degradation of its habitat would likely continue under all alternatives. Threats would include habitat effects from forest management practices, agriculture and livestock management, dams and barriers, urban and industrial development, mining, and estuary degradation (Oregon Department of Fish and Wildlife [ODFW] 2005a) (Section 3.2.4.5, Coastal Cutthroat Trout, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources.

4.2.4.6 Lamprey Effects under All Alternatives

While the primary interaction between lamprey and salmon and steelhead in the analysis area is predation on salmon and steelhead by Pacific and river lamprey, this interaction may be mitigated by the presence of marine mammals feeding on lamprey (Section 3.2.4.7, Lamprey, Interaction with Salmon and Steelhead). Along with salmon and steelhead, all lamprey species are prey of seals and sea lions; however, lamprey are considered preferred prey over salmon and steelhead because of their higher caloric value. The primary reason for analyzing interactions between lamprey and salmon and steelhead is Pacific and river lamprey predation on salmon and steelhead. Brook lamprey do not feed as adults (Section 3.2.4.7, Lamprey, Background). As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of available salmon and steelhead for lamprey would also change.

Implementation measures designed to improve hatcheries may also affect lamprey by improving water quality conditions in streams where hatcheries are located, where lamprey may pass through during migration, or where lamprey spawn nearby. However, new seasonal or permanent weirs planned under some of the action alternatives may isolate lamprey populations, limiting or slowing migration movement, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when lamprey trout are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize fish handling, and remove weirs when they are not needed to trap hatchery-origin fish to avoid unintentional trapping of other fish.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-98). Therefore, predation on salmon and steelhead by Pacific and river lamprey would not likely change compared to baseline conditions, and available juvenile salmon and steelhead prey would remain consistent with current numbers. In addition, water quality conditions at hatcheries would not improve, and bull trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely result in a reduction of salmon and steelhead available as a food source for lamprey. Under the implementation scenario for Alternative 2, the 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production and the 26 percent decrease in adult recruits (Table 4-98) would result in a reduction of Pacific and river lamprey prey resources when compared to Alternative 1. This prey base decrease may be mitigated by the availability of other species upon which lamprey prey, such as other fish and whales. In addition, hatchery improvements that would help passage of lamprey through fish entrainment structures may occur under Alternative 2 when BMPs are implemented. Correcting water quality issues at hatcheries would also benefit lamprey under the implementation scenario for Alternative 2 when compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 13, 10, and 10 percent, respectively, compared to Alternative 1, and would decrease salmon and steelhead adult recruits by 5, 3, and 1 percent, respectively (Table 4-98). While this decrease in smolt production and adult recruits would also decrease food resources for Pacific and river lamprey, it would not be as substantial a decrease as the implementation scenario for Alternative 2. Conversely, the negative effect of a reduced prey base under these alternatives would not be as substantial as the reduced prey base under the implementation scenario for Alternative 2, particularly when combined with the continued availability of other species upon which lamprey prey (e.g., other fish and marine mammals). In addition, salmon and steelhead hatchery improvement BMPs may benefit lamprey through the development of fish entrainment structures that do not prevent the movement of lamprey into streams.

The implementation scenario for Alternative 6 would result in a 0.4 percent and a 6 percent increase in total juvenile and adult recruit production, respectively (Table 4-98). These increases, although small, may result in an increase of salmon and steelhead as food resources for lamprey.

The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 6 when compared to Alternative 1. In contrast, the new seasonal weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) may adversely impact lamprey through habitat alteration and fragmentation, fish handling, and slowing lamprey migratory movements when compared to Alternative 1.

Pacific lamprey, western brook lamprey, and river lamprey are experiencing reduced access to spawning habitat, degradation of spawning and rearing areas, loss of emigrating juveniles to turbine entrainment and fish passage structures, poor recruitment, and the presence of nonindigenous predators (Section 3.2.4.7, Lamprey, Limiting Factors and Threats). These limiting factors and threats on lamprey populations would occur under the implementation scenarios for all of the action alternatives. They would continue to occur under Alternative 1, because hatchery production and hatchery activities would have no interaction with lamprey habitat, turbine entrainment, or recruitment, other than decreasing food resources (salmon and steelhead) for Pacific lamprey and river lamprey. Considering lamprey benefits and disadvantages that may occur under the alternatives, it is not expected that any of the alternatives, including the implementation scenario under Alternative 1, would help with the recovery of brook lamprey. The alternatives may result in an impact on Pacific lamprey and river lamprey due to the decrease of a food resource, salmon and steelhead (though these lamprey species also feed on other fish and marine mammals), and potential migratory barriers from new weirs.

4.2.4.7 Leopard Dace and Umatilla Dace Effects under All Alternatives

Leopard dace and Umatilla dace can be prey species of salmon and steelhead in freshwater environments (Section 3.2.4.8, Leopard Dace, Interaction with Salmon and Steelhead; Section 3.2.4.14, Umatilla dace, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interactions between leopard dace and Umatilla dace and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation on leopard dace and Umatilla dace would also change. Implementation measures designed to improve hatcheries may also benefit leopard dace and Umatilla dace by minimizing entrainment of juvenile fish at hatchery water intake screens and improving water quality conditions in streams where hatcheries occur and dace spawn nearby.

Under the implementation scenario for Alternative 1, there would be no change in the number of hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-98). Thus, salmon and steelhead predation on leopard dace and Umatilla dace would likely not change compared to baseline conditions, and hatchery improvements to update hatchery water intake screens and to correct water quality conditions would not occur.

The implementation scenarios under Alternative 3 through Alternative 5 would likely result in a reduction of predation on leopard dace and Umatilla dace from reductions in salmon and steelhead production when compared to Alternative 1. However, these reductions in predation and subsequent benefits to leopard dace and Umatilla dace may be minimized by predation from other species (such as bull trout and non-native fish), which would continue under any alternative. Under the implementation scenario for Alternative 2, the 26 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits compared to Alternative 1 (Table 4-98) may benefit leopard dace and Umatilla dace through decreased predation on these two species. The implementation scenario under Alternative 6 would result in an increase in adult recruits of 6 percent (Table 4-98), which could result in increased predation on leopard dace and Umatilla dace. Updating hatchery water intake screens (Alternative 3 to Alternative 5) and correcting water quality issues (Alternative 2 to Alternative 6) would also benefit leopard dace and Umatilla dace.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 5, 3, and 1 percent, respectively (Table 4-98). In addition, the benefits of updating hatchery water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5.

Implementation scenarios for Alternative 2 through Alternative 5 would likely result in less predation on leopard dace and Umatilla dace, and the implementation scenario for Alternative 2 would likely result in the greatest benefit to leopard dace and Umatilla dace. However, predation on leopard dace and Umatilla dace by salmon and steelhead has not been cited as a reason for their declines, nor have water quality issues or entrainment at water intake structures. Leopard dace and Umatilla dace declines have been attributed to reduced water flows, increasing water demands, barriers to movement, sedimentation, and introduction of non-native species that prey on dace (Section 3.2.4.8, Leopard Dace, Limiting Factors and Threats; Section 3.2.4.14, Umatilla Dace, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. It is likely that the threats described above would continue to impact leopard dace and Umatilla dace populations negatively regardless of alternative implementation.

4.2.4.8 Margined Sculpin Effects under All Alternatives

The margined sculpin is a predator of salmon and steelhead eggs and young (Section 3.2.4.9, Margined Sculpin, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interactions between margined sculpin and salmon and steelhead. A decrease in smolt production of both hatchery-origin and natural-origin salmon and steelhead would, thus, impact the prey resources of the margined sculpin. As hatchery production and the number of hatchery-origin and natural-origin salmon and steelhead change under the alternatives, the extent of available salmon and steelhead for margined sculpin predation would also change. Implementation measures designed to improve hatcheries may also benefit margined sculpin by minimizing entrainment of juvenile fish at hatchery water intake screens and improving water quality conditions in streams where hatcheries occur and margined sculpin may reside.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-98). Thus, margined sculpin predation on salmon and steelhead would not change compared to baseline conditions, and hatchery improvements to update water intake screens and to correct water quality conditions would not occur.

The implementation scenarios for all action alternatives would likely result in a reduction of prey resources (salmon and steelhead smolts) when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-98) would impact the food resources of margined sculpin, which would result in less prey availability, but not as much of a decrease as would occur under Alternative 1. Updating water intake screens and correcting water quality issues would also benefit margined sculpin.

The implementation scenarios for Alternative 3 through Alternative 5 would likely result in a decrease in salmon and steelhead smolt production by 13, 10, and 10 percent, respectively (Table 4-98), which would also likely result in fewer prey resources for margined sculpin, but not as much of a decrease as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of updating water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. The implementation scenario under Alternative 6 would result in similar effects on margined sculpin as the implementation scenario under Alternative 1 since the number of smolts produced would be similar, and no new weirs would be constructed under either alternative.

The implementation scenarios for Alternative 2 through Alternative 5 would result in an impact on the prey resources of margined sculpin, and the implementation scenario for Alternative 2 would result in the greatest impact. However, sculpins in general, feed on a variety of aquatic invertebrates, young fish (including salmon and steelhead), and fish eggs (Section 3.2.4.9, Margined Sculpin, Background). It is not known if margined sculpins depend on salmon and steelhead as a primary food resource. Based on the diverse diet of sculpins, however, it is likely that margined sculpins would alter their feeding habits to prey on other available resources if salmon and steelhead populations declined. Thus, their populations are not expected to decline as a result of implementing any of the action alternatives.

The reason for declines in margined sculpin populations includes human-induced activities that have impacted margined sculpin habitat (e.g., grazing, channelization, chemical use, logging, shoreline development, chemical use, and septic problems) and its limited distribution (Section 3.2.4.9, Margined Sculpin, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities have no relationship to these threat sources. It is likely that habitat conditions resulting from ongoing threats would continue to affect margined sculpin populations negatively regardless of alternative implementation. However, updating water intake screens and improving water quality conditions in streams associated with hatcheries would help to improve its survival at hatchery locations.

4.2.4.9 Mountain Sucker Effects under All Alternatives

Due to their small size (6 to 8 inches), mountain suckers can be prey of salmon and steelhead (Section 3.2.4.10, Mountain Sucker, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interactions between mountain suckers and salmon and steelhead under each of the alternatives. As hatchery production and the number of hatchery-origin and natural-origin salmon and steelhead change under the alternatives, the extent of predation on mountain suckers would also change. Implementation measures designed to improve hatcheries may also benefit the mountain sucker by minimizing entrainment of juvenile fish at hatchery water intake screens and improving water quality conditions in streams where hatcheries occur and mountain sucker may reside.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-98). Thus, predation on mountain suckers by salmon and steelhead would not likely change compared to baseline conditions, and hatchery improvements to update water intake screens and to correct water quality conditions would not occur.

The implementation scenarios under Alternative 2 through Alternative 5 would likely result in a reduction of predation on mountain suckers when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 43 percent decline in adult recruits (Table 4-98) may benefit mountain suckers through decreased predation on the species by salmon and steelhead compared to Alternative 1. Updating water intake screens and correcting water quality issues would also benefit the mountain sucker. The implementation scenario under Alternative 6 would result in a 6 percent increase in adult recruits (Table 4-98), which has the potential to result in increased predation on mountain suckers compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 5, 3, and 1, percent respectively (Table 4-98), which would likely result in less predation on mountain suckers, but not as much of a decrease as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of updating water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1. The implementation scenario under Alternative 6 would also help correct water quality issues compared to conditions under Alternative 1.

Although reduced predation upon mountain suckers would likely occur under implementation scenarios for Alternative 2 through Alternative 5when compared to Alternative 1, predation by salmon and steelhead has not been cited as a reason for mountain sucker declines (Section 3.2.4.10, Mountain Sucker, Limiting Factors and Threats). Similarly, entrainment of mountain suckers at hatchery water intake screens and water quality conditions at existing hatcheries have not been identified as threats to this species. Primary threats to mountain sucker are from habitat isolation due to passage barriers, habitat degradation (sedimentation), predation by non-native salmon, and hybridization with other suckers (Belica and Nibbelink 2006). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. It is likely that ongoing threats described above would continue to affect mountain sucker populations negatively regardless of alternative implementation.

4.2.4.10 Northern Pikeminnow Effects under All Alternatives

The northern pikeminnow is an important predator of juvenile salmon and steelhead (i.e., smolts) within the Columbia River Basin (Section 3.2.4.11, Northern Pikeminnow, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interaction between northern pikeminnow and salmon and steelhead under each of the alternatives.

A decrease in smolt production of both hatchery-origin and natural-origin salmon and steelhead would decrease the available prey resources of the northern pikeminnow. Implementation measures designed to improve hatcheries may also benefit northern pikeminnow by correcting water quality conditions in streams where hatcheries occur and northern pikeminnow may reside. Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-98). Therefore, northern pikeminnow predation on salmon and steelhead would not change compared to baseline conditions, and hatchery improvements to correct water quality conditions would not occur.

The implementation scenarios for Alternatives 2 through Alternative 5 would result in a negative impact on northern pikeminnow populations compared to Alternative 1 because of declines in salmon and steelhead smolt production, which would decrease an important food source for northern pikeminnow (although its preferred prey is American shad [Section 3.2.4.11, Northern Pikeminnow, Background]). Correcting water quality issues would benefit northern pikeminnow. The implementation scenario under Alternative 2 would result in the greatest negative impact because a 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-98) would substantially decrease salmon and steelhead food sources for northern pikeminnow. Correcting water quality issues would benefit northern pikeminnow. The implementation scenarios under Alternative 3 through Alternative 5 would likely result in a decrease in salmon and steelhead smolt production by 13, 10, and 10 percent, respectively, compared to Alternative 1 (Table 4-98). Such decreases in smolt production would lead to similar negative effects on northern pikeminnow populations as those occurring under the implementation scenario for Alternative 2, but the decrease in this food source would not be as substantial. The benefits of correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5, compared to Alternative 1.

The implementation scenario under Alternative 6 would likely result in similar effects on northern pikeminnow as the implementation scenario under Alternative 1 since the number of smolts produced would be similar, and the potential for improved water quality under

Alternative 6, compared to conditions under Alternative 1, would be beneficial to northern pikeminnow. While there would be substantial declines of an important food source for northern pikeminnow under the implementation scenario for Alternative 2 and lower amounts of decline under Alternative 3 through Alternative 5 compared to Alternative 1, the northern pikeminnow is not a listed species. The species is abundant in the analysis area and is currently controlled through a harvest program to limit its presence in the Columbia River Basin (LCFRB 2004) (Section 3.2.4.11, Northern Pikeminnow, Current Status and Trends). In the short term, a reduction in salmon and steelhead smolt production may result in increased predation pressure by northern pikeminnow until control measures help to stabilize the population. In the long term, the northern pikeminnow population would likely stabilize based on salmon and steelhead production decreases under the implementation scenarios for the action alternatives, along with baseline conditions expected to occur under Alternative 1, when combined with effects of the northern pikeminnow control program.

4.2.4.11 Rainbow Trout Effects under All Alternatives

The primary interaction between rainbow trout and salmon and steelhead is the ability of rainbow trout to outcompete natural-origin fish for available food resources, such as insects, amphibians, and small fish (Section 3.2.4.13, Rainbow Trout, Interaction with Salmon and Steelhead). Introduced rainbow trout can also outcompete natural-origin salmon and steelhead for available habitat, and prey on young salmon. They also present a genetic threat by interbreeding with natural-origin salmon and steelhead (Section 3.2.4.13, Rainbow Trout, Background). Interspecific competition, rainbow trout predation on salmon and steelhead, and genetic integrity of natural-origin salmon populations are the primary reasons to analyze interactions between rainbow trout and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead would change under the alternatives, the extent of competition, predation, and interbreeding would also change.

Implementation measures designed to improve hatcheries may also affect rainbow trout by correcting water quality conditions in streams where hatcheries are located, where rainbow trout may pass through during migration, or where rainbow trout spawn nearby. However, new seasonal or permanent weirs planned under some of the action alternatives may isolate rainbow trout populations, limiting or slowing movement of migrating rainbow trout, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when westslope cutthroat trout are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize fish handling, and remove weirs when they are not needed to trap hatchery fish to avoid unintentional trapping of other fish.

A reduction in hatchery-origin and natural-origin salmon and steelhead smolt production and a decrease in the number of adult recruits under Alternative 2 through Alternative 5, compared to Alternative 1, would have an adverse impact on the food resources of rainbow trout (but this may be mitigated by the use of other food resources by rainbow trout). Such decreases would also likely reduce competition for rainbow trout habitat and may reduce the risk of genetic interactions of rainbow trout with salmon and steelhead through interbreeding. In addition, water quality conditions at hatcheries would not improve, and rainbow trout would not be affected by the placement of new weirs. The implementation scenario under Alternative 6 may result in a potential for increased competition on rainbow trout food resources since there would be a 6 percent increase in salmon and steelhead adult recruits as compared to Alternative 1 (Table 4-98).

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production and adult recruits produced compared to baseline conditions (Table 4-98). Thus, rainbow trout predation on salmon and steelhead, competition for habitat, and compromises in genetic integrity through interbreeding would not likely change compared to baseline conditions. Additionally, other sources of prey for rainbow trout would remain available as described under baseline conditions. In addition, water quality conditions at hatcheries would not improve, and rainbow trout would not be affected by the placement of new weirs.

The implementation scenarios for Alternative 2 would likely reduce prey resources of rainbow trout, competition for habitat, and genetic risks between rainbow trout and salmon and steelhead. Correcting water quality issues at hatcheries would also benefit rainbow trout under the implementation scenario for Alternative 2 compared to Alternative 1.

Under the implementation scenario for Alternative 2, the 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-98) would negatively impact a prey resource of rainbow trout. However, other food sources would remain available (e.g., insects, amphibians, and other small fish) since hatchery production and activities would not affect these resources. Competition for available habitat would be substantially reduced under Alternative 2 compared to Alternative 1 since fewer salmon and steelhead adult recruits (26 percent) (Table 4-98) would compete with rainbow trout for prime habitat space.

Furthermore, there would be a substantial decrease in the risk for compromised genetic integrity through interbreeding under the implementation scenario for Alternative 2 compared to Alternative 1 because a large percentage of the current salmon and steelhead population would not be introduced into the analysis area. Correcting water quality issues at hatcheries would also benefit rainbow trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 13, 10, and 10 percent, respectively, compared to Alternative 1 (Table 4-98), resulting in a salmon and steelhead adult recruit decrease of 5, 3, and 1 percent, respectively. These reductions would represent similar effects on rainbow trout as those described under the implementation scenario for Alternative 2. However, such reductions in expected risks (i.e., decreased prey base) or increases in benefits (i.e., decreases in competition for habitat and compromised genetic integrity) would not be as substantial under the implementation scenarios for these action alternatives as under Alternative 2. The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 6 when compared to Alternative 1. In contrast, the new seasonal weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) may adversely impact rainbow trout through habitat alteration and fragmentation, fish handling, and slowing rainbow trout migratory movements when compared to Alternative 1. The increase of 6 percent adult salmon and steelhead recruits under the implementation scenario for Alternative 6 (Table 4-98) would result in a potential for increased competition between salmon and steelhead and rainbow trout and compromised genetic integrity compared to Alternative 1.

Rainbow trout are not listed, but populations have decreased over time due to various threats (Section 3.2.4.13, Rainbow Trout, Current Status and Trends). While Alternative 2 through Alternative 5 would result in benefits to rainbow trout through less competition for habitat and less opportunity to compromise genetic integrity, this species would continue to experience threats from other sources. In addition to interbreeding and competition, habitat degradation and fragmentation, non-native species introductions, and hybridization would continue under all of the alternatives, including Alternative 1 (Section 3.2.4.13, Rainbow Trout, Current Status and Trends; Section 3.2.4.13, Rainbow Trout, Limiting Factors and Threats). Hatchery production levels and activities under the implementation scenarios for any alternative would have no relationship to the activities that threaten rainbow trout, with the exception of the potential for decreased genetic interbreeding, decreased competition for food and habitat, and increased habitat fragmentation through new weir placement.

4.2.4.12 Westslope Cutthroat Trout Effects under All Alternatives

Westslope cutthroat trout directly compete with salmon and steelhead for habitat use and prey consumed (Section 3.2.4.15, Westslope Cutthroat Trout, Interactions with Salmon and Steelhead). They also hybridize with steelhead. These constitute the primary effects for analysis of interactions between westslope cutthroat trout and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of competition and hybridization between westslope cutthroat trout and salmon and steelhead would also change.

Implementation measures designed to improve hatcheries may also affect westslope cutthroat trout by correcting water quality conditions in streams where hatcheries are located, where westslope cutthroat trout may pass through during migration, or where westslope cutthroat trout spawn nearby. However, new seasonal or permanent weirs planned under some of the action alternatives may isolate westslope cutthroat trout populations, limiting or slowing movement of migrating westslope cutthroat trout, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when westslope cutthroat are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize fish handling, and remove weirs when they are not needed to trap hatchery fish to avoid unintentional trapping of other fish.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production and adult recruits compared to baseline conditions (Table 4-98). Thus, competition and hybridization between westslope cutthroat trout and salmon and steelhead would not likely change compared to baseline conditions. In addition, water quality conditions at hatcheries would not improve, and westslope cutthroat trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely result in less competition and hybridization between westslope cutthroat trout and salmon and steelhead when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 49 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production and the 26 percent decrease in adult recruits (Table 4-98) may benefit westslope cutthroat trout by reducing interspecific competition and hybridization. Correcting water quality issues at hatcheries would also benefit westslope cutthroat trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 13, 10, and 10 percent, respectively, and would decrease adult recruits by 5, 3, and 1 percent, respectively (Table 4-98). This would likely decrease interspecific competition and hybridization, but would not be as much of a decline as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. In contrast, the new seasonal weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) may adversely impact westslope cutthroat trout through habitat alteration and fragmentation, fish handling, and slowing coastal cutthroat trout migratory movements when compared to Alternative 1. The implementation scenario under Alternative 6 would result in less than a 1 percent increase in smolt production (Table 4-98), a 6 percent increase in adult recruits (Table 4-98), and slight improvements in water quality, which would likely result in a slight potential for increased competition and hybridization compared to Alternative 1.

Although reduced interspecific competition would likely occur under implementation scenarios for all alternatives compared to Alternative 1, interspecific competition has not been cited as a reason for westslope cutthroat trout declines (Section 3.2.4.15, Westslope Cutthroat Trout, Limiting Factors and Threats). Interspecific competition studies between westslope cutthroat trout and other natural-origin salmon and steelhead have not yet been conducted. NMFS (1999) does, however, summarize several studies demonstrating that, when in the presence of other salmonids, coastal cutthroat trout have altered their behavior and life history traits to avoid interspecific competition for the same food and resources. Previous studies regarding the presence of coastal cutthroat trout and steelhead in the same stream locations have shown that these species have different behaviors (e.g., feeding on different prey) when sympatric (living nearby, but not interbreeding), which can help in avoiding and/or minimizing interspecific competition (Pearcy et al. 1990).

The reason for recent declines in westslope cutthroat trout populations has been isolation of previously connected habitats, habitat loss, hybridization and competition with non-native salmonids, overfishing, and warming stream temperatures (Section 3.2.4.15, Westslope Cutthroat Trout, Limiting Factors and Threats). Outside of a decrease in the potential for hybridization and potential isolation of connected habitats through new weir placement, these threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these other threat sources. It is likely that ongoing threats, outside of hybridization, described above would continue to affect westslope cutthroat populations negatively regardless of alternative implementation.

4.2.4.13 Nonindigenous Fish Species

As described in Subsection 3.2.5, Nonindigenous Fish Species, nonindigenous fish species can impact native fish species through predation, competition, hybridization, infection (disease and parasites), and habitat alteration. In the Columbia River Basin, nonindigenous fish species compete with salmon and steelhead for similar prey. They also prey on salmon and steelhead, particularly on migrating juvenile salmon and steelhead. Changes in hatchery production and implementation measures to improve water quality and construct new weirs would have varying effects on the abundance and distribution of nonindigenous fish species.

The implementation scenario under Alternative 1 would not be expected to change the distribution and abundance of nonindigenous fish species. Ongoing research efforts document how nonindigenous fish species impact salmon and steelhead (see Subsection 3.2.5, Nonindigenous Fish Species). These studies are, however, focused on documenting the interactions between non-native and native fish species and recording the presence of nonindigenous species in the Columbia River Basin, but not implementing approaches to decrease nonindigenous fish impacts on natural-origin fish species distribution and abundance. Thus, under this alternative, there are no expected changes to nonindigenous fish species populations.

The implementation scenario under Alternative 2 would result in a 49 percent decrease in hatchery-origin and natural-origin migrating smolts throughout the Columbia River Basin (Table 4-98). This reduction in smolt abundance would decrease the food supply of predatory nonindigenous fish species, but would also diminish competition for prey species that the indigenous fish species, salmon, and steelhead consume. The nonindigenous fish that prey on salmon and steelhead smolts would place increased pressure on salmon and steelhead in the initial years of decreased hatchery production. Over time, however, their populations would be expected to stabilize based on prey availability, including salmon and steelhead smolts. In contrast, the decrease in competition for prey species would benefit nonindigenous fish species and could potentially increase their abundance over time. It is unknown which effect, increased predation pressure or decreased competition, would have the greatest impact on the distribution and abundance of nonindigenous species. Correcting water quality issues near hatcheries would benefit nonindigenous fish species, although not necessarily affecting their overall distribution and abundance.

The implementation scenarios for Alternative 3 through Alternative 5 would decrease salmon and steelhead smolt production by 13, 10, and 10 percent, respectively, compared to Alternative 1 (Table 4-98), which would also impact and benefit nonindigenous fish species as described under Alternative 2, but to a lesser extent based on the changes in smolt production. The reduction in salmon and steelhead smolt production under Alternative 3 through Alternative 5 would have less of an effect on the potential for increased predation pressure and decreased competition than Alternative 2 based on the magnitude of change. Improved water quality as compared to conditions under Alternative 1 would increase habitat potential for nonindigenous species.

The new seasonal weirs under Alternative 3, Alternative 4, and Alternative 5 and permanent weirs (Alternative 4 and Alternative 5) may adversely affect nonindigenous fish species through fish handling and slowing their migratory progress through tributaries to spawning areas. The implementation scenario under Alternative 6 would likely result in similar effects on nonindigenous fish species as Alternative 1 since the number of smolts produced would be similar (Table 4-98).

4.3 Socioeconomics

4.3.1 Introduction

This section provides an assessment of the socioeconomic effects of the alternatives evaluates predicted changes in values for key socioeconomic indicators, including hatchery program costs, harvest and economic values, and regional economic conditions.

The alternatives analyzed in this EIS present a range of basinwide hatchery production and operational changes that may have varying effects to many socioeconomic indicators (Table 4-99). Changes in hatchery production can affect the costs of operations and the economic benefit to the local area from those operations. Changes in hatchery production levels can have beneficial or adverse effects on harvest levels and the industries and communities that depend on them.

The effects from implementation scenarios associated with Alternative 2 through Alternative 6 are compared to effects expected under Alternative 1 (No Action), which represents a continuation of current hatchery practices. The harvest estimates provided in this section (both modeled values and average annual values) are considered reasonable estimates of average annual harvest over time and are shown in 2009 U.S. dollars for consistency. Although the analysis focuses on harvest-related effects from expected changes in Columbia River Basin hatchery production, other operational effects (such as effects on hatchery jobs and personal income generation from hatchery production changes) are also considered. For readability of the Socioeconomics section, all 11-by-17 foldout tables are included at the end of this section.

As described in Chapter 2, Alternatives, and Section 4.1.3, Implementation Scenarios, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 4-3). Table 4-99 shows the implementation measures that may affect socioeconomic indicators. Ten implementation measures may affect hatchery program costs because they may cost money to implement (Section 4.3.2.2, Hatchery Program Costs):

- Change production levels in hatchery programs.
- Update water intake screens at hatchery facilities.
- Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.

- Correct water quality issues at hatchery facilities.
- Install new seasonal weirs.
- Install new permanent weirs.
- Change hatchery program goals (i.e., harvest or conservation).
- Change hatchery program's operational strategy (i.e., isolated or integrated).
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Four implementation scenarios would affect harvest and economic values for fisheries (recreational and commercial) and three would affect regional economic conditions because they would influence harvest levels (Section 4.3.2.1, Harvest Estimates):

- Change production levels in hatchery programs.
- Establish new selective fisheries in terminal areas.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

As described in Section 3.3.2, Analysis Area, the analysis area for socioeconomics includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California; 2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska (Figure 3-1). The analysis area includes areas outside the project area because salmon produced within the project area can migrate outside the project area and contribute to fisheries in these areas.

Information is organized according to the following economic impact regions: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River within the Columbia River Basin and Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan De Fuca, British Columbia, and Southeast Alaska within the Pacific Ocean and Puget Sound. Four of these economic impact regions occur in the project area (lower Columbia River, mid Columbia River, upper Columbia River, and lower Snake River) (Figure 3-2). These four economic impact regions encompass the seven ecological provinces and two recovery domains that make up the project area (Section 2.2, Description of Project Area).

TABLE 4-99. SOCIOECONOMIC INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	SOCIOECONOMIC INDICATORS THAT MAY BE AFFECTED				
	HATCHERY PROGRAM COSTS	HARVEST AND ECONOMIC VALUES FOR RECREATIONAL FISHERIES	HARVEST AND ECONOMIC VALUES FOR COMMERCIAL FISHERIES	REGIONAL ECONOMIC CONDITIONS COLUMBIA RIVER BASIN	REGIONAL ECONOMIC CONDITIONS PACIFIC OCEAN AND PUGET SOUND
Change production levels in hatchery programs.	X	X	X	X	X
Update water intake screens at hatchery facilities.	X				
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	X[1]				
Correct water quality issues at hatchery facilities.	X				
Install new seasonal weirs.	X				
Install new permanent weirs.	X				
Establish new selective fisheries in terminal areas.		X			
Change hatchery program goals (i.e., harvest or conservation).	X				
Change hatchery program's operational strategy (i.e., isolated or integrated).	X				
Establish new hatchery programs.	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources.
[1] Individual hatchery facility structures vary significantly in design and preclude the ability to generate broad-scale estimates of costs associated with correcting facility fish passage (Appendix J).

4.3.2 Methods for Analysis

The analysis of socioeconomic effects considers predicted harvest-related effects within the Columbia River Basin, the Pacific Ocean, and Puget Sound, where Columbia River stocks contribute to hatchery operations-related effects. A comparative evaluation approach focusing on key socioeconomic indicators, including hatchery program costs, harvest and economic values, and regional economic conditions, is used to assess these effects. A cost-benefit analysis of the alternatives is not considered because the focus of this analysis is to compare the alternatives based on an evaluation of key socioeconomic indicators.

As indicated in Section 3.3.1, Introduction, table values and corresponding values in the sections are not rounded. This is to aid the reader in finding table numbers within the text. The use of unrounded numbers, however, should not be interpreted to suggest unusually high levels of precision in the estimates. All numbers represent a best estimate of the underlying values.

4.3.2.1 Harvest Estimates

The estimates of salmon and steelhead harvest for all economic impact regions under baseline conditions, which also represent Alternative 1 (No Action) and the action alternatives (Alternative 2 through Alternative 6), were produced with a harvest model developed for this EIS. Historical data were used, wherever possible, as input information for developing a harvest simulation model that was based on steady-state analysis (Appendix K). Key elements considered in the model for evaluating fishery effects included variation in abundance for Columbia River stocks, representative exploitation rates, regulations over baseline periods, and prescriptive rules that govern the conduct of fisheries (Appendix K).

For alternatives other than Alternative 1, the predicted number of fish caught in tribal, non-tribal commercial, and recreational fisheries from the harvest simulation model was used to estimate harvest for the mainstem Columbia River, terminal areas within the Columbia River Basin, and the Oregon, Washington, and California coast economic impact regions. For the Southeast Alaska, British Columbia, and Puget Sound economic impact regions, modeled catch estimates were used as scale factors and applied to the baseline harvest estimates to calculate harvest for commercial (non-tribal and tribal) and recreational fisheries. Similarly, for the Lower Snake River economic impact region, modeled catch estimates were used as scale factors and applied to the baseline (2008 to 2011 average) harvest estimates to calculate harvest for tribal commercial fisheries.

For the Southeast Alaska, British Columbia, and Puget Sound economic impact regions, modeled estimates of changes in total catch were allocated among the different fisheries. Catch estimates were then assigned to the economic impact regions corresponding to the location of the fisheries (refer to Appendix J).

4.3.2.2 Hatchery Program Costs

As summarized in Section 3.3.3, Hatchery Program Costs, and described in more detail in Appendix J, estimates of hatchery program costs are based on existing and proposed hatchery budgets (primarily hatchery programs funded by the Mitchell Act) in the Columbia River Basin. Included in Appendix J are average smolt production costs for hatchery programs funded by the Mitchell Act. These costs were used to estimate expenditures for all other hatchery programs in the Columbia River Basin. Smolt production expenses include headquarters' administrative and management, acclimation and release, and hatchery facility maintenance costs. Additional hatchery program costs would be associated with the action alternatives. These costs would be accrued through implementation of facility BMPs and installation of new weirs. Key considerations and assumptions used to develop costs can be found in Appendix J. BMP costs do not include fish passage.

The assignment of hatchery smolt production to either Mitchell Act-funded programs or to hatchery programs not funded by the Mitchell Act requires certain judgments and assumptions about the funding of many hatchery programs. These assumptions, in addition to the use of average costs derived from Mitchell Act-funded programs, may introduce some error into the hatchery program costs analysis. However, because the primary purpose of the analysis is to conduct a comparative assessment of hatchery production-related costs across the alternatives, and because any error introduced by these assumptions and judgments is generally constant across the analyses of the different alternatives, the results are considered accurate for portraying the relative cost differences among the alternatives.

4.3.2.3 Harvest and Economic Values

The comparative evaluation of harvest and related economic values considered effects of alternative-specific harvest and its effect on gross and net economic values for commercial and recreational fisheries affected by Columbia River Basin hatchery production. Economic factors used to estimate the gross and net economic values of changes in harvest were derived from different sources, assumptions, and data sources and are provided in Appendix J.

4.3.2.4 Regional Economic Conditions

The comparative analysis of regional economic conditions estimates the amount of personal income and number of jobs generated by harvest and hatchery production activity under the alternatives. In terms of harvest, there are three fishery components: 1) economic activity from tribal commercial harvests, 2) economic activity from non-tribal commercial harvests, and 3) economic activity generated by recreational fishing. In terms of hatchery production, the amount of personal income and estimated number of jobs generated are based on smolt production costs and weir/facility BMP implementation (including operation) costs estimated for each alternative.

4.3.3 Hatchery Program Costs

Hatchery program expenses were addressed for each alternative. They include headquarters' administrative and management, acclimation and release, hatchery facility maintenance, implementation of facility BMPs, and new weir installation costs (Section 4.3.2.2, Hatchery Program Costs).

4.3.3.1 Alternative 1 (No Action)

Under Alternative 1, 140,594,000 smolts would be produced in the Columbia River Basin, which would be the same as under baseline conditions (Table 4-4). Forty-five percent of the smolts would be released from Mitchell Act-funded hatchery programs, and 55 percent would be released from non-Mitchell Act-funded hatchery programs (Table 4-4). Estimated hatchery program costs would total $80.8 million, and annual costs to operate existing weirs would total an estimated $2.4 million (Table 4-100). No additional facility BMPs would be implemented under Alternative 1 and no new weirs would be constructed, so all hatchery program costs would be from smolt production and weir operations costs (Section 4.3.2.2, Hatchery Program Costs). These costs would total an estimated $83.2 million (Table 4-100).

4.3.3.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, Mitchell Act-funded hatchery programs would be terminated as described in Section 2.5, Alternatives Analyzed in Detail, reducing annual production by 82,613,000 smolts. In addition to termination of Mitchell Act-funded production, annual production in non-Mitchell Act-funded hatchery programs would be reduced by about 18,690,000 smolts compared to Alternative 1 (Table 4-4) so that hatchery programs would meet the performance goals of the Alternative 2 (Section 2.5, Alternatives Analyzed in Detail). As under Alternative 1, there would be no costs associated with installing new weirs under the implementation scenario for Alternative 2, although costs to operate existing weirs would continue at about $2.4 million annually, the same as under Alternative 1 (Section 2.5, Alternatives Analyzed in Detail). Unlike Alternative 1, however, additional facility BMPs would be implemented for hatchery programs not funded by the Mitchell Act (Section 2.5, Alternatives Analyzed in Detail). As a result, there would be $4.5 million in annualized new costs associated with implementing facility BMPs (Table 4-100). Because production levels would be decreased by 59 percent relative to Alternative 1 (Table 4-4), smolt production costs would be reduced by

$29.1 million compared to Alternative 1 (Table 4-100). As a result, total overall hatchery program costs in the Columbia River Basin would be reduced by $24.6 million annually under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-100).

4.3.3.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, annual hatchery production would be reduced by 13,384,000 smolts for hatchery programs funded by the Mitchell Act and by 12,796,000 smolts for hatchery programs not funded by the Mitchell Act compared to Alternative 1 (Table 4-4). These decreases in smolt production would help all Columbia River Basin hatchery programs meet intermediate performance goals (Section 2.5, Alternatives Analyzed in Detail). Unlike the implementation scenarios for Alternative 1 and Alternative 2, seasonal weirs would be installed and operated under the implementation scenario for Alternative 3 to help meet performance goals. Similar to Alternative 2, new facility BMPs would be implemented. The costs to implement facility BMPs and install and operate seasonal weirs would be an estimated $10.4 million annually, or $8.0 million higher compared to Alternative 1 (Table 4-100), but because production levels would be decreased by 19 percent relative to Alternative 1 (Table 4-4), smolt production costs would be reduced by $8.0 million compared to Alternative 1 (Table 4-100). As a result, total overall hatchery program costs in the Columbia River Basin would remain virtually unchanged, at $83.2 million annually, under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-100).

4.3.3.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, annual hatchery production would be reduced by 11,663,000 smolts for hatchery programs funded by the Mitchell Act and by 9,870,000 smolts for hatchery programs not funded by the Mitchell Act in the Columbia River Basin compared to Alternative 1 (Table 4-4). These decreases in smolt production would help Columbia River Basin hatchery programs meet intermediate and stronger performance goals (Section 2.5, Alternatives Analyzed in Detail). Similar to the implementation scenario for Alternative 3, new facility BMPs would be implemented, and new weirs would be installed and operated. However, the weirs under the implementation scenario for Alternative 3 would be seasonal weirs, and the weirs under the implementation scenario for Alternative 4 would be a combination of seasonal and permanent weirs (Box 4-3). In general, permanent weirs are more expensive than seasonal weirs (Box 4-3). The costs to implement facility BMPs and install and operate seasonal weirs under the implementation scenario for Alternative 4 would be an estimated

$10.7 million annually (Table 4-100), or about $8.3 million higher compared to Alternative 1, but because production levels would be decreased by 15 percent relative to Alternative 1 (Table 4-4), smolt production costs would be reduced by $6.6 million compared to Alternative 1 (Table 4-100). As a result, total overall hatchery program costs in the Columbia River Basin would increase by about $1.7 million annually under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-100).

4.3.3.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, annual hatchery production would be reduced by 13,203,000 smolts for hatchery programs funded by the Mitchell Act and by 7,751,000 smolts for hatchery programs not funded by the Mitchell Act in the Columbia River Basin compared to Alternative 1 (Table 4-4). These decreases in smolt production would help Columbia River Basin hatchery programs meet intermediate and stronger performance goals (Section 2.5, Alternatives Analyzed in Detail). Similar to the implementation scenario for Alternative 4, new facility BMPs would be implemented, and a combination of seasonal and permanent weirs would be installed and operated (Box 4-3). The costs to implement facility BMPs and install and operate seasonal weirs under the implementation scenario for Alternative 5 would be an estimated $10.8 million annually, or $8.4 million higher compared to Alternative 1, total smolt production costs would decrease by $2.6 million compared to Alternative 1 (Table 4-100). As a result, total overall hatchery program costs in the Columbia River Basin would increase by about $5.8 million annually under the implementation scenario for Alternative 5 compared to Alternative 1 (Table 4-100).

4.3.3.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, annual hatchery production would be decreased by 9,125,000 smolts for hatchery programs funded by the Mitchell Act, but would increase by 6,832,000 smolts for hatchery programs not funded by the Mitchell Act in the Columbia River Basin compared to Alternative 1 (Table 4-4). These changes in smolt production would help Columbia River Basin hatchery programs meet stronger performance goals (Section 2.5, Alternatives Analyzed in Detail).

As part of the implementation scenario for Alternative 6, new facility BMPs would be implemented, although no new weirs would be installed (Box 4-3). The costs to implement facility BMPs and to operate existing weirs under the implementation scenario for Alternative 6 could be as high as an estimated $9.6 million annually, or $7.2 million higher compared to Alternative 1. Additionally, total hatchery program costs would increase $4.7 million compared to Alternative 1 (Table 4-100).

The implementation scenario for Alternative 6 is the only one that would increase hatchery program costs. Compared to Alternative 1, total overall hatchery program costs in the Columbia River Basin would increase by about $11.9 million (Table 4-100).

4.3.4 Harvest and Economic Values

Commercial and recreational fishers are consumptive users of fishery resources, and they place monetary value on their fishing activities. For commercial fishers (including both tribal and non-tribal), the ex-vessel value (i.e., the price received for the product at the dock) of salmon and steelhead provides a measure of its gross economic value. If the cost of fishing (e.g., equipment, fuel, boats, insurance, etc.) that commercial fishers incur is considered, the resulting net income (ex-vessel value minus costs) provides a measure of net economic value.

Recreational fishers' willingness to pay for their recreational fishing experience represents a measure of gross economic value associated with fishing for salmon or steelhead. Because recreational anglers also incur costs to fish (e.g., bait, tackle, lodging, guide fees, boat-related expenses, travel expenses, etc.), subtracting out these costs provides a measure of net economic value (i.e., net willingness to pay) for fishing opportunities.

This section provides estimates of the incremental changes in gross and net economic values of the action alternatives relative to Alternative 1. Although the analysis focuses on estimating changes in value to users of fish resources (i.e., commercial and recreation fishers), salmon and steelhead resources also have economic (monetary) value for people who do not directly use or consume the resources (i.e., people who place value on protecting salmon resources in the Columbia River Basin but do not fish). These values are typically referred to as non-use or passive-use values. Although non-use values associated with the recovery of listed salmon and steelhead are theoretically measurable, and likely differ to some extent among the alternatives, data on the economic value for the general public associated with protecting or enhancing salmon resources in the Columbia River Basin are too limited to make reliable estimates of these values. As such, only use values are quantitatively evaluated in this assessment.

4.3.4.1 Alternative 1 (No Action)

4.3.4.1.1 Commercial Harvest and Economic Values

As explained in Section 4.3.2.1, Harvest Estimates, the number of salmon harvested and harvest values provided under Alternative 1 are estimates derived mostly from harvest modeling to allow for direct comparison with the action alternatives. These values do not correspond with baseline estimates provided in Section 3.3, Socioeconomics. Exceptions to this are the values for the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska regions. Table footnotes in this section indicate that harvest estimates for Alternative 1 in these three regions were derived from the 2002 through 2009 annual average values presented in Table 3-16 and Table 3-17. For the lower Snake River economic impact region, tribal harvest estimates for Alternative 1 were derived from annual average values over the 2008 through 2011 period.

Under the implementation scenario for Alternative 1, the ex-vessel value of harvesting 327,493 salmon and steelhead in the Columbia River Basin (Table 4-101) would be an estimated $5,591,040 (Table 4-102). About 50 percent ($2,815,591 in ex-vessel value) of the salmon and steelhead harvest in the Columbia River Basin would occur in the tribal commercial fisheries of the mid Columbia River economic impact region, and about 47 percent ($2,638,695 in ex-vessel value) would occur in non-tribal commercial fisheries in the lower Columbia River economic impact region (Table 4-102).

The net economic values (net income) for commercial fishers associated with harvest in the Columbia River Basin would be an estimated $5,088,864, with Chinook salmon accounting for $4,096,594 (81 percent) of this total (Table 4-103 – for this table, tribal fisheries were combined with non-tribal fisheries). As shown in Table 3-11, Chinook salmon also represents 75 percent of all hatchery-origin fish produced at hatcheries.

In the Pacific Ocean and Puget Sound, where stocks from other river systems substantially contribute to harvest (Table 3-10), the ex-vessel value of 871,595 Chinook salmon, coho salmon, sockeye salmon, and steelhead landed in commercial fisheries would be an estimated $32,478,946 (Table 4-104 and Table 4-105). Along the Washington and Oregon coasts exclusively, where the contribution of Columbia River stocks is substantial (Table 3-10), the ex-vessel value of all salmon commercially landed (129,208 fish) would be an estimated $2,635,952 under the implementation scenario for Alternative 1 (Table 4-104 and Table 4-105).

In the Puget Sound/Strait of Juan de Fuca economic impact region, where Columbia River stocks contribute only about 1 percent of the non-tribal commercial fisheries (Table 3-10), the ex-vessel value of the commercial harvest of all salmon (including non-Columbia River stocks) would be estimated at about $3,015,859 (Table 4-105). Last, in British Columbia and Southeast Alaska, the ex-vessel value of the commercial harvest of all salmon would be an estimated $26,827,136 for both areas (Table 4-105), but Columbia River stocks only meaningfully contribute to the Southeast Alaska Chinook commercial salmon fishery (28 percent) (Table 3-10).

In terms of net economic values, total net income to commercial fishers (non-tribal and tribal) from the harvest of all salmon in the Pacific Ocean and Puget Sound is estimated at $11,880,532 under the implantation scenario for Alternative 1. Most of this value ($8,552,636) goes to commercial fishers in the Southeast Alaska and British Columbia economic impact regions (Table 4-103).

4.3.4.1.2 Recreational Harvest and Economic Value

Under the implementation scenario for Alternative 1, the estimated recreational catch of salmon and steelhead in the Columbia River Basin would be 305,705 fish (Table 4-106). Anglers would make an estimated 1,515,038 trips and spend about $125,136,636 in trip-related expenditures (Table 4-106). Recreational catch and associated trips and expenditures would be highest in the lower Columbia River economic impact region, where an estimated 173,944 salmon and steelhead (57 percent of total catch) would be caught, and $68,853,072 in trip-related expenditures would be made (Table 4-106). Recreational catch and related spending would be second highest in the lower Snake River economic impact region (Table 4-106), where steelhead is the primary target species. An estimated 75,931 fish would be caught by recreational anglers in the lower Snake River economic impact region, generating 399,637 trips and $33,289,749 in expenditures (Table 4-106). The mid Columbia and upper Columbia economic impact regions combined contribute only about 18 percent of the total recreational catch and expenditures (Table 4-106). Recreational anglers in the Columbia River Basin would accrue an estimated $92,524,799 in net economic values under Alternative 1, with fishing for steelhead accounting for $51,634,211, fishing for Chinook salmon accounting for $28,433,130, and fishing for coho salmon accounting for $12,457,458 (Table 4-107).

In the Pacific Ocean and Puget Sound, total recreational catch would be an estimated 415,391 fish (Table 4-108), which includes harvest in distant recreational fisheries, such as Puget Sound/Strait of Juan de Fuca and British Columbia, where Columbia River contributions would be minor (Table 3-11). For recreational fisheries along the Washington coast where the Columbia River species (Chinook salmon and coho salmon) substantially contribute (Table 3-10), the recreational catch would be 87,971 fish, generating 72,107 trips and $10,637,280 in trip-related spending

(Table 4-108). Along the Oregon coast, recreational fisheries would harvest about 38,688 salmon, generating 47,180 trips and $5,647,976 in trip-related expenditures (Table 4-108). Salmon recreational fisheries along the California coast would be minor, with about 1,706 fish being caught by recreational anglers (Table 4-108).

Net economic values for salmon recreational anglers throughout the Pacific Ocean and Puget Sound would be an estimated $25,126,056. The primary contributor would be Puget Sound/Strait of Juan de Fuca with an estimated net economic value of $8,959,595 (36 percent) (Table 4-107). However, as indicated by data in Table 3-11, Columbia River stocks are relatively minor contributors to the Puget Sound/Strait of Juan de Fuca salmon and steelhead fisheries.

4.3.4.2 Alternative 2 (No Mitchell Act Funding)

4.3.4.2.1 Commercial Harvest and Economic Values

In comparison to Alternative 1, the commercial harvest of salmon and steelhead in the Columbia River Basin under the implementation scenario for Alternative 2 would decline by about 192,861 fish (59 percent), reducing ex-vessel value by about $2,841,364 (Table 4-101 and Table 4-102). The reduction in ex-vessel value would be split between tribal and non-tribal commercial fishers with tribal fishers experiencing a total revenue reduction of about $1,283,592. Non-tribal fishers would under a total reduction of about $1,557,772 compared to Alternative 1 (these reductions assume that current harvest rates consistent with existing management agreements would be adhered to by both tribal and non-tribal fishers) (Table 4-102).

The lower Columbia River economic impact region would experience the greatest declines in ex-vessel values ($1,557,772), followed by the mid Columbia River economic impact region ($1,244,650) and the lower Snake River economic impact region ($38,942 compared to the implementation scenario for Alternative 1 (Table 4-102). Under the implementation scenario for Alternative 2, net economic values for commercial fishers in the Columbia River Basin would decline by about $2,859,715 compared to Alternative 1, with Chinook salmon and coho salmon accounting for more than 99 percent of this decline ($2,841,336) (Table 4-103). This decline in commercial fisheries is due to reduced production associated with the closure of hatchery facilities that receive Mitchell Act funding. Chinook salmon is the most valuable commercial fishery in the Columbia River Basin. As shown in Table 3-11, Chinook salmon represent 75 percent of all hatchery-origin fish produced at hatcheries in the basin, and the net economic value of this fishery would decrease by 55 percent ($2,238,194) under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-103).

In the Pacific Ocean and Puget Sound, the decline in commercial harvest and ex-vessel value associated with reduced Columbia River hatchery production under the implementation scenario for Alternative 2 is estimated at 79,628 fish (Chinook salmon, coho salmon, sockeye salmon, and steelhead) and $3,382,517, respectively, compared to Alternative 1 (Table 4-104 and Table 4-105). The largest reduction in ex-vessel values would occur in the commercial fisheries of British Columbia ($1,373,017), followed by Southeast Alaska ($1,120,265), the Washington coast ($601,365), Puget Sound/Strait of Juan de Fuca ($149,938), and the Oregon coast ($137,933) (Table 4-105).

Under the implementation scenario for Alternative 2, reductions in net economic values in the Pacific Ocean and Puget Sound would be $1,284,167 compared to Alternative 1, with the regional distribution of declines generally following the pattern for reduced ex-vessel values (Table 4-103). Similar to the Columbia River Basin, Chinook salmon is the most valuable commercial fishery in the Pacific Ocean and Puget Sound. The net economic value of this fishery would decrease by 12 percent ($1,211,560) under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-103).

4.3.4.2.2 Recreational Harvest and Economic Values

The implementation scenario for Alternative 2 would result in a decline in the recreational catch of salmon and steelhead in the Columbia River Basin of 99,959 fish, a reduction of 33 percent compared to Alternative 1 (Table 4-106). Recreational fishing trips would decline by 468,627, and trip-related expenditures would be reduced by an estimated $38,605,875 compared to Alternative 1 (Table 4-106). The largest changes would occur in the lower Columbia River economic impact region, with the catch of salmon and steelhead reduced by 73,157 fish and trip-related expenditures declining by $27,823,106 (40 percent) compared to Alternative 1 (Table 4-106). Other economic impact regions would experience decreases in expenditures of $6,693,177 (31 percent) for the mid Columbia River economic impact region, $4,012,868 (12 percent) for the lower Snake River economic impact region, and $76,724 (5 percent) for the upper Columbia River economic impact region compared to Alternative 1 (Table 4-106).

Net economic values associated with recreational fishing for salmon and steelhead in the Columbia River Basin would be reduced by $28,619,506 under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-107). Steelhead is the most valuable recreational fishery in the Columbia River Basin. Under the implementation scenario for Alternative 2, the net economic value of this fishery would decline by 21 percent ($10,993,094) compared to Alternative 1 (Table 4-107). The Chinook and coho salmon recreational fisheries would closely follow with net economic value reductions of $9,119,991 and $8,506,421, respectively (Table 4-107).

Under the implementation scenario for Alternative 2, the change in recreational catch in the Pacific Ocean and Puget Sound attributable to changes in hatchery production in the Columbia River Basin would be an overall reduction of 63,165 fish (Table 4-108), reducing recreational fishing trips by 59,555 trips and trip-related expenditures by $8,532,905 compared to Alternative 1 (Table 4-108). The greatest changes would be in the Washington coast economic impact region, where the catch declines would be an estimated 31,964 fish. Recreational fishing trips would decline by 26,200 trips, and trip-related spending would be reduced by $3,865,024 (Table 4-108).

Other economic impact regions with expected substantial reductions compared to Alternative 1 would include the Oregon coast economic impact region (14,004 fish and $2,044,413 in trip-related expenditures) and the British Columbia economic impact region (8,996 fish and $1,414,157 trip-related expenditures) (Table 4-108). Southeast Alaska and California would experience the lowest changes in recreational catch: a reduction in 5,076 fish and 618 fish harvested, respectively, and a reduction of $797,944 and $118,954, respectively, in expenditures (Table 4-108).

In comparison to Alternative 1, net economic values for recreational anglers throughout the Pacific Ocean and Puget Sound that are associated with production declines in Columbia River hatchery programs would be reduced region-wide by an estimated $3,553,662 under the implementation scenario for Alternative 2, with the biggest declines along the Washington coast ($1,600,059) (Table 4-107).

4.3.4.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

4.3.4.3.1 Commercial Harvest and Economic Values

Under the implementation scenario for Alternative 3, the salmon and steelhead harvest in commercial fisheries in the Columbia River Basin would decline by about 54,684 fish, reducing ex-vessel value by about $694,373 compared to Alternative 1 (Table 4-101 and Table 4-102). Non-tribal commercial fishers in the lower Columbia River economic impact region would experience the largest reduction in revenues at $397,295 compared to Alternative 1 (Table 4-102). The ex-vessel value reduction in the mid Columbia River and lower Snake River economic impact regions tribal fisheries would total an estimated $260,609 and $36,470, respectively, compared to the implementation scenario for Alternative 1 (Table 4-102).

Net economic values for commercial fishers would decline by $633,353 with about 60 percent ($382,906) due to reductions in the harvest of Chinook salmon (Table 4-103). The net economic value of the coho salmon fishery would decline by 34 percent ($242,394) under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-103).

In the Pacific Ocean and Puget Sound, the decline in harvest and ex-vessel value under the implementation scenario for Alternative 3 associated with changes in Columbia River hatchery production is estimated at 11,598 fish and $341,834 in ex-vessel value compared to Alternative 1 (Table 4-104 and Table 4-105). The largest reduction in ex-vessel values ($193,001) would occur in British Columbia, although the biggest reduction in catch would occur along the Washington coast (5,863 fish) (Table 4-105). The non-tribal Chinook salmon fishery in Southeast Alaska would experience increased harvest (1,255 fish), and ex-vessel values would increase by $60,782 (Table 4-104 and Table 4-105). Other declines in ex-vessel values would include a reduction of $153,804 for the Washington coast economic impact region, $42,154 for the Oregon coast economic impact region, and $13,657 for the Puget Sound/Strait of Juan de Fuca economic impact region compared to Alternative 1 (Table 4-105).

Under the implementation scenario for Alternative 3, net economic values for commercial fishers in the Pacific Ocean and Puget Sound overall would decrease by an estimated $139,768 compared to Alternative 1 (Table 4-103). Chinook salmon is the most valuable commercial fishery in the Pacific Ocean and Puget Sound; the net economic value of this fishery would decline by 1 percent ($106,679) under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-103).

4.3.4.3.2 Recreational Harvest and Economic Values

Under the implementation scenario for Alternative 3, the recreational catch of salmon and steelhead in the Columbia River Basin would be reduced by 31,829 fish, a decline of 10 percent relative to catch conditions for Alternative 1 (Table 4-106). Recreational fishing trips would decline by 152,347 trips, and trip-related expenditures would be reduced by an estimated $12,573,966 (Table 4-106).

Similar to the implementation scenario for Alternative 2, the greatest changes would occur in the lower Columbia River economic impact region, representing about 60 percent ($7,529,132) of the reduction in total trip-related spending ($12,573,966) in the Columbia River Basin (Table 4-106). Other economic impact regions would experience decreases in expenditures of $3,816,894 (12 percent) for the lower Snake River economic impact region, $1,193,743 (6 percent) for the mid Columbia River economic impact region, and $34,197 (2 percent) for the upper Columbia River economic impact region compared to Alternative 1 (Table 4-106).

Net economic values associated with recreational fishing for salmon and steelhead in the Columbia River Basin would be reduced by $9,303,998 under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-107). Steelhead is the most valuable recreational fishery in the Columbia River Basin; the net economic value of this fishery would decline by 9 percent ($4,413,823) under the implementation scenarios for Alternative 3 compared to Alternative 1 (Table 4-107).

The implementation scenario for Alternative 3 would result in a reduction in the recreational catch in the Pacific Ocean and Puget Sound by 21,018 fish (Table 4-108), with 19,436 fewer recreational fishing trips and $2,708,057 less in trip-related expenditures compared to Alternative 1 (Table 4-108). Similar to the implementation scenario for Alternative 2, the greatest changes would be in the Washington coast economic impact region, where the recreational catch would decline by an estimated 14,806 fish, and trip-related spending would decline by $1,790,312 (Table 4-108).

Other economic impact regions with considerable reductions compared to Alternative 1 would include the Oregon coast (4,864 fish and $710,085 in trip-related expenditures) and British Columbia (1,202 fish and $189,034 in trip-related expenditures) (Table 4-108). Similar to Alternative 2, Southeast Alaska and California would experience the lowest changes: an increase of 275 fish and a decrease of 169 fish harvested, respectively, and an increase of $43,294 and a decrease of $32,529 in expenditures, respectively.

Net economic values for recreational anglers throughout the Pacific Ocean and Puget Sound would decline region-wide by an estimated $1,191,522 under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-107).

4.3.4.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

4.3.4.4.1 Commercial Harvest and Economic Values

For the Columbia River Basin, the implementation scenario for Alternative 4 would have the lowest reductions in ex-vessel values and net economic values of the action alternatives based on a decrease of 27,411 fish compared to Alternative 1 (Table 4-101, Table 4-102, and Table 4-103). Catch and related values would increase under Alternative 6 compared to Alternative 1. Non-tribal commercial fishers in the Columbia River Basin would experience a decrease of $34,667 in total ex-vessel value compared to Alternative 1 (Table 4-102). For tribal commercial fishers, total ex-vessel value would decline by $258,517 compared to Alternative 1 (Table 4-102).

The greatest ex-vessel value change compared to Alternative 1 would be within the mid Columbia River economic impact region ($222,061), followed by the lower Snake River economic impact region ($36,667) and the lower Columbia River economic impact region ($34,667) (Table 4-102). The lower Columbia River economic impact region ex-vessel value reduction would be a non-tribal decrease, whereas decreases in the mid Columbia River and lower Snake River economic impact regions would all be tribal decreases.

For the Columbia River Basin overall, ex-vessel values would decline by about $293,185 (Table 4-102), and net economic values would decrease by $278,048 under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-103). The net economic value of the coho salmon fishery for the Columbia River Basin would decrease under the implementation scenario for Alternative 4 by 19 percent ($134,510) compared to Alternative 1 (Table 4-103).

In the Pacific Ocean and Puget Sound, the declines in harvest and ex-vessel value associated with changes in Columbia River hatchery production under the implementation scenario for Alternative 4 are estimated at 7,235 fish and $123,701 in ex-vessel value compared to Alternative 1 (Table 4-104 and Table 4-105). Increases in ex-vessel value in the Southeast Alaska Chinook salmon fishery ($137,059) would largely offset the predicted decreases elsewhere in the economic impact regions, most notably in the Washington coast economic impact region ($129,460) (Table 4-105). Net economic values in the Pacific Ocean and Puget Sound would decrease under the implementation scenario for Alternative 4 by an estimated $63,046 overall compared to Alternative 1 (Table 4-103). The net economic value of the Chinook salmon fishery would decline by less than 1 percent ($30,723) under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-103).

4.3.4.4.2 Recreational Harvest and Economic Values

Under the implementation scenario for Alternative 4, the recreational catch in the Columbia River Basin would be reduced by 25,094 fish with a decrease in expenditures of $10,102,932 compared to Alternative 1 (Table 4-106). Catch reductions in the lower Columbia River economic impact region (13,329 fish) would account for about 53 percent of this decline. This would result in an expenditure decrease of $5,098,878 (7 percent), followed by expenditure reductions in the lower Snake River economic impact region ($3,816,894, 12 percent), the mid Columbia River economic impact region ($1,157,963, 5 percent), and the upper Columbia River economic impact region ($34,197, 2 percent) (Table 4-106). Region-wide, recreational fishing would decline by an estimated 122,230 trips, and trip-related expenditures would decrease by an estimated $10,102,932 compared to Alternative 1 (Table 4-106).

Net economic values associated with recreational anglers in the Columbia River Basin would be reduced by about $7,464,731 under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-107). Steelhead is the most valuable recreational fishery in the Columbia River Basin; for Alternative 4, the net economic value of this fishery would decline by 9 percent ($4,596,072) under the implementation scenario (Table 4-107).

In the Pacific Ocean and Puget Sound, the recreational catch of Columbia River salmon under the implementation scenario for Alternative 4 would decline by 18,503 fish, a region-wide reduction of 5 percent compared to Alternative 1 (Table 4-108). The most substantial changes would occur along the Washington coast, where the recreational catch of salmon would decline by 14,534 fish, and trip-related expenditures would decrease by $1,757,423 (Table 4-108). The Oregon coast economic impact region would experience the next-highest declines, with 3,854 fewer fish, 4,700 fewer trips, and $562,637 less in trip-related expenditures (Table 4-108). Similar to commercial fisheries, recreational fisheries in Southeast Alaska would experience a predicted increase in recreational catch (621 fish) and associated numbers of recreational fishing trips (509 trips) compared to Alternative 1 (Table 4-108). For the Pacific Ocean and Puget Sound, net economic values would decline by about $1,041,683 region-wide under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-107).

4.3.4.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

4.3.4.5.1 Commercial Harvest and Economic Values

Under the implementation scenario for Alternative 5, the salmon and steelhead harvest in commercial fisheries in the Columbia River Basin would decline by about 34,021 fish, resulting in a reduction in ex-vessel value of $109,543 compared to Alternative 1 (Table 4-101 and Table 4-102). Tribal commercial fisheries in the mid Columbia River and lower Snake River economic impact area would increase by $99,875 and $32,310 in ex-vessel values, respectively, whereas the non-tribal commercial fisheries in the lower Columbia River would be reduced by $278,038 (Table 4-102).

Overall, net economic value for commercial fishers in the Columbia River Basin would decline by $227,312 under the implementation scenario for Alternative 5 compared to Alternative 1

(Table 4-103). The net economic value of the coho salmon fishery would decrease by 34 percent ($237,203) compared to Alternative 1 (Table 4-103).

In the Pacific Ocean and Puget Sound, the declines in harvest and ex-vessel values associated with reduced Columbia River hatchery production under the implementation scenario for Alternative 5 are estimated at 8,302 fish and $201,415 in ex-vessel value compared to Alternative 1 (Table 4-104 and Table 4-105). The greatest reduction in ex-vessel values ($146,834) would occur in the commercial fisheries along the Washington coast (Table 4-105).

Overall, net economic values in the Pacific Ocean and Puget Sound under the implementation scenarios for Alternative 5 would likely decrease by an estimated $94,234 compared to Alternative 1 (Table 4-103). Chinook salmon is the most valuable commercial fishery in the Pacific Ocean and Puget Sound; under the implementation scenario for Alternative 5, the net economic value of this fishery would decline by less than 1 percent ($65,752) compared to Alternative 1 (Table 4-103).

4.3.4.5.2 Recreational Harvest and Economic Values

The implementation scenario for Alternative 5 would have the lowest amount of negative effects on recreational harvest, associated trips, and spending in the Columbia River Basin compared to Alternative 1 (Table 4-106). Under the implementation scenario for Alternative 5, the total recreational catch of salmon and steelhead would decline by about 12,256 fish (4 percent) compared to Alternative 1 (305,705 fish), with recreational fishing trips declining by 50,590 trips, and trip-related expenditures declining by $4,137,407 compared to Alternative 1 (Table 4-106).

Almost all of the reduction in catch (13,708 fish) and expenditures ($4,957,137) would occur in the lower Columbia River economic impact region (Table 4-106). Catch and expenditures also would decline slightly (less than 1 percent) in the mid Columbia River economic impact region (Table 4-106). The reductions in expenditures in these two economic impact regions would be partially offset by trip-related spending increases in the other two economic impact regions, with expenditures rising by $304,264 (19 percent) in the upper Columbia River economic impact region and by $542,327 (2 percent) in the lower Snake River economic impact region (Table 4-106).

Net economic values in the Columbia River Basin would be reduced by an estimated $3,089,585, with declines in the coho salmon recreational fishery responsible for about $2,621,980 of this decrease (Table 4-107). Steelhead is the most valuable recreational fishery in the Columbia River

Basin; the net economic value of this fishery would decline under the implementation scenario for Alternative 5 by 1 percent ($654,424) compared to Alternative 1 (Table 4-107).

In the Pacific Ocean and Puget Sound, the recreational catch of salmon under Alternative 5 would decline by 17,619 fish, recreational fishing trips would decrease by 16,379 trips, and trip-related expenditures would drop by $2,252,351 compared to Alternative 1 (Table 4-108). Most of the reductions in expenditures would occur in the Washington coast economic impact region ($1,551,378, 15 percent), followed by Oregon ($618,550, 11 percent), British Columbia ($106,874, less than 1 percent), California ($28,680, 9 percent), and Puget Sound/Strait of Juan de Fuca ($27,543, less than 1 percent) (Table 4-108). In contrast, expenditures for Southeast Alaska would increase by an estimated $80,674 (1 percent) (Table 4-108). Under the implementation scenario for Alternative 5, Pacific Ocean and Puget Sound net economic values would decline by an estimated $1,008,710 region-wide compared to Alternative 1 (Table 4-107).

4.3.4.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

4.3.4.6.1 Commercial Harvest and Economic Values

The implementation scenario for Alternative 6 would result in increased harvests in all economic impact regions in the Columbia River Basin, making it the only implementation scenario to generate increased harvests compared to Alternative 1. Under the implementation scenario for Alternative 6, the salmon and steelhead harvest in commercial fisheries in the Columbia River Basin would increase by about 10,158 fish, resulting in an rise in ex-vessel value of $774,974 compared to Alternative 1 (Table 4-101 and Table 4-102). Tribal commercial fisheries in the mid and upper Columbia River and lower Snake River economic impact regions would increase by $544,587 in ex-vessel value, whereas the non-tribal commercial fisheries in the lower Columbia River would rise by $230,387 (Table 4-102).

Overall, net economic value for commercial fishers in the Columbia River Basin would increase by $503,146 under the implementation scenario for Alternative 6 compared to Alternative 1 (Table 4-103). The net economic value of the coho salmon fishery, however, would decrease by 18 percent ($125,683) compared to Alternative 1 (Table 4-103).

In the Pacific Ocean and Puget Sound, effects on harvests would be mixed, with overall catch and ex-vessel values declining in the Washington, Oregon, and Puget Sound/Strait of Juan de Fuca coastal regions, but increasing in the British Columbia and Southeast Alaska coastal regions. Region-wide, catch would increase by 4,737 fish, and ex-vessel value would increase by

$471,672 under the implementation scenario for Alternative 6 compared to Alternative 1 (Table 4-104 and Table 4-105). Effects, however, would differ for non-tribal and tribal commercial fishers. For non-tribal fishers, ex-vessel value is estimated to increase by $499,987, but ex-vessel value is estimated to fall by $28,315 for tribal fishers, compared to Alternative 1 (Table 4-104).

Overall, net economic values in the Pacific Ocean and Puget Sound under the implementation scenarios for Alternative 6 would increase by an estimated $138,218 compared to Alternative 1 (Table 4-103). Under the implementation scenario for Alternative 6, the net economic value of the Chinook salmon fishery would increase by 2 percent ($166,493) in the Pacific Ocean and Puget Sound compared to Alternative 1 (Table 4-103). However, the net economic value of the coho fishery would decline by 2 percent ($28,275) compared to Alternative 1 (Table 4-103).

4.3.4.6.2 Recreational Harvest and Economic Values

The implementation scenario for Alternative 6 would result in increased recreational harvest, associated trips, and spending in the Columbia River Basin compared to Alternative 1 (Table 4-106). Under the implementation scenario for Alternative 6, total recreational catch of salmon and steelhead would increase by about 8,767 fish (3 percent) compared to Alternative 1 (305,705 fish), with recreational fishing trips increasing by 52,637 trips, and trip-related expenditures increasing by $4,349,272 compared to Alternative 1 (Table 4-106).

Much of the increase in catch (4,613 fish) and expenditures ($2,286,991) would occur in the lower Columbia River economic impact region (Table 4-106). Catch and expenditures also would increase in the lower Snake River economic impact region (by 3,819 fish and $1,674,330 in expenditures) and in the upper Columbia River economic impact region (by 1,186 fish and $519,967 in expenditures) (Table 4-106). Conversely, these increases would be partially offset by reductions in catch (851 fish) and expenditures ($132,016) in the mid Columbia River economic impact region compared to Alternative 1 (Table 4-106).

Net economic values in the Columbia River Basin would increase by an estimated $3,214,605, although the net economic value of the coho salmon recreational fishery would decline by $1,623,724 (Table 4-107). The net economic value of the steelhead fishery would increase by about 3 percent ($1,581,416) under the implementation scenario for Alternative 6 compared to Alternative 1 (Table 4-107).

In the Pacific Ocean and Puget Sound, the recreational catch of salmon under Alternative 6 would decline by 14,678 fish, recreational fishing trips would decrease by 13,805 trips, and trip-related expenditures would drop by $1,770,537 compared to Alternative 1 (Table 4-108). Most of the reductions in expenditures would occur in the Washington coast economic impact region ($1,642,792, 15 percent) and the Oregon coast economic impact regions ($618,258, 11 percent). In contrast, trip-related expenditures in the British Columbia and Southeast Alaska regions would increase by a combined $520,324 (2 percent) (Table 4-108). Pacific Ocean and Puget Sound net economic values under the implementation scenario for Alternative 6 would decline by an estimated $865,323 region-wide compared to Alternative 1 (Table 4-107).

4.3.5 Regional Economic Conditions

The assessment of regional economic conditions relies on changes in personal income and jobs as key indicators of the direction and magnitude of economic effects (note that personal income differs from net economic value, as described in Section 4.3.4, Harvest and Economic Values). Commercial and recreational fisheries generate personal income and jobs in regional economies through the export of products and services to outside economies (Section 3.3.7, Regional Economic Conditions). Commercial catch is frequently sold directly, or after processing, to individuals or businesses located outside the regional economy. Similarly, non-local recreational anglers (i.e., anglers who do not live in a local area) spend money on guide services, lodging, and other goods and services. These expenditures generate household income and employment in many sectors of the regional economy (Section 3.3.7, Regional Economic Conditions). This regional transfer of money supports wages and other forms of compensation. Those payments are then re-spent regionally, resulting in a multiplier effect. Additionally, hatchery facility operations, including employment of hatchery workers and procurement of goods and services, directly and indirectly generate economic impacts in the Columbia River Basin. The following sections identify the expected incremental changes in regional economic activity by alternative, as characterized by personal income and employment levels.

4.3.5.1 Alternative 1 (No Action)

4.3.5.1.1 Columbia River Basin

Under Alternative 1 for the Columbia River Basin, hatchery operations and related fisheries operations for the four economic impact regions combined contribute $173,564,549 in personal income to the regional economy and 4,503 jobs (Table 4-109 and Table 4-110). Estimates of personal income include income derived from by commercial fisheries ($17,858,948, 10 percent), recreational fisheries ($91,617,079, 53 percent), and expenditures related to hatchery facility operations and maintenance ($64,088,521, 37 percent) (Table 4-109). Most of this personal income would occur in the lower Columbia River economic impact region ($79,018,436, which accounts for 46 percent of the income), followed by the lower Snake River economic impact region ($48,474,718, 28 percent), mid Columbia River economic impact region ($37,847,797, 22 percent), and upper Columbia River economic impact region ($8,223,597, 4 percent) (Table 4-109)[3].

Under Alternative 1, hatchery production spending on labor and procurement of goods and services is estimated to generate $64,088,521 in personal income and support about 1,282 jobs in the Columbia River Basin (Table 4-109 and Table 4-110). Hatchery-generated economic impacts would be greatest in the lower Snake River economic impact region, where $24,009,550 in personal income and 480 jobs are estimated to be supported by hatchery facility operations, closely followed by the lower Columbia River economic impact region where $22,728,721 in personal income and 455 jobs are supported by hatchery facility operations (Table 4-109 and Table 4-110).

4.3.5.1.2 Pacific Ocean and Puget Sound

For the Pacific Ocean and Puget Sound, salmon and steelhead fishing generated an estimated $109,516,765 in personal income, 64 percent ($69,918,324) of which was derived from recreational fishing activity, and an estimated $39,598,442 of which was derived from commercial fishing activity (Table 4-111). Income under Alternative 1 is estimated to be greatest in the British Columbia and Southeast Alaska economic impact regions, which contribute $48,307,483 and $27,991,656, respectively (Table 4-111). As shown in Table 3-10, however, the contribution of Columbia River stocks to British Columbia and Southeast Alaska fisheries is relatively small, particularly in British Columbia. The commercial and recreational fishery personal income in the British Columbia region is estimated to support 836 jobs (Table 4-112). In the Southeast Alaska economic impact region, total salmon catch is estimated to generate 485 jobs (Table 4-112). In the Puget Sound/Strait of Juan de Fuca economic impact region, the marine salmon fisheries would generate an estimated $20,025,412 in personal income and 347 jobs (Table 4-111 and Table 4-112). About two-thirds of the effects in this economic impact region would be generated by recreational fishing under Alternative 1 (Table 4-111 and Table 4-112). Columbia River stocks would contribute less than 1 percent of the total harvest in all Puget Sound/Strait of Juan de Fuca marine fisheries except the Chinook salmon recreational fishery (6 percent) (Table 3-11). Changes in hatchery production under Alternative 1 would have

[3] For a description of how personal income and employment were derived, refer to Appendix J.

little effect on the Puget Sound/Strait of Juan de Fuca economic impact region compared to other economic impact regions (such as the Washington and Oregon coasts) within the Pacific Ocean and Puget Sound region.

In the Washington and Oregon coast economic impact regions, where Columbia River stocks substantially contribute to the fish caught in most fisheries (Table 3-11), overall regional economic effects of salmon and steelhead fisheries are lower than in the Columbia River Basin, including an estimated $9,883,061 in personal income and 294 jobs in the Washington coast economic impact region, and $3,153,852 in personal income and 94 jobs in the Oregon coast economic impact region (Table 4-111 and Table 4-112).

4.3.5.2 Alternative 2 (No Mitchell Act Funding)

4.3.5.2.1 Columbia River Basin

Under the implementation scenario for Alternative 2, commercial and recreational harvest would decrease in all Columbia River Basin economic impact regions relative to Alternative 1, resulting in reduced personal income and employment within all economic impact regions for these two catch types (Table 4-109 and Table 4-110). In addition, changes in hatchery operations would reduce hatchery costs in all Columbia River Basin economic impact regions, resulting in reduced personal income and employment within all economic impact regions (Table 4-109 and Table 4-110). This decline would be driven largely by the decrease in hatchery production costs.

Based on salmon catch estimates and hatchery operations, the overall decline is estimated to be greatest in the lower Columbia River economic impact region, where personal income and employment would decrease by $33,810,857 and 806 jobs (Table 4-109 and Table 4-110). On a percentage basis, however, the decline would be largest in the mid Columbia River economic impact region, where income and employment would decrease an estimated 47 and 45 percent, respectively, ($17,980,764 and 469 jobs) relative to Alternative 1 (Table 4-109 and Table 4-110).

4.3.5.2.2 Pacific Ocean and Puget Sound

Under the implementation scenario for Alternative 2, personal income and employment would decrease overall and in all coastal economic impact regions under compared to Alternative 1 (Table 4-111 and Table 4-112). These reductions would be largest in the Washington coast economic impact region ($3,342,512 and 99 jobs) and British Columbia (a decrease of $3,716,139 in personal income and a loss of 64 jobs) (Table 4-111 and 4-112). For the Washington and Oregon coast economic impact regions, personal income and employment would decline by an estimated 34 to 36 percent, respectively, compared to Alternative 1 (Table 4-111 and Table 4-112). Personal income and employment also would decrease in California, but, relative to Alternative 1, the declines would be minor, resulting in the loss of $56,247 in personal income and one estimated job (Table 4-111 and Table 4-112).

Although the total personal income loss would be $3,716,139 from 64 fewer jobs in the British Columbia economic impact region under the implementation scenario for Alternative 2, this amounts to a decrease of only about 8 percent compared to Alternative 1 (Table 4-111 and Table 4-112). The impact on the Southeast Alaska economic impact region would be about 9 percent ($2,385,737 in personal income and 41 jobs) compared to Alternative 1 (Table 4-111 and Table 4-112). In the Puget Sound/Strait of Juan de Fuca economic impact region, regional economic impacts of the implementation scenario for Alternative 2 would be low ($927,705 in personal income, 16 jobs, and a 5 percent decline) relative to Alternative 1 (Table 4-111 and Table 4-112).

4.3.5.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

4.3.5.3.1 Columbia River Basin

Under the implementation scenario for Alternative 3, personal income and employment related to harvest would decrease in all economic impact regions within the Columbia River Basin, relative to Alternative 1 (Table 4-109 and Table 4-110). The reductions, however, would not be as great as under Alternative 2 (Table 4-109 and Table 4-110). In absolute terms, the reduction in harvest-related regional economic activity would be greatest in the lower Columbia River economic impact region, where personal income would be reduced by an estimated $6,537,798 (12 percent), and employment would decrease by about 166 jobs (12 percent) (Table 4-109 and Table 4-110). In the other Columbia River Basin economic impact regions, personal income and jobs losses from harvest-related effects are estimated to be no greater than 12 percent of personal income and jobs under Alternative 1, with the upper Columbia River economic impact region having the lowest impacts (Table 4-109 and Table 4-110).

Under the implementation scenario for Alternative 3, economic activity supported by hatchery facility operations and maintenance would decrease in the Columbia River Basin, resulting in the total loss of an estimated $51,610 in personal income and one estimated job (less than 1 percent) compared to Alternative 1 (Table 4-109 and Table 4-110). Hatchery facility operations-related personal income and job losses, which would be much lower than under Alternative 2, would occur in two of the basin's four economic impact regions (Table 4-109 and Table 4-110). Relative to Alternative 1, these reductions would be greatest in the lower Snake River economic impact region, where personal income and employment would decline by an estimated $733,500 and 15 jobs, a 3 percent reduction (Table 4-109 and Table 4-110). Due to increased expenditures for facility BMP implementation and weir construction and operations compared to Alternative 1, overall hatchery facility operations-related spending would increase in the upper Columbia River and mid Columbia River economic impact regions. This would result in an estimated rise of $596,174 in personal income and 12 jobs in the upper Columbia River economic impact region, and an increase of $113,795 in personal income and two jobs in the mid Columbia River economic impact region (Table 4-109 and Table 4-110).

4.3.5.3.2 Pacific Ocean and Puget Sound

Under the implementation scenario for Alternative 3, harvest-related reductions in personal income and jobs relative to Alternative 1 would be about 80 percent lower than the reduction that would occur under Alternative 2 (Table 4-111 and 4-112). For the Puget Sound/Strait of Juan de Fuca and British Columbia economic impact regions, the reductions would be about 1 percent or less compared to Alternative 1 (Table 4-111 and Table 4-112). For the Southeast Alaska economic impact region, personal income and employment would increase by less than 1 percent compared to Alternative 1. In the Oregon and Washington coast economic impact regions, where contributions of Columbia River stocks are more substantial, harvest-related reductions in personal income and jobs would be greater, at 12 percent ($389,136 and 12 jobs) and almost 14 percent ($1,321,722 and 40 jobs), respectively, compared to Alternative 1 (Table 4-111 and Table 4-112). Although the percentage loss in California would be similar (10 percent), the loss in personal income would be low ($15,413, and about one job) compared to Alternative 1 (Table 4-111 and Table 4-112).

4.3.5.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

4.3.5.4.1 Columbia River Basin

The decrease in personal income ($7,618,788) and jobs (245 jobs) under the implementation scenario for Alternative 4 would be lower (a 4 percent decrease for income and 5 percent decrease for jobs) than the decrease projected under the implementation scenarios for Alternative 2 and Alternative 3. For commercial and recreation fishery-related effects, personal income and jobs would either be unchanged or lower compared to Alternative 2 and Alternative 3 (Table 4-109 and Table 4-110). Due to increased spending for facility BMPs and weir construction and operations, hatchery-operation, facility-related effects would be positive in all economic impact regions other than the lower Snake River economic impact region (Table 4-109 and Table 4-110). Within economic impact regions, the percentage decrease in commercial harvest under the implementation scenario for Alternative 4 would be greatest for the mid Columbia River economic impact region compared to Alternative 1, with economic activity based on the commercial harvest expected to decrease by 10 percent ($1,252,816 in personal income and 37 jobs).

For economic activity generated by the recreational harvest, personal income and job reductions would be greatest in the lower Columbia River and lower Snake River economic impact region, with personal income reductions of $3,755,164 and $2,770,882, respectively, and job reductions of 95 and 106, respectively, compared to Alternative 1 (Table 4-109 and Table 4-110). Increases attributable to hatchery facility operation-related effects would be greatest for the lower Columbia River economic impact region ($1,129,496 in personal income, 23 jobs, and a 5 percent increase), followed by the upper Columbia River economic impact region ($596,174 in personal income, 12 jobs, and an 8 percent increase) (Table 4-109 and Table 4-110). The lower Snake River economic impact region would experience a reduction in personal income and jobs ($681,572 in personal income, 14 jobs, and a 3 percent decline) related to decreased spending for hatchery facilities operations, facility BMPs, and weirs compared to Alternative 1 (Table 4-109 and Table 4-110).

4.3.5.4.2 Pacific Ocean and Puget Sound

The overall decrease in personal income and employment under the implementation scenario for Alternative 4 would be $1,544,939 and 47 jobs compared to Alternative 1 (Table 4-111 and Table 4-112). Similar to regional economic effects under Alternative 3, effects in the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions under the implementation scenario for Alternative 4 would be relatively minor, with personal income and jobs changing by 1 percent or less when compared to Alternative 1 (Table 4-111 and Table 4-112). In the Oregon coast economic impact region, regional economic activity (personal income and jobs) generated by salmon harvest would decrease by 10 percent relative to Alternative 1 (Table 4-111 and Table 4-112). This reduction represents an estimated loss of $318,893 in personal income and nine jobs (Table 4-111 and Table 4-112).

Reductions in personal income and jobs within the Washington coast economic impact region would be about 13 percent, with personal income declining by $1,258,324 and employment decreasing by 38 jobs compared to Alternative 1 (Table 4-111 and Table 4-112). For California, the reduction in personal income would be about 6 percent, with personal income declining by $9,477 with one estimated job loss (Table 4-111 and Table 4-112).

4.3.5.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

4.3.5.5.1 Columbia River Basin

Under the implementation scenario for Alternative 5, the change in personal income and jobs for the Columbia River Basin related to the commercial harvest would be less severe than under Alternative 2 or Alternative 3 and similar to the expected economic effects under Alternative 4 (Table 4-109 and Table 4-110). Among the alternatives that would result in reduced commercial fishing (Alternative 2 through Alternative 5), this alternative would have the lowest effect on commercial fisheries compared to Alternative 1 (Table 4-109 and Table 4-110).

Under the implementation scenario for Alternative 5, total personal income and employment changes resulting from commercial and recreational fishing effects and hatchery facility operations-related effects would be mixed, with positive net effects in the mid Columbia, upper Columbia, and lower Snake River economic impact regions and negative net effects in the lower Columbia River economic impact region. Overall, positive regional impacts would be greatest in the lower Snake River economic impact region, with an increase of $2,897,548 in personal income and 66 jobs (Table 4-109 and Table 4-110). This increase would be attributable to both commercial and recreational fishing effects, as well as to hatchery facility operations, including implementation of facility BMPs and construction and operation of weirs (Table 4-109 and Table 4-110). Economic activity associated with hatchery facility operations and maintenance under the implementation scenario for Alternative 5 would increase in three of the four economic impact regions in the Columbia River Basin, with the primary increase occurring in the lower Snake River economic impact region ($2,450,356 in personal income and 49 jobs) (Table 4-109 and Table 4-110). In the lower Columbia River economic impact region, overall personal income and job effects would be negative, with personal income falling by $4,546,208 and 155 jobs lost (Table 4-109 and Table 4-110).

4.3.5.5.2 Pacific Ocean and Puget Sound

The overall personal income and employment effects under the implementation scenario for Alternative 5 would be similar to those under the implementation scenarios for Alternative 3 and Alternative 4 (Table 4-111 and Table 4-112). Under the implementation scenario for Alternative 5, regional economic effects in the Puget Sound/Strait of Juan de Fuca, British

Columbia, and Southeast Alaska economic impact regions also would be similar to the relatively minor effects under the other action alternatives, with economic activity affecting these economic impact regions by 1 percent or less (Table 4-111 and Table 4-112). Impacts would be greater in the Oregon and Washington coast economic impact regions, where Columbia River stocks are more important compared to Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska (Table 4-111 and Table 4-112). Regional economic activity related to salmon catch would decrease by 11 percent in the Oregon coast economic impact region and by 12 percent in the Washington coast economic impact region, compared to Alternative 1 (Table 4-111 and Table 4-112).

Within the Oregon coast economic impact region, personal income under Alternative 5 is estimated to decrease by $341,776 and employment by an estimated 10 jobs compared to Alternative 1 (Table 4-111 and Table 4-112). Estimated regional economic effects in the Washington coast economic impact region would include $1,170,213 in reduced personal income and 35 fewer jobs compared to Alternative 1 (Table 4-111 and Table 4-112). As with the other alternatives, regional economic effects within the California coast economic impact region would be negligible, with personal income related to recreational fishing decreasing by $13,589 (Table 4-111).

4.3.5.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

4.3.5.6.1 Columbia River Basin

Under the implementation scenario for Alternative 6, the change in personal income and jobs for the Columbia River Basin related to the commercial harvest would be positive for all economic impact regions compared to Alternative 1, with the greatest increases in the mid Columbia River region ($655,782 in personal income and 20 jobs) (Table 4-109 and Table 4-110). Regional economic effects related to the recreational fishery would be positive in all regions other than the mid Columbia River economic impact region, where personal income and jobs would decline by less than 1 percent compared to Alternative 1 (Table 4-109 and Table 4-110). Economic activity associated with hatchery facility operations and maintenance, including implementation of facility BMPs and operations of weirs, under Alternative 6 would increase in all four economic impact regions in the Columbia River Basin, with the primary increase occurring in the lower Snake River economic impact region ($3,915,414 in personal income and 78 jobs) (Table 4-109 and Table 4-110).

Under the implementation scenario for Alternative 6, overall personal income and employment changes resulting from both fishery and hatchery facility operations-related effects would be positive in all four economic impact regions in the Columbia River Basin, with the greatest increases occurring in the lower Snake River region ($5,165,441 in personal income and 126 jobs) (Table 4-109 and Table 4-110). On a percentage basis, the greatest effects of the implementation scenario for Alternative 6, compared to Alternative 1, would occur in the upper Columbia River economic impact region, where personal income and jobs would increase by 46 percent ($3,829,665 in personal income and an increase of 83 jobs) (Table 4-109 and Table 4-110).

4.3.5.6.2 Pacific Ocean and Puget Sound

Under the implementation scenario for Alternative 6, the overall income and employment effects would be similar to those under Alternative 3 through Alternative 5. Slight positive effects would occur in the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions, whereas negative effects would occur in the Oregon, Washington, and California coast economic impact regions (Table 4-111 and Table 4-112). Under the implementation scenario for Alternative 6, increases in personal income and jobs in the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions would range from less than 1 percent to about 2 percent (Table 4-111 and Table 4-112). Impacts would be greater in the Oregon and Washington coast economic impact regions where Columbia River stocks are more important compared to the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska regions. (Table 4-111 and Table 4-112). Regional economic activity related to salmon catch would decrease by 10 percent in the Oregon coast economic impact region and by 11 percent in the Washington coast economic impact region, compared to Alternative 1 (Table 4-111 and Table 4-112).

Within the Oregon coast economic impact region, personal income under the implementation scenario for Alternative 6 is estimated to decrease by $327,134 and employment by an estimated 10 jobs compared to Alternative 1 (Table 4-111 and Table 4-112). Estimated impacts within the Washington coast economic impact region include $1,084,380 in reduced income and 33 fewer jobs compared to Alternative 1 (Table 4-111 and Table 4-112). As with the other alternatives, regional economic effects within the California coast economic impact region would be slight, with income related to recreational fishing decreasing by $12,417 (Table 4-111).

Table 4-100. Estimates of Annual Hatchery Facility Costs (millions of U.S. dollars) by Alternative.

Hatchery Operator	Alternative 1 (No Action)			Alternative 2				Alternative 3				Alternative 4				Alternative 5				Alternative 6			
	Smolt Production Costs U.S. Dollars ($)[2,4]	Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)[4]	BMP Costs U.S. Dollars ($)	Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)[4]	BMP Costs[1] U.S. Dollars ($)	Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)[4]	BMP Costs[1] U.S. Dollars ($)	Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)[4]	BMP Costs[1] U.S. Dollars ($)	Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)[4]	BMP Costs[1] U.S. Dollars ($)	Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)
Washington Department of Fish and Wildlife (WDFW)																							
MA Hatchery Programs	5.5			0.0				3.2				3.3				3.0				3.5			
Non-MA Hatchery Programs	16.8			14.1				14.9				15.2				15.3				17.4			
All Hatchery Programs	22.3		22.3	14.1	1.3		15.4	18.1	2.4		20.5	18.5	2.4		20.9	18.3	2.4		20.7	20.9	up to 2.4[3]		23.3
ODFW																							
MA Hatchery Programs	7.7			0.0				7.0				7.7				7.0				7.9			
Non-MA Hatchery Programs	11.3			9.7				9.7				10.0				10.8				11.4			
All Hatchery Programs	19.0		19.0	10.4	1.1		11.5	16.7	2.1		18.8	17.7	2.1		19.8	17.8	2.1		19.9	19.3	up to 2.1[3]		21.4
USFWS																							
MA Hatchery Programs	6.9			0.0				6.9				6.9				6.9				6.9			
Non-MA Hatchery Programs	5.5			4.8				5.5				5.5				5.5				5.9			
All Hatchery Programs	12.4		12.4	4.8	0.8		5.6	12.4	0.8		13.2	12.4	0.8		13.2	12.4	0.8		13.2	12.8	up to 0.8[3]		13.6
Idaho Department of Fish and Game (IDFG)																							
MA Hatchery Programs	0.0			0.0				0.0				0.0				0.0				0.0			
Non-MA Hatchery Programs	18.6			17.1				17.2				17.2				19.0				20.5			
All Hatchery Programs	18.6		18.6	17.1	0.6		17.7	17.2	0.7		17.9	17.2	0.7		17.9	19.0	0.7		19.7	20.5	up to 0.7[3]		21.2
Yakama Nation																							
MA Hatchery Programs	1.4			0.0				1.5				1.5				1.7				2.6			
Non-MA Hatchery Programs	0.9			0.9				0.9				0.9				0.9				0.9			
All Hatchery Programs	2.3		2.3	0.9	0.1		1.0	2.4	0.3		2.7	2.4	0.3		2.7	2.6	0.3		2.9	3.5	up to 0.3[3]		3.8
Nez Perce Tribe																							
MA Hatchery Programs	0.0			0.0				0.0				0.0				0.0				0.0			
Non-MA Hatchery Programs	0.9			0.9				0.9				0.9				0.9				1.0			
All Hatchery Programs	0.9		0.9	0.9	0.1		1.0	0.9	0.1		1.0	0.9	0.1		1.0	0.9	0.1		1.0	1.0	up to 0.1[3]		1.1

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Table 4-100. Estimates of Annual Hatchery Facility Costs (millions of U.S. dollars) by Alternative (continued).

Hatchery Operator	Alternative 1 (No Action) Smolt Production Costs U.S. Dollars ($)[2,4]	Alternative 1 Weir Costs[1] U.S. Dollars ($)	Alternative 1 Total Cost U.S. Dollars ($)	Alternative 2 Smolt Production Costs U.S. Dollars ($)[4]	Alternative 2 BMP Costs U.S. Dollars ($)	Alternative 2 Weir Costs[1] U.S. Dollars ($)	Alternative 2 Total Cost U.S. Dollars ($)	Alternative 3 Smolt Production Costs U.S. Dollars ($)[4]	Alternative 3 BMP Costs[1] U.S. Dollars ($)	Alternative 3 Weir Costs[1] U.S. Dollars ($)	Alternative 3 Total Cost U.S. Dollars ($)	Alternative 4 Smolt Production Costs U.S. Dollars ($)[4]	Alternative 4 BMP Costs[1] U.S. Dollars ($)	Alternative 4 Weir Costs[1] U.S. Dollars ($)	Alternative 4 Total Cost U.S. Dollars ($)	Alternative 5 Smolt Production Costs U.S. Dollars ($)[4]	Alternative 5 BMP Costs[1] U.S. Dollars ($)	Alternative 5 Weir Costs[1] U.S. Dollars ($)	Alternative 5 Total Cost U.S. Dollars ($)	Alternative 6 Smolt Production Costs U.S. Dollars ($)[4]	Alternative 6 BMP Costs[1] U.S. Dollars ($)	Alternative 6 Weir Costs[1] U.S. Dollars ($)	Alternative 6 Total Cost U.S. Dollars ($)
Confederated Tribes of the Umatilla Indian Reservation																							
MA Hatchery Programs	0.0			0.0				0.0				0.0				0.0				0.0			
Non-MA Hatchery Programs	0.0			0.0				0.0				0.0				0.0				0.0			
All Hatchery Programs	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0
Confederated Tribes of Colville																							
MA Hatchery Programs	0.0			0.0				0.0				0.0				0.0				0.0			
Non-MA Hatchery Programs	0.1			0.1				0.1				0.1				0.8				1.5			
All Hatchery Programs	0.1		0.1	0.1	0.0		0.1	0.1	0.0		0.1	0.1	0.0		0.1	0.8	0.0		0.8	1.5	0.0		1.5
Jointly Funded Hatchery Programs																							
MA Hatchery Programs	0.8			0.0				0.8				0.8				1.4				1.5			
Non-MA Hatchery Programs	4.4			4.1				4.2				4.2				5.0				4.5			
All Hatchery Programs	5.2		5.2	4.1	0.5		4.6	5.0	0.8		5.8	5.0	0.8		5.8	6.4	0.8		7.2	6.0	up to 0.8[3]		6.8
ALL OPERATORS (TOTAL)																							
MA Hatchery Programs	22.3			0.0				19.4				20.2				20.0				22.4			
NON-MA Hatchery Programs	58.5			51.7				53.4				54.0				58.2				63.1			
ALL Hatchery Programs	80.8	2.4	83.2	51.7	4.5	2.4	58.6	72.8	7.2	3.2	83.2	74.2	7.2	3.5	84.9	78.2	7.2	3.6	89.0	85.5	Up to 7.2[3]	2.4	95.1

Source: Estimates are based on average costs per smolt available from selective hatchery programs (Appendix J), and on facility BMP and weir cost estimates provided by D.J. Warren and Associates (D. Warren, pers. comm., D.J. Warren and Associates, Principal, June 13, 2009). Refer to Appendix J for additional methodology details.

[1] Facility BMP and weir costs are annualized.

[2] All dollar values are expressed in 2009 dollars.

[3] Alternative 6 has less of a mandate to implement facility BMPs. As a result, actual facility BMP costs for implementing Alternative 6 may be overestimated to some extent.

[4] Hatchery production costs estimated in this table are based on the assignment of programs to either Mitchell Act-funded or non-Mitchell Act-funded programs (Section 4.3.2.2, Hatchery Program Costs).

MA = Funded by the Mitchell Act.

Non-MA = Funded by a source other than the Mitchell Act.

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TABLE 4-101. EFFECTS ON COMMERCIAL HARVEST IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

	ALTERNATIVE 1 (NO ACTION)[1]	ALTERNATIVE 2 CHANGE FROM ALTERNATIVE 1			ALTERNATIVE 3 CHANGE FROM ALTERNATIVE 1			ALTERNATIVE 4 CHANGE FROM ALTERNATIVE 1			ALTERNATIVE 5 CHANGE FROM ALTERNATIVE 1			ALTERNATIVE 6 CHANGE FROM ALTERNATIVE 1		
ECONOMIC IMPACT REGION	NUMBER OF FISH	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)
Lower Columbia River																
Non-tribal	139,232	37,944	-101,288	-72.7	109,404	-29,828	-21.4	134,172	-5,060	-3.6	112,303	-26,929	-19.3	142,298	3,066	2.2
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**139,232**	**37,944**	**-101,288**	**-72.7**	**109,404**	**-29,828**	**-21.4**	**134,172**		**-3.6**	**112,303**	**-26,929**	**-19.3**	**142,298**	**3,066**	**2.2**
Mid Columbia River																
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	182,846	92,315	-90,531	-49.5	158,964	-23,882	-13.1	161,467	-21,379	-11.7	174,098	-8,748	-4.8	188,181	5,335	2.9
TOTAL	**182,846**	**92,315**	**-90,531**	**-49.5**	**158,964**	**-23,882**	**-13.1**	**161,467**	**-21,379**	**-11.7**	**174,098**	**-8,748**	**-4.8**	**188,181**	**5,335**	**2.9**
Upper Columbia River																
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	787	787	NA	1,196	1,196	NA
TOTAL	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**787**	**787**	**NA**	**1,196**	**1,196**	**NA**
Lower Snake River																
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	5,415	4,373	-1,042	-19.2	4,441	-947	-18.0	4,443	-972	-18.0	6,284	869	16.0	5,976	561	10.4
TOTAL	**5,415**	**4,373**	**-1,042**	**-19.2**	**4,441**	**-947**	**-18.0**	**4,443**	**-972**	**-18.0**	**6,284**	**869**	**16.0**	**5,976**	**561**	**10.4**
ALL COLUMBIA RIVER BASIN																
NON-TRIBAL	**139,232**	**37,944**	**-101,288**	**-72.7**	**109,404**	**-29,828**	**-21.4**	**134,172**	**-5,060**	**-3.6**	**112,303**	**-26,929**	**-19.3**	**142,298**	**3,066**	**2.2**
TRIBAL	**188,261**	**96,688**	**-91,573**	**-48.6**	**163,405**	**-24,865**	**-13.2**	**165,910**	**-22,351**	**-11.9**	**181,169**	**-7,092**	**-3.8**	**195,353**	**7,092**	**3.8**
TOTAL	**327,493**	**134,632**	**-192,861**	**-58.9**	**272,809**	**-54,693**	**-16.7**	**300,082**	**-27,411**	**-8.4**	**293,472**	**-34,021**	**-10.4**	**337,651**	**10,158**	**3.1**

Source: All harvest values in this table were developed by the Mitchell Act Fishery Modeling Team and exclude ceremonial and subsistence harvests. Refer to Appendix K for harvest modeling details.

[1] All values for Alternative 1 are modeled values; consequently, these values do not match the average annual (2002 through 2009) values presented in Section 3.3, Socioeconomics, which are substantially greater because of a surge in run size between 2002 and 2006.

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Table 4-102. Effects on Commercial Gross (ex-vessel) Value in the Columbia River Basin by Alternative.

Economic Impact Region	Alternative 1 (No Action)[1] U.S. Dollars ($)[2]	Alternative 2 U.S. Dollars ($)	Alternative 2 Change from Alternative 1 U.S. Dollars ($)	Alternative 2 Change from Alternative 1 Percent (%)	Alternative 3 U.S. Dollars ($)	Alternative 3 Change from Alternative 1 U.S. Dollars ($)	Alternative 3 Change from Alternative 1 Percent (%)	Alternative 4 U.S. Dollars ($)	Alternative 4 Change from Alternative 1 U.S. Dollars ($)	Alternative 4 Change from Alternative 1 Percent (%)	Alternative 5 U.S. Dollars ($)	Alternative 5 Change from Alternative 1 U.S. Dollars ($)	Alternative 5 Change from Alternative 1 Percent (%)	Alternative 6 U.S. Dollars ($)	Alternative 6 Change from Alternative 1 U.S. Dollars ($)	Alternative 6 Change from Alternative 1 Percent (%)
Lower Columbia River																
Non-tribal	2,638,695	1,080,923	-1,557,772	-59.0	2,241,400	-397,295	-15.1	2,604,027	-34,667	-1.3	2,360,656	-278,038	-10.5	2,869,082	230,387	8.7
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**2,638,695**	**1,080,923**	**-1,557,772**	**-59.0**	**2,241,400**	**-397,295**	**-15.1**	**2,604,027**	**-34,667**	**-1.3%**	**2,360,656**	**-278,038**	**-10.5**	**2,869,082**	**230,387**	**8.7**
Mid Columbia River																
Non-tribal	0	0	0	0.0	0	0	NA	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	2,815,591	1,570,941	-1,244,650	-44.2	2,554,982	-260,609	-9.3	2,593,529	-222,061	-7.9	2,915,465	99,875[3]	3.5[3]	3,285,585	469,994	16.7
TOTAL	**2,815,591**	**1,570,941**	**-1,244,650**	**-44.2**	**2,554,982**	**-260,609**	**-9.3**	**2,593,529**	**-222,061**	**-7.9**	**2,915,465**	**99,875**	**3.5**	**3,285,585**	**469,994**	**16.7**
Upper Columbia River																
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	36,311	36,311	NA	53,720	53,720	NA
TOTAL	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**36,311**	**36,311**	**NA**	**53,720**	**53,720**	**NA**
Lower Snake River																
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	136,754	97,821	-38,942	-28.5	100,284	-36,470	-26.7	100,298	-36,456	-26.7	169,064	32,310	23.6	157,627	20,873	15.3
TOTAL	**136,754**	**97,821**	**-38,942**	**-28.5**	**100,284**	**-36,470**	**-26.7**	**100,298**	**-36,456**	**-26.7**	**169,064**	**32,310**	**23.6**	**157,627**	**20,873**	**15.3**
ALL COLUMBIA RIVER BASIN																
NON-TRIBAL	**2,638,695**	**1,080,923**	**-1,557,772**	**-59.0**	**2,241,400**	**-397,295**	**-15.1**	**2,604,027**	**-34,667**	**-1.3**	**2,360,656**	**-278,038**	**-10.5**	**2,869,082**	**230,387**	**8.7**
TRIBAL	**2,952,345**	**1,668,753**	**-1,283,592**	**-43.5**	**2,655,266**	**-297,079**	**-10.1**	**2,693,828**	**-258,517**	**-8.8**	**3,120,841**	**168,496**	**5.7**	**3,496,932**	**544,587**	**18.4**
TOTAL	**5,591,040**	**2,749,676**	**-2,841,364**	**-50.8**	**4,896,666**	**-694,374**	**-12.4**	**5,297,855**	**-293,184**	**-5.2**	**5,481,497**	**-109,542**	**-2.0**	**6,366,014**	**774,974**	**13.9**

Source: All values were derived based on modeled harvest estimates (Table 4-101) and application of ex-vessel value factors identified in Appendix J.

[1] With the exception of the lower Snake River economic impact region, all values for Alternative 1 are based on modeled harvest values (Table 4-101); consequently, these values do not match the average annual (2002 through 2009) values presented in Section 3.3, Socioeconomics. Values for the lower Snake River economic impact region are based on average annual harvests over the 2008 to 2011 period.

[2] All dollar values are expressed in 2009 dollars.

[3] The tribal commercial ex-vessel value is higher in the mid Columbia River economic impact region under Alternative 4 compared to Alternative 1 despite a reduction in overall fish harvests (see Table 4-101). This occurs because the harvest of Chinook salmon, which increases under Alternative 4, generates greater ex-vessel value per fish than does the harvest of coho salmon, which decreases by a larger number of fish under the implementation scenario for Alternative 4.

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Table 4-103. Net Economic Value of Commercial Fisheries (tribal and non-tribal) in which Columbia River Stocks Contribute by Alternative.

	Alternative 1 (No Action)[1]		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
Economic Impact Region/Species	Number of Fish	Net Economic Value in U.S. Dollars ($)[2]	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)
COLUMBIA RIVER BASIN												
Chinook Salmon	181,664	4,096,594	-99,253	-2,238,194	-16,980	-382,906	-6,012	-113,573	-201	-4,533	27,299	615,603
Coho Salmon	106,795	707,146	-91,088	-603,142	-36,607	-242,394	-20,314	-134,510	-35,823	-237,203	-18,981	-125,683
Sockeye Salmon	2,166	14,342	-179	-1,185	-5	-33	-5	-33	398	2,635	398	2,635
Steelhead	36,868	270,782	-2,341	-17,194	-1,092	-8,020	-1,080	-7,932	1,605	11,788	1,442	10,591
TOTAL	**327,493**	**5,088,864**	**-192,861**	**-2,859,715**	**-54,684**	**-633,353**	**-27,411**	**-278,048**	**-34,021**	**-227,312**	**10,158**	**503,146**
PACIFIC OCEAN AND PUGET SOUND												
California Coast												
Chinook Salmon	0	0	0	0	0	0	0	0	0	0	0	0
Coho Salmon	0	0	0	0	0	0	0	0	0	0	0	0
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Oregon Coast (Astoria[3])												
Chinook Salmon	3,889	129,639	-1,500	-50,002	-332	-11,067	-263	-8,767	-328	-10,934	-103	-3,433
Coho Salmon	13,678	101,731	-4,241	-31,543	-1,784	-13,269	-1,726	-12,837	-1,522	-11,320	-1,766	-13,135
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**17,567**	**231,371**	**-5,741**	**-81,545**	**-2,116**	**-24,336**	**-1,989**	**-21,604**	**-1,850**	**-22,254**	**-1,869**	**-16,568**
Washington Coast												
Chinook Salmon	28,916	669,691	-11,154	-258,325	-2,464	-57,066	-1,952	-45,208	-2,436	-56,417	-766	-17,740
Coho Salmon	82,725	329,001	-7,449	-29,625	-3,399	-13,518	-3,329	-13,240	-2,931	-11,657	-2,813	-11,187
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**111,641**	**998,692**	**-18,603**	**-287,950**	**-5,863**	**-70,584**	**-5,281**	**-58,448**	**-5,367**	**-68,074**	**-3,579**	**-28,928**
Puget Sound/Strait of Juan de Fuca												
Chinook Salmon	45,246	822,608	-6,452	-117,304	-318	-5,785	-112	-2,032	-325	-5,906	168	3,054
Coho Salmon	191,097	1,275,225	-1,096	-7,311	-639	-4,263	-647	-4,317	-556	-3,710	-411	-2,741
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**236,343**	**2,097,833**	**-7,548**	**-124,614**	**-957**	**-10,048**	**-759**	**-6,349**	**-881**	**-9,616**	**-243**	**313**

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TABLE 4-103. NET ECONOMIC VALUE OF COMMERCIAL FISHERIES (TRIBAL AND NON-TRIBAL) IN WHICH COLUMBIA RIVER STOCKS CONTRIBUTE BY ALTERNATIVE (CONTINUED).

	Alternative 1 (No Action)[1]		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
Economic Impact Region/Species	Number of Fish	Net Economic Value in U.S. Dollars ($)[2]	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)	Change in Number of Fish	Change in Net Economic Value in U.S. Dollars ($)
Southeast Alaska/British Columbia												
Chinook Salmon	502,773	8,543,546	-46,251	-785,929	-1,928	-32,761	1,488	25,283	442	7,505	10,864	184,613
Coho Salmon	3,271	9,089	-1,486	-4,129	-734	-2,040	-694	-1,928	-646	-1,795	-436	-1,212
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**506,044**	**8,552,636**	**-47,737**	**-790,058**	**-2,662**	**-34,801**	**794**	**23,355**	**-204**	**5,710**	**10,428**	**183,401**
ALL PACIFIC OCEAN AND PUGET SOUND												
CHINOOK SALMON	**580,824**	**10,165,485**	**-65,357**	**-1,211,560**	**-5,042**	**-106,679**	**-839**	**-30,723**	**-2,647**	**-65,752**	**10,163**	**166,493**
COHO SALMON	**290,771**	**1,715,047**	**-14,272**	**-72,608**	**-6,556**	**-33,089**	**-6,396**	**-32,323**	**-5,655**	**-28,482**	**-5,426**	**-28,275**
STEELHEAD	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**871,595**	**11,880,532**	**-79,628**	**-1,284,167**	**-11,598**	**-139,768**	**-7,235**	**-63,046**	**-8,302**	**-94,234**	**4,737**	**138,218**

Source: Catch (number of fish) values for the Columbia River Basin, California coast, Oregon coast, and Washington coast are modeled estimates provided by the Mitchell Act Fishery Modeling Team; catch values for Puget Sound and Southeast Alaska/British Columbia are average annual values; net economic value factors identified in Appendix J were applied to these catch estimates.

[1] Alternative 1 values for the Columbia River Basin, California coast, Oregon coast, and Washington coast are based on modeled harvest values provided by the Mitchell Act Fishery Modeling Team; consequently, harvest (number of fish) values for these regions in this table do not match average annual harvest values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2009 dollars.

[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook and coho salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

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Table 4-104. Effects on Commercial Harvest in the Pacific Ocean and Puget Sound by Alternative.

Economic Impact Region	Alternative 1 (No Action)[1] Number of Fish	Alternative 2 Number of Fish	Alternative 2 Change from Alternative 1 Number of Fish	Alternative 2 Change from Alternative 1 Percent (%)	Alternative 3 Number of Fish	Alternative 3 Change from Alternative 1 Number of Fish	Alternative 3 Change from Alternative 1 Percent (%)	Alternative 4 Number of Fish	Alternative 4 Change from Alternative 1 Number of Fish	Alternative 4 Change from Alternative 1 Percent (%)	Alternative 5 Number of Fish	Alternative 5 Change from Alternative 1 Number of Fish	Alternative 5 Change from Alternative 1 Percent (%)	Alternative 6 Number of Fish	Alternative 6 Change from Alternative 1 Number of Fish	Alternative 6 Change from Alternative 1 Percent (%)
California Coast																
TOTAL	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**
Oregon Coast (Astoria[2])																
Non-tribal	17,567	11,826	-5,741	-32.7	15,451	-2,116	-12.0	15,578	-1,989	-11.3	15,717	-1,850	-10.5	15,698	-1,869	-10.6
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**17,567**	**11,826**	**-5,741**	**-32.7**	**15,451**	**-2,116**	**-12.0**	**15,578**	**-1,989**	**-11.3**	**15,717**	**-1,850**	**-10.5**	**15,698**	**-1,869**	**-10.6**
Washington Coast																
Non-tribal	27,444	17,957	-9,487	-34.6	24,450	-2,994	-10.9	24,742	-2,702	-9.8	24,740	-2,704	-9.9	25,229	-2,215	-8.1
Tribal	84,197	75,081	-9,116	-10.8	81,328	-2,869	-3.4	81,618	-2,579	-3.1	81,534	-2,663	-3.2	82,833	-1,364	-1.6
TOTAL	**111,641**	**93,038**	**-18,603**	**-16.7**	**105,778**	**-5,863**	**-5.3**	**106,360**	**-5,281**	**-4.7**	**106,274**	**-5,367**	**-4.8**	**108,062**	**-3,579**	**-3.2**
Puget Sound/Strait of Juan de Fuca																
Non-tribal	22,836	21,892	-944	-4.1	22,682	-154	-0.7	22,704	-132	-0.6	22,696	-140	-0.6	22,780	-56	-0.2
Tribal	213,507	206,903	-6,604	-3.1	212,704	-803	-0.4	212,880	-627	-0.3	212,766	-741	-0.3	213,320	-187	-0.1
TOTAL	**236,343**	**228,795**	**-7,548**	**-3.2**	**235,386**	**-957**	**-0.4**	**235,584**	**-759**	**-0.3**	**235,462**	**-881**	**-0.4**	**236,100**	**-243**	**-0.1**
British Columbia (Non-tribal)	237,646	213,033	-24,613	-10.4	233,729	-3,917	-1.6	235,611	-2,035	-0.9	235,104	-2,542	-1.1	241,911	4,265	1.8
TOTAL	**237,646**	**213,033**	**-24,613**	**-10.4**	**233,729**	**-3,917**	**-1.6**	**235,611**	**-2,035**	**-0.9**	**235,104**	**-2,542**	**-1.1**	**241,911**	**4,265**	**1.8**
Southeast Alaska (Non-tribal)	268,398	245,275	-23,123	-8.6	269,653	1,255	0.5	271,227	2,829	1.1	270,736	2,338	0.9	274,561	6,163	2.3
TOTAL	**268,398**	**245,275**	**-23,123**	**-8.6**	**269,653**	**1,255**	**0.5**	**271,227**	**2,829**	**1.1**	**270,736**	**2,338**	**0.9**	**274,561**	**6,163**	**2.3**
ALL PACIFIC OCEAN AND PUGET SOUND																
NON-TRIBAL	**573,891**	**509,983**	**-63,908**	**-11.1**	**565,965**	**-7,926**	**-1.4**	**569,862**	**-4,029**	**-0.7**	**568,993**	**-4,898**	**-0.9**	**580,179**	**6,288**	**1.1**
TRIBAL	**297,704**	**281,984**	**-15,720**	**-5.3**	**294,032**	**-3,672**	**-1.2**	**294,498**	**-3,206**	**-1.1**	**294,300**	**-3,404**	**-1.1**	**296,153**	**-1,551**	**-0.5**
TOTAL	**871,595**	**791,967**	**-79,628**	**-9.1**	**859,997**	**-11,598**	**-1.3**	**864,360**	**-7,235**	**-8.3**	**863,293**	**-8,302**	**-1.0**	**876,332**	**4,737**	**0.5**

Source: Catch (number of fish) values for the Columbia River Basin, California coast, Oregon coast, and Washington coast are modeled estimates provided by the Mitchell Act Fishery Modeling Team; catch values for Puget Sound, Southeast Alaska, and British Columbia are average annual values.
[1] Alternative 1 values for the California coast, Oregon coast, and Washington coast are based on modeled harvest values provided by the Mitchell Act Fishery Modeling Team; consequently, harvest (number of fish) values for these regions in this table do not match average annual harvest values presented in Section 3.3, Socioeconomics.
[2] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook and coho salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

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Table 4-105. Effects on Commercial Gross (Ex-Vessel) Value in the Pacific Ocean and Puget Sound by Alternative.

	Alternative 1 (No Action)[1]	Alternative 2			Alternative 3			Alternative 4			Alternative 5			Alternative 6		
			Change from Alternative 1			Change from Alternative 1			Change from Alternative 1			Change from Alternative 1			Change from Alternative 1	
Economic Impact Region	**U.S. Dollars ($)[2]**	**U.S. Dollars ($)**	**U.S. Dollars ($)**	**Percent (%)**	**U.S. Dollars ($)**	**U.S. Dollars ($)**	**Percent (%)**	**U.S. Dollars ($)**	**U.S. Dollars ($)**	**Percent (%)**	**U.S. Dollars ($)**	**U.S. Dollars ($)**	**Percent (%)**	**U.S. Dollars ($)**	**U.S. Dollars ($)**	**Percent (%)**
California Coast																
TOTAL	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**
Oregon Coast (Astoria[3])																
Non-tribal	394,505	256,571	-137,933	-35.0	352,351	-42,154	-10.7	356,810	-37,695	-9.6	356,166	-38,339	-9.7	364,752	-29,753	-7.5
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**394,505**	**256,571**	**-137,933**	**-35.0**	**352,351**	**-42,154**	**-10.7**	**356,810**	**-37,694**	**-9.6**	**356,166**	**-38,339**	**-9.7**	**364,752**	**-29,753**	**-7.5**
Washington Coast																
Non-tribal	840,307	530,699	-309,608	-36.8	760,081	-80,226	-9.5	772,402	-67,905	-8.1	764,352	-75,955	-9.0	798,426	-41,881	-5.0
Tribal	1,401,139	1,109,383	-291,756	-20.8	1,327,562	-73,577	-5.3	1,339,584	-61,555	-4.4	1,330,260	-70,879	-5.1	1,373,231	-27,908	-2.0
TOTAL	**2,241,447**	**1,640,082**	**-601,365**	**-26.8**	**2,087,643**	**-153,804**	**-6.9**	**2,111,986**	**-129,460**	**-5.8**	**2,094,613**	**-146,834**	**-6.6**	**2,171,657**	**-69,790**	**-3.1**
Puget Sound/Strait of Juan de Fuca																
Non-tribal	289,174	271,121	-18,052	-6.2	287,131	-2,043	-0.7	287,624	-1,550	-0.5	287,278	-1,896	-0.7	288,778	-396	-0.1
Tribal	2,726,685	2,594,799	-131,886	-4.8	2,715,070	-11,615	-0.4	2,718,912	-7,773	-0.3	2,715,668	-11,017	-0.4	2,726,279	-406	0.0
TOTAL	**3,015,859**	**2,865,921**	**-149,938**	**-5.0**	**3,002,201**	**-13,657**	**-0.5**	**3,006,536**	**-9,323**	**-0.3**	**3,002,946**	**-12,913**	**-0.4**	**3,015,057**	**-802**	**0.0**
British Columbia (Non-tribal)	13,823,870	12,450,853	-1,373,017	-9.9	13,630,870	-193,000	-1.4	13,739,589	-84,282	-0.6	13,707,279	-116,591	-0.8	14,097,298	273,428	2.0
TOTAL	**13,823,870**	**12,450,853**	**-1,373,017**	**-9.9**	**13,630,870**	**-193,001**	**-1.4**	**13,739,589**	**-84,282**	**-0.6**	**13,707,279**	**-116,591**	**-0.8**	**14,097,298**	**273,428**	**2.0**
Southeast Alaska (Non-tribal)	13,003,266	11,883,001	-1,120,265	-8.6	13,064,048	60,782	0.5	13,140,324	137,059	1.1	13,116,528	113,262	0.9	13,301,855	298,589	2.3
TOTAL	**13,003,266**	**11,883,001**	**-1,120,265**	**-8.6**	**13,064,048**	**60,782**	**0.5**	**13,140,324**	**137,059**	**1.1**	**13,116,528**	**113,262**	**0.9**	**13,301,855**	**298,589**	**2.3**
ALL PACIFIC OCEAN AND PUGET SOUND																
NON-TRIBAL	**28,351,122**	**25,392,245**	**-2,958,875**	**-10.4**	**28,094,481**	**-256,641**	**-0.9**	**28,296,749**	**-54,373**	**-0.2**	**28,231,603**	**-119,519**	**-0.4**	**28,851,109**	**499,987**	**1.8**
TRIBAL	**4,127,824**	**3,704,182**	**-423,642**	**-10.3**	**4,042,632**	**-85,193**	**-2.1**	**4,058,496**	**-69,328**	**-1.7**	**4,045,928**	**-81,896**	**-2.0**	**4,099,510**	**-28,315**	**-0.7**
TOTAL	**32,478,946**	**29,096,427**	**-3,382,517**	**-10.4**	**32,137,113**	**-341,834**	**-1.1**	**32,355,245**	**-123,701**	**-0.4**	**32,277,531**	**-201,415**	**-0.6**	**32,950,619**	**471,672**	**1.5**

Source: Table developed from harvest estimates from Table 4-104 and application of ex-vessel value factors identified in Appendix J.

[1] Alternative 1 values for the California coast, Oregon coast, and Washington coast are based on modeled harvest values provided by the Mitchell Act Fishery Modeling Team; consequently, harvest (number of fish) values for these regions in this table do not match average annual harvest values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2009 dollars.

[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook and coho salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

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TABLE 4-106. EFFECTS ON RECREATIONAL CATCH, RECREATIONAL FISHING TRIPS, AND EXPENDITURES IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6		
	ALTERNATIVE 1 (NO ACTION)[1]		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)
Lower Columbia River																
Catch (number of fish)	173,944	100,787	-73,157	-42.1	153,979	-19,965	-11.5	160,615	-13,329	-7.7	160,236	-13,708	-7.9	178,557	4,613	2.7
Trips (number of trips)	839,365	500,182	-339,183	-40.4	747,579	-91,786	-10.9	777,267	-62,098	-7.4	778,934	-60,431	-7.2	867,244	27,880	3.3
U.S. Dollar Expenditures ($)[2]	68,853,072	41,029,966	-27,823,106	-40.4	61,323,940	-7,529,132	-10.9	63,759,194	-5,093,878	-7.4	63,895,936	-4,957,137	-7.2	71,140,064	2,286,991	3.3
Mid Columbia River																
Catch (number of fish)	52,218	34,744	-17,474	-33.5	49,138	-3,080	-5.9	49,237	-2,981	-5.7	51,739	-479	-0.9	51,367	-851	-1.6
Trips (number of trips)	257,026	176,675	-80,350	-31.3	242,695	-14,331	-5.6	243,125	-13,901	-5.4	256,703	-322	-0.1	255,441	-1,585	-0.6
U.S. Dollar Expenditures ($)	21,410,238	14,717,061	-6,693,177	-31.3	20,216,495	-1,193,743	-5.6	20,252,275	-1,157,963	-5.4	21,383,377	-26,861	-0.1	21,278,222	-132,016	-0.6
Upper Columbia River																
Catch (number of fish)	3,612	3,437	-175	-4.8	3,534	-78	-2.2	3,534	-78	-2.2	4,306	694	19.2	4,798	1,186	32.8
Trips (number of trips)	19,011	18,089	-921	-4.8	18,600	-411	-2.2	18,600	-411	-2.2	22,663	3,653	19.2	25,253	6,242	32.8
U.S. Dollar Expenditures ($)	1,583,577	1,506,853	-76,724	-4.8	1,549,380	-34,197	-2.2	1,549,380	-34,197	-2.2	1,887,841	304,264	19.2	2,103,544	519,967	32.8
Lower Snake River																
Catch (number of fish)	75,931	66,778	-9,153	-12.1	67,225	-8,706	-11.5	67,225	-8,706	-11.5	77,168	1,237	1.6	79,750	3,819	5.0
Trips (number of trips)	399,637	351,463	-48,174	-12.1	353,816	-45,821	-11.5	353,816	-45,821	-11.5	406,147	6,511	1.6	419,737	20,100	5.0
U.S. Dollar Expenditures ($)	33,289,749	29,276,881	-4,012,868	-12.1	29,472,855	-3,816,894	-11.5	29,472,855	-3,816,894	-11.5	33,832,076	542,327	1.6	34,964,079	1,674,330	5.0
ALL COLUMBIA RIVER BASIN																
CATCH (NUMBER OF FISH)	**305,705**	**205,746**	**-99,959**	**-32.7**	**273,876**	**-31,829**	**-10.4**	**280,611**	**-25,094**	**-8.2**	**293,449**	**-12,256**	**-4.0**	**314,472**	**8,767**	**2.9**
TRIPS (NUMBER OF TRIPS)	**1,515,038**	**1,046,410**	**-468,627**	**-30.9**	**1,362,690**	**-152,347**	**-10.1**	**1,392,807**	**-122,230**	**-8.1**	**1,464,447**	**-50,590**	**-3.3**	**1,567,675**	**52,637**	**3.5**
U.S. DOLLAR EXPENDITURES ($)	**125,136,636**	**86,530,761**	**-38,605,875**	**-30.9**	**112,562,671**	**-12,573,966**	**-10.0**	**115,033,704**	**-10,102,932**	**-8.1**	**120,999,229**	**-4,137,407**	**-3.3**	**129,485,909**	**4,349,272**	**3.5**

Source: Catch (number of fish harvested) values are modeled estimates provided by the Mitchell Act Fishery Modeling Team. Number of trips and expenditures were derived based on the modeled catch estimates shown in the table (Appendix J).

[1] All values for Alternative 1 are based on modeled harvest (number of fish) values; consequently, these values do not match the average annual (2002 through 2006) values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2009 dollars.

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TABLE 4-107. CHANGE IN NET ECONOMIC VALUE OF RECREATIONAL FISHERIES IN WHICH COLUMBIA RIVER STOCKS CONTRIBUTE BY ALTERNATIVE.

			CHANGE COMPARED TO ALTERNATIVE 1									
	ALTERNATIVE 1 (NO ACTION)		ALTERNATIVE 2		ALTERNATIVE 3		ALTERNATIVE 4		ALTERNATIVE 5		ALTERNATIVE 6	
ECONOMIC IMPACT REGION/SPECIES	NUMBER OF TRIPS	NET ECONOMIC VALUE IN U. S. DOLLARS ($)[1,2]	NUMBER OF TRIPS	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF TRIPS	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF TRIPS	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF TRIPS	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF TRIPS	NET ECONOMIC VALUE IN U. S. DOLLARS ($)
COLUMBIA RIVER BASIN												
Chinook Salmon	465,575	28,433,130	-149,334	-9,119,991	-31,057	-1,896,680	-11,652	-711,581	3,059	186,818	53,330	3,256,913
Coho Salmon	203,983	12,457,458	-139,288	-8,506,421	-49,017	-2,993,495	-35,321	-2,157,077	-42,933	-2,621,980	-26,588	-1,623,724
Sockeye Salmon	0	0	0	0	0	0	0	0	0	0	0	0
Steelhead	845,479	51,634,211	-180,005	-10,993,094	-72,274	-4,413,823	-75,258	-4,596,072	-10,716	-654,424	25,895	1,581,416
TOTAL	1,515,038	92,524,799	-468,627	-28,619,506	-152,347	-9,303,998	-122,230	-7,464,731	-50,590	-3,089,585	52,637	3,214,605
PACIFIC OCEAN AND PUGET SOUND												
California Coast												
Chinook Salmon	0	0	0	0	0	0	0	0	0	0	0	0
Coho Salmon	2,106	128,626	-763	-46,595	-209	-12,742	-128	-7,841	-184	-11,234	-168	-10,254
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2,106	128,626	-763	-46,595	-209	-12,742	-128	-7,841	-184	-11,234	-168	-10,254
Oregon Coast												
Chinook Salmon (Astoria[3])	766	46,771	-296	-18,098	-66	-4,022	-52	-3,203	-65	-3,947	-21	-1,266
Coho Salmon	46,415	2,834,586	-16,782	-1,024,875	-5,866	-358,233	-4,648	-283,831	-5,102	-311,611	-5,144	-314,143
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	47,180	2,881,358	-17,078	-1,042,973	-5,932	-362,255	-4,700	-287,034	-5,167	-315,558	-5,165	-315,409
Washington Coast												
Chinook Salmon	9,111	556,447	-3,515	-214,649	-775	-47,355	-615	-37,544	-766	-46,804	-241	-14,717
Coho Salmon	62,996	3,847,220	-22,685	-1,385,410	-11,361	-693,806	-11,298	-690,002	-9,750	-595,442	-10,895	-665,373
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	72,107	4,403,667	-26,200	-1,600,059	-12,136	-741,161	-11,913	-727,545	-10,516	-642,246	-11,136	-680,090
Puget Sound/Strait of Juan de Fuca												
Chinook Salmon	49,535	3,025,145	-3,598	-219,753	-177	-10,838	-62	-3,806	-181	-11,065	94	5,721
Coho Salmon	97,173	5,934,449	-382	-23,312	-223	-13,593	-225	-13,767	-194	-11,830	-143	-8,742
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	146,708	8,959,595	-3,980	-243,064	-400	-24,430	-288	-17,573	-375	-22,895	-49	-3,021
Southeast Alaska/British Columbia												
Chinook Salmon	136,182	7,328,256	-11,523	-620,320	-757	-50,733	142	-1,539	-133	-16,577	2,715	143,551
Coho Salmon	23,326	1,424,555	-11	-651	-3	-200	-2	-150	-3	-200	-2	-100
Steelhead	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	159,508	8,752,811	-11,534	-620,971	-760	-50,934	139	-1,690	-137	-16,777	2,713	143,451
ALL PACIFIC OCEAN AND PUGET SOUND												
CHINOOK SALMON	**195,594**	**10,956,619**	**-18,933**	**-1,072,820**	**-1,775**	**-112,948**	**-588**	**-46,091**	**-1,146**	**-78,393**	**2,547**	**133,289**
COHO SALMON	**232,016**	**14,169,437**	**-40,622**	**-2,480,842**	**-17,661**	**-1,078,574**	**-16,302**	**-995,591**	**-15,233**	**-930,317**	**-16,352**	**-998,612**
STEELHEAD	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**427,610**	**25,126,056**	**-59,555**	**-3,553,662**	**-19,436**	**-1,191,522**	**-16,890**	**-1,041,683**	**-16,379**	**-1,008,710**	**-13,805**	**-865,323**

Source: Trip estimates for all alternatives were derived based on the catch estimates shown in the Table 4-108 and the methods and trips factors described in Appendix J. Application of net income (net economic value) factors for recreational fishing are identified in Appendix J.
[1] All dollar values are expressed in 2009 dollars.
[2] Values in this table for the Columbia River Basin and for the California, Oregon, and Washington coasts for Alternative 1 do not match those in Section 3.3, Socioeconomics, because these values are based on modeled estimates of harvest provided by the Mitchell Act Fishery Modeling Team.
[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the EIS alternatives on Chinook salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) for additional details pertaining to this assumption.

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TABLE 4-108. EFFECTS ON RECREATIONAL CATCH, RECREATIONAL FISHING TRIPS, AND EXPENDITURES IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

ECONOMIC IMPACT REGION	ALTERNATIVE 1 (NO ACTION)[1]	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
	NUMBER	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)
California Coast																
Catch (number of fish)	1,706	1,088	-618	-36.2	1,537	-169	-9.9	1,602	-104	-6.1	1,557	-149	-8.7	1,570	-136	-8.0
Trips (number of trips)	2,106	1,343	-763	-36.2	1,898	-209	-9.9	1,978	-128	-6.1	1,922	-184	-8.7	1,938	-168	-8.0
U.S. Dollar Expenditures ($)[2]	328,373	209,420	-118,954	-36.2	295,844	-32,529	-9.9	308,355	-20,018	-6.1	299,694	-28,680	-8.7	302,196	-26,177	-8.0
Oregon Coast																
Catch (number of fish)	38,688	24,684	-14,004	-36.2	33,824	-4,864	-12.6	34,834	-3,854	-10.0	34,451	-4,237	-11.0	34,453	-4,235	-10.9
Trips (number of trips)	47,180	30,102	-17,078	-36.2	41,249	-5,932	-12.6	42,480	-4,700	-10.0	42,013	-5,167	-11.0	42,016	-5,165	-10.9
U.S. Dollar Expenditures ($)	5,647,976	3,603,563	-2,044,413	-36.2	4,937,892	-710,085	-12.6	5,085,339	-562,637	-10.0	5,029,426	-618,550	-11.0	5,029,718	-618,258	-10.9
Washington Coast																
Catch (number of fish)	87,971	56,007	-31,964	-36.3	73,165	-14,806	-16.8	73,437	-14,534	-16.5	75,141	-12,830	-14.6	74,385	-13,586	-15.4
Trips (number of trips)	72,107	45,907	-26,200	-36.3	59,971	-12,136	-16.8	60,194	-11,913	-16.5	61,591	-10,516	-14.6	60,971	-11,136	-15.4
U.S. Dollar Expenditures ($)	10,637,280	6,772,256	-3,865,024	-36.3	8,846,968	-1,790,312	-16.8	8,879,858	-1,757,423	-16.5	9,085,902	-1,551,378	-14.6	8,994,488	-1,642,792	-15.4
Puget Sound/Strait of Juan de Fuca																
Catch (number of fish)	92,426	89,919	-2,507	-2.7	92,174	-252	-0.3	92,245	-181	-0.2	92,190	-236	-0.3	92,395	-31	0.0
Trips (number of trips)	146,708	142,728	-3,980	-2.7	146,308	-400	-0.3	146,420	-288	-0.2	146,333	-375	-0.3	146,658	-49	0.0
U.S. Dollar Expenditures ($)	10,778,632	10,486,219	-292,413	-2.7	10,749,242	-29,390	-0.3	10,757,491	-21,141	-0.2	10,751,089	-27,543	-0.3	10,774,998	-3,634	0.0
British Columbia																
Catch (number of fish)	134,453	125,457	-8,996	-6.7	133,251	-1,202	-0.9	134,002	-451	-0.3	133,773	-680	-0.5	136,410	1,957	1.5
Trips (number of trips)	110,207	102,834	-7,373	-6.7	109,222	-986	-0.9	109,838	-370	-0.3	109,650	-557	-0.5	111,811	1,604	1.5
U.S. Dollar Expenditures ($)	21,136,673	19,722,516	-1,414,157	-6.7	20,947,639	-189,034	-0.9	21,065,794	-70,879	-0.3	21,029,799	-106,874	-0.5	21,444,318	307,645	1.5
Southeast Alaska																
Catch (number of fish)	60,147	55,071	-5,076	-8.4	60,422	275	0.5	60,768	621	1.0	60,660	513	0.9	61,500	1,353	2.2
Trips (number of trips)	49,301	45,140	-4,161	-8.4	49,527	226	0.5	49,810	509	1.0	49,721	421	0.9	50,410	1,109	2.2
U.S. Dollar Expenditures ($)	9,455,404	8,657,460	-797,944	-8.4	9,498,698	43,294	0.5	9,553,028	97,624	1.0	9,536,079	80,674	0.9	9,668,084	212,679	2.2
ALL PACIFIC OCEAN AND PUGET SOUND																
CATCH (NUMBER OF FISH)	**415,391**	**352,226**	**-63,165**	**-15.2**	**394,373**	**-21,018**	**-5.1**	**396,888**	**-18,503**	**-4.5**	**397,772**	**-17,619**	**-4.2**	**400,713**	**-14,678**	**-0.4**
TRIPS (NUMBER OF TRIPS)	**427,610**	**368,055**	**-59,555**	**-13.9**	**408,174**	**-19,436**	**-4.5**	**410,720**	**-16,890**	**-3.9**	**411,231**	**-16,379**	**-3.8**	**413,805**	**-13,805**	**-0.3**
U.S. DOLLAR EXPENDITURES ($)	**57,984,339**	**49,451,434**	**-8,532,905**	**-14.7**	**55,276,282**	**-2,708,057**	**-4.7**	**55,649,866**	**-2,334,473**	**-4.0**	**55,731,988**	**-2,252,351**	**-3.9**	**56,213,802**	**-1,770,537**	**-0.3**

Source: Catch (number of fish harvested), trips, and expenditure values for Alternative 1 for the Puget Sound, British Columbia, and Southeast Alaska are based on average annual values. All other values are based on modeled estimates of harvest provided by the Mitchell Act Fishery Modeling Team and shown in the table. The number of trips and expenditures for all alternatives were derived based on the catch estimates shown in the table (Appendix J).

[1] Alternative 1 values for the California coast, Oregon coast, and Washington coast are based on modeled harvest (number of fish) values; consequently, these values do not match the average annual (2002 through 2009) values presented in Section 3.3, Socioeconomics. Alternative 1 values for Puget Sound, British Columbia, and Southeast Alaska are based on average annual (2002 through 2009) values and therefore match the values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2009 dollars.

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TABLE 4-109. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON PERSONAL INCOME IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6		
	ALTERNATIVE 1 (NO ACTION)		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	U.S. DOLLARS ($)[1]	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)
Lower Columbia River																
Commercial	5,531,814	1,651,496	-3,880,318	-70.1	4,544,428	-987,386	-17.8	5,459,471	-72,343	-1.3	4,686,463	-845,350	-15.3	5,842,720	310,906	5.6
Recreational	50,757,901	30,246,943	-20,510,958	-40.4	45,207,488	-5,550,412	-10.9	47,002,737	-3,755,164	-7.4	47,103,542	-3,654,359	-7.2	52,443,851	1,685,951	3.3
Hatchery Facility Operations[2]	22,728,721	13,309,140	-9,419,581	-41.4	22,700,642	-28,080	-0.1	23,858,217	1,129,496	5.0	22,682,223	-46,499	-0.2	24,120,755	1,392,034	6.1
TOTAL	**79,018,436**	**45,207,579**	**-33,810,857**	**-42.8**	**72,452,558**	**-6,565,878**	**-8.3**	**76,320,426**	**-2,698,010**	**-3.4**	**74,472,228**	**-4,546,208**	**-5.8**	**82,407,326**	**3,388,890**	**4.3**
Mid Columbia River																
Commercial	12,028,734	5,839,900	-6,188,833	-51.5	10,579,517	-1,449,217	-12.0	10,775,918	-1,252,816	-10.4	11,604,703	-424,031	-3.5	12,684,516	655,782	5.5
Recreational	15,542,810	10,683,883	-4,858,927	-31.3	14,676,210	-866,600	-5.6	14,702,184	-840,626	-5.4	15,523,310	-19,500	-0.1	15,446,972	-95,838	-0.6
Hatchery Facility Operations[2]	10,276,254	3,343,250	-6,933,004	-67.5	10,390,049	113,795	1.1	10,390,049	113,795	1.1	10,980,964	704,710	6.9	10,716,955	440,702	4.3
TOTAL	**37,847,797**	**19,867,033**	**-17,980,764**	**-47.5**	**35,645,775**	**-2,202,022**	**-5.8**	**35,868,151**	**-1,979,647**	**-5.2**	**38,108,977**	**261,179**	**0.7**	**38,848,444**	**1,000,646**	**2.6**
Upper Columbia River																
Commercial	0	0	0	0.0	0	0	0.0	0	0	0.0	57,230	57,230	NA	84,918	84,918	NA
Recreational	1,149,601	1,093,903	-55,698	-4.8	1,124,776	-24,825	-2.2	1,124,776	-24,825	-2.2	1,370,482	220,881	19.2	1,527,073	377,471	32.8
Hatchery Facility Operations[2]	7,073,996	7,165,437	91,441	1.3	7,670,170	596,174	8.4	7,670,170	596,174	8.4	8,299,477	1,225,481	17.3	10,441,272	3,367,276	47.6
TOTAL	**8,223,597**	**8,259,340**	**35,743**	**0.4**	**8,794,946**	**571,349**	**6.9**	**8,794,946**	**571,349**	**6.9**	**9,727,190**	**1,503,593**	**18.3**	**12,053,263**	**3,829,665**	**46.6**
Lower Snake River																
Commercial	298,401	234,132	64,268	-21.5	238,290	60,110	-20.1	238,376	-60,025	-20.1	351,889	53,488	17.9	332,944	34,543	11.6
Recreational	24,166,767	21,253,617	-2,913,150	-12.1	21,395,885	-2,770,882	-11.5	21,395,885	-2,770,882	-11.5	24,560,471	393,703	1.6	25,382,251	1,215,484	5.0
Hatchery Facility Operations[2]	24,009,550	21,684,229	-2,325,321	-9.7	23,276,050	-733,500	-3.1	23,327,978	-681,572	-2.8	26,459,907	2,450,356	10.2	27,924,964	3,915,414	16.3
TOTAL	**48,474,718**	**43,171,979**	**-5,302,739**	**-10.9**	**44,910,226**	**-3,564,492**	**-7.4**	**44,962,239**	**-3,512,480**	**-7.2**	**51,372,266**	**2,897,548**	**6.0**	**53,640,159**	**5,165,441**	**10.7**
ALL COLUMBIA RIVER BASIN																
COMMERCIAL	**17,858,948**	**7,725,528**	**-10,133,420**	**-56.7**	**15,362,235**	**-2,496,713**	**-14.0**	**16,473,765**	**-1,385,184**	**-7.8**	**16,700,285**	**-1,212,151**	**-6.5**	**18,945,098**	**1,086,149**	**6.1**
RECREATIONAL	**91,617,079**	**63,278,346**	**-28,338,733**	**-30.9**	**82,404,359**	**-9,212,720**	**-10.1**	**84,225,582**	**-7,391,497**	**-8.1**	**88,557,805**	**-3,059,274**	**-3.3**	**94,800,147**	**3,183,068**	**3.5**
HATCHERY FACILITY OPERATIONS[2]	**64,088,521**	**45,502,057**	**-18,586,465**	**-29.0**	**64,036,911**	**-51,610**	**-0.1**	**65,246,414**	**1,157,893**	**1.8**	**68,422,570**	**4,334,049**	**6.8**	**73,203,947**	**9,115,426**	**14.2**
TOTAL	**173,564,549**	**116,505,931**	**-57,058,618**	**-32.9**	**161,803,505**	**-11,761,044**	**-6.8**	**165,945,761**	**-7,618,788**	**-4.4**	**173,680,660**	**116,111**	**0.1**	**186,949,192**	**13,384,643**	**7.7**

Source: Based on modeled estimates of harvest provided by the Mitchell Act Fishery Modeling Team (Appendix K) and application of personal income factors identified in Appendix J.
[1] All dollar values are expressed in 2009 dollars.
[2] The estimates of personal income related to hatchery production in this table are based on hatchery production costs reported in Table 4-100.

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TABLE 4-110. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON JOBS IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6		
	ALTERNATIVE 1 (NO ACTION)		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER OF JOBS[1]	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)
Lower Columbia River																
Commercial	140.2	41.9	-98.3	-70.1	115.2	-25.0	-17.8	138.4	-1.8	-1.3	118.8	-21.4	-15.3	148.1	7.9	5.6
Recreational	1,286.3	766.5	-519.8	-40.4	1,145.6	-140.7	-10.9	1,191.1	-95.2	-7.4	1,193.7	-92.6	-7.2	1,329.0	42.7	3.3
Hatchery Facility Operations	454.6	266.2	-188.4	-41.4	454.0	-0.6	-0.1	477.2	22.6	5.0	453.6	-0.9	-0.2	482.4	27.8	6.1
TOTAL	**1,881.1**	**1,074.5**	**-806.5**	**-42.9**	**1,714.8**	**-166.2**	**-8.8**	**1,806.6**	**-74.4**	**-4.0**	**1,766.1**	**-115.0**	**-6.1**	**1,959.5**	**78.4**	**4.2**
Mid Columbia River																
Commercial	359.4	174.5	-184.9	-51.5	316.1	-43.3	-12.0	321.9	-37.4	-10.4	346.7	-12.7	-3.5	379.0	19.6	5.5
Recreational	464.4	319.2	-145.2	-31.3	438.5	-25.9	-5.6	439.2	-25.1	-5.4	463.8	-0.6	-0.1	461.5	-2.9	-0.6
Hatchery Facility Operations	205.5	66.9	-138.7	-67.5	207.8	2.3	1.1	207.8	2.3	1.1	219.6	14.1	6.9	214.3	8.8	4.3
TOTAL	**1,029.3**	**560.5**	**-468.7**	**-45.5**	**962.4**	**-66.9**	**-6.5**	**969.0**	**-60.3**	**-5.9**	**1,030.1**	**0.8**	**0.1**	**1,054.8**	**25.5**	**2.5**
Upper Columbia River																
Commercial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	NA	2.8	2.8	NA
Recreational	38.1	36.3	-1.8	-4.8	37.3	-0.8	-2.2	37.3	-0.8	-2.2	45.4	7.3	19.2	50.6	12.5	32.8
Hatchery Facility Operations	141.5	143.3	1.8	1.3	153.4	11.9	8.4	153.4	11.9	8.4	166.0	24.5	17.3	208.8	67.3	47.6
TOTAL	**179.6**	**179.6**	**-0.0**	**0.0**	**190.7**	**11.1**	**6.2**	**190.7**	**11.1**	**6.2**	**213.3**	**33.7**	**18.8**	**262.3**	**82.7**	**46.0**
Lower Snake River																
Commercial	11.4	8.9	-2.5	-21.5	9.1	-2.3	-20.1	9.1	-2.3	-20.4	13.4	2.0	17.9	12.7	1.3	11.6
Recreational	921.7	810.6	-111.1	-12.1	816.0	-105.7	-11.5	816.0	-105.7	-11.5	936.7	15.0	1.6	968.1	46.4	5.0
Hatchery Facility Operations	480.2	433.7	-46.5	-9.7	465.5	-14.7	-3.1	466.6	-13.6	-2.8	529.2	49.0	10.2	558.5	78.3	16.3
TOTAL	**1,413.3**	**1,253.2**	**-160.1**	**-11.3**	**1,290.6**	**-122.6**	**-8.7**	**1,291.7**	**-121.6**	**-8.6**	**1,479.3**	**66.1**	**4.7**	**1,539.3**	**126.0**	**8.9**
ALL COLUMBIA RIVER BASIN																
COMMERCIAL	**510.9**	**225.2**	**-285.7**	**-55.9**	**440.3**	**-70.6**	**-13.8**	**469.4**	**-41.6**	**-8.1**	**480.8**	**-30.2**	**-5.9**	**542.5**	**31.6**	**6.2**
RECREATIONAL	**2,710.5**	**1,932.6**	**-777.9**	**-28.7**	**2,437.4**	**-273.1**	**-10.1**	**2,483.7**	**-226.8**	**-8.4**	**2,639.6**	**-70.9**	**-2.6**	**2,809.2**	**98.7**	**3.6**
HATCHERY FACILITY OPERATIONS	**1,281.8**	**910.0**	**-371.7**	**-29.0**	**1,280.7**	**-1.0**	**-0.1**	**1,304.9**	**23.2**	**1.8**	**1,368.5**	**86.7**	**6.8**	**1,464.1**	**182.3**	**14.2**
TOTAL	**4,503.2**	**3,067.9**	**-1,435.3**	**-31.9**	**4,158.5**	**-344.7**	**-7.7**	**4,258.0**	**-245.2**	**-5.4**	**4,488.9**	**-14.3**	**-0.3**	**4,815.8**	**312.6**	**6.9**

Source: Derived based on application of earnings-per-job factors to total personal income generated by commercial and recreational harvest (Appendix J) and on application of jobs per million dollars of hatchery production costs from Table 4-100.

[1] Jobs are expressed in full- and part-time jobs.

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TABLE 4-111. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON PERSONAL INCOME IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	U.S. DOLLARS ($)[1]	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)
California Coast																
Commercial	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Recreational	155,302	99,055	-56,247	-36.2	139,889	-15,413	-9.9	145,825	-9,477	-6.1	141,713	-13,589	-8.8	142,885	-12,417	-8.0
TOTAL	**155,302**	**99,055**	**-56,247**	**-36.2**	**139,889**	**-15,413**	**-9.9**	**145,825**	**-9,477**	**-6.1**	**141,713**	**-13,589**	**-8.8**	**142,885**	**-12,417**	**-8.0**
Oregon Coast																
Commercial	642,845	415,752	-227,093	-35.3	575,543	-67,302	-10.5	583,226	-59,618	-9.3	581,202	-61,643	-9.6	597,525	-45,319	-7.0
Recreational	2,511,007	1,602,163	-908,844	-36.2	2,189,173	-321,834	-12.8	2,251,732	-259,275	-10.3	2,230,875	-280,133	-11.2	2,229,192	-281,815	-11.2
TOTAL	**3,153,852**	**2,017,915**	**-1,135,937**	**-36.0**	**2,764,716**	**-389,136**	**-12.3**	**2,834,959**	**-318,893**	**-10.1**	**2,812,076**	**-341,776**	**-10.8**	**2,826,718**	**-327,134**	**-10.4**
Washington Coast																
Commercial	3,416,494	2,426,480	-990,014	-29.0	3,172,436	-244,059	-7.1	3,213,941	-202,554	-5.9	3,181,478	-235,016	-6.9	3,314,324	-102,170	-3.0
Recreational	6,466,567	4,114,069	-2,352,498	-36.4	5,388,904	-1,077,663	-16.7	5,410,796	-1,055,771	-16.3	5,531,371	-935,196	-14.5	5,484,357	-982,210	-15.2
TOTAL	**9,883,061**	**6,540,549**	**-3,342,512**	**-33.8**	**8,561,339**	**-1,321,722**	**-13.4**	**8,624,737**	**-1,258,324**	**-12.7**	**8,712,848**	**-1,170,213**	**-11.8**	**8,798,681**	**-1,084,380**	**-11.0**
Puget Sound/Strait of Juan de Fuca																
Commercial	6,863,355	6,292,723	-570,633	-8.3	6,826,089	-37,266	-0.5	6,843,674	-19,681	-0.3	6,826,810	-36,545	-0.5	6,871,357	8,002	0.1[2]
Recreational	13,162,057	12,804,984	-357,073	-2.7	13,126,167	-35,889	-0.3	13,136,241	-25,815	-0.2	13,128,423	-33,634	-0.3	13,157,619	-4,437	0.0
TOTAL	**20,025,412**	**19,097,706**	**-927,705**	**-4.6**	**19,952,257**	**-73,155**	**-0.4**	**19,979,915**	**-45,496**	**-0.2**	**19,955,233**	**-70,179**	**-0.4**	**20,028,976**	**3,564**	**0.0**
British Columbia																
Commercial	15,332,844	13,807,688	-$1,525,156	-9.9	15,117,434	-215,410	-1.4	15,238,048	-94,796	-0.6	15,202,321	-130,524	-0.9	15,635,142	302,298	2.0
Recreational	32,974,638	30,783,656	-2,190,983	-6.6	32,681,746	-292,893	-0.9	32,864,805	-109,833	-0.3	32,809,032	-165,607	-0.5	33,451,241	476,602	1.4
TOTAL	**48,307,483**	**44,591,344**	**-3,716,139**	**-7.7**	**47,799,179**	**-508,303**	**-1.1**	**48,102,853**	**-204,629**	**-0.4**	**48,011,352**	**-296,130**	**-0.6**	**49,086,383**	**778,901**	**1.6**
Southeast Alaska																
Commercial	13,342,903	12,193,378	-1,149,526	-8.6	13,405,273	62,370	0.5	13,483,542	140,638	1.1	13,459,124	116,220	0.9	13,649,291	306,388	2.3
Recreational	14,648,753	13,412,541	-1,236,212	-8.4	14,715,826	67,073	0.5	14,799,997	151,244	1.0	14,773,737	124,985	0.9	14,978,245	329,493	2.2
TOTAL	**27,991,656**	**25,605,919**	**-2,385,737**	**-8.5**	**28,121,099**	**129,444**	**0.5**	**28,283,538**	**291,882**	**1.0**	**28,232,861**	**241,205**	**0.9**	**28,627,537**	**635,881**	**2.3**
ALL PACIFIC OCEAN AND PUGET SOUND																
COMMERCIAL	**39,598,442**	**35,136,021**	**-4,462,421**	**-11.3**	**39,096,776**	**-501,666**	**-1.3**	**39,362,431**	**-236,011**	**-0.6**	**39,250,934**	**-347,508**	**-0.9**	**40,067,640**	**469,198**	**1.2**
RECREATIONAL	**69,918,324**	**62,816,467**	**-7,101,857**	**-10.2**	**68,241,705**	**-1,676,619**	**-2.4**	**68,609,396**	**-1,308,928**	**-1.9**	**68,615,150**	**-1,303,174**	**-1.9**	**69,443,539**	**-474,784**	**-0.7**
TOTAL	**109,516,765**	**97,952,488**	**-11,564,278**	**-10.6**	**107,338,480**	**-2,178,285**	**-2.0**	**107,971,827**	**-1,544,939**	**-1.4**	**107,866,084**	**-1,650,681**	**-1.5**	**109,511,179**	**-5,586**	**0.0**

Source: Derived based on harvest estimates from Table 4-104 and Table 4-108, and on application of personal income factors identified in Appendix J.

[1] All dollar values are expressed in 2009 dollars.

[2] Personal income from commercial fishing would be higher in the Puget Sound/Strait of Juan de Fuca economic impact region under Alternative 6 compared to Alternative 1 despite a reduction in overall fish harvests (see Table 4-104) because the harvest of Chinook salmon, which would increase under Alternative 6, would generate higher personal income per fish than would the harvest of coho salmon, which would decrease by a larger number of fish under Alternative 6.

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TABLE 4-112. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON JOBS IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6		
	ALTERNATIVE 1 (NO ACTION)		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER OF JOBS[1]	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)
California Coast																
Commercial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recreational	2.8	1.8	-1.0	-36.2	2.5	-0.3	-9.9	2.6	-0.2	-6.1	2.5	-0.2	-8.8	2.6	-0.2	-8.0
TOTAL	**2.8**	**1.8**	**-1.0**	**-36.2**	**2.5**	**-0.3**	**-9.9**	**2.6**	**-0.2**	**-6.1**	**2.5**	**-0.2**	**-8.8**	**2.6**	**-0.2**	**-8.0**
Oregon Coast																
Commercial	18.4	11.9	-6.5	-35.3	16.5	-1.9	-10.5	16.7	-1.7	-9.3	16.6	-1.8	-9.6	17.1	-1.3	-7.0
Recreational	75.8	48.4	-27.4	-36.2	66.2	-9.6	-12.7	68.1	-7.7	-10.1	67.4	-8.4	-11.0	67.4	-8.4	-11.1
TOTAL	**94.2**	**60.3**	**-33.9**	**-36.0**	**82.7**	**-11.5**	**-12.2**	**84.8**	**-9.4**	**-9.9**	**84.1**	**-10.1**	**-10.8**	**84.5**	**-9.7**	**-10.3**
Washington Coast																
Commercial	100.0	71.1	-28.9	-28.9	92.8	-7.1	-7.1	94.0	-5.9	-5.9	93.1	-6.9	-6.9	97.0	-3.0	-3.0
Recreational	193.6	123.2	-70.4	-36.4	161.2	-32.4	-16.7	161.8	-31.8	-16.4	165.5	-28.1	-14.5	163.9	-29.7	-15.3
TOTAL	**293.6**	**194.3**	**-99.3**	**-33.8**	**254.0**	**-39.6**	**-13.5**	**255.8**	**-37.7**	**-12.9**	**258.6**	**-35.0**	**-11.9**	**260.9**	**-32.7**	**-11.1**
Puget Sound/Strait of Juan de Fuca																
Commercial	118.8	108.9	-9.9	-8.3	118.2	-0.6	-0.5	118.5	-0.3	-0.3	118.2	-0.6	-0.5	118.9	0.1	0.1[2]
Recreational	227.8	221.7	-6.2	-2.7	227.2	-0.6	-0.3	227.4	-0.4	-0.2	227.3	-0.6	-0.3	227.8	-0.1	0.0
TOTAL	**346.6**	**330.6**	**-16.1**	**-4.6**	**345.4**	**-1.3**	**-0.4**	**345.9**	**-0.8**	**-0.2**	**345.4**	**-1.2**	**-0.4**	**346.7**	**0.1**	**0.0**
British Columbia																
Commercial	265.4	239.0	-26.4	-9.9	261.7	-3.7	-1.4	263.8	-1.6	-0.6	263.2	-2.3	-0.9	270.7	5.2	2.0
Recreational	570.8	532.9	-37.9	-6.6	565.7	-5.1	-0.9	568.9	-1.9	-0.3	567.9	-2.9	-0.5	579.1	8.3	1.4
TOTAL	**836.2**	**771.9**	**-64.3**	**-7.7**	**827.4**	**-8.8**	**-1.1**	**832.7**	**-3.5**	**-0.4**	**$831.1**	**-5.1**	**-0.6**	**$849.7**	**$13.5**	**1.6**
Southeast Alaska																
Commercial	231.0	211.1	-19.9	-8.6	232.1	1.1	0.5	233.4	2.4	1.1	233.0	2.0	0.9	236.3	5.3	2.3
Recreational	253.6	232.2	-21.4	-8.4	254.7	1.2	0.5	256.2	2.6	1.0	255.7	2.2	0.9	259.3	5.7	2.2
TOTAL	**484.5**	**443.3**	**-41.3**	**-8.5**	**486.8**	**2.2**	**0.5**	**489.6**	**5.1**	**1.0**	**488.7**	**4.2**	**0.9**	**495.6**	**11.0**	**2.3**
ALL PACIFIC OCEAN AND PUGET SOUND																
COMMERCIAL	**733.6**	**642.0**	**-91.6**	**-12.5**	**721.2**	**-12.4**	**-1.7**	**726.4**	**-7.2**	**-1.0**	**724.0**	**-9.5**	**-1.3**	**739.9**	**6.4**	**0.9**
RECREATIONAL	**1,324.4**	**1,160.1**	**-164.3**	**-12.4**	**1,277.6**	**-46.8**	**-3.5**	**1,285.0**	**-39.4**	**-3.0**	**1,286.4**	**-38.0**	**-2.9**	**1,300.0**	**-24.4**	**-1.8**
TOTAL	**2,058.0**	**1,802.0**	**-255.9**	**-12.4**	**1,998.8**	**-59.2**	**-2.9**	**2,011.4**	**-46.5**	**-2.3**	**2,010.4**	**-47.5**	**-2.3**	**2,039.9**	**-18.0**	**-0.9**

Source: Derived based on earnings-per-job factors to total personal income by commercial and recreational harvest. Refer to Appendix J for additional information.

[1] Jobs are expressed in full- and part-time jobs.

[2] Jobs generated by commercial fishing would be higher in the Puget Sound/Strait of Juan de Fuca economic impact region under Alternative 6 compared to Alternative 1 despite a reduction in overall fish harvests (see Table 4-104) because the harvest of Chinook salmon, which would increase under Alternative 6, would generate higher personal income and employment per fish than would the harvest of coho salmon, which would decrease by a larger number of fish under Alternative 6.

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4.4 Environmental Justice

4.4.1 Introduction

This section describes the effects of changes in hatchery production and the resulting predicted changes in tribal harvest, revenues, and other tribal values derived from the production and harvesting of salmon and steelhead resources. It also addresses effects on other user groups and communities of concern, specifically minority and low-income populations. These effects are considered indicators of potential environmental justice impacts.

Communities of concern that rely on Columbia River salmon and steelhead harvest as a source of revenue, including tribal and non-tribal fishing communities, may be affected by the alternatives analyzed in this EIS. Communities of concern that rely on Columbia River salmon and steelhead as a source of sustenance and for ceremonial purposes, central to their culture, may be affected by the alternatives in this EIS. Additionally, changes in overall hatchery production and the economic effect that the hatchery operations have on local communities may affect communities of concern.

Modifications in Columbia River hatchery production of salmon and steelhead, based on the alternative implementation scenarios, and the changes in harvest that may result could affect communities of concern throughout the analysis area (Section 3.4.2, Analysis Area). As described in Section 4.1.3, Implementation Scenarios, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures under each alternative are combined to create an implementation scenario (Table 4-3). Table 4-113 identifies the different implementation measures, including the four measures that may affect environmental justice indicators. These four implementation measures that may affect environmental justice indicators are as follows:

- Change production levels in hatchery programs.
- Establish new selective fisheries in terminal areas.
- Establish new hatchery programs.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

Because all four of the above implementation measures may affect harvest, the analysis below is focused on changes in harvest across the alternatives.

Table 4-113. Environmental Justice Indicators that May be Affected by Implementation Measures Included under the Alternatives' Implementation Scenarios.

Implementation Measures Incorporated in One or More of the Alternatives' Implementation Scenarios	Environmental Justice Indicators That May Be Affected				
	Fish Harvest and Tribal Values	Ceremonial and Subsistence Harvest for Tribes	Tribal Salmon Fishing and Hatchery Program Revenue	Net Revenue for Non-tribal User Groups of Concern	Per Capita Income in Communities of Concern
Change production levels in hatchery programs.	X	X	X	X	X
Update water intake screens at hatchery facilities.					
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.					
Correct water quality issues at hatchery facilities.					
Install new temporary weirs.					
Install new permanent weirs.					
Establish new selective fisheries in terminal areas.	X	X	X	X	X
Change hatchery program goals (i.e., harvest or conservation).					
Change hatchery program's operational strategy (i.e., isolated or integrated).					
Establish new hatchery programs.	X	X	X	X	X
Terminate hatchery programs that only support harvest if they fail to meet performance goals.	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act, as well as to hatchery programs receiving funding from other sources. Implementation measures that were not applied under any of the alternatives are not included in this table.

As described in Section 3.4.3.1, Approach for Identifying Environmental Justice User Groups and Communities of Concern, the target area for analyzing environmental justice effects includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California and 2) the Puget Sound/Strait of Juan de Fuca.

Most of the information presented in this section is at the county level. For consistency with information presented in Sections 3.3, Socioeconomics, and 4.3, Socioeconomics, and environmental justice information presented in Section 3.4, Environmental Justice, results of the analyses presented in this section are generally presented and described by economic impact region. The areas discussed include the lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, and Puget Sound/Strait of Juan de Fuca regions.

4.4.2 Methods for Analysis

The analysis of environmental justice effects is based on evaluating environmental justice groups and communities of concern in the context of the applicable environmental justice indicators described in Section 3.4, Environmental Justice. As described below, separate indicators are used for tribal interests, non-tribal user groups, and communities of concern. For each indicator, analytical findings serve as the basis for conclusions concerning potential environmental justice effects.

As described in Section 4.3.2.1, Harvest Estimates, historical averages and estimates from harvest modeling are used to characterize salmon and steelhead catch under Alternative 1 (No Action) and the action alternatives. These harvest estimates provide the foundation for assessing changes relevant to the environmental justice indicators under the alternatives. As indicated in Section 3.4.3, Environmental Justice Methodology, the values in the tables of this section were used to compare relative numerical and proportional differences among alternatives, and they should not be considered precise predictions of actual harvests in the future. Refer to Appendix J (Socioeconomic Impact Methods) and Appendix K (Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS) for more detailed information on the methods used to estimate harvest levels by alternative.

As described in Section 3.4, Environmental Justice, the EIS alternatives may affect eight groups of Native Americans within the Columbia River Basin: Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of Warm Springs Reservation, Yakama Nation, Confederated Tribes of the Colville Reservation, Cowlitz Indian Tribe, Confederated Tribes of the Grand Ronde, and Shoshone-Bannock Tribes.

4.4.3 Indicators of Environmental Justice Effects

A range of categories (or indicators) was used to determine the presence or absence of potential environmental justice effects and their extent. Because indicators of environmental justice effects can vary across user groups, separate indicators were developed for tribes, other user groups, and communities, as described below.

4.4.3.1 Tribal Indicators of Environmental Justice Effects

Selection of indicators to represent potential effects on tribal peoples appropriately is based both on cultural and economic criteria. Although economic issues are of concern to tribes based on the need for jobs and income, the tribes also place great importance on spiritual, cultural, and lifestyle values associated with fish and wildlife (Section 3.4.4.1, Native American Tribes of Concern). Consequently, this analysis uses the following indicators to predict effects on affected tribes: fish harvest and tribal values, ceremonial and subsistence harvests, and tribal fishing and hatchery revenue.

4.4.3.1.1 Fish Harvests and Tribal Values

From a tribal perspective, the value of the salmon is self-evident and extends beyond economic measures, as discussed in Section 3.4.4.1.1, Fish Harvests and Tribal Values. Numbers of salmon harvested provide one important indicator of the health of stocks, and they are an appropriate measure of relative harvest abundance and tribal value.

4.4.3.1.2 Ceremonial and Subsistence Harvests

A portion of tribal fish harvests is used to meet ceremonial and subsistence needs, which serve as an indicator of cultural viability. As such, this indicator addresses potential effects on cultural sustainability, passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health, as discussed in Section 3.4.4.1.2, Ceremonial and Subsistence Harvests.

4.4.3.1.3 Tribal Salmon Fishing and Hatchery Program Revenue

This tribal indicator directly addresses economic revenue obtained by the tribes from the sale of commercially caught salmon, steelhead, and/or salmon eggs. Tribes also receive economic revenue from processing salmon. For this analysis, a comparison of direct revenues from the sale of tribal harvests was used as an indicator of economic-based environmental justice concerns for tribes, including changes in tribal income associated with each alternative.

4.4.3.2 Non-tribal User Group Indicators of Environmental Justice Effects

For non-tribal commercial fishers, changes in fish harvest are considered the primary factor affecting environmental justice concerns for this user group. Changes in net revenues (i.e., profits) are tied directly to fish harvest and were estimated for the economic analysis (Section 4.3, Socioeconomics). In turn, net revenues earned by commercial fishers affect overall income levels and poverty rates, which are key environmental justice issues (Section 3.4.4.2, Non-tribal User Groups of Concern).

4.4.3.3 Community Indicators of Environmental Justice Effects

The direct economic effects of fish harvests in the Columbia River Basin associated with commercial and recreational fishing also ripple through the local economies. Similarly, hatchery operations not only provide direct economic benefits in the form of employment and labor income, but hatchery-related spending attributed to fish production has secondary economic benefits in the affected economy. These indirect economic benefits provide income and employment to local residents not engaged in fish harvest and/or hatchery operations. From the perspective of environmental justice, changes in these regional economic benefits can have an impact on low-income and minority populations in the affected economic impact regions. Change in per capita income generated from fish harvest is used as an indicator of potential economic benefits at a community level (i.e., county level).

4.4.4 Analysis of Environmental Justice Effects

The analysis of environmental justice effects is based on evaluating the environmental justice groups and communities of concern in the context of the applicable statewide values for the environmental justice indicators described above. For each indicator, a summary of effects across alternatives is presented. The summaries serve as the basis for conclusions concerning potential environmental justice effects.

4.4.4.1 Fish Harvest and Tribal Values

Table 4-114 presents a summary of estimated total fish harvests (i.e., commercial, ceremonial, and subsistence) by Native American tribes in the affected economic impact regions based on harvest modeling results, as explained in Section 4.3.2, Methods for Analysis. As indicated in Section 3.4.3, Environmental Justice Methodology, the values in the tables of this section were used to compare relative numerical and proportional differences among alternatives, and they should not be considered precise predictions of actual harvests in the future. Refer to Appendix J (Socioeconomic Impact Methods) and Appendix K (Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS) for more detailed information on the methods used to estimate harvest levels by alternative.

TABLE 4-114. TOTAL TRIBAL FISH HARVESTS (COMMERCIAL AND CEREMONIAL AND SUBSISTENCE) BY NUMBER OF FISH.

ECONOMIC IMPACT REGION	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE (CHANGE IN NUMBER OF FISH FROM ALTERNATIVE 1)				
		2	3	4	5	6
Lower Columbia River	0	0	0	0	0	0
Mid Columbia River	202,476	-90,531	-23,882	-21,379	-8,748	5,535
Upper Columbia River	2,876	-29	-18	-18	787	1,196
Lower Snake River	11,448	-1,042	-974	-972	869	561
Washington Coast[1]	84,197	-9,116	-2,869	-2,579	-2,663	-1,364
Oregon Coast	0	0	0	0	0	0
California Coast	0	0	0	0	0	0
Puget Sound/Strait of Juan de Fuca (marine)[1]	213,507	-6,604	-803	-627	-741	-187
Total	514,504	-107,322	-28,546	-25,575	-10,496	5,741

Source: Estimates were developed by the Mitchell Act Fishery Modeling Team with the exception of Puget Sound/Strait of Juan de Fuca economic impact region under Alternative 1, which represents average harvest between 2002 and 2009 (Appendix K).
[1] In the Puget Sound/Strait of Juan de Fuca and Washington coast economic impact regions, values for Alternative 1 represent total harvest by tribes in those economic impact regions, not just fish originating from the Columbia River.
Note: Harvest totals for the mid Columbia River and upper Columbia River economic impact regions do not match commercial harvest totals in Table 4-101 for these regions because estimated ceremonial and subsistence harvests are included in the totals of this table and are not included in the totals of Table 4-101.

4.4.4.1.1 Alternative 1 (No Action)

Under Alternative 1, Native American tribes in the affected economic impact regions would catch an estimated 514,504 fish annually (Table 4-114). Tribal fish harvest occurs primarily in five economic impact regions: mid Columbia River, upper Columbia River, lower Snake River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions (Table 4-114).

Most harvest of Columbia River salmon and steelhead would occur in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions because salmon harvests in the Puget Sound/Strait of Juan de Fuca and Washington coast economic impact regions are primarily fish originating from outside the Columbia River Basin (see Table 3-10). The largest percentage of Columbia River fish would be taken in the mid Columbia River economic impact region (Table 4-114), largely reflecting the contribution to tribal commercial fisheries in Zone 6, which occurs between Bonneville Dam and Dalles Dam (i.e., the mid Columbia River economic impact region). The Warm Springs, Nez Perce, Yakama, and Umatilla Tribes are the only tribes that fish in Zone 6 fisheries (Section 3.4.4.1, Native American Tribes of Concern). Alternative 1 would maintain current harvest opportunities and would not result in changes to different economic, material, and cultural activities and values, when compared to baseline conditions.

4.4.4.1.2 Alternative 2 (No Mitchell Act Funding)

The implementation scenario for Alternative 2 would result in the largest annual decline in tribal fish harvests (107,322 fish) among the implementation scenarios for Alternative 2 through Alternative 6, when compared to Alternative 1 (Table 4-114). In total, tribal harvests would decrease by 21 percent compared to Alternative 1 (Table 4-114). The most substantial decreases would occur in the mid Columbia River economic impact region, where tribal harvests would decline by 90,531 fish (45 percent) compared to harvest conditions under Alternative 1 for this economic impact region (202,476 fish) (Table 4-114). The tribes that would be most affected by changes in harvest in the mid Columbia River economic impact region would be the Warm Springs, Nez Perce, Yakama, and Umatilla Tribes.

Outside the Columbia River Basin, under the implementation scenario for Alternative 2, declines in tribal harvests would be concentrated in the Washington coast economic impact region (9,116 fish), mostly affecting the Makah Tribes and other coastal tribes that fish off the Washington Coast (e.g., Quileute and Quinault) (Table 4-114). Although Columbia River fish do not contribute substantially to the tribal harvests in the Puget Sound/Strait of Juan de Fuca economic impact region (Table 3-10), some fish stray into the Strait of Juan de Fuca and the marine waters of Puget Sound. Puget Sound/Strait of Juan de Fuca tribes could be affected indirectly if reductions in the ocean abundance of Columbia River fish would lead to more harvest of Puget Sound/Strait of Juan de Fuca stocks. Increased harvest would limit the number of fish available for tribes that fish in the terminal areas of Puget Sound/Strait of Juan de Fuca under the implementation scenario for Alternative 2 compared to Alternative 1 (W. Beattie, pers. comm., Northwest Indian Fisheries Commission, Conservation Planning Coordinator, May 22, 2009).

Based on the economic and social importance of salmon and steelhead to tribes, estimated losses in tribal fish harvests under the implementation scenario for Alternative 2 would result in the decline of certain economic, material, and cultural activities and values, thereby reducing the social and economic wellbeing of tribes that catch salmon and steelhead originating from the Columbia River Basin. Reductions in tribal harvests under the implementation scenario for Alternative 2 would result in social and cultural effects beyond the loss of commercial harvest revenues and related income. As discussed in Section 3.4.4.1.1, Fish Harvests and Tribal Values, regional tribes use salmon and steelhead in various ways, including for personal and family consumption, formal and informal distribution and sharing within and between tribes, and ceremonial uses. Salmon and steelhead are regularly eaten by individuals and families and are served at gatherings of elders and to guests at feasts and traditional dinners. Tribes throughout the region treat salmon ceremoniously. Salmon is of nutritional, cultural, and economic importance to tribes. To tribes of this region, salmon is a core symbol of tribal identity, individual identity, and the ability of tribal cultures to endure. Under the implementation scenario for Alternative 2, substantial reductions in salmon and steelhead harvests, particularly in the mid Columbia River economic impact region, compared to Alternative 1, would diminish the cultural and social benefits that salmon and steelhead harvests currently provide to tribes in the region.

4.4.4.1.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, annual tribal harvests would decline by an estimated 28,546 fish per year, which represents a decrease of 6 percent compared to Alternative 1 (Table 4-114). Expected declines in tribal harvests would follow patterns comparable to Alternative 2 across economic impact regions, with the greatest effects occurring in the mid Columbia River economic impact region where the Columbia River Basin tribal harvest is concentrated (Table 4-114). The tribes that would be most affected by changes in harvest in the mid Columbia River economic impact region would be the Warm Springs, Nez Perce, Yakama, and Umatilla Tribes. Other economic impact regions subject to declines in fish harvest are (in descending order) the Washington coast economic impact region (2,869 fish), the lower Snake River economic impact region (974 fish), Puget Sound/Strait of Juan de Fuca economic impact region (803 fish), and the upper Columbia River economic impact region (18 fish) (Table 4-114). Tribes in the lower Snake River economic impact region may also experience declines in fish harvests.

Based on the economic and social importance of salmon and steelhead to tribes, the estimated losses in tribal fish harvests under Alternative 3 would result in the decline of certain economic, material, and cultural activities and values, thereby reducing the social and economic wellbeing of tribes that catch salmon and steelhead originating from the Columbia River Basin. Reductions in tribal harvests under the implementation scenario for Alternative 3 would result in social and cultural effects beyond the loss of commercial harvest revenues and related income. As discussed in Section 3.4.4.1.1, Fish Harvests and Tribal Values, regional tribes use salmon and steelhead in various ways, including for personal and family consumption, formal and informal distribution and sharing within and between tribes, and ceremonial uses. Salmon and steelhead are regularly eaten by individuals and families and are served at gatherings of elders and to guests at feasts and traditional dinners. Tribes throughout the regions treat salmon ceremoniously. Salmon is of nutritional, cultural, and economic importance to tribes. To tribes of this region, salmon is a core symbol of tribal identity, individual identity, and the ability of tribal cultures to endure. Under the implementation scenario for Alternative 3, substantial reductions in salmon and steelhead harvests, particularly in the mid Columbia River economic impact region, compared to Alternative 1, would diminish the cultural and social benefits that salmon and steelhead harvests currently provide to tribes in the region.

4.4.4.1.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Overall, annual reductions in tribal fish harvests under the implementation scenario for Alternative 4 would be slightly lower (25,575 fish) than, but similar to, those described under the implementation scenario for Alternative 3 (28,546 fish) when compared to Alternative 1, with minor variations across economic impact regions (Table 4-114). Accordingly, the implementation scenario for Alternative 4 would have an environmental justice effect on tribes similar to that described under the implementation scenario for Alternative 3 when compared to Alternative 1. These effects would include reducing the social and economic wellbeing of tribes that catch salmon and steelhead originating from the Columbia River Basin. Reductions in tribal harvests under the implementation scenario for Alternative 4 would result in social and cultural effects beyond the loss of commercial harvest revenues and related income. As discussed in Section 3.4.4.1.1, Fish Harvest and Tribal Values, regional tribes use salmon and steelhead in various ways, including for personal and family consumption, formal and informal distribution and sharing within and between tribes, and ceremonial uses. Salmon and steelhead are regularly eaten by individuals and families and are served at gatherings of elders and to guests at feasts and traditional dinners. Tribes throughout the regions treat salmon ceremoniously. Salmon is of nutritional, cultural, and economic importance to tribes. To tribes of this region, salmon is a core symbol of tribal identity, individual identity, and the ability of tribal cultures to endure. Under the implementation scenario for Alternative 4, substantial reductions in salmon and steelhead harvests, particularly in the mid Columbia River economic impact region, compared to Alternative 1, would diminish the cultural and social benefits that salmon and steelhead harvests currently provide to tribes in the region.

4.4.4.1.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

For most economic impact regions, reductions in tribal fish harvests would occur under the implementation scenario for Alternative 5, compared to Alternative 1, but these reductions (a total net decline of 11,496 fish) would be lower than under most other action alternatives (Alternative 2 through Alternative 6). Most of the reduced harvest would occur in the mid Columbia River with a decrease of 8,748 fish (Table 4-114), although harvest reductions also would have an environmental justice effect on tribes in the Washington coast (2,663 fish) and Puget Sound/Strait of Juan de Fuca (741 fish) economic impact regions. There would be an increase in tribal fish harvests for the upper Columbia River economic impact region (787 fish) and the lower Snake River economic impact region (869 fish) compared to Alternative 1 (Table 4-114), resulting in a slight beneficial effect on tribes that harvest fish in the upper Columbia River and lower Snake River economic impact regions.

There would be a relatively small decline in various economic, material, and cultural activities and values, thereby reducing the social and economic wellbeing of tribes that fish in the mid Columbia River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions. Reductions in tribal harvests under the implementation scenario for Alternative 5 would result in social and cultural effects beyond the loss of commercial harvest revenues and related income. As discussed in Section 3.4.4.1.1, Fish Harvest and Tribal Values, regional tribes use salmon and steelhead in various ways, including for personal and family consumption, formal and informal distribution and sharing within and between tribes, and ceremonial uses. Salmon and steelhead are regularly eaten by individuals and families and are served at gatherings of elders and to guests at feasts and traditional dinners. Tribes throughout the regions treat salmon ceremoniously. Salmon is of nutritional, cultural, and economic importance to tribes. To tribes of these regions, salmon is a core symbol of tribal identity, individual identity, and the ability of tribal cultures to endure. Under the implementation scenario for Alternative 5, reductions in salmon and steelhead harvests, particularly in the mid Columbia River economic impact region, compared to Alternative 1, would diminish the cultural and social benefits that salmon and steelhead harvests currently provide to tribes in these regions.

The tribal harvest increase in the upper Columbia River and lower Snake River economic impact region would benefit various economic, material, and cultural activities and values. The increase would also improve the social and economic wellbeing of tribes in that region.

4.4.4.1.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would result in differing effects across the economic impact regions, with fish harvests in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions increasing, and harvests in the Washington Coast and Puget Sound/Strait of Juan de Fuca economic impact regions decreasing, when compared to Alternative 1. In total, harvests would increase by 5,741 under Alternative 6, representing a 1 percent increase when compared to Alternative 1 (514,504) (Table 4-114).

The most substantial increase in harvests under Alternative 6 would occur in the mid Columbia River economic impact region, where tribal harvests would increase by 5,535 fish (3 percent) compared to Alternative 1 (202,476 fish) (Table 4-114). The tribes that would benefit the most from this increase in harvest in the mid Columbia River economic impact region would be the Warm Springs, Nez Perce, Yakama, and Umatilla Tribes. Under the implementation scenario for Alternative 6, fish harvests in the upper Columbia River economic impact region would increase by 1,196 fish compared to Alternative 1 (Table 4-114).

Outside the Columbia River Basin, declines in tribal harvests would be concentrated in the Washington coast economic impact region, where harvests would decline by 1,364, or 2 percent, when compared to Alternative 1 harvests (84,197). Additionally, the harvest in the Puget Sound/Strait of Juan de Fuca economic impact region would decline by 187 fish. The harvest reductions in the Washington coast and Puget Sound/Strait of Juan de Fuca economic impact regions would be smaller than under any of the other action alternative implementation scenarios, compared to Alternative 1 (Table 4-114).

As a result of these differing harvest effects across the economic impact regions, there would be a relatively small decline in various economic, material, and cultural activities and values for tribes that fish in the Washington coast economic impact region and potentially in the Puget Sound/Strait of Juan de Fuca economic impact region. These effects would however, reduce the social and economic wellbeing of tribes that catch salmon and steelhead originating from the Columbia River Basin. Reductions in tribal harvests under the implementation scenario for Alternative 6 would result in social and cultural effects beyond the loss of commercial harvest revenues and related income. As discussed in Section 3.4.4.1.1, Fish Harvests and Tribal Values, regional tribes use salmon and steelhead in various ways, including for personal and family consumption, formal and informal distribution and sharing within and between tribes, and ceremonial uses. Salmon and steelhead are regularly eaten by individuals and families and are served at gatherings of elders and to guests at feasts and traditional dinners. Tribes throughout the regions treat salmon ceremoniously today. Salmon is of nutritional, cultural, and economic importance to tribes. To tribes of these regions, salmon is a core symbol of tribal identity, individual identity, and the ability of tribes' cultures to endure. Under the implementation scenario for Alternative 6, reductions in salmon and steelhead harvests in the Washington coast and Strait of Juan de Fuca/Puget Sound economic impact regions would diminish the cultural and social benefits that salmon and steelhead harvests currently provide to tribes in the regions. However, there may be an increase in various economic, material, and cultural activities and values that would improve the social and economic wellbeing of tribes that fish in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions under the implementation scenario for Alternative 6 when compared to Alternative 1.

4.4.4.2 Ceremonial and Subsistence Harvests

As described under Section 3.4.4.1.2, Ceremonial and Subsistence Harvests, ceremonial and subsistence harvest of salmon, primarily Chinook salmon and coho salmon, plays a key role in the cultural viability of tribes in the affected economic impact regions, particularly those economic impact regions within the Columbia River Basin. Each year, an estimated minimum of 28,539 fish are taken for ceremonial and subsistence use, including 19,630 fish in the mid Columbia River economic impact region, 6,033 fish in the lower Snake River economic impact region, and 2,876 fish in the upper Columbia River economic impact region (Table 3-26). As indicated in Section 3.4.3, Environmental Justice Methodology, the values in the tables of this section were used to compare relative numerical and proportional differences among alternatives, and they should not be considered precise predictions of actual harvests in the future. Refer to Appendix J, Socioeconomic Impact Methods, for a detailed description of methods, including data sources and assumptions for estimating ceremonial and subsistence harvest.

No established ceremonial and subsistence harvest occurs in the lower Columbia River economic impact region. Effects of the alternatives on ceremonial and subsistence fishing in other economic impact regions where Columbia River stocks are caught are believed to be negligible (L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, April 8, 2009), and they were not quantified for this analysis.

Ceremonial and subsistence harvest typically occurs before fish are taken for commercial purposes (W. Beattie, pers. comm., Northwest Indian Fisheries Commission, Conservation Planning Coordinator, May 22, 2009), although ceremonial and subsistence harvest can occur at other times of the year. Ceremonial and subsistence harvests generally do not vary substantially from year to year because tribes take fish to meet the need that a given number of tribal members have for fresh fish; in practice, fish tribes take for ceremonial and subsistence purposes are considered priority fish (L. Lestelle, pers. comm., Biostream Environmental, Fisheries Biologist, March 28, 2012). As a result, changes in hatchery production would be expected to affect commercial tribal fisheries primarily, although effects on ceremonial and subsistence harvests could result from implementing certain action alternatives.

4.4.4.2.1 Alternative 1 (No Action)

Under Alternative 1, Native American tribes in the affected economic impact regions would likely continue current levels of ceremonial and subsistence harvests. As discussed above, ceremonial and subsistence harvests in the Columbia River Basin annually average at least 28,539 fish, with much of the catch (19,630 fish) occurring in the mid Columbia River economic impact region and smaller harvests occurring in the lower Snake River economic impact region (6,033 fish) and the upper Columbia River economic impact region (2,876 fish) (Table 3-26). Alternative 1 would maintain current ceremonial and subsistence harvest opportunities and would not be expected to result in changes in tribal cultural viability, which includes passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health (Section 3.4.4.1.2, Ceremonial and Subsistence Harvests).

4.4.4.2.2 Alternative 2 (No Mitchell Act Funding)

Under the Alternative 2 implementation scenario, total tribal harvests (commercial plus ceremonial and subsistence) in the mid Columbia River economic region would be substantially reduced, and there would be a minor reduction of the total tribal harvest in the upper Columbia River economic impact regions when compared to Alternative 1 (Table 4-114). These reductions indicate that ceremonial and subsistence harvests would likely decline in those regions. A relatively small reduction in the total tribal harvest would also occur in the lower Snake River economic impact region compared to Alternative 1 (Table 4-114), but harvest estimates suggest that levels of salmon and steelhead harvest would be sufficient to meet current ceremonial and subsistence needs, although meeting current ceremonial and subsistence needs could further reduce fish available for commercial tribal harvests.

In the mid Columbia River economic impact region, harvest estimates produced from the implementation scenario for Alternative 2 suggest that levels of salmon and steelhead harvest would be sufficient in the Columbia River mainstem to meet current ceremonial and subsistence needs, although meeting them could further reduce fish available for commercial tribal harvests compared to Alternative 1. In terminal areas, however, levels of coho and Chinook salmon (spring and fall) may be insufficient to meet current ceremonial and subsistence needs. Similarly, in the upper Columbia River terminal areas, harvest estimates suggest that levels of spring Chinook salmon may not be sufficient to meet current ceremonial and subsistence needs compared to Alternative 1.

As discussed in Section 3.4.4.1.2, Ceremonial and Subsistence Harvests, salmon and steelhead harvests provide a major part of the subsistence resources for tribes within the region. They are important for maintaining tribal cultural viability and sustainability, passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health. Additionally, salmon is a key food in Native American traditional ceremonies, such as winter ceremonials, first salmon ceremonies, naming ceremonies, giveaways and feasts, and funerals. As a result, reductions of ceremonial and subsistence harvests under the implementation scenario for Alternative 2, compared to Alternative 1, would result in an environmental justice impact in the mid Columbia River and upper Columbia River economic impact regions.

4.4.4.2.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the Alternative 3 implementation scenario, total (commercial plus ceremonial and subsistence) tribal harvests in the mid Columbia River and upper Columbia River economic impact regions would be reduced when compared to Alternative 1, although the reductions would be much smaller than under Alternative 2 (Table 4-114). Harvest estimates produced from the implementation scenario for Alternative 3 suggest that levels of salmon and steelhead would be sufficient in the Columbia River mainstem and terminal areas to meet current ceremonial and subsistence needs in both economic impact regions, although meeting the current ceremonial and subsistence needs may further reduce fish available for commercial tribal harvests compared to Alternative 1.

As a result, no environmental justice impacts related to ceremonial and subsistence harvests are anticipated under the implementation scenario for Alternative 3 relative to Alternative 1. Implementation of Alternative 3 would not be expected to result in changes in tribal cultural viability, relative to Alternative 1, which includes passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health (Section 3.4.4.1.2, Ceremonial and Subsistence Harvests).

4.4.4.2.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Overall, annual reductions in tribal fish harvests under the implementation scenario for Alternative 4 would be slightly lower than, but similar to, those under the implementation scenario for Alternative 3 when compared to Alternative 1, with minor variations across economic impact regions (Table 4-114). Accordingly, the implementation scenario for Alternative 4 would have the same environmental justice effect on tribes relative to ceremonial and subsistence harvests as described under the implementation scenario for Alternative 3, with no anticipated effects relative to Alternative 1. As a result, implementation of Alternative 4 would not be expected to result in changes in tribal cultural viability, which includes passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health (Section 3.4.4.1.2, Ceremonial and Subsistence Harvests).

4.4.4.2.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, overall annual fish harvests by tribes would decline in the mid Columbia River economic impact region, and they would increase in the upper Columbia River and lower Snake River economic impact regions (Table 4-114). Levels of salmon and steelhead would be sufficient in the Columbia River mainstem and terminal areas to meet current ceremonial and subsistence needs in these economic impact regions, although meeting the current ceremonial and subsistence needs may further reduce fish available for commercial tribal harvests, compared to Alternative 1. As a result, no environmental justice effects related to ceremonial and subsistence harvests are anticipated under the implementation scenario for Alternative 5 compared to Alternative 1. Implementation of Alternative 5 would not be expected to result in changes in tribal cultural viability, which includes passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health (Section 3.4.4.1.2, Ceremonial and Subsistence Harvests).

4.4.4.2.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Total annual fish harvests by tribes would increase in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions under the Alternative 6 implementation scenario compared to Alternative 1 (Table 4-114). This increase indicates harvests would be sufficient to meet current tribal demand for ceremonial and subsistence fish in these regions. As a result, no environmental justice effects related to ceremonial and subsistence harvests are anticipated under the implementation scenario for Alternative 6 relative to Alternative 1. Implementation of Alternative 6 would not be expected to result in changes in tribal cultural viability, which includes passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health (Section 3.4.4.1.2, Ceremonial and Subsistence Harvests).

4.4.4.3 Tribal Salmon Fishing and Hatchery Program Revenue

Changes in commercial harvests by tribes would have a direct effect on revenue derived from the sale of these fish. Indirectly, changes in tribal revenue affect the economic welfare of tribes. Table 4-115 presents a summary of projected tribal salmon fishing revenue across alternatives. Additionally, spending on hatchery programs operated by tribes supports hatchery jobs and provides an indirect source of income to communities where the hatcheries are located, affecting the economic welfare of tribes (comparisons of hatchery program costs to Alternative 1 under all alternatives do not include BMP-related costs). Alternative 1 represents a continuation of current hatchery and harvest practices, and tribal fishing revenues under Alterative 1 are based on predicted harvest estimates provided by the Mitchell Act Fishery Modeling Team (with the exception of the lower Snake River and Puget Sound/Strait of Juan de Fuca economic impact regions, as explained in Section 4.3.2, Methods for Analysis).

TABLE 4-115. TRIBAL FISHING REVENUE.

Economic Impact Region	Alternative 1 (No Action) ($)[1]	Alternative (Change in Revenues from Alternative 1) 2 ($)	3 ($)	4 ($)	5 ($)	6 ($)
Mid Columbia River	2,815,591	-1,244,650	-260,609	-222,061	99,875	469,994
Upper Columbia River	0	0	0	0	36,311	53,720
Lower Snake River	136,754	-38,942	-36,470	-36,456	32,310	20,873
Washington Coast	1,401,139	-291,756	-73,577	-61,555	-70,879	-27,908
Puget Sound/Strait of Juan de Fuca (marine)	2,726,685	-131,886	-11,615	-7,773	-11,017	-406
Total	7,080,169	-1,707,234	-382,271	-327,845	86,600	516,273

Source: Estimates of tribal salmon revenues were derived by the Mitchell Act Socioeconomics Team using harvest modeling estimates for all areas provided by the Mitchell Act Fishery Modeling Team with the exception of the lower Snake River economic impact region and Puget Sound/Strait of Juan de Fuca (marine) area under Alternative 1. Tribal salmon revenues under Alternative 1 reflect average annual tribal harvest from 2008 to 2011 in the lower Snake River tribal fishery, and from 2002 to 2009 for the Puget Sound/Strait of Juan de Fuca (marine) area.
[1] All dollars are in 2009 U.S. dollars.
Note: Revenues do not include any monetary value attributable to tribal ceremonial and subsistence catch.

4.4.4.3.1 Alternative 1 (No Action)

Under Alternative 1, commercial catch by tribes that harvest Columbia River salmon and steelhead in the affected economic impact regions would generate approximately $7,080,169 in revenues annually (Table 4-115). Tribal revenues from commercial fishing would be largest in the mid Columbia River economic impact region ($2,815,591), which accounts for 41 percent of total tribal salmon revenue generated in the affected economic impact regions (Table 4-115). Tribal salmon revenues in other economic impact regions affected by Columbia River salmon and steelhead include the Puget Sound/Strait of Juan de Fuca economic impact region ($2,726,685), the Washington coast economic impact region ($1,401,139), and the lower Snake River economic impact region ($136,754) (Table 4-115). Tribal catch in the upper Columbia River economic impact region is primarily for ceremonial and subsistence uses and, thus, generates little revenue from commercial sales. Under Alternative 1, these revenues would be maintained and would continue to have a positive effect on the economic livelihood and welfare of tribal members.

Under Alternative 1, annual smolt production costs for hatchery programs operated by the Yakama Nation would be an estimated $2.3 million, an estimated $0.9 million for hatcheries operated by the Nez Perce Tribe, and an estimated $0.1 million for hatcheries operated by the Confederated Tribes of Colville (Table 4-100). These operating costs do not include hatchery programs that the tribes jointly operate with other entities. Total annual smolt production costs at tribal hatcheries are estimated at $3.3 million. Under Alternative 1, maintaining these hatchery operations expenditures would continue to support hatchery jobs and would provide an indirect source of income to communities where the hatcheries are located.

4.4.4.3.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, the tribal commercial harvest and associated fishing revenues would decline in all economic impact regions compared to Alternative 1 (Table 4-115). In total, tribal fishing revenues would decline by an estimated $1,707,234 annually when compared to Alternative 1 (Table 4-115). These effects would be concentrated in the mid Columbia River economic impact region ($1,244,650) (Table 4-115). Tribal fishing revenue in the lower Snake River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions would also be negatively affected under the implementation scenario for Alternative 2, compared to Alternative 1 (Table 4-115). Revenue effects would include reductions in harvest-related revenues, including the sale of fish and fish eggs, as well as reduced fish processing revenues.

Tribes would also be directly affected by reductions in expenditures on smolt production for hatchery programs that they operate. Under the implementation scenario for Alternative 2, smolt production costs for tribally maintained hatchery programs would decrease by about 42 percent (to a total of $1.9 million) relative to Alternative 1 (Table 4-100). The greatest impact would occur for hatchery programs maintained by the Yakama Nation, for which operating expenditures would decrease from an estimated $2.3 million to $0.9 million annually (Table 4-100).

4.4.4.3.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The decline in total tribal fishing revenue under the implementation scenario for Alternative 3 would be an estimated $382,271 annually, when compared to Alternative 1 (Table 4-115). All tribes engaged in commercial fisheries supported by Columbia River stocks would experience a decline in fishing revenues under the implementation scenario for Alternative 3 (Table 4-115). Similar to the effects of the implementation scenario for Alternative 2, the greatest effects on tribal revenues would be expected to occur in the mid Columbia River economic impact region under the implementation scenario for Alternative 3 (a reduction of $260,609) (Table 4-115). Decreases in tribal revenue would also be expected to occur in the lower Snake River, Washington coast, and the Puget Sound economic impact regions (Table 4-115). Effects would include reductions in harvest-related revenues, as well as in the sale of fish and fish eggs and reduced fish processing revenues. Under the implementation scenario for Alternative 3, smolt production costs for tribally maintained hatchery programs would increase by about 3 percent (to a total of $3.4 million) compared to Alternative 1, entirely due to an increase in smolt production costs at facilities operated by the Yakama Nation (Table 4-100).

4.4.4.3.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Tribal fishing revenues under the implementation scenario for Alternative 4 would decline by $327,845 annually compared to Alternative 1. This revenue reduction would be similar to, but slightly lower than, the reduction estimated for Alternative 3, with minor variations across economic impact regions (Table 4-115). As a result, the implementation scenario for Alternative 4 would negatively affect tribal revenues from commercially harvested Columbia River salmon and steelhead in the mid Columbia River, lower Snake River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions. As previously indicated, revenue effects would include reductions in harvest-related revenues, as well as in the sale of fish and fish eggs and reduced fish processing revenues. Under the implementation scenario for Alternative 4, smolt production costs for tribally maintained hatchery programs would increase by about 3 percent (to a total of $3.4 million) relative to Alternative 1 (Table 4-100), which is similar to the implementation scenario for Alternative 3.

4.4.4.3.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

In contrast to the other alternatives, total tribal fishing revenues under the implementation scenario for Alternative 5 would increase by an estimated $86,600 annually compared to Alternative 1 (Table 4-115). Across economic impact regions, however, effects on tribal fishing revenue would vary. In the mid Columbia River and lower Snake River economic impact regions, revenues would increase by an estimated $99,875 and $32,310 per year, respectively (Table 4-115). In the upper Columbia River economic impact region, fish harvest levels would be high enough to support both ceremonial and subsistence needs and a small commercial fishery, generating an estimated $36,311 in tribal fishing revenues. Declines in tribal fishing revenues would be anticipated in the Washington coast and Puget Sound/Strait of Juan de Fuca economic impact regions, with the largest declines in the Washington coast economic impact region, corresponding with the relatively large reduction in tribal harvest in that region (Table 4-115). Effects would include reductions in harvest-related revenues, such as the sale of fish and fish eggs, as well as reduced fish processing revenues. Tribes in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions would realize increases in tribal revenues from the sale of fish and fish eggs, as well as from fish processing compared to Alternative 1 (Table 4-115).

Smolt production costs for tribally maintained hatchery programs would increase under Alternative 5 by approximately 30 percent (to a total of $4.3 million) compared to Alternative 1 (Table 4-100). Increases in smolt production costs would occur at hatcheries operated by Yakama Nations and Confederated Tribes of Colville.

4.4.4.3.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Effects on tribal fishing revenues under the implementation scenario for Alternative 6 would be similar to those for Alternative 5, with annual tribal revenues increasing in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions and declining in the Washington coast and Puget Sound/Strait of Juan de Fuca economic impact regions compared to Alternative 1. The increases would be larger, however, and the decreases would be smaller than under Alternative 5, with net tribal revenues totaling $516,273 across the economic impact regions (Table 4-115). In the mid Columbia River and upper Columbia River economic impact regions, tribal revenues would increase by $469,994 and $53,720, respectively, under the implementation scenario for Alternative 6, compared to Alternative 1 (Table 4-115). In the lower Snake River economic impact region, the increase would be smaller, at $20,873 (Table 4-115). In the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions, tribes would be expected to realize increases in revenues from the sale of fish and fish eggs, as well as fish processing. Conversely, in the Washington coast and Puget Sound/Strait of Juan de Fuca economic impact regions, revenues would decrease by an estimated $27,908 and $406, respectively, compared to Alternative 1 (Table 4-115). Tribes in these economic impact regions would experience reductions in harvest-related revenues, such as the sale of fish and fish eggs, as well as reduced fish processing revenues.

Smolt Production costs for tribally maintained hatchery programs would increase under the implementation scenario for Alternative 6 by approximately 82 percent (to a total of $6.0 million) compared to Alternative 1. This change reflects relatively large increases at Yakama Nation hatcheries ($1.2 million) and Confederated Tribes of Colville hatcheries ($1.4 million) (Table 4-100).

4.4.4.4 Non-tribal User Groups of Concern

Hatchery production and management actions also would affect non-tribal commercial salmon fishers along the Washington coast and the Oregon coast (Section 3.4.4.2, Non-tribal User Groups of Concern). Although Table 3-27 identifies 11 communities of concern for commercial fishers, only five of these communities (La Push, Neah Bay, and Westport [Washington], Dodson [Oregon], and Longview [Washington]) are affected by the harvesting of salmon originating from the Columbia River Basin. No meaningful numbers of salmon originating from the Columbia River Basin are commercially harvested south of Astoria, Oregon. As a result, no net revenue effects are identified for Oregon communities south of Astoria or for port communities in California. For the other communities of commercial fishers, changes in commercial catch directly affect net revenues (or profits) realized by commercial fishers operating out of these coastal ports.

Table 4-116 summarizes changes in total net revenues for commercial fishers in these five communities. Alternative 1 represents a continuation of current hatchery production and harvest management practices, and estimates of net revenues of commercial fishing under Alternative 1 are based on predicted harvests developed by the Mitchell Act Fishery Modeling Team. As indicated in Section 3.4.3, Environmental Justice Methodology, the values in the tables of this section were used to compare relative numerical and proportional differences among alternatives, and they should not be considered precise predictions of actual harvests in the future. Refer to Appendix J (Socioeconomic Impact Methods) and Appendix K (Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS) for more detailed information on the methods used to estimate harvest levels by alternative.

Table 4-116. Estimates of Annual Net Revenues of Non-tribal Commercial Fishers, by Economic Impact Region and Port Community of Concern.

Economic Impact Region/ Port[1]	Alternative 1 (No Action) ($)[2]	Alternative (change in revenues from Alternative 1)				
		2 ($)	3 ($)	4 ($)	5 ($)	6 ($)
Washington Coast						
La Push	91,889	-34,047	-8,649	-7,273	-8,229	-4,318
Neah Bay	37,224	-14,008	-3,372	-2,773	-3,262	-1,446
Westport	202,455	-76,222	-18,362	-15,105	-17,704	-7,882
Oregon Coast						
Coos Bay	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Tillamook	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
California Coast						
Crescent City	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Eureka	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Fort Bragg	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
San Francisco	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Lower Columbia River						
Dodson	95,648	-64,307	-15,667	-702	-13,037	6,376
Longview	89,909	-60,449	-14,727	-659	-12,255	5,994
Total	**314,670**	**-249,033**	**-60,777**	**-26,512**	**-54,187**	**-1,276**

Source: Estimates of non-tribal commercial fishing net revenues were derived by the Mitchell Act Socioeconomics Team using modeled harvest estimates provided by the Mitchell Act Fishery Modeling Team for all areas (Appendix K).
[1] Only port communities that were identified as commercial fishers' communities of concern in Table 3-27 have been included in this table.
[2] All dollars are in 2009 U.S. dollars.
[3] No meaningful numbers of Columbia River salmon are commercially harvested south of Astoria; thus, no fishing net revenues are estimated for communities south of Astoria, Oregon, including those elsewhere in Oregon and in California.

4.4.4.4.1 Alternative 1 (No Action)

Under Alternative 1, total net revenues associated with the salmon harvest by non-tribal commercial fishers in commercial fishing port communities of concern would be an estimated $314,670 annually (Table 4-116). Along the Washington coast, fishers in the port communities of Westport and La Push account for an estimated $202,455 and $91,889 in annual net revenues, respectively (Table 4-116). Net revenues of commercial fishers operating out of Neah Bay (Washington) would be an estimated $37,224 annually (Table 4-116). In the lower Columbia River economic impact region, commercial fishing for salmon would generate an estimated $95,648 annually for commercial fishers operating out of Dodson, Oregon, and $89,909 for commercial fishers operating out of Longview, Washington (Table 4-116). The revenues generated by commercial fishing (i.e., the sale of fish and fish eggs and fish processing revenues) also would benefit businesses (and individuals) that support commercial fishers in these port communities.

4.4.4.4.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, net revenues for non-tribal commercial fishers would decline in five port communities of concern (La Push, Neah Bay, Westport, Dodson, and Longview) by a total of $249,033 annually compared to Alternative 1 (Table 4-116). Reductions in net revenues would be expected to result in decreased employment opportunities for commercial fishers and for businesses (and individuals) that support commercial fishing activity in these communities. Reductions in commercial salmon revenues could further contribute to already challenging economic conditions in these communities.

4.4.4.4.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, net revenues accruing to non-tribal commercial fishers in port communities of concern would decline by an estimated $60,777 annually compared to Alternative 1 (Table 4-116). Similar to Alternative 2, Alternative 3 would reduce annual commercial fishing net revenue in five port communities of concern (La Push, Neah Bay, Westport, Dodson, and Longview). This would be expected to decrease employment opportunities for commercial fishers and support businesses. Reduced commercial salmon revenues may further contribute to already challenging economic conditions in these communities. However, the effects on commercial fishers in the affected port communities would be slightly more concentrated than under Alternative 2, primarily impacting the port communities of Westport (decrease of $18,362), Dodson (decrease of $15,667), and Longview (decrease of $14,727) compared to Alternative 1 (Table 4-116).

4.4.4.4.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce net revenues of commercial fishers by an estimated $26,512 annually compared to Alternative 1 (Table 4-116). Similar to the effect of implementation scenarios for Alternatives 2 and 3, all five commercial fisher communities of concern (La Push, Neah Bay, Westport, Dodson, and Longview) would be negatively affected. About 57 percent of the effects would occur in the community of Westport (decrease of $15,105 compared to Alternative 1) (Table 4-116). Economic opportunities for commercial fishers and support businesses would be affected, although the effects would be relatively small in the communities of Dodson and Longview (Table 4-116).

4.4.4.4.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce non-tribal commercial fishing net revenue by an estimated $54,187 annually compared to Alternative 1 (Table 4-116). Reductions in revenue would affect all five non-tribal port communities of concern. The net revenue changes would be similar to the implementation scenario for Alternative 3 (Table 4-116). Anticipated negative economic impacts on these communities would also be similar, resulting in a decrease in employment opportunities for commercial fishers and for businesses that support commercial fishing activity.

4.4.4.4.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would reduce annual commercial fishing net revenue by $1,276 annually compared to Alternative 1 (Table 4-116). Revenue effects on port communities of concern would vary, with a relatively small (compared to Alternative 2 through Alternative 5) negative impact on net revenues in Westport (decrease of $7,882), La Push (decrease of $4,318) and Neah Bay (decrease of $1,446), and similarly small increases in net revenues for commercial fishers in Dodson ($6,376) and Longview ($5,994). Economic opportunities related to commercial fishing would be expected to decrease somewhat in La Push, Neah Bay, and Westport, but they would increase in Dodson and Longview (Table 4-116).

4.4.4.5 Other Communities of Concern

Changes in commercial and recreational fish harvests and hatchery operations also would affect non-fishing dependent communities and regions through inter-industry links to the directly affected groups and communities. These effects on other communities of concern would include impacts generated by some of the direct income for fish harvesters and hatchery staff and indirect effects on fish processors and other businesses supported by commercial fishing, recreational support businesses, and businesses that serve hatchery operations. For this analysis, changes in county-wide per capita income, a key indicator of potential environmental justice effects, are estimated for the 37 counties that are identified in Table 4-117 as environmental justice communities of concern, either because of low income levels, minority percentages, or both.

TABLE 4-117. PER CAPITA INCOME CHANGES FOR COUNTIES IDENTIFIED AS ENVIRONMENTAL JUSTICE COMMUNITIES OF CONCERN.

	Alternative 1	Alternative (Change in per capita income from Alternative 1)				
Economic Impact Region/County	**(No Action) ($)[1]**	**2 ($)**	**3 ($)**	**4 ($)**	**5 ($)**	**6 ($)**
Lower Columbia River						
Benton Co. (OR)	25,620	-13.15	-1.44	-0.37	-0.94	1.66
Marion Co. (OR)	21,980	-3.57	-0.39	-0.10	-0.26	0.45
Multnomah Co. (OR)	28,500	-4.62	-1.03	-0.46	-0.80	0.23
Washington Co. (OR)	30,020	-1.11	-0.01	0.13	-0.01	0.16
Mid Columbia River						
Hood River Co. (OR)	22,760	-22.76	-2.26	-2.26	2.80	2.80
Jefferson Co. (OR)	18,890	-100.72	-15.02	-12.65	0.49	12.12
Morrow Co. (OR	18,980	-36.50	0.60	0.60	3.71	2.32
Sherman Co. (OR)	20,310	-245.34	-4.30	-4.30	26.46	19.89
Umatilla Co. (OR)	19,680	-26.43	-5.06	-4.42	-0.71	2.74
Wasco Co, (OR)	21,770	-88.77	-14.07	-12.03	0.83	11.17
Benton Co. (WA)	26,250	-5.22	0.70	0.74	1.22	1.04
Franklin Co. (WA)	18,670	-10.01	0.47	0.51	2.04	1.86
Grant Co. (WA)	19,200	0.11	1.09	1.09	2.53	6.72
Klickitat Co. (WA)	20,480	-176.00	-36.11	-33.36	-15.23	-6.11
Walla Walla Co. (WA)	21,780	-9.51	-1.34	-1.34	-1.24	1.37
Upper Columbia River						
Chelan Co. (WA)	23,340	-0.02	1.27	1.27	3.55	9.05
Douglas Co. (WA)	22,520	-0.03	2.40	2.40	6.69	17.07
Kittitas Co. (WA)	24,450	0.37	2.42	2.42	5.32	14.17
Okanogan Co. (WA)	19,370	-0.03	2.23	2.23	6.25	15.95
Yakima Co, (WA)	18,560	0.06	0.41	0.41	1.19	2.81
Lower Snake River						
Clearwater Co. (ID)	21,700	-51.67	-38.58	-38.20	23.50	42.79
Idaho Co. (ID)	18,300	-33.06	-25.78	-25.78	13.00	22.47
Latah Co. (ID)	19,200	-3.90	-1.23	-1.23	4.11	6.57
Lewis Co. (ID)	18,580	-85.91	-57.52	-57.52	49.09	81.59
Nez Perce Co. (ID)	23,130	-8.36	-5.60	-5.60	4.78	7.94
Shoshone Co. (ID)	18,670	-11.39	-3.59	-3.34	12.00	19.17
Valley Co. (ID)	27,380	-16.89	-6.71	-6.38	15.67	24.57
Whitman Co. (WA)	18,550	-6.50	-4.12	-4.05	3.86	6.82

TABLE 4-117. PER CAPITA INCOME CHANGES FOR COUNTIES IDENTIFIED AS ENVIRONMENTAL JUSTICE COMMUNITIES OF CONCERN (CONTINUED).

ECONOMIC IMPACT REGION/COUNTY	ALTERNATIVE 1 (NO ACTION) ($)[1]	ALTERNATIVE (CHANGE IN PER CAPITA INCOME FROM ALTERNATIVE 1) 2 ($)	3 ($)	4 ($)	5 ($)	6 ($)
Washington Coast						
Clallam Co. (WA)	24,210	-7.50	-2.31	-2.07	-2.14	-1.39
Grays Harbor Co. (WA)	21,290	-20.80	-7.97	-7.54	-7.09	-6.41
Oregon Coast						
Coos Co. (OR)	21,680	-2.52	-0.69	-0.43	-0.61	-0.56
Lincoln Co. (OR)	23,470	-5.86	-1.62	-0.99	-1.42	-1.30
California Coast						
Del Norte Co. (CA)	19,020	-0.03	-0.01	-0.01	-0.01	-0.01
Humboldt Co. (CA)	23,500	-0.05	-0.01	-0.01	-0.01	-0.01
Mendocino Co. (CA)	24,100	-0.09	-0.03	-0.02	-0.02	-0.02
Monterey Co. (CA)	25,340	-0.03	-0.01	-0.01	-0.01	-0.01
San Francisco Co. (CA)	44,370	-0.04	-0.01	-0.01	-0.01	-0.01

Sources: Estimated by the Mitchell Act Socioeconomics Team based on average per capita income from the U.S. Census Bureau, American Community Survey, 5-Year Estimates (2005 to 2009) database and predicted changes in personal income by economic impact region and county based on estimated changes in harvest and hatchery operations.
[1] All dollars are in 2009 U.S. dollars.

4.4.4.5.1 Alternative 1 (No Action)

Annual per capita income across environmental justice communities of concern would range from about $18,300 (Idaho County, lower Snake River economic impact region) to $44,370 (San Francisco County, California coast economic impact region) (Table 4-117). Income levels can vary substantially, both within and across economic impact regions. Under Alternative 1, annual per capita income levels reflect baseline conditions, including income from salmon harvesting and hatchery operations in the environmental justice communities of concern.

4.4.4.5.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, reductions in per capita income would occur for 34 of 37 counties compared to Alternative 1, although all of these decreases in per capita income are 1.2 percent or less compared to county-wide per capita income levels under Alternative 1 (Table 4-117). Across the 34 counties where negative effects on per capita income are estimated, the largest change under Alternative 2 would occur in Sherman County (mid Columbia River economic impact region), declining by 1.2 percent ($245.34) compared to Alternative 1 (Table 4-117). Under the implementation scenario for Alternative 2, relatively large reductions in annual per capita income also are estimated to occur in Klickitat County ($176.00) and Jefferson County ($100.72), both located in the mid Columbia River economic impact region.

4.4.4.5.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under Alternative 3, the declines in per capita income caused by changes in salmon harvest and hatchery operations would generally be lower than the implementation scenario for Alternative 2, relative to Alternative 1 (Table 4-117). Of the 37 counties, 28 would experience declines in annual per capita incomes. The reductions would be relatively small, generally not exceeding 0.5 percent of countywide per capita income levels, with the largest reduction ($57.52) estimated for Lewis County in the lower Snake River economic impact region. Among the nine counties experiencing gains in annual per capita income under Alternative 3, the changes would be nearly imperceptible (less than $2.50), but would occur in all five counties in the upper Columbia River economic impact region due to increases in hatchery-related operations spending (i.e., expenditures related to construction and operations of weirs and facility BMP measures) (Table 4-117). These changes in per capita income represent only slight increases in income levels; as a result, the communities would remain environmental justice communities of concern even with the increases in income levels under the implementation scenario for Alternative 3.

4.4.4.5.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, declines in annual per capita income in environmental justice communities of concern would occur in 27 out of the 37 counties, but these declines would be less than 0.5 percent when compared to Alternative 1 (Table 4-117). These declines in per capita income would be similar to those occurring under the implementation scenario for Alternative 3, and they would occur in communities in the lower Snake River economic impact region. The declines would result from decreases in both recreational fishery harvest and hatchery production. In most communities in the lower Columbia River and mid Columbia River economic impact regions, increases in per capita income due to hatchery operations would be more than offset by decreases in harvest-related income, resulting in small net declines in per capita income. These communities in the lower Columbia River and mid Columbia River economic impact regions would remain environmental justice communities of concern, as would the communities in these two economic impact regions with the slight increases in income under Alternative 4 compared to Alternative 1.

4.4.4.5.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, annual per capita income would decrease by less than 0.5 percent for 16 of the 37 communities compared to Alternative 1 (Table 4-117). Communities with negative effects on per capita income would be concentrated in the lower Columbia River economic impact region and the Washington, Oregon, and California coast economic impact regions. For the 21 communities in which per capita income would increase under the implementation scenario for Alternative 5, the increase would be 0.5 percent or less when compared to Alternative 1.These increases in per capita income would result from both increases in fishery harvests and in hatchery production in the mid Columbia River and lower Snake River economic impact regions. In the upper Columbia River economic impact region, increases in per capita income would result from rises in hatchery-related operations expenditures in the region (Table 4-117). However, the slight increases in per capita income levels under Alternative 5 would not change the communities' designation as environmental justice communities of concern relative to Alternative 1.

4.4.4.5.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, annual per capita income would increase by less than 0.5 percent for 27 of the 37 communities of concern compared to Alternative 1 (Table 4-117). Increases in per capita income would occur in 27 of the 28 communities (Klickitat County) in the Columbia River Basin economic impact regions. However, all of these 27 communities would remain designated environmental justice communities of concern based on the relatively small increases in income levels under the implementation scenario for Alternative 6. Among the 10 environmental justice communities of concern where annual per capita income would decline under Alternative 6, 9 are located in the Washington, Oregon, and California coast economic impact regions (Table 4-117). The per capita income reductions in these communities, which would result from reduced fishery harvests, would be slight (less than $6.50 annually in each community) compared to Alternative 1.

4.5 Wildlife

4.5.1 Introduction

This section evaluates the potential effect of the EIS alternatives on Wildlife resources. These resources include all non-fish aquatic, marine and terrestrial species that would be affected by implementing any of the alternatives.

As described in Section 3.5, Wildlife, hatchery operations have the potential to affect wildlife by changing the total abundance of salmon and steelhead in aquatic and marine environments. Changes in the abundance of salmon and steelhead can affect wildlife predator/prey interactions. In addition, hatcheries could affect wildlife through transfer of toxic contaminants or pathogens from hatchery-origin fish to wildlife, operation of weirs (which could block or entrap wildlife), or predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities). This section describes the effects of implementing the proposed alternatives on 1) ESA-listed aquatic, marine, and terrestrial wildlife species, 2) non-listed birds, 3) non-listed marine mammals, and 4) other non-listed aquatic and terrestrial wildlife species, including invertebrates.

As described in Chapter 2, Alternatives and Section 4.1.3, Implementation Scenarios, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 4-3). Table 4-118 shows the implementation measures that may affect wildlife. Six implementation measures may affect wildlife species:

- Change production levels in hatchery programs.
- Correct water quality issues at hatchery facilities.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new hatchery programs.
- Terminate hatchery programs that only support harvest if they fail to meet performance goals.

TABLE 4-118. WILDLIFE SPECIES THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

Implementation Measures Incorporated in One or More of the Alternatives' Implementation Scenarios	Wildlife Species that May be Affected						
	Killer Whale	Seals, Sea Lions, River Otters, and Mink	Bird Species that Eat Salmon and Steelhead	Bird Species that Eat Similar Foods as Salmon and Steelhead	Salamanders and Frogs	Aquatic Insects	Marine Invertebrates
Change production levels in hatchery programs.	X	X	X	X	X	X	X
Update water intake screens at hatchery facilities.							
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.							
Correct water quality issues at hatchery facilities.		X	X	X	X	X	
Install new temporary weirs.		X	X	X			
Install new permanent weirs.		X	X	X			
Establish new selective fisheries in terminal areas.							
Change hatchery program goals (i.e., harvest or conservation).							
Change hatchery program's operational strategy (i.e., isolated or integrated).							
Establish new hatchery programs.	X	X	X	X	X	X	X
Terminate hatchery programs that only support harvest if they fail to meet performance goals.	X	X	X	X	X	X	X

Three of these implementation measures (change production levels in hatchery programs, establish new hatchery programs, and terminate hatchery programs that only support harvest if they fail to meet performance goals) relate to changes in production levels and could affect all wildlife species. Specifically, changes in production levels may affect predator/prey interactions, the transfer of contaminants from hatchery-origin fish to wildlife species, and the number of salmon and steelhead carcasses available to wildlife. Two implementation measures relate to weirs (install permanent and temporary weirs) and may affect river otters, mink, and bird species. One implementation measure targets water quality (correct water quality issues at hatchery facilities) and may affect any wildlife species found near the hatchery facilities. As described in Section 3.6, Water Quality and Quantity, however, all hatchery facilities are currently in compliance with their NPDES permits, and this would continue to occur under all of the alternatives.

The primary focus of this analysis relates to effects on wildlife predators that feed on salmon and steelhead with additional information on wildlife that have other relationships with salmon. Discussion of several topics is relevant to more than one wildlife group, including availability of salmon and steelhead to wildlife predators, transfer of contaminants from hatchery-origin to wildlife species, weirs, predator control programs, and availability of nutrients from salmon carcasses. To avoid duplicating the discussions for each wildlife group, these topics are presented in separate sections before the analyses of effects on each wildlife group.

As described in Section 3.5.2, Analysis Area, the analysis area for wildlife is the same as the project area (Section 2.2, Description of Project Area). Information is organized according to species, although some species are grouped when appropriate. Some wildlife species are found throughout the analysis area, while others are only found in part of the analysis area (Table 3-29, Table 3-30, and Table 3-31).

4.5.2 Methods for Analysis

Analyses conducted for wildlife were based on the use of literature representing best available science and other studies that identified effects that occurred from similar or related projects within and near the analysis area. No modeling was conducted. No evidence was found that wildlife predators distinguish between hatchery-origin salmon and steelhead and natural-origin salmon and steelhead. However, Hanson et al. (2010) concludes that “it is highly likely that some of fish consumed by [Southern Resident killer] whales included hatchery fish, because some of the stocks we identified in the whales’ diet contain high proportions of hatchery origin fish. For example, in many of the South Puget Sound Chinook salmon stocks, the hatchery contribution to these runs exceeds 75 percent [Pacific Fishery Management Council 2009], and hatchery fish account for approximately 30 percent of the run of Lower Fraser River Chinook salmon (C. Parken pers. comm.).” Therefore, the analysis on effects of the alternatives on wildlife considers changes in total salmon and steelhead production under the assumption that wildlife predators do not distinguish between hatchery-origin and natural-origin fish.

4.5.3 Basinwide Effects under All Alternatives

4.5.3.1 Availability of Salmon and Steelhead to Wildlife Predators

Information summarized in Table 4-119 provides estimates in changes in salmon and steelhead availability for wildlife predators. Alternative 2 through Alternative 5 would reduce hatchery production of salmon and steelhead (Chinook salmon, steelhead, coho salmon, and chum salmon) relative to Alternative 1, which is predicted to increase the number of natural-origin salmon and steelhead available to predators in the analysis area. Although the abundance of natural-origin salmon and steelhead for each affected ESU is expected to increase under the alternatives, the total abundance of salmon and steelhead (natural-origin and hatchery-origin) would be substantially lower than Alternative 1. The expected decrease in total abundance would be highest under the implementation scenario for Alternative 2 and lowest under the implementation scenario for Alternative 4 and Alternative 5 (Table 4-119). Alternative 6 would result in a small increase in total production of hatchery-origin and natural-origin smolts (total) and adults. Also provided in Table 4-119 are changes in adult Chinook salmon recruits, an indicator of abundance in the ocean, because Southern Resident killer whales prefer to feed on Chinook salmon (Section 3.5.3.1.1, Killer Whale [Southern Resident DPS]).

TABLE 4-119. REDUCTIONS IN SALMON AND STEELHEAD ABUNDANCE RELATIVE TO ALTERNATIVE 1 BY ACTION ALTERNATIVE.

	ALTERNATIVE (PERCENT [%] DECREASE [-] OR INCREASE [+] RELATIVE TO ALTERNATIVE 1 [NO ACTION])				
AGE CLASS	2	3	4	5	6
Total Hatchery-origin and Natural-origin Smolts (All Species/ESUs)	-49	-13	-10	-10	+0.4
Total Hatchery-origin and Natural-origin Adult Recruits (All Species/ESUs)	-26	-5	-3	-1	+6
Total Chinook Salmon Adult Recruits (Hatchery-origin and Natural-origin)	-36	-5	-2	-2	+7

4.5.3.2 Transfer of Toxic Contaminants and Pathogens

As discussed in Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens, limited information is available on the relative contribution of contaminants from ingestion of hatchery-origin fish compared to natural-origin fish. Developing hatchery-origin and natural-origin salmon and steelheads may accumulate contaminants from a variety of sources in freshwater and marine environments (Johnson et al. 2007; Puget Sound Action Team [PSAT] 2007). For example, tissue analyzed and obtained from fish occurring within watersheds and river segments exceeded listed limits for contaminants, such as polychlorinated biphenyls (PCBs) and chlorinated hydrocarbons (Section 3.6, Water Quality and Quantity). Although there is some potential for elevated contaminant loads to occur in hatchery-origin fish prior to their release due to their ingestion of fish feed, data are insufficient to determine if fish feed increases contaminant loading in hatchery-origin fish compared to natural-origin salmonids (Johnson et al. 2007). Thus, for this analysis, it is assumed that hatchery-origin fish would not contain higher contaminant loads than natural-origin fish because both types of fish rear in, and migrate through, potentially impaired waters. Therefore, the potential for transfer of toxins to wildlife from fish ingestion is expected to be proportional to the total number of salmon and steelhead (natural-origin plus hatchery-origin) available to wildlife predators. The implementation scenarios for Alternative 2 through Alternative 5 would reduce the number of salmon and steelhead (natural-origin plus hatchery-origin) available to wildlife (Table 4-119) relative to Alternative 1 and would, therefore, reduce the potential for transfer of toxic contaminants from salmon and steelhead to wildlife. Alternative 6 would result in a small increase in the number of salmon and steelhead (natural-origin plus hatchery-origin) available to wildlife (Table 4-119) relative to Alternative 1 and would, therefore, increase the potential for transfer of toxic contaminants from salmon and steelhead to wildlife.

Information on the transfer of pathogens from salmon to, or through, wildlife species is lacking, as discussed in Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens. There is no information in the literature indicating that wildlife species are susceptible to fish pathogens. One exception is salmon poisoning disease, a rickettsial disease borne by salmon and steelhead that sickens dogs, wild canids, and possibly other carnivores that ingest infected fish (Ettinger and Feldman 1995). However, hatchery programs have not been found to cause or contribute to the transfer of this disease. Thus, no effects are expected under any of the alternatives.

4.5.3.3 Weirs and Predator Control Programs

A weir can alter stream channels and habitat upstream and downstream by reducing upstream water velocity and accumulating debris. Weirs can inhibit upstream and downstream passage of aquatic wildlife, such as macroinvertebrates, amphibians, bird, and mammal species that use streams as corridors (e.g., river otter, mink, and merganser species). Although weirs currently occur within the Columbia River Basin, no research has been conducted to date demonstrating the effects of weirs on wildlife. The implementation scenarios for Alternative 2 and Alternative 6 assume that no new weirs would be constructed. Thus, the alternative would result in no additional effects on wildlife compared to Alternative 1. The implementation scenarios for Alternative 3 through Alternative 5 would involve construction of new weirs on Columbia River tributaries. As described in Section 4.2.3.1.1, Effects on the Viable Salmonid Population Concept, Effects on Genetic Diversity, new weirs proposed under implementation scenarios for Alternative 3 through Alternative 5 could pose some risks to wildlife due to alteration of stream habitat, flow regimes, and blockage of aquatic wildlife passage. Potential effects could be higher under these three alternatives than under Alternative 1 and Alternative 2 because new weirs could be installed on streams currently lacking them. No changes in predator control programs would occur under any of the alternatives.

4.5.3.4 Availability of Nutrients/Distribution of Salmon Carcasses

As described in Subsection 3.5.6.5, Nutrients/Distribution of Salmon Carcasses, freshwater and terrestrial food webs are affected by salmon and steelhead carcass availability and the influx of associated marine-derived nutrients. Birds, mammals, and aquatic invertebrates feed directly on salmon and steelhead carcasses, and the decomposer communities (i.e., organisms including bacteria, fungi, and invertebrates, that decompose organic material) that develop on carcasses are, in turn, consumed by other aquatic invertebrate species. Carcasses in streams result from natural-origin and hatchery-origin spawners and from hatchery-origin fish that return to hatchery facilities to spawn and then are placed out into streams by hatchery operators. Placement of salmon and steelhead carcasses would continue under all of the alternatives; however, out-planted hatchery carcasses likely comprise a relatively small proportion of the total available carcasses.

Reductions in hatchery production and total adult salmon and steelhead (hatchery-origin and natural-origin combined) under the implementation scenarios for Alternative 2 through Alternative 5 would probably decrease the number of carcasses that would be available for wildlife compared to Alternative 1, with Alternative 2 resulting in the greatest decline (Table 4-119). The small increase in total adult salmon and steelhead (hatchery-origin and natural-origin combined) for Alternative 6 (Table 4-119) would increase carcasses available for wildlife consumption. Similarly, nutrient availability for aquatic invertebrates that scavenge on salmon carcasses in spawning streams would be reduced under implementation scenarios for

Alternative 2 through Alternative 5, with Alternative 2 resulting in the greatest decrease compared to Alternative 1. Alternative 6 would increase nutrient availability in freshwater and terrestrial systems. Changes in carcass availability for direct consumption and nutrient availability may affect the abundance, distribution, or behavior of wildlife populations, for example, feeding by wintering bald eagles. These changes would likely only be detectable under Alternative 2, which would reduce adult salmon and steelhead returns by 26 percent. Changes in nutrient availability for the remaining alternatives would likely be within the range of natural variation and probably would not be measurable.

4.5.3.5 Hatchery Facility Effects

As described in Section 3.5.6.4, Hatchery Facility Effects, and Section 3.6.4, Water Quantity, the operation of hatchery facilities can affect water volume and flow, particularly in the bypass areas. Depending on the timing and degree of alterations, habitat availability for stream-breeding amphibians (e.g., salamanders), crustaceans (a marine invertebrate), and aquatic insects could be affected. The amount of water used may vary among alternatives. The implementation scenarios for Alternative 2 through Alternative 6 would reduce hatchery production, relative to Alternative 1, and this may result in more water in the bypass areas associated with hatchery facilities relative to Alternative 1 (Section 4.6.4, Water Quantity). For Alternative 2 through Alternative 6, more water would improve habitat for stream-breeding amphibians, crustaceans, and aquatic insects relative to Alternative 1. Improvements in habitat under the implementation scenarios for Alternative 2 through Alternative 6 may expand distribution of some aquatic and terrestrial wildlife species (especially during the summer months when water levels are low) relative to Alternative 1.

Hatchery facilities contain rearing ponds with asphalt or other lined walls. If amphibians entered these ponds, they may become trapped and drown. As described in Section 3.5.6.4, Hatchery Facility Effects, susceptibility of amphibians to this type of mortality depends on the occurrence of the animals in the hatchery vicinity, mobility of the species, steepness of the rearing pond walls, and elevation of the pond water relative to the height of the walls. Because none of these factors would vary among the alternatives, there would be no expected change in mortality of amphibians through drowning under the Alternative 2 through Alternative 6 implementation scenarios compared to Alternative 1.

Additional potential sources of mortality at the hatchery facilities include entrapment in fish screens, weirs, and other exclusionary devices. Improvements in fish screens and fish passage under the implementation scenarios for Alternative 2 through Alternative 6 may reduce the quantity of aquatic and terrestrial wildlife entrapped near the hatchery facilities relative to Alternative 1. Effects of the weirs are discussed in Section 4.5.3.3, Weirs and Predator Control Programs.

4.5.4 Wildlife Species Effects

4.5.4.1 ESA-listed Species

4.5.4.1.1 Killer Whale (Southern Resident DPS)

As described in Section 3.5.3, ESA-listed Species, Southern Resident killer whales have been observed in nearshore waters of Washington and Oregon and close to the mouth of the Columbia River during winter and early spring months, but they may occur in ocean waters in any month (Zamon et al. 2007; Hanson and Emmonds 2011; Ford et al. 2012). Based on available information on prey preference and chemical analyses, this stock is thought to feed on salmon and steelhead year-round. They prefer Chinook salmon while in inland waters of Puget Sound and the Straits of Georgia and Juan de Fuca (Ford and Ellis 2006; Hanson et al. 2010; Hanson 2011). Although fewer prey samples have been identified in ocean waters, available evidence indicates that killer whales consume Chinook salmon, chum salmon, and steelhead. The preference of Southern Resident killer whales for Chinook salmon in inland waters (even when other species are more abundant), combined with information indicating that the whales consume Chinook salmon year-round, suggests that Southern Resident killer whales may prefer Chinook salmon when they are available in coastal waters. Coastal sightings in California and Westport, Washington, have coincided with large runs of Chinook salmon (citations in NMFS 2008b). Although greatly reduced from historical numbers, Columbia River Chinook salmon production exceeds that of other Pacific Northwest river systems, including the Fraser River and Puget Sound (NMFS 2008b). Salmon production from Columbia River hatcheries may have partially compensated for declines in many natural-origin salmon populations to the benefit of resident killer whales. In Washington, hatchery-origin fish now account for about 75 percent of all Chinook salmon and coho salmon and nearly 90 percent of all steelhead harvested (NMFS 2008b). The contribution of all salmon and steelhead from the Columbia River Basin to the prey available to the whales in the ocean is substantial. Based on the Southern Resident killer whale's preference for Chinook salmon, the analysis of alternatives below focuses on effects on the abundance of Chinook salmon available to Southern Resident killer whales in the ocean.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect the Southern Resident killer whales because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

The implementation scenario for Alternative 2 would reduce the number of adult Columbia River Basin Chinook salmon in the ocean by approximately 36 percent and all salmon and steelhead species by 26 percent compared to Alternative 1 (Table 4-119). Ford et al. (2009) and Ward et al. (2013) found that Southern Resident killer whale survival rates and fecundity correlated directly with Chinook salmon abundance. Given the likelihood that Southern Resident killer whales strongly prefer Chinook salmon, many of which originate in the Columbia River Basin, the implementation scenario for Alternative 2 would likely affect the prey base for Southern Resident killer whales. The reduction of an important food source under the implementation scenario for Alternative 2 could result in poorer breeding-female condition, reduced viability of offspring, and reduced adult fitness and survival compared to Alternative 1. As a result, abundance of the Southern Resident DPS of killer whales may be reduced under the implementation scenario for Alternative 2 when compared to Alternative 1. However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin Chinook salmon in the whales' diet and the locations and timing of consumption of Columbia River Basin Chinook salmon.

Possible effects on killer whales might include feeding on a higher proportion of natural-origin Chinook salmon due to the different proportions available between natural-origin and hatchery-origin salmon under the implementation scenario for Alternative 2 compared to Alternative 1. Within the analysis area for wildlife, the effects of the implementation scenario for Alternative 2 are unknown due to lack of data regarding whether killer whales concentrate feeding at the river mouth. Moreover, it is not known whether killer whales target Columbia River Basin Chinook salmon, although the whales likely feed on these salmon anywhere they occur within the whales' range. The impact of the implementation scenario for Alternative 2 may be mitigated to some extent because Southern Resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs from California (Krahn et al. 2007, 2009; Northwest Fisheries Science Center 2013), but it is not known how frequently this occurs.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce the number of adult Columbia River Basin salmon (all species) in the ocean by approximately 5 percent (Table 4-119) compared to Alternative 1. This reduction in Columbia River Basin adult salmon recruitment compared to Alternative 1 would likely be within the range of annual natural variability and would be difficult to distinguish from other sources of natural-origin salmon and steelhead population variability that are unrelated to the action alternatives. Therefore, the implementation scenario for Alternative 3 would not be expected to affect the population abundance of Southern Resident killer whales. The impact of the implementation scenario for Alternative 3 may be mitigated to some extent because Southern Resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs from California (Krahn et al. 2007, 2009; Northwest Fisheries Science Center 2013), but it is not known how frequently this occurs. The implementation scenario for Alternative 3 may result in killer whales feeding on a higher proportion of natural-origin Chinook salmon compared to hatchery-origin Chinook salmon than under Alterative 1 due to the different proportions available between the two groups.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce the number of adult Columbia River Basin Chinook salmon in the ocean by approximately 2 percent and all salmon and steelhead species by 3 percent (Table 4-119) compared to Alternative 1. This small reduction in Columbia River Basin adult salmon recruitment compared to Alternative 1 would likely be within the range of annual natural variability and would be difficult to distinguish from other sources of natural-origin salmon and steelhead population variability that are unrelated to the action alternatives. Therefore, the implementation scenario for Alternative 4 would not be expected to impact the population abundance of the Southern Resident stock of killer whales. The impact of the implementation scenario for Alternative 4 may be mitigated to some extent because Southern Resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs from California (Krahn et al. 2007, 2009; Northwest Fisheries Science Center 2013), but it is not known how frequently this occurs. The implementation scenario for Alternative 4 may result in killer whales feeding on a higher proportion of natural-origin Chinook salmon compared to hatchery-origin Chinook salmon than under Alterative 1 due to the different proportions available between the two groups.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce the number of adult Columbia River Basin Chinook salmon in the ocean by approximately 2 percent and all salmon and steelhead species by 1 percent (Table 4-119) compared to Alternative 1. This small reduction in Columbia River Basin adult salmon recruitment compared to Alternative 1 would likely be within the range of annual natural variability and would be difficult to distinguish from other sources of natural-origin salmon and steelhead population variability that are unrelated to the action alternatives. Therefore, the implementation scenario for Alternative 5 would not be expected to impact the population abundance of the Southern Resident stock of killer whales. The impact of the implementation scenario for Alternative 5 may be mitigated to some extent because Southern Resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs from California (Krahn et al. 2007, 2009; Northwest Fisheries Science Center 2013), but it is not known how frequently this occurs. The implementation scenario for Alternative 5 may result in killer whales feeding on a higher proportion of natural-origin Chinook salmon compared to hatchery-origin Chinook salmon than under Alterative 1 due to the different proportions available between the two groups.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase the number of adult Columbia River Basin Chinook salmon in the ocean by approximately 7 percent and all salmon and steelhead species by 6 percent (Table 4-119) compared to Alternative 1. This small increase in Columbia River Basin adult salmon recruitment compared to Alternative 1 would likely be within the range of annual natural variability and would be difficult to distinguish from other sources of natural-origin salmon and steelhead population variability that are unrelated to the action alternatives. Therefore, the implementation scenario for Alternative 6 would not be expected to add a substantial benefit for the population abundance of the Southern Resident stock of killer whales. The benefit of the implementation scenario for Alternative 6 may be modified to some extent because Southern Resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs from California (Krahn et al. 2007, 2009; Northwest Fisheries Science Center 2013), but it is not known how frequently this occurs.

4.5.4.1.2 Marbled Murrelet

As summarized in Section 3.5.3, ESA-listed Species, marbled murrelets are opportunistic feeders that consume a diverse prey base, which may include salmon smolts, in marine habitats (Burkett 1995; Ostrand et al. 2004; McShane et al. 2004). This species' density is low near the mouth of the Columbia River, and diet studies do not suggest heavy reliance on salmon and steelhead smolts (Burkett 1995). Information on prey choice of marbled murrelets (summarized in Section 3.5.3.1.2, Marbled Murrelet) is not adequate to characterize the abundance and species composition of salmon and steelhead in the marbled murrelet's diet; however, it is assumed that some juvenile salmon and steelhead may be taken by murrelets near the mouth of the Columbia River.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect marbled murrelet because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

The implementation scenario for Alternative 2 would reduce overall and steelhead smolt production in the Columbia River Basin by approximately 49 percent relative to Alternative 1 (Table 4-119). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, a 49 percent reduction would likely result in this species finding alternative prey sources. This reduction would be unlikely to change diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce overall salmon and steelhead smolt production in the Columbia River Basin by approximately 13 percent relative to Alternative 1 (Table 4-119). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, a 13 percent reduction would likely result in this species finding alternative prey sources. This reduction would be unlikely to change diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce overall salmon and steelhead smolt production in the Columbia River Basin by approximately 10 percent relative to Alternative 1

(Table 4-119). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, it is expected that a reduction of 10 percent would result in this species finding alternative prey sources. This reduction would be unlikely to change diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce overall salmon and steelhead smolt production in the Columbia River Basin by approximately 10 percent relative to Alternative 1 (Table 4-119). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, it is expected that a reduction of 10 percent would result in this species finding alternative prey sources. This reduction would be unlikely to change diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase overall salmon and steelhead smolt production in the Columbia River Basin by approximately 0.4 percent relative to Alternative 1 (Table 4-119). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, it is not expected that an increase of 0.4 percent would affect their diet, distribution, or abundance compared to Alternative 1.

4.5.4.2 Non-listed Birds

4.5.4.2.1 Bald Eagle

As summarized in Section 3.5.4.1.1, Bald Eagle, bald eagles that breed along the lower Columbia River are year-round residents. Bald eagles are protected under the Bald Eagle and Golden Eagle Protection Act. In eastern Washington, Oregon, and Idaho, the reservoirs and major tributaries of the Columbia and Snake Rivers are important wintering habitats (Stinson et al. 2001). The proportion of salmon and steelhead in the diet of these bald eagles is not known, but it appears that spawning salmon and their carcasses are a preferred prey resource when available (Fitzner and Hanson 1979). Live salmon do not appear to be the primary food source of bald eagles in the Columbia River Basin, although Cederholm et al. (2001) considered bald eagles to have a strong relationship with salmon and steelhead in marine habitats. Salmon and steelhead smolts are consumed by nesting eagles on the lower Columbia River and estuary, but their significance in the diet of this eagle population is unknown. As discussed in Section 4.5.3.4, Availability of

Nutrients/Distribution of Salmon Carcasses, the number of salmon carcasses would decrease under the implementation scenarios for Alternative 2 through Alternative 5 and increase under Alternative 6.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect the bald eagle because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

The implementation scenario for Alternative 2 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 49 percent and 26 percent, respectively (Table 4-119), compared to Alternative 1. The large decrease in numbers of live adults, smolts, and carcasses could affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River Basin. Bald eagles consume a wide range of fish and waterfowl, but elimination of a large number of salmon and steelhead from their prey base may result in changes in bald eagle abundance, distribution, and fitness within the Columbia River Basin. Possible results in the resident population of the lower Columbia River and estuary would include reduced survival of adults and immature bald eagles, poor condition and fitness of adults entering the breeding season, and poor survival of pre-fledgling chicks compared to Alternative 1.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 13 percent and 5 percent, respectively (Table 4-119), compared to Alternative 1. The decrease in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River Basin. However, the effects of production changes under this alternative may be difficult to separate from other sources of natural variability in the prey base such as variability in waterfowl populations in the upper Columbia River Basin (including Snake River) and non-salmonid freshwater and marine fish species. Bald eagles consume a wide range of fish and waterfowl and would likely forage on non-salmon prey, but this reduction may result in changes in bald eagle diet, distribution, and abundance compared to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 10 percent and 3 percent, respectively (Table 4-119), compared to Alternative 1. The decrease in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River Basin. However, the effects of production changes under this alternative may be difficult to separate from other sources of natural variability in the prey base such as variability in waterfowl populations in the upper Columbia River Basin (including Snake River) and non-salmonid freshwater and marine fish species. Bald eagles consume a wide range of fish and waterfowl and would likely forage on other fish. As a result, the implementation scenario for Alternative 4 would not likely affect bald eagle diet, distribution, or abundance compared to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 10 percent and 1 percent, respectively (Table 4-119), compared to Alternative 1. The decrease in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River Basin. However, the effects of production changes under this alternative may be difficult to separate from other sources of natural variability in the prey base such as variability in waterfowl populations in the upper Columbia River Basin (including Snake River) and non-salmonid freshwater and marine fish species. Bald eagles consume a wide range of fish and waterfowl and would likely forage on other fish. As a result, the implementation scenario for Alternative 5 would not likely affect bald eagle diet, distribution, or abundance compared to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 0.4 percent and 6 percent, respectively (Table 4-119), compared to Alternative 1. The increase in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would slightly increase the availability of salmon carcasses for overwintering bald eagles in the Columbia River Basin. However, the effects of production changes under this alternative may be difficult to separate from other sources of natural variability in the prey base such as variability in waterfowl populations in the upper Columbia River Basin (including Snake River) and non-salmonid freshwater and marine fish species. Bald eagles consume a wide range of fish and waterfowl and would likely forage on other fish. As a result, the implementation scenario for Alternative 6 would not likely affect bald eagle diet, distribution, or abundance compared to Alternative 1.

4.5.4.2.2 Other Birds

As described in Section 3.5.4.1.2, Other Birds, avian predators on salmon and steelhead are present throughout the Columbia River Basin. They concentrate in the estuary and at reservoirs and tailrace outfalls below dams. Population increases of Caspian terns and double-crested cormorants have been linked to environmental changes associated with dredge spoils management and hydroelectric projects on the Columbia River that increase salmon and steelhead smolt vulnerability during the birds' nesting season (NMFS 2008c). In particular, the Caspian tern and double-crested cormorant breeding colonies on East Sand Island in the lower estuary have grown in recent years, and the site currently supports the largest breeding colonies of these species in western North America. The Caspian tern (and, to a lesser extent, the double-crested cormorant) are considered to depend heavily on salmon and steelhead smolts as prey, and these species are the focus of the following analysis. Bald eagles that are resident or overwintering migrants in the Columbia River and Snake River Basins also exploit spawned-out salmon carcasses, and they are included in the analysis because of the high importance of salmon in their diet (Section 4.5.4.2.1, Bald Eagle).

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect other fish-eating birds because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

Compared to Alternative 1, a large reduction in salmon and steelhead smolt production in the Columbia River Basin under the implementation scenario for Alternative 2 (approximately 49 percent) (Table 4-119) would have an effect on most salmon-eating birds. Caspian terns and double-crested cormorants nesting on East Sand Island in the lower Columbia River would be most affected by this alternative because these species rely heavily on salmon and steelhead during the breeding season, and this nesting site supports the largest breeding concentrations.

Caspian terns and double-crested cormorants are highly opportunistic, wide-ranging, and can change their prey, foraging areas, and nesting sites (provided undisturbed areas with the correct substrate are available). However, the magnitude of the change in prey base under the implementation scenario for Alternative 2 would likely negatively affect their abundance and ability to breed successfully on the Columbia River compared to Alternative 1, although the degree of this effect is unknown. Their distribution also would likely change compared to Alternative 1. Under conditions of food shortage, most birds may leave the area without nesting, and those that do attempt to breed may desert nests. Chicks and fledglings may not survive, and/or the abundance of adults may decline. Ultimately, the size of the west coast Caspian tern population may be reduced compared to Alternative 1, but the amount of this decline cannot be predicted.

Other avian predators (gull species, American white pelican, osprey, harlequin duck, and mergansers) depend considerably less on salmon and steelhead than do Caspian terns. This alternative may result in changes in the diet, distribution, and abundance of some avian predator populations compared to Alternative 1, although the degree of this effect is unknown.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce overall salmon and steelhead smolt production in the Columbia River Basin by 13 percent compared to Alternative 1 (Table 4-119). Conservatively, it is possible that other prey species populations may not be adequate to support salmon-eating bird populations, especially Caspian terns, in some years. For Caspian terns, a decrease of 13 percent may affect distribution and abundance in the Columbia River with possible area results that include reduced numbers of birds attempting to breed, nest failures, or a decrease in fitness compared to Alternative 1. Other less dependent avian predators would likely forage on non-salmon or steelhead species. However, there may be changes in the diet, distribution, and abundance of some avian populations that prey on salmon and steelhead compared to Alternative 1, although the degree of this affect is unknown.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce overall salmon and steelhead smolt production in the Columbia River Basin by approximately 10 percent relative to Alternative 1

(Table 4-119). Caspian terns and other avian predators would likely consume other prey species if this alternative were implemented, depending on their availability. The impact of the relatively small change in hatchery production under the implementation scenario for Alternative 4 would probably not be discernible relative to other natural sources of variability in the birds' prey base, which includes other fish species. As a result, there would not be any expected changes in diet, distribution, and abundance of avian predator populations compared to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce overall salmon and steelhead smolt production in the Columbia River Basin by 10 percent compared to Alternative 1 (Table 4-119). Caspian terns and other avian predators would likely consume other prey species if this alternative were implemented, depending on their availability. The impact of the relatively small change in hatchery production under the implementation scenario for Alternative 5 would probably not be discernible relative to other natural sources of variability in the birds' prey base, which includes other fish species. As a result, there would not be any expected changes in diet, distribution, and abundance of avian predator populations compared to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase overall salmon and steelhead smolt production in the Columbia River Basin by 0.4 percent compared to Alternative 1 (Table 4-119). The impact of the relatively small change in hatchery production under the implementation scenario for Alternative 6 would probably not be discernible relative to other natural sources of variability in the birds' prey base, which includes other fish species. As a result, there would not be any expected changes in diet, distribution, and abundance of avian predator populations compared to Alternative 1.

4.5.4.3 Marine Mammals

Three non-ESA-listed marine mammal species (Steller sea lion, California sea lion, and harbor seal) forage on salmon and steelhead in the lower Columbia River and estuary during fall and winter. Potential effects of the alternatives are described below.

4.5.4.3.1 Steller Sea Lion

As summarized in Section 3.5.5.1.1, Steller Sea Lion, the eastern stock of Steller sea lions is present year-round on the coasts of Oregon and Washington, and the stock follows migrating salmon and steelhead into the lower Columbia River as far as Bonneville Dam. Foraging studies at Pacific Northwest coastal sites describe a wide variety of prey species, including Pacific whiting, rockfish, eulachon, Pacific hake, anchovy, Pacific herring, staghorn sculpin, salmonids, octopus, and lamprey. Steller sea lions have exploited salmon and white sturgeon at Bonneville Dam in increasing numbers since they first occurred at this site in 2003, and they are thought to have consumed up to 1 percent of salmon runs in recent years.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect Steller sea lions because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

The implementation scenario for Alternative 2 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 49 percent and 26 percent, respectively, compared to Alternative 1 (Table 4-119). The importance of salmon and steelhead in the diet of Steller sea lions in the Columbia River has been established in monitoring studies at the Bonneville Dam since 2003.

Steller sea lions are opportunistic foragers that do not breed in the Columbia River Basin. The reduction in overall production of Columbia River Basin salmon and steelhead under the implementation scenario for Alternative 2, the largest reduction, compared to Alternative 1 would affect the prey base for Steller sea lions. However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range, as well as the locations and timing of consumption of Columbia River Basin salmon and steelhead. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall eastern stock Steller sea lion population abundance would be expected under the implementation scenario for Alternative 2 relative to Alternative 1.

A reduction in available hatchery-origin salmon and steelhead in the Columbia River Basin could motivate sea lions that congregate at Bonneville Dam to forage at other sites with more abundant prey. Alternatively, some Steller sea lions may continue to exploit vulnerable salmon and steelhead runs at Bonneville Dam, in which case the reduction in availability of hatchery-origin fish may result in increased consumption of natural-origin fish. No studies are available that would help predict what magnitude of changes in prey density or ease of capture would lead to either outcome.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 13 percent and 5 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range, as well as the locations and timing of consumption of Columbia River Basin salmon and steelhead. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall eastern stock Steller sea lion population abundance would be expected under the implementation scenario for Alternative 3 relative to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 10 percent and 3 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range, as well as the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small reduction in one potential prey resource is not likely to be discernible among other sources of variability in the Steller sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall eastern stock Steller sea lion population abundance would be expected under the implementation scenario for Alternative 4 relative to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 10 percent and 1 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia

River Basin salmon and steelhead in the sea lions' diet throughout their range and the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small reduction in one potential prey resource is not likely to be discernible among other sources of variability in the Steller sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall eastern stock Steller sea lion population abundance would be expected under the implementation scenario for Alternative 5 relative to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 0.4 percent and 6 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range and the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small change in one potential prey resource is not likely to be discernible among other sources of variability in the Steller sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall eastern stock Steller sea lion population abundance would be expected under the implementation scenario for Alternative 6 relative to Alternative 1.

4.5.4.3.2 California Sea Lion

California sea lions are opportunistic foragers, responding to seasonal and local availability of a variety of fish species. In the Columbia River, they are present seasonally (January to late May), when they consume substantial numbers of adult Chinook salmon and steelhead, in particular at the tailrace of Bonneville Dam (River Mile [RM] 146) (Section 3.5.5.1.2, California Sea Lion).

As summarized in Section 3.5.5.1.2, California Sea Lion, male California sea lions are present in Pacific Northwest waters during the non-breeding season, and they follow migrating salmon and steelhead into the lower Columbia River as far as Bonneville Dam. Foraging studies at Columbia River estuary sites describe a wide variety of prey species, including forage fish species, rockfish, eulachon, Pacific hake, salmonids, octopus, and lamprey. California sea lions have exploited salmon at Bonneville Dam in increasing numbers in the past two decades and are estimated to have consumed as much as 4.7 percent of all salmonid runs at the peak of their impact on fisheries in 2007. Following implementation of management measures in 2008, and in response to the size of salmon and steelhead runs in recent years, the number of California sea lions present at the Bonneville Dam has declined, but their predation levels on salmon and steelhead run remain an important management issue.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect California sea lions because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

The implementation scenario for Alternative 2 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 49 percent and 26 percent, respectively, compared to Alternative 1 (Table 4-119). California sea lions are wide-ranging and highly opportunistic in their prey choices. They would likely increase their use of different prey species and other locations. Sea lion predation on marine forage fish, in particular, may increase. However, alternate prey species may not be adequate to support existing population numbers every year, depending on a number of natural oceanic conditions not related to any of the action alternatives. A conservative interpretation of available information would be that the large reduction in the abundance of salmon and steelhead under this alternative would substantially reduce the prey base for California sea lions spending the non-breeding season in the lower Columbia River and could affect adult fitness and survival. Numbers of sea lions at Bonneville Dam would probably decline compared to Alternative 1, but the amount of this decline cannot be predicted. Depending on the availability of alternate prey, this alternative would likely affect the abundance and distribution of California sea lions in the Columbia River compared to Alternative 1. These sea lions would likely move to other areas in the Pacific Northwest with concentrated, readily exploited prey resources. Under the implementation scenario for Alternative 2, some California sea lions may continue to exploit the vulnerable salmon and steelhead runs at Bonneville Dam compared to Alternative 1, in which case the reduction in availability of hatchery-origin fish may result in increased consumption of natural-origin fish. No studies are available that would help predict what magnitude of changes in prey density or ease of capture would lead to either outcome.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 13 percent and 5 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range and the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small reduction in one potential prey resource is not likely to be discernible among other sources of variability in the Steller sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall California sea lion population abundance would be expected under the implementation scenario for Alternative 3 relative to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 10 percent and 3 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range and the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small reduction in one potential prey resource is not likely to be discernible among other sources of variability in the California sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall California sea lion population abundance would be expected under the implementation scenario for Alternative 4 relative to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 10 percent and 1 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range and the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small reduction in one potential prey resource is not likely to be discernible among other sources of variability in the California sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall California sea lion population abundance would be expected under the implementation scenario for Alternative 5 relative to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase overall production of salmon and steelhead smolts and adults in the Columbia River Basin by 0.4 percent and 6 percent, respectively, compared to Alternative 1 (Table 4-119). However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River Basin salmon and steelhead in the sea lions' diet throughout their range and the locations and timing of consumption of Columbia River Basin salmon and steelhead. This small change in one potential prey resource is not likely to be discernible among other sources of variability in the California sea lion prey base. Given that this stock consumes a wide variety of prey, and most individuals feed in marine or estuarine waters, no change in overall California sea lion population abundance would be expected under the implementation scenario for Alternative 6 relative to Alternative 1.

4.5.4.3.3 Harbor Seal

Although resident in coastal areas and the estuary, harbor seals are wide-ranging and highly opportunistic in their foraging, responding to seasonal availability of many prey species. As described in Section 3.5.5.1.3, Harbor Seal, the importance of salmon and steelhead in the diet of harbor seals may be greatest during spring and fall months. However, the frequency of occurrence of adult (fall months) and juvenile salmon (spring months) in scat samples on the lower Columbia River was about 10 percent and 19 percent, respectively (Browne et al. 2002), suggesting that seals are not closely dependent on salmon and steelhead in the analysis area. Harbor seal numbers in the Columbia River peak from December to mid-March, when they consume substantial numbers of smelt (Jeffries 1984; Beach et al. 1985; Jeffries 1986; NMFS 1993 *in* LCFRB 2004).

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect harbor seals because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

Relative to Alternative 1, overall production of salmon and steelhead smolts and adults in the Columbia River Basin would decrease by 49 percent and 26 percent, respectively, under the implementation scenario for Alternative 2 (Table 4-119), resulting in a reduced prey base for harbor seals in the lower Columbia River and estuary. This mobile, opportunistic species would likely shift to other non-salmon and steelhead prey in coastal and estuarine waters. However, alternate prey species may not be sufficient to support existing harbor seal populations, depending on conditions in marine waters and the estuary that are not related to the action alternatives. Thus, in some years, alternate prey may be scarce, affecting the diet, distribution, and fitness of harbor seals. Poorer breeding conditions may result in reduced fitness of harbor seals, leading to lower reproductive rates and poorer survival of adults and offspring. Consequently, there may be an overall reduction in harbor seal abundance under the implementation scenario for Alternative 2 compared to Alternative 1, but the magnitude cannot be predicted with available information.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would decrease overall production of salmon and steelhead smolts and adults in the Columbia River Basin by approximately 13 percent and 5 percent, respectively, relative to Alternative 1 (Table 4-119), reducing the prey base of harbor seals as discussed under the implementation scenario for Alternative 2. The seals would likely increase consumption of other prey species if this alternative were implemented, depending on availability. The impact of the relatively small change in salmon and steelhead production under the implementation scenario for Alternative 3 may not be discernible relative to other natural sources of variability in the seals' prey base, which includes a variety of other marine fish species. As a result, no changes in distribution or abundance would be expected under the implementation scenario for Alternative 3 relative to Alternative 1.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would decrease overall production of salmon and steelhead smolts and adults in the Columbia River Basin by approximately 10 percent and 3 percent, respectively, relative to Alternative 1 (Table 4-119), reducing the prey base of harbor seals as discussed under the implementation scenario for Alternative 2. The seals would likely increase consumption of other prey species if this alternative were implemented, depending on availability. However, the impact of the relatively small change in salmon and steelhead production under the implementation scenario for Alternative 4 compared to Alternative 1 would probably not be discernible relative to other natural sources of variability in the seals' prey base, which includes a variety of other marine fish species. As a result, no changes in distribution or abundance would be expected under the implementation scenario for Alternative 4 relative to Alternative 1.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would decrease overall production of salmon and steelhead smolts and adults in the Columbia River Basin by approximately 10 percent and 1 percent, respectively, relative to Alternative 1 (Table 4-119), reducing the prey base of harbor seals as discussed under the implementation scenario for Alternative 2. The seals would likely increase consumption of other prey species if this alternative were implemented, depending on availability. However, the impact of the relatively small change in salmon and steelhead production under the implementation scenario for Alternative 5 compared to Alternative 1 would probably not be discernible relative to other natural sources of variability in the seals' prey base, which includes a variety of other marine fish species. As a result, no changes in distribution or abundance would be expected under the implementation scenario for Alternative 5 relative to Alternative 1.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase overall production of salmon and steelhead smolts and adults in the Columbia River Basin by approximately 0.4 percent and 6 percent, respectively, relative to Alternative 1 (Table 4-119). The result of the small increase in salmon and steelhead production under the implementation scenario for Alternative 6 would probably not be discernible relative to other natural sources of variability in the harbor seals' prey base, which includes a variety of other marine fish species compared to Alternative 1. As a result, no changes in diet, distribution, or abundance would be expected under the implementation scenario for Alternative 6 relative to Alternative 1.

4.5.4.3.4 Other Aquatic and Terrestrial Wildlife

River otter and mink are widely distributed predators in freshwater aquatic habitats in the Columbia River Basin, as well as in the estuary and nearshore marine environments (Section 3.5.6.1, Distribution of Other Aquatic and Terrestrial Wildlife and Their Food Resources). Otter depend more on aquatic habitats and fish species as prey than do mink (Melquist 1997). They feed on several life stages of salmon and steelhead (juveniles, spawning fish, and salmon carcasses).

Two salamander species (Pacific giant salamander and Cope's giant salamander) may prey on or compete with salmon and steelhead in streams, but their relationships with salmon and steelhead are poorly understood. If giant salamanders prey on salmon and steelhead, it would most likely be on natural-origin fry. Since hatchery-origin fish are generally released as smolts, they would likely be less vulnerable to giant salamanders because of their larger size. However, salmon and steelhead fry and smolts may compete with giant salamanders for aquatic and terrestrial insect prey.

Salmon and steelhead smolts and juveniles feed on marine invertebrates, as do many other types of predators, including forage fishes and some marine birds and marine mammals. In freshwater systems, salmon and steelhead fry consume aquatic insects. Spawning salmon and steelhead spawning activities increase niche space for benthic aquatic invertebrates. Salmon carcasses contribute nutrients to streams, helping to support increases in aquatic invertebrate populations.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect river otter, mink, amphibians, freshwater aquatic invertebrates, or marine invertebrates because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2 (No Mitchell Act Funding)

The substantial decrease in total salmon and steelhead smolt and adult production in the Columbia River Basin under the implementation scenario for Alternative 2 (49 percent for smolts and 26 percent for adults, compared to Alternative 1 [Table 4-119]) would affect the food supply available to river otter. Because otters have a strong relationship with salmonid populations, and salmon and steelhead are likely to be among the most easily acquired prey (especially spawning fish and carcasses), changes resulting from Alternative 2 would reduce their prey base. Depending on the availability of alternate prey, food scarcity could ultimately affect river-otter population size by decreasing survival or fitness of adults and juveniles and potentially reducing reproductive success. Available information on the diets of mink and their foraging behavior (Cederholm et al. 2001; Melquist 1997) suggests that the impact of Alternative 2 on this species would be small compared to Alternative 1 because they are not closely linked to salmon and steelhead and use many other prey sources.

The implementation scenario for Alternative 2 may affect the prey base for giant salamander species compared to Alternative 1, and the expected increase in the abundance of natural-origin salmon and steelhead fry may benefit salamanders by increasing potential prey populations.

However, larger juvenile salmon and steelhead rearing in streams with giant salamanders may compete for aquatic macroinvertebrates and insects. Thus, the alternative may reduce competition compared to Alternative 1.

The implementation scenario for Alternative 2 would reduce predation pressure on marine invertebrates and aquatic insect populations because numbers of juvenile salmon and steelhead would be lower. In freshwater systems, nutrient import from marine waters would be reduced because fewer adult carcasses would be deposited in spawning streams. However, an analysis of the effects of this alternative on marine invertebrate and aquatic insect populations would require information that is not currently available about interactions among competing predators and other aquatic ecosystem effects.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

The implementation scenario for Alternative 3 would reduce salmon and steelhead smolt and adult production in the Columbia River Basin by 13 percent and 5 percent, respectively, compared to Alternative 1 (Table 4-119). Depending on the availability of alternate prey, food scarcity could affect river-otter population size compared to Alternative 1 by decreasing survival or fitness of adults and juveniles and potentially reducing reproductive success in some years. As described under the implementation scenario for Alternative 2, effects on mink would be small due to the diversity of their prey consumption.

As discussed under the implementation scenario for Alternative 2, the effects of the implementation scenario for Alternative 3 on giant salamanders would depend on the extent to which hatchery-origin salmon and steelhead are present in streams that these salamanders occupy. Information about interactions among salamanders and salmon and steelhead is not currently available.

As discussed under the implementation scenario for Alternative 2, there would be a reduction in predation pressure on marine invertebrates and aquatic insect populations under the implementation scenario for Alternative 3 when compared to Alternative 1. There would also be a reduction in nutrient import into freshwater systems compared to Alternative 1. However, an analysis of the effects of this alternative on overall marine invertebrate and aquatic insect populations would require information that is not currently available about interactions among competing predators and other aquatic ecosystem effects.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would reduce salmon and steelhead smolt and adult production in the Columbia River Basin by 10 percent and 3 percent, respectively, compared to Alternative 1 (Table 4-119). River otters and mink would likely shift to alternate prey if they were available. The effect of this alternative on the prey base would probably not be discernible relative to other natural and unrelated sources of variability in prey population sizes compared to Alternative 1.

As discussed under the implementation scenario for Alternative 2, the effects of the implementation scenario for Alternative 4 on giant salamanders would depend on the extent to which hatchery-origin salmon and steelhead are present in streams these salamanders occupy. Information is not currently available about interactions among salamanders and salmon and steelhead.

There would be a reduction in predation pressure on marine invertebrates and invertebrate populations under the implementation scenario for Alternative 4 compared to Alternative 1. Considering natural variability of salmon and steelhead, marine invertebrates, and insect populations, it is unlikely that this decrease would affect distribution or abundance of either marine invertebrates or aquatic insects.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would reduce salmon and steelhead smolt and adult production in the Columbia River Basin by 10 percent and 1 percent, respectively, compared to Alternative 1 (Table 4-119). River otters and mink would likely shift to alternate prey if available. The effect of this alternative on the prey base would probably not be discernible relative to other natural and unrelated sources of variability in prey population sizes compared to Alternative 1.

As discussed under the implementation scenario for Alternative 2, the effects of the implementation scenario for Alternative 5 on giant salamanders would depend on the extent to which hatchery-origin salmon and steelhead are present in streams these salamanders occupy. Information is not currently available about interactions among salamanders and salmon and steelhead.

With decreased numbers of hatchery-origin salmon and steelhead, there would be a reduction in predation pressure on marine invertebrates and invertebrate populations under the implementation scenario for Alternative 5 compared to Alternative 1. Considering natural variability of salmon and steelhead, marine invertebrates, and insect populations, it is unlikely that this decrease would affect distribution or abundance of either marine invertebrates or aquatic insects.

Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would increase salmon and steelhead smolt and adult production in the Columbia River Basin by 0.4 percent and 6 percent, respectively, compared to Alternative 1 (Table 4-119). The effect of this alternative on the prey base would probably not be discernible relative to other natural and unrelated sources of variability in prey population sizes compared to Alternative 1.

As discussed under the implementation scenario for Alternative 2, the effects of the implementation scenario for Alternative 6 on giant salamanders would depend on the extent to which hatchery-origin salmon and steelhead are present in streams that these salamanders occupy. Information is not currently available about interactions among salamanders and salmon and steelhead.

With increased numbers of hatchery-origin salmon and steelhead under the implementation scenario for Alternative 6, there would be an increase in predation pressure on marine invertebrates and invertebrate populations compared to Alternative 1. Considering natural variability of salmon and steelhead, marine invertebrates, and insect populations, it is unlikely that this increase would affect distribution or abundance of either marine invertebrates or aquatic insects under the implementation scenario for Alternative 6 compared to Alternative 1.

4.6 Water Quality and Quantity

4.6.1 Introduction

This section describes the effects of implementing the alternatives on water quality and quantity. Successful operation of Federal, state, and tribal hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in the hatchery facility, is discharged to adjacent receiving environments. Various components of water quality and quantity that could be affected by hatchery operations are discussed in Section 3.6, Water Quality and Quantity.

As described in Section 4.1.3, Implementation Scenarios, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 4-2). Table 4-120 shows the implementation measures that may affect water quality and quantity indicators. Six implementation measures may affect water quality and quantity indicators:

- Change production levels in hatchery programs.
- Correct water quality issues at hatchery facilities.
- Install new seasonal weirs.
- Install new permanent weirs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

All of these implementation measures are related to changes in production levels (including those associated with new and terminated hatchery programs), installation of weirs, and improvements to the water quality of the hatchery effluent (Table 4-120). The analysis is based primarily on the above issues because the number of hatchery-origin fish produced determines the quantity of water needed for operations, the amount of chemicals and solids in the effluent discharged, and how many returning hatchery-origin fish end up as carcasses in local streams. Effects of installing new weirs and correcting water quality issues at hatchery facilities are also discussed. As described in Section 3.6.2 (Analysis Area), the analysis area for water quality and quantity is the same as the project area (Section 2.2, Description of Project Area).

TABLE 4-120. WATER QUALITY AND QUANTITY INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	WATER QUALITY AND QUANTITY INDICATORS THAT MAY BE AFFECTED			
	WATER QUALITY PARAMETERS[1]	COMPLIANCE WITH APPLICABLE HATCHERY REGULATIONS	SURFACE WATER DIVERSIONS AND CONSUMPTION	GROUNDWATER DIVERSIONS AND CONSUMPTION
Change production levels in hatchery programs.	X	X	X	X
Update water intake screens at hatchery facilities.				
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.				
Correct water quality issues at hatchery facilities.	X			
Install new seasonal weirs.			X	
Install new permanent weirs			X	
Establish new selective fisheries in terminal areas.				
Change hatchery program goals (i.e., harvest or conservation).				
Change hatchery program's operational strategy (i.e., isolated or integrated).				
Establish new hatchery programs.	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X

[1] Water quality parameters include temperature, nutrients, dissolved oxygen, pH, sediment, PCBs and dichlorophenyltrichloroethane (DDT) and its metabolites, pathogens, steroid hormones, and hatchery treatment chemicals.

4.6.2 Methods for Analysis

The qualitative analysis conducted for water quality and quantity for this section was based on use of literature, as referenced in Section 3.6.3, Water Quality, representing best available science, consistency with the regulatory requirements identified in Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance, and use of other studies that identified effects that resulted from similar or related projects within and near the analysis area. No modeling was conducted.

4.6.3 Water Quality

Changes in salmon production levels (including those associated with new and terminated hatchery programs) have the potential to affect water quality in downstream receiving environments of each hatchery program (Section 3.6.3, Water Quality). Increases in production could degrade the quality of the water being discharged from hatchery facilities to downstream receiving environments. Concurrently, decreasing production would improve the quality of the water being discharged from the hatchery facilities to downstream receiving environments through reductions in temperature, ammonia, nutrients (e.g., nitrogen), biochemical oxygen demand (BOD), pH, sediment levels, therapeutics (e.g., antibiotics), fungicides, disinfectants, steroid hormones, anesthetics, pesticides, herbicides, and pathogens (Section 3.6.3.1, Water Quality Parameters). Based on current best available science, it is unclear whether the amount of PCBs and DDT would be affected by changes in production levels since it is unclear how these changes would affect the distribution of hatchery-origin salmon carcasses, which could release PCBs and DDTs into the freshwater aquatic system. As a result, changes in PCBs and DDTs will not be compared across alternatives.

Operation of hatchery facilities requires compliance with Federal and state water quality regulations and state water use regulations (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance). Currently, all hatchery programs in the analysis area are in compliance with their NPDES discharge permits (Table 3-5), although periodic effluence limit exceedances do occur (and are reported as required), and some permits may not reflect current water quality conditions and available technologies (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance). Hatchery programs are a possible source of several parameters that have been identified as impairing segments of the Columbia and Snake Rivers: algae, ammonia, dissolved oxygen, nutrients, pathogens, pH, sediment, sedimentation, temperature, and total phosphorus (Table 3-34). Thus, any decrease in hatchery production may decrease the contribution of hatchery facilities to the impairment of these waters. Any hatchery facility that would increase production under any of the alternatives would have to do so in compliance with its NPDES permit and applicable Federal, state, and tribal regulations (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance). Effluent discharge limits would not be expected to change in these cases, and any increase in effluent discharge would have to be reported to the permitting authority and may require a permit modification. As a result, compliance with applicable water quality regulations across alternatives will not be further analyzed.

4.6.3.1 Alternative 1 (No Action)

Alternative 1 would not result in changes to water quality parameters since there would be no expected changes in species production levels (Table 4-4) relative to baseline conditions (Section 3.6.3, Water Quality). Effluent discharged by hatchery facilities would be expected to continue contributing similar levels of pollutants to receiving waters, and periodic effluent permit limit exceedances would be expected to occur at a similar frequency. However, water quality may improve in watersheds with total daily maximum loads (TMDLs) that are currently in place or will be developed or revised in the future. As NPDES permits are renewed (every 5 to 10 years), hatchery facilities in these watersheds would be required to comply with effluent limits that reflect current technologies and watershed conditions, as well as TMDLs that are in place or will be revised or developed, likely resulting in lower pollutant discharge limits (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance). Also under Alternative 1, hatchery facilities that currently are not covered by NPDES permits may be required to comply with the TMDLs in the future and to obtain NPDES permit coverage.

4.6.3.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, hatchery production would decrease by 59 percent overall compared to Alternative 1 (Table 4-4). This decrease would improve water quality through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance). The risk of one-time effluent permit limit exceedances may also decrease with lower production levels compared to Alternative 1. As under Alternative 1, water quality may further improve as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future.

4.6.3.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Similar to the implementation scenario for Alternative 2, the implementation scenario for Alternative 3 would result in a 19 percent decrease in hatchery production compared to Alternative 1 (Table 4-4). This decrease would improve water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water

Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters, and would possibly reduce the risk of one-time effluent permit limit exceedances, relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance), but not to the same level as Alternative 2, which would result in a 59 percent decrease in hatchery production levels. As under Alternative 1, water quality may further improve as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future.

4.6.3.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 4 would result in a 15 percent decrease in hatchery production relative to Alternative 1 (Table 4-4). This decrease would improve water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters, and would possibly reduce the risk of one-time effluent permit limit exceedances, relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance), but not to the same level as Alternative 2 and Alternative 3, which would have a 59 percent and 19 percent reduction, respectively. As under Alternative 1, water quality may further improve as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future.

4.6.3.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 5 would result in a 15 percent reduction in hatchery production relative to Alternative 1 (Table 44-4). This decrease would improve water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters, and possibly the risk of one-time effluent permit limit exceedances, relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance) similar to the implementation scenario for Alternative 4, which would also have a 15 percent reduction in production levels relative to Alternative 1. As under Alternative 1, water quality may further improve as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future.

4.6.3.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

The implementation scenario for Alternative 6 would result in a 2 percent reduction in hatchery production relative to Alternative 1 (Table 4-4). This reduction would not improve, or would only slightly improve, water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). The contribution of hatchery facilities to the impairment of 303(d) waters, as well as the risk of one-time effluent permit limit exceedances, relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance) would be similar to, or slightly less than, that which would occur under the implementation scenario for Alternative 1. As under Alternative 1, water quality may further improve as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future.

4.6.4 Water Quantity

Changes in production levels have the potential to affect water quantity by changing the amount of water withdrawn from a surface water body or groundwater for hatchery operations (Section 3.6.4, Water Quantity). Additionally, some hatchery facilities do not return diverted waters to the intake point (meaning that diverted waters are taken from one part of the river or stream and discharged to a different location downstream of the intake point) (Section 3.6.4.1, Surface Water Diversion and Consumption). Discharges to waters not at the intake point are considered consumptive water uses. Groundwater withdrawals have the potential to modify groundwater levels and inflow into surface water bodies (Section 3.6.4.2, Groundwater Diversion and Consumption).

Installation of weirs also has the potential to alter surface water flow at and around the locations of the weirs (Section 3.6.4.1, Surface Water Diversion and Consumption). This potential effect would be present year-around where permanent weirs are installed. The potential effect from a seasonal weir would be present only while the weir is installed.

4.6.4.1 Alternative 1 (No Action)

Alternative 1 would not result in changes to water quantity since there would be no expected changes in species production levels relative to baseline conditions (Section 3.6.4, Water Quantity). No new weirs would be installed under Alternative 1 relative to baseline conditions (Table 4-6), so no changes in water flow would be expected relative to baseline conditions.

4.6.4.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, hatchery production would decrease by 59 percent overall compared to Alternative 1 (Table 4-4). This change in production might increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This decrease would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. No new weirs would be installed under this alternative (Table 4-6); therefore, no changes would be expected in water flow relative to Alternative 1.

4.6.4.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, hatchery production would decrease by 19 percent compared to Alternative 1 (Table 4-4). This change in production might increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This decrease would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. Compared to Alternative 1, nine new seasonal weirs would be installed, potentially increasing negative effects on stream flow (Table 4-6), but such effects would be temporary.

4.6.4.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, hatchery production would decrease by 15 percent compared to Alternative 1 (Table 4-4). It is possible that this change in production would increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This decrease would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. Compared to Alternative 1, 11 new permanent weirs would be installed, potentially negatively impacting stream flow (Table 4-6). Effects from weirs under the implementation scenario for Alternative 4 would be greater than under the implementation scenarios for Alternative 1 through Alternative 3 because of the number of permanent weirs to be installed.

4.6.4.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, hatchery production would decrease by 15 percent compared to Alternative 1 (Table 4-4). It is possible that this change in production would increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. Compared to Alternative 1, 12 new permanent weirs would be installed, potentially negatively impacting stream flow (Table 4-6). Effects from permanent weirs under the implementation scenario for Alternative 5 would be greater than under the implementation scenarios for Alternative 1 through Alternative 3 and would be similar to the implementation scenario for Alternative 4.

4.6.4.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, hatchery production would decrease by 2 percent compared to Alternative 1 (Table 4-4). It is possible that this change in production would slightly increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would slightly decrease the amount of consumptive water use compared to Alternative 1. This decrease may contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. As under Alternative 1 and Alternative 2, no new permanent weirs would be installed (Table 4-6), so effects from weirs on stream flow under the implementation scenario for Alternative 6 would be lower than under the implementation scenarios for Alternative 3 through Alternative 5, which include the installation of permanent weirs.

4.7 Human Health

4.7.1 Introduction

This section evaluates the potential effects human health from implementation of any of the alternatives. This includes evaluation of human exposure to both chemical typically used and hatchery facilities and diseases that humans may be exposed to at hatchery facilities.

Hatchery facilities routinely use chemicals in the management of their facilities. These chemicals include therapeutics (e.g., antibiotics), fungicides, disinfectants, anesthetics, pesticides, and herbicides (Section 3.6.3.1, Water Quality Parameters). These chemicals are not considered hazardous to human health when safety precautions and regulations are followed (Section 3.7.3, Safe Handling of Hatchery Chemicals). However, some chemicals (e.g., antibiotics) do not have established water quality criteria. If discharged to surface waters near hatchery facilities, these chemicals may pose a threat to human health (Section 3.7.4.2, Therapeutics).

Hatchery workers may also be exposed to diseases while handling fish. A number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species (Section 3.7.6, Relevant Disease Vectors and Transmission). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Section 3.7.6, Relevant Disease Vectors and Transmission). Concerns have also been raised that farm- or hatchery-raised fish may contain toxic contaminants that pose a health risk to consumers (Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish).

As described in Section 4.1.3, Implementation Scenarios, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 4-2). Table 4-121 shows the implementation measures that may affect human health. Three implementation measures may affect human health indicators:

- Change production levels in hatchery programs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

TABLE 4-121. HUMAN HEALTH INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	HUMAN HEALTH INDICATORS THAT MAY BE AFFECTED		
	HATCHERY CHEMICAL USE, HANDLING, AND SAFETY	TRANSFER OF TOXIC CONTAMINANTS FROM FISH TO HUMANS	RELEVANT DISEASE VECTORS AND TRANSMISSION FROM FISH TO HUMANS
Change production levels in hatchery programs.	X	X	X
Update water intake screens at hatchery facilities.			
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.			
Correct water quality issues at hatchery facilities.			
Install new temporary weirs.			
Install new permanent weirs.			
Establish new selective fisheries in terminal areas.			
Change hatchery program goals (i.e., harvest or conservation).			
Change hatchery program's operational strategy (i.e., isolated or integrated).			
Establish new hatchery programs.	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X

Because all of these implementation measures are related to changes in production levels (including those associated with new and terminated hatchery programs), the analysis below indicates how production levels affect 1) the use, handling, and safety of chemicals in hatcheries (Section 3.7.3, Safe Handling of Hatchery Chemicals, and Section 3.7.4, Chemicals Used in Hatchery Facilities); 2) the transfer of toxic contaminants from fish to humans (Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish); and 3) the potential for transfer of disease from fish to humans (Section 3.7.6, Relevant Disease Vectors and Transmission). As described in Section 3.7.2 (Analysis Area), the analysis area for human health is the same as the project area (Section 2.2, Description of Project Area).

4.7.2 Methods for Analysis

The qualitative analysis conducted for human health for this section was based on use of literature representing best available science and other studies identifying effects that resulted from similar or related projects within and near the analysis area (Sections: 3.7.4, Chemicals Used in Hatchery Facilities; Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish; and Section 3.7.6, Relevant Disease Vectors and Transmission). No modeling was conducted.

4.7.3 Hatchery Chemical Use, Handling, and Safety

Hatchery facilities use a variety of chemicals to maintain a clean environment for the production of disease-free fish (Section 3.7.4, Chemicals Used in Hatchery Facilities). Common chemical classes include disinfectants, therapeutics, anesthetics, pesticides/herbicides, and feed additives. As described in Section 3.7.3 (Safe Handling of Hatchery Chemicals), these chemicals are not considered hazardous to human health when safety precautions and regulations are followed.

4.7.3.1 Alternative 1 (No Action)

Under Alternative 1, hatchery production levels would not change relative to baseline conditions, so there would be no expected change in the amount of chemicals used within the hatcheries relative to baseline conditions. There also would be no expected change in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to baseline conditions derived from production levels. However, reductions in pollutant discharge levels may occur as hatcheries would be required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future (Section 3.6.3.2.1, Federal Regulations; and Section 4.6.3, Water Quality). All safety precautions and regulations would continue to be followed. As a result, there would be no expected changes in risk to human health under Alternative 1 when compared to baseline conditions.

4.7.3.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, hatchery production levels would be reduced 59 percent relative to Alternative 1 (Table 4-4), so there would be a reduction in the amount of chemicals used within the hatcheries relative to Alternative 1. There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to Alternative 1. However, because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to

Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality). As under Alternative 1, further reductions in pollutant discharge levels may occur as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future (Section 3.6.3.2.1, Federal Regulations; and Section 4.6.3, Water Quality).

4.7.3.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Similarly to the implementation scenario for Alternative 2, the implementation scenario for Alternative 3 would result in a 19 percent decrease in hatchery production relative to Alternative 1 (Table 4-4). This decrease would reduce the amount of chemicals used within the hatcheries relative to Alternative 1. There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to Alternative 1. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality). However, risk to human health would not be reduced to the same level as under the implementation scenario for Alternative 2, which would reduce hatchery production levels by 59 percent relative to Alternative 1 (Table 4-4). As under Alternative 1, further reductions in pollutant discharge levels may occur as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future (Section 3.6.3.2.1, Federal Regulations; and Section 4.6.3, Water Quality).

4.7.3.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, hatchery production levels would be reduced 15 percent relative to Alternative 1, so there would be a reduction in the amount of chemicals used within the hatcheries (Table 4-4). There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to Alternative 1. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality). As under Alternative 1, further reductions in pollutant discharge levels may occur as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future (Section 3.6.3.2.1, Federal Regulations; and Section 4.6.3, Water Quality).

4.7.3.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, hatchery production levels would be reduced 15 percent relative to Alternative 1, so there would be a reduction in the amount of chemicals used within the hatcheries (Table 4-4). There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to Alternative 1. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality). The risk to human health under the implementation scenario for Alternative 5 would be most similar to conditions under the implementation scenario for Alternative 4, which would also have a 15 percent reduction in production levels relative to Alternative 1 (Table 4-4). As under Alternative 1, further reductions in pollutant discharge levels may occur as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future (Section 3.6.3.2.1, Federal Regulations; and Section 4.6.3, Water Quality).

4.7.3.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, hatchery production levels would be reduced slightly by 2 percent relative to Alternative 1, so the amount of chemicals used within the hatcheries would be similar to, or slightly reduced from, Alternative 1 conditions (Table 4-4). The amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) would also be similar to, or slightly reduced, compared to Alternative 1. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risks to hatchery workers under Alternative 6 as compared to Alternative 1. However, there may be a slightly reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality). The risk to human health under the implementation scenario for Alternative 6 would be most similar to conditions under the implementation scenario for Alternative 1, with a slight reduction in production levels of 2 percent compared to

Alternative 1 (Table 4-4). As under Alternative 1, further reductions in pollutant discharge levels may occur as hatcheries are required to comply with new or renewed NPDES permits or applicable TMDLs that are currently in place or may be developed or revised in the future (Section 3.6.3.2.1, Federal Regulations; and Section 4.6.3, Water Quality).

4.7.4 Toxic Contaminants in Hatchery-origin Fish

As described in Section 3.7.5 (Toxic Contaminants in Hatchery-origin Fish), hatchery-origin fish have the potential to accumulate chemicals used during their production. Hatchery-origin fish may contain residues of antibiotics, metals, or other organic pollutants, which may be consumed by people fishing from the waterways to which the fish are released. The source of metals or other organic pollutants may be from the feed supplied to the fish, products used to maintain the hatchery facilities (i.e., cleaning products or lead-based paints used on the interior of holding tanks), or pollutants that occur in rivers, estuaries, and oceans where the fish migrate or reside following their departure from hatchery facilities. Accumulation of chemicals in fish tissues depends on many factors (e.g., chemistry of the compound, dose, and frequency). The potential for human exposure depends on the concentration of the chemicals in tissue residues and the frequency of consumption. The effects of the proposed alternatives on this issue are described below.

4.7.4.1 Alternative 1 (No Action)

Fish production under Alternative 1 would be the same as under baseline conditions. As a result, there would be no change in the transfer of toxic contaminants from hatchery-origin fish to humans under Alternative 1 when compared to baseline conditions.

4.7.4.2 Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 2 would be reduced by 59 percent relative to Alternative 1 (Table 4-4). Reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. It is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 3 would be reduced by 19 percent relative to Alternative 1 (Table 4-4). Reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. It is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 4 would be reduced by 15 percent relative to Alternative 1 (Table 4-4). Reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. It is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 5 would be reduced by 15 percent relative to Alternative 1 (Table 4-4). As under Alternative 2 through Alternative 4, reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans.

Again, it is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.6 Alternative 6 (Preferred Alternative - All Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 6, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 6 would be reduced by 2 percent relative to Alternative 1 (Table 4-4). With slightly reduced production levels, the number of hatchery-origin salmon and steelhead that would be eaten by humans would be similar to, or slightly lower than, Alternative 1; thus, the transfer of contaminants from hatchery-origin salmon and steelhead to humans would be similar or slightly reduced. It is not known if consumption patterns would change due to slightly reduced availability of hatchery-origin salmon and steelhead.

4.7.5 Relevant Disease Vectors and Transmission

As described in Section 3.7.6 (Relevant Disease Vectors and Transmission), a number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species primarily through seafood consumption (i.e., improperly or under-cooked fish) or handling of infected fish or fish carcasses. The transmission of fish-borne pathogens to humans is rare, and it can be controlled by using the proper safety measures.

All existing hatchery programs implement practices to minimize the potential of pathogens occurring in fish. This would continue to occur under all of the alternatives. Reduced production levels under the implementation scenarios for Alternative 2 through Alternative 6 may reduce the potential for the transmission of pathogens from hatchery-origin fish to humans through consumption or handling relative to Alternative 1 since there would be fewer hatchery-origin fish to handle and consume, but risks would be negligible under all alternatives.

4.8 Summary of Resource Effects

Table 4-122 summarizes predicted effects from implementation of the No-action Alternative (Alternative 1) and the action alternatives (Alternative 2 through Alternative 6). The summary reflects the detailed resource discussions in EIS Section 4.2, Fish, through Section 4.7, Human Health. These sections contain explanations of the conclusions presented in Table 4-122.

TABLE 4-122. SUMMARY OF ENVIRONMENTAL CONSEQUENCES FOR IMPLEMENTATION SCENARIOS OF EIS ALTERNATIVES BY RESOURCE.

RESOURCE	INDICATOR	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6 (PREFERRED ALTERNATIVE)
Fish	**VSP Indicator**[1]: Increase in estimated natural-origin spawner abundance (all ESUs/DPSs)	342,772 (baseline total estimated abundance)	Increase of 15% compared to Alternative 1	Increase of 11% compared to Alternative 1	Increase of 11% compared to Alternative 1	Increase of 10% compared to Alternative 1	Increase of 7% compared to Alternative 1
	VSP Indicator[1]: Increase in ESU/DPS estimated mean adjusted productivity	Estimated baseline productivity for the 17 existing ESUs/DPSs	15 of 17 ESUs/DPSs with increased productivity compared to Alternative 1	15 of 17 ESUs/DPSs with increased productivity compared to Alternative 1	15 of 17 ESUs/DPSs with increased productivity compared to Alternative 1	15 of 17 ESUs/DPSs with increased productivity compared to Alternative 1	11 of 17 ESUs/DPSs with increased productivity compared to Alternative 1
	VSP Indicator[1]: Estimated Increase of primary[2] and contributing[2] salmon and steelhead populations with *stronger* performance for genetic diversity	46% meet stronger performance	Increase of 48% compared to Alternative 1	Increase of 26% compared to Alternative 1	Increase of 35% compared to Alternative 1	Increase of 37% compared to Alternative 1	Increase of 13% compared to Alternative 1
	Number of new weirs installed to manage pHOS	0 new weirs	Same as Alternative 1	9 new weirs compared to Alternative 1	11 new weirs compared to Alternative 1	12 new weirs compared to Alternative 1	Same as Alternative 1
Socioeconomics	Commercial gross ex-vessel value (2009 U.S. dollars [$]) in the Columbia River Basin	$5,591,040 ex-vessel value	Ex-vessel value reduction of 51% compared to Alternative 1	Ex-vessel value reduction of 12% compared to Alternative 1	Ex-vessel value reduction of 5% compared to Alternative 1	Ex-vessel value reduction of 3% compared to Alternative 1	Ex-vessel value increases of 14% compared to Alternative 1[3]
	Total (direct and secondary) economic benefit to income (2007 U.S. dollars [$]) in the Columbia River Basin	$173,564,549 total personal income	Reduction in total income benefit of 33% compared to Alternative 1	Reduction in total income benefit of 7% compared to Alternative 1	Reduction in total income benefit of 4% compared to Alternative 1	Same as Alternative 1	Increase in total income benefit of 8% compared to Alternative 1
	Total (direct and secondary) economic impacts on jobs in the Columbia River Basin	4,503 jobs	32% reduction in jobs compared to Alternative 1	8% reduction in jobs compared to Alternative 1	5% reduction in jobs compared to Alternative 1	Less than 1% reduction in jobs compared to Alternative 1	7% increase in jobs compared to Alternative 1
	Recreational expenditures (2009 U.S. dollars [$]) in the Columbia River Basin	$125,136,636 in recreational expenditures	31% reduction in recreational expenditures compared to Alternative 1	10% reduction in recreational expenditures compared to Alternative 1	8% reduction in recreational expenditures compared to Alternative 1	3% reduction in recreational expenditures compared to Alternative 1	3% increase in recreational expenditures compared to Alternative 1
Environmental Justice	Total tribal fish harvests (commercial, ceremonial, and subsistence) by number of fish in the Columbia River Basin	216,800 fish harvested	42% reduction in fish harvests compared to Alternative 1	11% reduction in fish harvests compared to Alternative 1	10% reduction in fish harvests compared to Alternative 1	5% reduction in fish harvests compared to Alternative 1	3% increase in fish harvests compared to Alternative 1[4]
	Tribal fishing revenue in the Columbia River Basin (2009 U.S. dollars [$])	$2,952,345 tribal fishing revenue	44% decrease in tribal fishing revenue compared to Alternative 1	10% decrease in tribal fishing revenue compared to Alternative 1	9% decrease in tribal fishing revenue compared to Alternative 1	6% increase in tribal fishing revenue compared to Alternative 1	18% increase in tribal fishing revenue compared to Alternative 1[3]

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TABLE 4-122. SUMMARY OF ENVIRONMENTAL CONSEQUENCES FOR IMPLEMENTATION SCENARIOS OF EIS ALTERNATIVES BY RESOURCE (CONTINUED).

RESOURCE	INDICATOR	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6 (PREFERRED ALTERNATIVE)
Wildlife	Caspian terns and bald eagles	Populations likely to increase	Potential reductions in abundance, distribution, and fitness relative to Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Southern Resident Killer Whale (listed)	80 individuals are currently in Southern Resident stock; populations would continue to fluctuate	Potential reductions in abundance relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	California sea lions	Populations likely increasing	Abundance in Columbia River would probably decline relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Steller sea lions (Eastern)	Populations likely increasing	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Human Health	Use of chemicals and antibiotics	Chemicals and antibiotics would be used consistent with Federal and state guidelines; potential pathogen exposure	Potential decrease in use of chemicals and antibiotics; no change in exposure to pathogens	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
Water Quality and Quantity	NPDES permits and changes in water quality	Continued compliance with NPDES permits	Continued compliance, potential improvements in water quality, and reduction in water use	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

[1] VSP, based on McElhany (2000), is a conceptual framework for evaluation of the viability of salmonid populations based on measurable indicators of population health—abundance, productivity, diversity, and spatial structure (See Section 3.2.3.1.1, Effects on the Viable Salmonid Population Concept). The EIS only summarizes effects on abundance, productivity, and diversity here. See Section 4.2.1, Methods for Determining Effects on VSP for Salmon and Steelhead, for more information.
[2] "Primary" and "contributing" populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers. They are applied in this final EIS (Section 2.4, Alternative Development). Not all recovery plans for salmon and steelhead utilize this same hierarchical structure to identifying recovery goals for listed populations.
[3] Changes in commercial gross ex-vessel value result from a combination of changes in total number of fish harvested and changes to the composition of the fish harvest, based on changes in the hatchery production in the alternative implementation scenario.
[4] Increase in total Columbia River tribal harvests result from changes to hatchery program production numbers and the composition of the species and run-type released, i.e., a higher proportion of upriver bright (URB) Chinook salmon than tule Chinook salmon. These changes can result in more of these fish available for harvest under the EIS harvest rate assumptions.

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Chapter 5

Cumulative Effects

5 CUMULATIVE EFFECTS

5.1 Introduction

The National Environmental Policy Act defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 Code of Federal Regulations [CFR] 1508.7). Chapter 3, Affected Environment describes the baseline conditions for each resource and reflects the effects of past and existing actions (including hydropower, habitat loss, harvest, and hatchery production). Chapter 4, Environmental Consequences, evaluates the direct and indirect effects of the alternatives on each resource's baseline conditions. Chapter 5, Cumulative Effects, now considers the cumulative effects of each alternative in the context of past actions, existing conditions, and reasonably foreseeable future actions and conditions.

The cumulative effects analysis is important for review of this proposed action because it is pertinent to development of a policy direction that will inform the future funding of Mitchell Act hatchery programs. As climate change and development continue to affect the Columbia River Basin, decisions on Mitchell Act funding will have to be responsive to such changes. It is also a valuable tool to provide anticipated impact trends within the Columbia River Basin. The direct and indirect analysis area includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California; 2) British Columbia (Canada); 3) Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska (Figure 3-1). The cumulative effects analysis in this Chapter (5) uses the same analysis area.

Provided below are known future actions reasonably likely to occur within the analysis area. Expected future actions include climate change, proposed developments, and planned habitat restoration activities.

Many plans, regulations, and laws are in place to minimize the effects of development and to restore habitat function (Section 1.7, Relationship to Other Plans, Regulations, Agreements, Laws, and Executive and Secretarial Orders). However, it is unclear if these plans, regulations, and laws can successfully meet the environmental goals and objectives contained therein. In addition, it is impossible to predict the magnitude of effects from future development and habitat restoration for several reasons: 1) the activities have not yet been proposed, 2) mitigation measures have not been identified for many proposed projects, or 3) there is uncertainty whether mitigation measures will be fully implemented. When combined with climate change, however, a general trend in expected cumulative impacts can be estimated.

Section 5.2, Past and Present Actions, summarizes past and present factors influencing the Columbia and Snake Rivers. Section 5.3, Future Actions, discusses all expected future actions within the action area. The cumulative effects analysis in Section 5.4, Resource Effects from Climate Change and Future Actions, focuses on the effects of each alternative in the context of future climate change when combined with future actions.

5.2 Past and Present Actions

Since the Columbia River Basin represents both the direct and indirect analysis area and the cumulative effects analysis area for this environmental impact statement (EIS), the existing baseline conditions, as described in the resource subsections in Chapter 3, include influences from historical and current conditions. Human uses and development have had substantial influences on the area. Human presence in the project area dates back more than 10,000 years when the Columbia River was the dominant contributor of food, water, and transportation for humans. Presently, the primary influencing factors on the Columbia and Snake Rivers are the dams that provide electrical power, flood control, and navigational opportunities, as well as supporting agricultural needs, while simultaneously resulting in long-term environmental impacts on aquatic life. Associated development and human uses have also impacted the Columbia River ecosystem. These factors include port improvements, dredging, fishing, urban pollution, and channelization. Despite these extensive uses, however, the basin is considered a diverse, highly productive ecosystem that will continue to provide both important biological functions and economic services. Human uses and associated development, as stressors to the existing ecosystem, are expected to continue under future actions as described below.

5.3 Future Actions

Future actions include discussion of climate change, the effects of development and proposed or ongoing projects, and habitat restoration and protection of salmon and steelhead efforts. Each of the above topics is described in terms of effects on the project area and proposed alternatives.

5.3.1 Climate Change

Climate change could affect all of the alternatives equally. In other words, trends in environmental changes would likely take place basinwide, so no single implementation scenario would be affected more than another. Long-term climate changes that have taken place and are expected to continue in the Columbia River Basin include the following ranges and variations (as summarized in data from the Joint Institute for the Study of Atmosphere and Ocean Climate Impacts Group 1999, Climate Impacts Group 2004, West Coast Governor's Global Warming Initiative 2004, Kay et al. 2005, Independent Science Advisory Board [ISAB] 2007a, Mote and Salathe 2009, and Mote et. al. 2014):

1) Projections of annual average precipitation vary from an 11 percent decrease for 2030 to 2059, to an 18 percent increase from 2070 to 2099, depending on which future emissions assumption is modeled. Reductions in summer precipitation are more consistent across model outcomes, however, and they are projected to decrease by as much as 30 percent by the end of the century.

2) An increase in average annual temperature of between 3.3 and 9.7°F from 2070 to 2099 is projected (compared to the period from 1970 to 1999). If realized, these changes could result in the following climatic trends:

    - Warmer air temperatures will result in more precipitation falling as rain rather than snow.
    - Snow pack will diminish, and stream flow timing will be altered.
    - Peak river flows will likely increase.
    - Water temperatures will continue to rise.
    - The ocean will continue to rise, resulting in coastal erosion and an increased proportion of salinity in estuaries.
    - There will be increased water stratification in lakes, marine estuaries, and the ocean.

- The likelihood of extreme events (floods, droughts, fires, and insect outbreaks) is expected to increase.

In general, the long-term effects of climate change would likely be similar in nature, but greater in magnitude, to some of the effects of short-term, climate variability observed on an annual basis. This would be a result of similarities between the regional climate shifts projected for anthropogenic climate change (warmer wetter winters, resulting in increased winter stream flow; warmer summers; and an increase in sea level) and some of the effects experienced during La Niña winters (increased precipitation and winter streamflow) and El Niño years (warmer winters, resulting in decreased spring and summer streamflow and increased sea level). Some short-term climate variation is normal, but longer-term trends now indicate a changing climate (Climate Impacts Group 2010).

5.3.2 Development

Development that has occurred within the Columbia River Basin over the past decade has affected the abundance, distribution, and health of hatchery-origin and natural-origin salmon and steelhead, other fish, socioeconomics, wildlife populations, and water quantity and quality. Provided below is a bulleted list of these development trends taken from ISAB (2007a,b) and the Lower Columbia River Estuary Partnership (2005), followed by some of the larger planned projects within the Columbia River Basin. These trends cannot be quantified in full detail because some of the development projects are in the early stages of permitting and planning, while others are closer to implementation decisions demonstrated by completion of records of decision (RODs) or draft EISs. However, this analysis assumes that all of the projects described in this chapter would be implemented during the 10-year period of the proposed action to provide a review of the highest-impact potential scenario.

- Human populations are increasing primarily in urban metropolitan areas, with smaller increases in rural areas. This increase is expected to continue until at least 2030.
- Freshwater withdrawals for domestic, industrial, commercial, and public uses are increasing, whereas withdrawals for irrigation purposes are decreasing due to the conversion of agricultural lands to residential areas.
- Forests are being converted for development, which is resulting in forest fragmentation.
- Mining in the Columbia River Basin is focused on sand and gravel with the removal occurring along or within rivers.

- Electrical demand continues to increase by approximately 1 percent per year.
- Globalization of trade has contributed to the loss of trade in some areas (e.g., the Mexico strawberry market) and to the increase in trade in other areas (e.g., increased Columbia River Basin wine production due to Australia droughts).
- An increase in ship traffic is likely to occur because of Columbia River channel-deepening projects.
- New port infrastructure projects continue to result in loss of aquatic habitat.
- Hazardous materials transport and airborne pollution have been increasing in the Columbia River Basin.

The project list provided below has been updated for the final EIS. Projects listed in the draft EIS that are now completed have been removed from this list.

United States (U.S.) Army Corps of Engineers (USACE) – Jetty Rehabilitation at the Mouth of the Columbia River. This project (located in Clatsop County, Oregon) began in 2005 when U.S. District Court Judge Ricardo Martinez ruled in favor of the Columbia River Channel Improvement Project (*Northwest Environmental Advocates v. National Marine Fisheries Service, United States Army Corps Of Engineers and Ports Of Vancouver, Woodland, Kalama, Longview, Portland, And St. Helens*), confirming that USACE and National Marine Fisheries Service (NMFS) had properly analyzed the project's impacts under federal law. The project involves repair of damaged portions of the jetty, along with rebuilding existing haul roads at the jetty. The effort involves placing approximately 70,000 tons of stone on the north and south sides of the jetty, as well as using 50,000 tons of small rock material for the access road areas. This navigation project will occur within a 0.5-mile-wide navigation channel extending for about 6 miles through a jettied entrance between the Columbia River and the Pacific Ocean. Construction began in 2013 on the South Jetty dune augmentation. From 2014 to 2021, construction will continue on the North Jetty, South Jetty, and Jetty A. Based on NMFS' final biological opinion prepared for the project, mitigation measures include habitat improvements to benefit fish and wildlife listed under the Endangered Species Act (ESA). Additionally, an adaptive management team will be convened for periodic environmental evaluation of the project. More information can be found at the following website:

http://www.nwp.usace.army.mil/Missions/Currentprojects/MouthoftheColumbiaRiverjetties.aspx

Oregon Liquefied Natural Gas (LNG) – Terminal Construction and Operation, Warrenton, Oregon. For this project, Oregon LNG proposes to site, construct, and operate an LNG export terminal on the northern portion of the East Skipanon Peninsula near the confluence of the Skipanon and Columbia Rivers in Warrenton, Clatsop County, Oregon. The proposed Oregon LNG Terminal would be located at River Mile (RM) 11.5 of the Columbia River within an approximate 96-acre parcel of land that is owned by the state of Oregon and leased to the Port of Astoria by the Oregon Department of State Lands. Oregon LNG holds a long-term sublease with the Port of Astoria for the entire land parcel. The project received land use approval from the City of Warrenton, and the Port of Astoria approved a lease for the project. Upon completion, which the developer anticipates to occur in 2019, the terminal would operate as a marine loading terminal with two full-containment, 160,000-cubic-meter, LNG storage tanks and facilities to support ship berthing and cargo loading. Oregon Pipeline, an affiliated company, is planning the construction of an 87-mile pipeline to connect the terminal to the Williams Northwest Pipeline in Woodland, Washington. The project is currently being reviewed by permitting agencies. More information can be found at the following website:

http://www.oregonlng.com

USACE – Columbia River Federal Navigation Channel Operations and Maintenance Dredging and Dredged Material Placement Network Update, RM 3 to RM 106.5, Washington and Oregon. This project, extending from the mouth of the Columbia River to RM 106.5 (near the I-5 Bridge between Vancouver, Washington, and Portland, Oregon), has been ongoing since 2006. It involves navigation improvements and expanded restoration components. A draft environmental assessment (EA) was recently prepared to further describe and assess future operations and maintenance plans (USACE 2014a). The program is intended to provide a continuous, safe, reliable commercial shipping channel in the Columbia River by periodically removing unsafe and restricting shoals, which requires dredging, shoreline placement, and transporting dredged materials to upland sites. More information can be found at the following website:

http://www.nwp.usace.army.mil/Portals/24/docs/announcements/EA/Draft_EA_2Apr2014_CR-FNC.pdf

In addition to this project, other continued USACE maintenance activities would occur, including work at the mouth of the Columbia River and at cities alongside the Columbia River, as well as continued maintenance of the Columbia River pile dike system.

USACE – Wahkiakum Ferry Channel Project, Wahkiakum County, Washington. This project is located in the Columbia River at RM 43.5 in Wahkiakum County, Washington. USACE released a draft EA in June 2014 for a proposed action that would realign and widen the existing channel to accommodate continuous, safe, and reliable use by Wahkiakum County's new, wider and longer ferry, the M/V *Oscar B*. The new channel configuration would provide the ferry with a wider turning radius to and from the Puget Island ferry berth. The Wahkiakum ferry provides interstate transportation to the entire Lower Columbia region. The ferry runs between Cathlamet, Washington and Westport, Oregon, carrying more than 50,000 vehicles each year.

Columbia River Ports – Continued Port Improvements, Ports of Kalama, Longview, Portland, St. Helens, and Vancouver. Planned continued improvements for each of these ports will occur over time, including redevelopment and replacements, stabilization activities, maintenance dredging, and environmental mitigation activities. These activities are expected to continue for long-term port stability.

5.3.3 Habitat Restoration and Protection of Salmon and Steelhead

Throughout the Columbia River Basin, habitat restoration efforts are supported by Federal, state, and local agencies; tribes; environmental organizations; and communities. Projects supported by these entities focus on improving general habitat and ecosystem function or species-specific conservation objectives that, in some cases, are identified through ESA recovery plans. The larger, more region-wide, restoration and conservation efforts, either underway or planned throughout the Columbia River Basin, are presented below. These actions have helped restore habitat, improve fish passage, and reduce pollution. While these efforts are reasonably likely to occur, funding levels may vary on an annual basis.

Bonneville Power Association (BPA), Bureau of Reclamation (BOR), and USACE – Federal Columbia River Power System (FCRPS) NMFS Biological Opinion, Columbia River, Washington, Oregon, and Idaho. The FCRPS Biological Opinion (2008, adaptive management plan in 2009, supplemental biological opinions in 2010 and 2014) describes how BPA, BOR, and USACE will operate the 14 Federal dams on the Columbia and Snake Rivers over the next 10 years (2008 to 2018) to protect ESA-listed fish. The 2008 FCRPS Biological Opinion describes a comprehensive set of actions designed to ensure that the operational effects of the FCRPS on 13 listed salmon and steelhead species and their critical habitat in the Columbia River Basin comply with ESA section 7(a)(2). The suite of actions developed in 2014, called the Reasonable and Prudent Alternative (RPA), addresses and improves the factors limiting fish survival across all life stages to reduce or mitigate for the adverse effects of the hydroelectric system. Actions include, among other things, hydropower actions, such as flow and fish passage; estuary and tributary habitat improvements; and hatchery and predation management measures. The RPA also includes a robust adaptive management framework designed to adjust implementation activities based on new scientific information. Monitoring and research activities are conducted to assess the effects of the RPA, and adaptive management requires responding to new information by adjusting implementation to achieve the FCRPS Biological Opinion's survival objectives.

The Biological Opinion is comprehensive, and it includes hydroelectric, habitat, hatchery, and harvest measures to address the biological needs of salmon and steelhead in every life stage. It includes commitments to achieve at least 96 percent dam passage survival for spring juvenile migrants and 93 percent dam passage survival for summer migrants on average, per dam. The Biological Opinion proposes new and expanded hatchery facilities that would promote salmon and steelhead recovery and hatchery reforms that would reduce impacts on listed fish. With regard to habitat, actions would be implemented to protect and improve tributary and estuary environments and to reduce limiting factors based on the biological needs of listed fish. These habitat actions must achieve specific habitat quality improvement targets. Predation management actions would address juvenile and adult losses from birds, other fish, and marine mammals. Also included are established performance standards and a comprehensive research, monitoring, and evaluation program.

Associated with the Biological Opinion, BPA negotiated memorandums of agreement (also referred to as the 2008 Columbia Basin Fish Accords) with four Indian tribes (Confederated Tribes of Umatilla Indian Reservation, Confederated Tribes of Warm Springs Reservation, Confederated Tribes and Bands of Yakama Nation, and Confederated Tribes of Colville Indian Reservation), two states (Idaho and Montana), and two Federal action agencies (USACE and BOR) to augment and advance these actions. The memorandums of agreement are for 10 years, and they include projects to benefit fish (such as habitat restoration, hatchery actions, and hydroelectric actions), as described in the FCRPS Biological Opinion. The Fish Accords would result in $933 million funding for fish recovery from 2008 through 2017.

National Oceanic and Atmospheric Administration (NOAA) – Community-based Restoration Program (CRP). The NOAA CRP is a national effort to invest funding and technical expertise in high-priority habitat restoration projects that instill strong conservation values and engage citizens in hands-on activities. Through the program, NOAA, its partners, and thousands of volunteers are actively restoring coastal, marine, and migratory fish habitat across the nation. In 2013, NOAA awarded $10.8 million in funding for 19 coastal habitat restoration projects across the United States through the CRP. More than $3 million in funding was contributed to projects in Oregon and Washington. NOAA CRP support and funding are expected to continue into the future. More information can be found at the following website:

http://www.habitat.noaa.gov/restoration/programs/crp.html

NMFS – Pacific Coastal Salmon Recovery Fund (PCSRF), Columbia and Snake Rivers. Congress created the PCSRF in 2000 to address ESA-listed salmon, as well as impacts from the Pacific Salmon Treaty Agreement between the United States and Canada. Under the PCSRF, states and tribes of the Pacific Coast region (Washington, Oregon, California, Idaho, and Alaska) implement projects and activities to restore and protect salmon and steelhead and their habitat. The types of projects funded by the PCSRF have included protection, restoration, and creation of instream, wetland, estuarine, riparian, and upland habitats; land acquisition; fish passage; hatchery enhancements; watershed planning and assessment; and research, monitoring, and evaluation studies. For this EIS, applicable projects are located in the designated regions: Lower Columbia Salmon Recovery, Middle Columbia Salmon Recovery, Upper Columbia River Recovery, and Snake River Recovery. More information can be found at the following website:

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/pacific_coastal_salmon_recovery_fund.html

Northwest Power Planning and Conservation Council – Fish and Wildlife Program, Columbia and Snake Rivers. The Fish and Wildlife Program was developed for the 31 dams within the Columbia River Basin that USACE operates (21 dams) and BOR (10 dams). Due to construction and operation of these dams, the Northwest Power Act requires the Northwest Power Planning and Conservation Council to prepare a program to protect, mitigate, and enhance fish and wildlife habitat and related spawning grounds affected by hydroelectric development. In November 2013, the Council approved recommendations for 83 projects in Oregon, Washington, and Idaho. The program budget averages $143 million per year for funding projects. Funding is allocated for spill and flow management to support fish survival, predator control, fish habitat improvements, funding support for the Fish Passage Center, and designation of new protected areas. More information can be found at the following website:

http://www.nwcouncil.org/media/6874426/ISRP2013-11.pdf

State of Idaho – ESA Section 6 Cooperative Agreement. The state of Idaho's Department of Lands is pursuing an ESA Section 6 Cooperative Agreement. A draft EIS is anticipated for release in 2015. This forestry program, if approved, would apply to forestry management and timber harvest on state and private lands (voluntary) in the Salmon and Clearwater Basins in Idaho. The intent of the cooperative agreement is to develop forest management practices that would better protect aquatic habitat for ESA-listed fish. An EIS is currently being prepared for this program.

As described above under NMFS' biological opinion for the FCRPS, 2008 Columbia Basin Fish Accords restoration funds include $41.3 million for the next 10 years to provide permanent protection of fish and wildlife habitat through land purchases, conservation easements, habitat restoration, and water transactions in the Upper Lemhi, Lower Lemhi, and Pahsimeroi Rivers and in the lower Clearwater and Potlatch watersheds of Idaho. Under these agreements, the Federal agencies, tribes, and states would work together to provide tangible survival benefits for salmon recovery by upgrading passage over Federal dams and by restoring river and estuary habitat.

State of Oregon – Oregon Plan for Salmon and Watersheds. The Oregon Plan for Salmon and Watersheds includes voluntary restoration actions by private landowners, monitoring, and scientific oversight that is coordinated with state and Federal agencies and tribes. The Oregon Legislature allocates monies drawn from the Oregon Lottery and salmon license plate funds, which have provided $100 million and $5 million, respectively, to projects benefiting water, salmon, and other fish throughout Oregon. Projects include reducing road-related impacts on salmon and trout streams by improving water quality, fish habitat, and fish passage; providing monitoring and education support; helping local coastal watershed councils; and providing staff technical support. More information can be found at the following website:

http://www.oregon.gov/OPSW/Pages/index.aspx

State of Washington – Governor's Salmon Recovery Office. The Governor's Salmon Recovery Office arose from Washington's Salmon Recovery Act, and it includes the Salmon Recovery Funding Board (SRFB). SRFB has helped finance more than 900 salmon recovery projects focused on habitat protection and restoration projects. Its budget from 2011 to 2013 (most recent information available) is $4.2 million for operating costs and $219 million for capital costs obtained through state general obligation bonds and PCSRF. SRFB administers two grant programs (general salmon recovery grants and Puget Sound Acquisition and Restoration grants). Municipalities, tribal governments, state agency nonprofit organizations, regional fisheries enhancement groups, and private landowners may apply for these grants. More information can be found at the following website:

http://www.rco.wa.gov/salmon_recovery/index.shtml

Miscellaneous Funding Sources – Regional and Local Habitat Restoration and Conservation Support. Numerous environmental organizations, communities, and tribes have contributed to salmon habitat restoration and conservation efforts. These projects are often funded by in-kind matches with funding provided by NOAA CRP, PCSRF, the three states' salmon recovery funds, and other sources. The projects vary, ranging from small- to large-scale efforts that include habitat conservation, creation, enhancement, restoration, and protection. These projects may also be initiated and developed under recovery plans prepared for threatened and endangered species. For example, the Cooperative Endangered Species Conservation Fund (ESA section 6), provides grants to states and territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species. Project examples include donating conservation easements, excavating new tidal channels, removing invasive species, stabilizing streambanks, installing or upgrading culverts, removing barriers to fish migration, planting riverbanks, conserving water, restoring wetlands, and managing grazing to protect high-quality aquatic habitat, among others.

USACE – Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, Oregon. The double-crested cormorant colony on East Sand Island has recently increased to almost 15,000 nesting pairs, which has resulted in substantial predation on juvenile salmon and steelhead. These nesting cormorants annually consume about 11 million juvenile salmon and steelhead. To lower this predation rate, USACE is recommending a management plan for reducing available nesting acreage, removing cormorant eggs, applying culling and hazing techniques, and using monitoring and adaptive management to determine the extent of effort needed to reduce cormorant impacts in subsequent nesting seasons. The draft EIS was published in June 2014 (USACE 2014b), and a final EIS will be prepared to respond to agency and public comments and to select a preferred alternative.

Other similar management actions have been taken by Federal agencies for Caspian terns and marine mammals, which are also species that prey on salmon and steelhead. The intent is to reduce future predation by wildlife on salmon and steelhead as the fish migrate through the Columbia River.

5.4 Resource Effects from Climate Change and Future Actions

This section presents information regarding cumulative effects on fish, socioeconomics, environmental justice, water quality and quantity, and human health. Each subsection includes effects of past and present conditions and the expected direct and indirect effects of the alternatives.

5.4.1 Fish

Section 3.2, Fish, describes how past and present conditions have influenced fish populations in the analysis area (Section 3.2.2, Analysis Area). These conditions represent effects from many years of development, as well as habitat restoration in the basin, and, most likely, climate changes. The expected direct and indirect effects of the alternatives on fish populations are described in Section 4.2, Fish. Future actions are described in Section 5.3. This section considers impacts that may occur as a result of any one of the alternatives being implemented at the same time as other anticipated future actions (e.g., development) and presents information in the context of future climate change.

5.4.1.1 Salmon and Steelhead

According to ISAB (2007a), the effects of future climate change on salmon and steelhead would vary among species and with life history stages, but they potentially may affect virtually every species and life history stage of salmon and steelhead in the Columbia River Basin. Rising temperatures will increase disease and/or mortality in several iconic salmon species, especially for spring/summer Chinook salmon and sockeye salmon in the interior Columbia and Snake River Basins (Mote et al. 2014).The cumulative effects on salmon and steelhead may be greater than those described in Section 4.2.3, Effects on Salmon and Steelhead, for all alternatives because this is a newly emerging area of scientific study. Changing environmental conditions are also likely to occur as a result of future development in the Columbia River Basin. The following sections analyze the cumulative effects of future climate change and development on the categories of effects that are described in Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species, and analyzed in Section 4.2.3, Effects on Salmon and Steelhead.

5.4.1.1.1 Effects on the Viable Salmonid Population Concept

McElhany et al. (2000) developed the Viable Salmonid Population (VSP) concept as a means to evaluate the conservation status of Pacific salmon and steelhead. These VSP indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins). This section examines the likely cumulative effects of future climate change and development that would add to the effects identified in Section 3.2.3.1.1, Effects on the Viable Salmonid Population Concept.

Effects on Abundance and Productivity

Climate change in the Columbia River Basin may reduce the abundance and productivity of salmon and steelhead populations compared to anticipated direct and indirect conditions considered in Section 4.2.3, Effects on Salmon and Steelhead, for all alternatives through the following mechanisms:

- Increased mortality would occur due to more frequent flood flows, changed thermal regime during incubation, and lower disease resistance (Table 5-1).
- Warmer winters would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limited (Table 5-1).
- Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival (Table 5-1).

Changing environmental conditions are also likely to occur as a result of development in the Columbia River Basin. While habitat restoration programs are in place, it is unclear whether these programs will fully mitigate for the effects of ongoing and planned development projects. As a result, cumulative effects for hatchery-origin salmon and steelhead on natural-origin salmon and steelhead abundance and productivity would be greater under all alternatives than those considered in Section 4.2.3.1.1, Effects on the Viable Salmonid Population Concept, Effects on Abundance and Productivity.

Effects on Genetic Diversity

Future climate change is expected to result in changing environmental conditions for salmon and steelhead (Section 5.3.1, Climate Change). As described in Section 3.2.3.1.1.2, Effects on Genetic Diversity, unique patterns of genetic diversity can be lost in natural-origin populations when they interbreed with hatchery-origin fish. Although Alternative 2 through Alternative 6 would generally reduce direct and indirect genetic risks of hatchery-origin fish on natural-origin salmon and steelhead populations compared to Alternative 1 (Section 4.2.3, Effects on Salmon and Steelhead), genetic risks would still exist, and they may exacerbate the effects of climate change on natural-origin salmon and steelhead populations. For example, if hatchery production disrupts unique patterns of genetic diversity in a natural-origin salmon or steelhead population, that population may be less able to adapt to the changing environmental conditions anticipated because of future climate change (Section 5.3.1, Climate Change).

TABLE 5-1. POTENTIAL IMPACTS OF CLIMATE CHANGE ON SALMON LIFE CYCLE STAGES.

LIFE STAGE	HIGH TEMPERATURE EFFECTS
Egg	1) Increased maintenance metabolism would lead to smaller fry. 2) Lower disease resistance might lead to lower survival. 3) Changed thermal regime during incubation may lead to lower survival. 4) Faster embryonic development would lead to earlier hatching. 5) Mortality might increase due to more frequent flood flows as snow level rises.
Spring, Summer Rearing	1) Faster yolk utilization might lead to early emergence. 2) Smaller fry would likely have lower survival rates. 3) Higher maintenance metabolism would lead to greater food demand. 4) Growth rates would be slower if food became limited or if temperature increases exceeded optimal levels; growth could be enhanced if food was available, and temperatures did not reach stressful levels. 5) Predation risk would increase if temperatures exceeded optimal levels.
Overwinter Rearing	1) Smaller size at start of winter would likely result in lower winter survival. 2) Mortality would increase due to more frequent flood flows as snow level rises. 3) Warmer winter would lead to higher metabolic demands, which might also contribute to lower winter survival if food became limited, or higher winter survival if growth and size were enhanced. 4) Warmer winters might increase predator activity/hunger, which could also contribute to lower winter survival.

Source: ISAB 2007a

Changing environmental conditions are also likely to occur because of development in the basin. While habitat restoration programs are in place, it is unclear whether these programs will fully mitigate for the effects of ongoing and planned development projects. As a result, cumulative genetic risks of hatchery-origin salmon and steelhead on natural-origin salmon and steelhead would be greater under all alternatives than those considered in Section 4.2.3, Effects on Salmon and Steelhead.

Effects on Spatial Structure

It is unclear how climate change would affect the spatial structure of salmon and steelhead populations, but it is expected that some level of negative effect on these VSP indicators of population status would occur. These effects would likely be similar under all of the alternatives. When combined with the negative effects of future development, it is anticipated that negative trends in the spatial structure of salmon and steelhead populations would occur. It is possible that habitat restoration actions may improve spatial structural conditions within the basin, but the degree to which that would occur is uncertain in light of concurrent negative climate change and development impacts.

5.4.1.1.2 Hatchery Facility Risks

If the combined effect of future climate change and development actions is an increase in basin water temperatures, there may be increased cumulative mortality of salmon and steelhead at weirs and other collection facilities beyond what is considered in the direct and indirect impact analyses (Section 4.2.3.1.2, Hatchery Facility Risks) for all alternatives. This is because increased temperatures resulting from future climate change and development actions may increase the stress level of fish, which may increase mortality rates (Section 5.3.1, Climate Change). Though habitat restoration programs are in place, it is unclear if these programs will fully mitigate for the effects of ongoing and planned development projects on water temperature.

5.4.1.1.3 Risks from Competition with and Predation from Hatchery-origin Fish

Due to future climate change and development in the Columbia River Basin, cumulative competition and predation impacts on natural-origin fish may be greater under all alternatives than effects considered in the direct and indirect impact analyses (Section 4.2.3.1.3, Risks of Competition with and Predation from Hatchery-origin Fish).

Specific climate change effects would likely include the following:

- Predation risk would increase if temperatures exceed optimal levels (Table 5-1).
- Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival (Table 5-1).
- Food may be less available, while metabolic rates may rise (Table 5-1).
- There would be greater metabolic demands, which would increase competition for food (Table 5-1).

Again, while habitat restoration programs are in place in the basin, it is unclear whether these programs will fully mitigate for the effects of ongoing and planned development projects. Therefore, the positive effects of restoration activities on competition and predation are uncertain, particularly when combined with climate change impacts.

5.4.1.1.4 Risks Associated with Masking

No cumulative effects would be expected beyond those already considered in the direct and indirect impact analyses (Section 4.2.3.1.4, Risks of Masking) for all alternatives as a result of future climate change, development, or habitat restoration. This is because these cumulative effect factors would not affect a hatchery program manager's ability to determine the abundance and productivity of natural-origin salmon and steelhead populations over time.

5.4.1.1.5 Risks Associated with Fisheries that Target Hatchery-origin Fish

No cumulative effects would be expected beyond those already considered in the direct and indirect analyses (Section 4.2.3, Effects on Salmon and Steelhead) for all alternatives as a result of future climate change, development, or habitat restoration. If the abundance and productivity of natural-origin salmon and steelhead decline as a result of cumulative effects, including future climate change, then fishing rates would be reduced to keep impacts on natural-origin populations to an acceptable management level. Conversely, if abundance and productivity increase as a result of habitat restoration actions, fishing rates may be correspondingly increased, but would remain within acceptable management levels.

5.4.1.1.6 Benefits of Nutrient Cycling

If there is decreased survival of natural-origin salmon and steelhead as a result of future climate change (Table 5-1) or development, the importance of hatchery-origin fish for nutrient cycling may be greater than what is considered in the direct and indirect analyses (Section 4.2.3.1.5, Benefits of Nutrient Cycling) for all alternatives. Cumulative effects would likely reduce the available nutrient-cycling source, which could be detrimental to fish life cycles in the long term. Habitat restoration actions may mitigate for this potential cumulative effect, but it is uncertain whether these initiatives could fully mitigate for the combined negative effects of future climate change and development in the basin.

5.4.1.1.7 Risks Associated with Disease Transfer

Future climate change and development may reduce disease resistance (Table 5-1) compared to conditions considered in the direct and indirect analyses (Section 4.2.3.1.6, Risks Associated with Disease Transfer) because increased temperatures would likely stress salmon and steelhead, resulting in increased vulnerability to disease. Therefore, the cumulative effects of future climate change, along with other future and ongoing development actions, may increase the risk of hatchery-origin fish transmitting disease to natural-origin fish beyond what is considered in Section 4.2.3.1.6, Risks Associated with Disease Transfer, under all alternatives. It is unclear whether habitat restoration actions in the basin would fully mitigate for the combined negative effects of climate change and development on reduced disease resistance.

5.4.1.2 Other Fish Species with a Relationship to Salmon and/or Steelhead

Other cold-water fish may also be affected by future climate change (O'Neal 2002). In many cases, climate change effects on fish at one life history stage may contribute to increased mortality at later stages (ISAB 2007a). For example, if climate change leads to increases in water temperature, food may be less available, while metabolic rates may be higher. This may result in smaller fish with a reduced ability to survive at later life stages. As a result, climate change may reduce the future abundance of other fish species that have a relationship with salmon and/or steelhead compared to direct and indirect conditions considered in Section 4.2.4, Effects on Other Fish Species that Have a Relationship to Salmon and Steelhead, for all alternatives.

Fish habitat may also be affected by future changes in water temperatures, precipitation, and extreme events that may result in an increased likelihood of floods and droughts, as well as degraded or lost fish habitat, which can occur from development and climate changes. Changes in habitat quality and quantity will influence the abundance of warm-water fish. In response to sealevel rise and increasing salinity levels in rivers and estuaries, warm-water fish could shift habitat use to upstream habitats. Fish that are more adaptable to warmer aquatic conditions could ultimately replace cold-water fish as the dominant species.

The combined effects of development and climate changes within the Columbia River Basin would likely be negative for these other fish species, as well as for salmon and steelhead. As discussed, the mitigated benefits from habitat restoration actions in the basin are difficult to predict in light of negative effects from concurrent development and climate changes. It is possible that habitat restoration actions could have localized, microclimate benefits for some cold-water species other than salmon and steelhead, but this benefit cannot be quantified.

5.4.2 Socioeconomics

Section 3.3, Socioeconomics, describes how past and existing conditions have influenced socioeconomics in the analysis area (Section 3.3.2, Analysis Area). These conditions represent effects from many years of development, as well as habitat restoration in the basin, and, most likely, indirect effects from climate changes. The expected effects of the alternatives on socioeconomics are described in Section 4.3, Socioeconomics. Future actions are described in Section 5.3. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses future impacts that have not already been described and evaluated in Section 4.3, Socioeconomics.

5.4.2.1 Hatchery Facility Costs

Hatchery facility costs include those associated with smolt production and release, implementation of facility best management practices, and construction of weirs. Future climate change, basinwide development, and/or restoration actions are not expected to affect hatchery facility costs, so there would be no cumulative effects beyond those considered in Section 4.3, Socioeconomics, for all alternatives.

5.4.2.2 Gross and Net and Economic Values

Commercial and recreational fishers are consumptive users of fishery resources, and they place monetary value on their fishing activities. For commercial fishers (including both tribal and non-tribal), the ex-vessel value (i.e., the price received for the product at the dock) of salmon and steelhead provides a measure of its gross economic value. If the cost of fishing (e.g., equipment, fuel, boats, insurance, etc.) is calculated, the resulting net income (ex-vessel value minus costs) provides a measure of net economic value.

Recreational anglers' total willingness to pay for their recreational fishing experience represents a measure of gross economic value associated with fishing for salmon or steelhead. Because recreational anglers also incur costs to fish (e.g., bait, tackle, lodging, guide fees, boat-related expenses, travel expenses, etc.), subtracting these costs provides a measure of the net economic value (i.e., net willingness to pay) for fishing opportunities.

Although unquantifiable, future climate change and development actions may reduce the number of salmon and steelhead available for harvest over time. This, in turn, would reduce the total ex-vessel value obtained by commercial fishers relative to conditions considered in Section 4.3, Socioeconomics, for all alternatives. As a result, the cumulative effects on gross and net economic values for commercial fishers may differ from those considered in Section 4.3, Socioeconomics, for all alternatives. If abundance of salmon and steelhead decreases as a result of future climate change, combined with development in the Columbia River Basin, cumulative gross and net economic values for commercial fisheries may be lower than those considered in

Section 4.3, Socioeconomics, for all alternatives, unless prices increase as a result of reduced supply[1].

Future climate change, combined with development in the basin, may affect the cost recreational anglers incur or their total willingness to pay. If fewer fish are available for harvest, and more restrictions are in place (e.g., reduced bag limits and fishing seasons), fewer recreational fishers may be willing to pay for the opportunity to fish. As a result, cumulative effects on gross and net economic values for recreational fishers may lead to future values that are lower than those considered in Section 4.3, Socioeconomics, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change or development on available fish for commercial or recreational harvest.

5.4.2.3 Regional and Local Economic Impacts

The assessment of regional and local economic effects of the alternatives incorporates changes in personal income and jobs as key indicators of the direction and magnitude of economic effects (personal income differs from net economic value). Commercial and recreational fisheries generate personal income and jobs in regional economies through the export of products and services to outside economies. Commercial catch is frequently sold directly, or after processing, to individuals or businesses located outside the regional economy. Similarly, non-local recreational anglers (i.e., anglers who do not live in a local area) spend money on guide services, lodging, and other goods and services that generate household income and employment in many sectors of the regional economy. This regional transfer of money supports payments to labor, and those payments are then re-spent regionally, resulting in a multiplier effect. Additionally, hatchery facility operations, including employment of hatchery workers and procurement of goods and services, directly and indirectly generate economic impacts.

Future climate change and development-related impacts may reduce the number of salmon and steelhead available for harvest, which would reduce the total number of salmon and steelhead exported to outside economies relative to conditions considered in Section 4.3, Socioeconomics, for all alternatives. As a result, the cumulative effects creating regional and local economic impacts may differ from those considered in Section 4.3, Socioeconomics, for all alternatives. If abundance of salmon and steelhead decreases as a result of future climate change and

[1] Because of the wide availability of farmed fish, the market may not support increased prices for natural-origin salmon (Appendix I).

development, the cumulative future regional and local effects of commercial fisheries may be lower than those considered in Section 4.3, Socioeconomics, for all alternatives.

Future climate change and development-related impacts on fish abundance may affect the export of services to economies outside of the Pacific Northwest. Recreational anglers may decide not to travel to the Columbia River Basin from outside areas if fewer fish are available for harvest and more fishing restrictions are in place. As a result, the cumulative effects on regional and local economic conditions may lead to a more significant potential decrease in regional and economic conditions than those considered in Section 4.3, Socioeconomics.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change or development on available fish for commercial or recreational harvest, and therefore, on regional and local economies. Such benefits may be more readily quantifiable at the local habitat or microclimate level, which may or may not represent conditions at the broader regional or local economic environment level.

5.4.3 Environmental Justice

Section 3.4, Environmental Justice, describes how past and present conditions have influenced environmental justice in the analysis area (Section 3.4.2, Analysis Area). Section 3.4, Environmental Justice, also describes the methods for identifying environmental justice user groups and communities of concern. Environmental user groups and communities of concern include Native American tribes that fish for Columbia River Basin salmon and steelhead, low-income or minority communities, and low-income or minority fishing groups. The expected effects of the alternatives on environmental justice are described in Section 4.4, Environmental Justice. Future actions are described in Section 5.3. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses future impacts that have not already been described and evaluated in Section 4.4, Environmental Justice.

5.4.3.1 Fish Harvest and Tribal Value

From a tribal perspective, the value of the salmon is self-evident and extends beyond economic measures. Numbers of salmon harvested provide an indicator of stock health and represent an appropriate measure of relative harvest abundance and tribal value.

As described in Section 5.4.2, Socioeconomics, future climate change and ongoing or planned development in the basin may reduce the number of salmon and steelhead available for harvest.

As a result, cumulative effects on fish harvest and tribal value may be lower than those considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by tribes in the action area. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future tribal uses.

5.4.3.2 Ceremonial and Subsistence Harvest for Tribes

A portion of tribal fish harvests is used to meet ceremonial and subsistence needs, which serve as an indicator of cultural viability. As such, this indicator focuses on the potential effects on cultural sustainability, passing on tribal knowledge to future tribal generations, the preservation of tribal identity, and tribal health.

As described in Section 5.4.2, Socioeconomics, future climate change and/or development may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to lower ceremonial and subsistence harvests than are considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including those planned or currently managed by tribes in the action area. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future tribal ceremonial and subsistence uses.

5.4.3.3 Tribal Fishing and Hatchery Revenue

This tribal indicator directly addresses economic revenue obtained by the tribes from the sale of commercially caught salmon, steelhead, and/or salmon eggs. Tribes also receive economic revenue from processing salmon.

As described in Section 5.4.2, Socioeconomics, future climate change and development may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less tribal economic revenue from the sale of commercially caught salmon than what is considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by tribes in the action area. It is unknown whether these future beneficial actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future revenues.

5.4.3.4 Net Revenue for Non-tribal User Groups of Concern

Hatchery management would also affect non-tribal commercial salmon harvest along the Washington coast and as far south as Cape Falcon (just south of Astoria) along the Oregon coast. Based on the sociodemographic data for these port communities, commercial fishers in select port communities have been identified as environmental justice groups of concern. These include commercial fishers in La Push, Neah Bay, and Westport, Washington, and in Astoria and Dodson, Oregon.

As described in Section 5.4.2, Socioeconomics, future climate change and planned and ongoing development in the basin may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less future net revenue for non-tribal user groups of concern than what is considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by non-tribal user groups in the action area. It is unknown whether these future actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future revenues.

5.4.3.5 Per Capita Income in Communities of Concern

Future changes in commercial and recreational fish harvests and hatchery operations would also affect total regional income at the community level through inter-industry links in the affected regions. Community-level effects include the following:

- Direct income effects on fish harvesters and hatchery staff
- Indirect effects on fish processors, recreational support businesses, and businesses that serve hatchery operations

As described in Section 5.4.2, Socioeconomics, future climate change and development in the basin may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less future per capita income in communities of concern than that considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these future actions would fully, or even partially, mitigate for the effects of climate change and development on available fish for future revenues and per capita incomes in communities of concern.

5.4.4 Wildlife

Section 3.5, Wildlife, describes how past and present conditions have influenced wildlife populations in the Columbia River Basin. These conditions represent effects from many years of basin-wide development, as well as habitat restoration, and, most likely, climate changes. The effects of the alternatives on wildlife populations are described in Section 4.5, Wildlife. Future actions are described in Section 5.3. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses future effects that have not already been described and evaluated in Section 4.5, Wildlife.

As described in Section 5.4.1, Fish, climate change, and development in the Columbia River Basin may reduce the abundance and productivity of natural-origin salmon and steelhead populations. Hatchery-origin salmon and steelhead would be similarly affected, but to a lesser degree since they would have more favorable conditions in their early life stages (while in the hatchery facility) as water temperature and food availability would be controlled. Overall, the total number of salmon and steelhead available as prey to wildlife may be lower than that considered in Section 4.5, Wildlife, for all alternatives. Reduced abundance of salmon and steelhead would also decrease the number of salmon and steelhead carcasses available to wildlife for scavenging and for nutrient contribution to the freshwater system.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on salmon and steelhead abundances. Therefore, it is difficult to estimate future trends in available prey bases for wildlife and available nutrient contributions to the freshwater system. Again, however, localized microclimate fish habitat improvements may be realized from these restoration actions. This potential benefit would be experienced in the future by wildlife that reside in the same localized ecosystems.

5.4.5 Water Quality and Quantity

Section 3.6, Water Quality and Quantity, describes how past and present conditions have influenced water quality and quantity in the Columbia River Basin, including conditions resulting from past development and ongoing restoration actions. Climate change effects on present water quality and quantity are likely represented in these current conditions as well. The effects of the alternatives on water quality and quantity are described in Section 4.6, Water Quality and Quantity. Future actions are described in Section 5.3. This section considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This section only discusses future impacts that have not already been described and evaluated in Section 4.6, Water Quality and Quantity.

Successful operation of Federal, state, and tribal hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in the hatchery facility, is discharged to adjacent receiving environments (Section 3.6, Water Quality and Quantity). Climate change is expected to affect water quality by increasing water temperatures and changing seasonal river flows. As a result, cumulative effects may lead to impaired water quality and less quantity than is considered in Section 4.6, Water Quality and Quantity.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these future actions would fully, or even partially, mitigate for the impacts of climate change and development on water quality and quantity, but this is the goal of many of the restoration programs. It is unlikely that substantial water quality and quantity benefits would be realized in the action area in the future, although minor improvements would likely occur over time from local restoration efforts.

5.4.6 Human Health

Section 3.7, Human Health, describes how past and present conditions have influenced human health in the analysis area (Section 3.7.2, Analysis Area), including conditions resulting from past development and ongoing restoration actions. The expected effects of the alternatives on human health are described in Section 4.7, Human Health. Future actions are described in Section 5.3. This section considers potential impacts that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses impacts that have not already been described and evaluated in Section 4.7, Human Health.

5.4.6.1 Hatchery Chemical Use, Handling, and Safety

Hatchery facilities use a variety of chemicals to maintain a clean environment for the production of disease-free fish (Section 3.7.4, Chemicals Used in Hatchery Facilities). Common chemical classes include disinfectants, therapeutics, anesthetics, pesticides/herbicides, and feed additives. Future, climate change, development, and habitat restoration actions in the basin are not expected to affect the use, handling, or safety of chemicals used in hatchery facilities because all chemicals would continue to be used according to their labels. As a result, no cumulative effects would be expected beyond those already discussed in Section 4.7, Human Health.

5.4.6.2 Transfer of Toxic Contaminants from Fish to Humans

As described in Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish, hatchery-origin fish have the potential to accumulate chemicals used during their production and before their release. Hatchery-origin fish may contain residues of antibiotics, metals, or other organic pollutants that may be consumed by people fishing from the waterways into which the fish are released. Future climate change, development, and habitat restoration actions in the basin are not expected to affect the transfer of toxic contaminants from fish to humans. As a result, no cumulative effects would be expected beyond those already discussed in Section 4.7, Human Health.

5.4.6.3 Relevant Disease Vectors and Transmission from Fish to Humans

As described in Section 3.7.6, Relevant Disease Vectors and Transmission, a number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species, primarily through seafood consumption (e.g., improperly or undercooked fish) or handling of infected fish or fish carcasses. The transmission of fish-borne pathogens to humans is rare and can be controlled with the proper safety measures. All existing hatchery programs implement practices to minimize the potential of pathogens occurring in fish, and this would continue into the future under all of the alternatives (Section 4.7, Human Health). Future, climate change, development, and habitat restoration actions in the basin are not expected to affect the transmission of disease from fish to humans, so no cumulative effects would be expected beyond those already discussed in Section 4.7, Human Health.

Science, Service, Stewardship

Chapter 6

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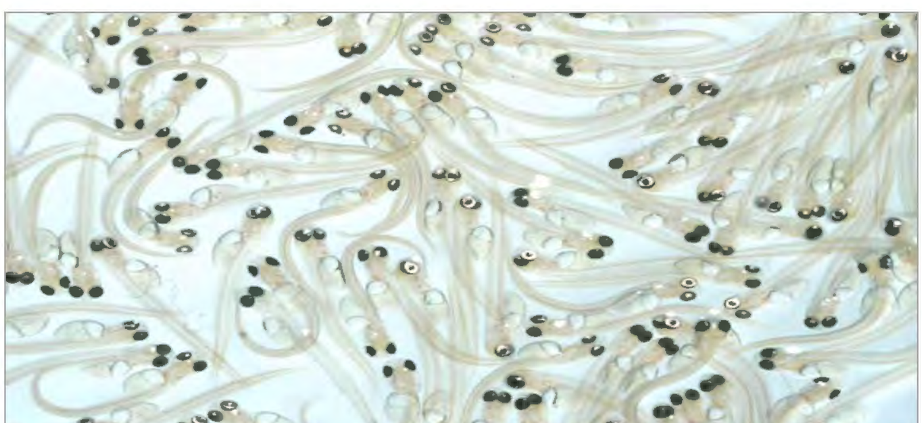

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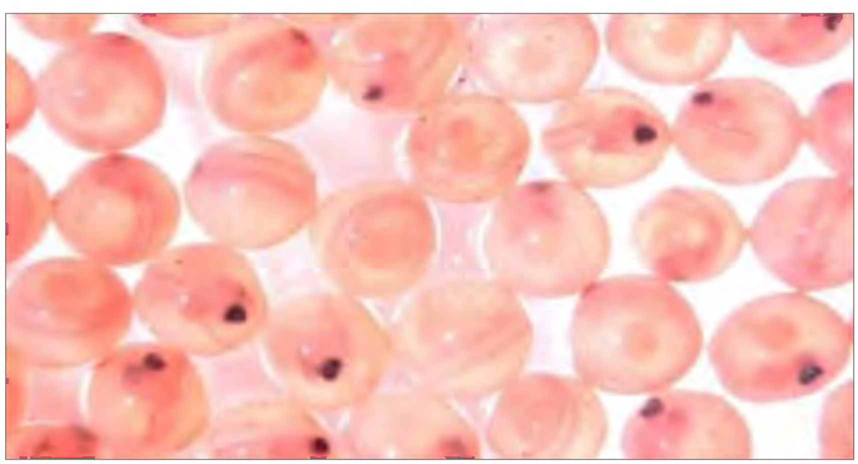
Science, Service, Stewardship

Distribution List

Chapter 7



Distribution List

Federal and State Agencies

Alaska Department of Fish and Game, Juneau Office
Bonneville Power Administration
Council of Environmental Quality
Department of Fisheries and Oceans, Government of Canada
Idaho Department of Fish and Game
NMFS Northwest Fisheries Science Center
Oregon Department of Fish and Wildlife, Salem Office
U.S. Army Corps of Engineers, Portland District
U.S. Department of the Interior, Bureau of Indian Affairs
U.S. Fish & Wildlife Service, Western Washington Office
U.S. Fish & Wildlife Service, Portland Oregon Office
U.S. Environmental Protection Agency, Region 10
Washington Department of Fish and Wildlife, Olympia Office

Elected Officials

Governor's Offices in California, Idaho, Oregon, and Washington
United States Representatives in California, Idaho, Oregon, and Washington
United States Senators in California, Idaho, Oregon, and Washington

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Utilities

Chelan PUD
Douglas PUD
PacifiCorp
Cowlitz PUD
Grant PUD
Portland General Electric
Lewis PUD
Idaho Power

Western Oregon Native American Tribes

Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians
Confederated Tribes of the Grand Ronde Community of Oregon
Coquille Indian Tribe
Cow Creek Band of Umpqua Tribe of Indians
Klamath Tribe
Siletz Tribe

Columbia River Basin Native American Tribes

Burns Paiute Tribe
Coeur d'Alene Tribe
Confederated Tribes of the Colville Reservation
Confederated Salish and Kootenai Tribes
Confederated Tribes of the Umatilla Reservation
Confederated Tribes of the Warm Springs Reservation of Oregon
Confederated Tribes and Bands of the Yakama Nation
Cowlitz Indian Tribe
Kalispel Tribe
Kootenai Tribe of Idaho
Nez Perce Tribe
Shoshone-Bannock Tribes
Shoshone-Paiute Tribe
Spokane Tribe of Indians

Puget Sound and Olympic Peninsula Native American Tribes

Chehalis Tribe
Hoh Tribe
Jamestown S'Klallam Tribe
Lower Elwha Klallam Tribe
Lummi Indian Nation
Makah Indian Tribe
Muckleshoot Indian Tribe
Nisqually Indian Tribe
Nooksack Indian Tribe
Port Gamble S'Klallam Tribe
Puyallup Tribe
Quileute Tribe
Quinault Indian Nation
Sauk-Suiattle Indian Tribe
Shoalwater Bay Indian Tribe
Skokomish Tribe
Snoqualmie Tribe
Squaxin Island Tribe
Stillaguamish Tribe
Suquamish Tribe
Swinomish Indian Tribal Community
Tulalip Tribes
Upper Skagit Tribe

Councils and Commissions

Columbia River Inter-Tribal Fish Commission
Northwest Indian Fisheries Commission
Northwest Power and Conservation Council
Pacific Fishery Management Council
Pacific Salmon Commission
Pacific States Marine Fisheries Commission
Point No Point Treaty Council
Skagit System Cooperative
Upper Columbia United Tribes

Organizations and Associations

Artists 4 Action
Clatsop County Economic Development
Coastal Conservation Association - Pacific Northwest
Columbia River Gillnetters Association
Fisherman's Advisory Committee of Tillamook
Hatchery Scientific Review Group
Ilwaco Charter Association
Long Live the Kings
Lower Columbia Fisheries Coalition
Lower Columbia Fish Recovery Board
Native Fish Society
Northwest Marine Trade
Northwest River Partners
Northwest Sportfishing Industry Association
Oregon Trout

Organizations and Associations (continued)

Public Power Council
Salmon for All
Save Our Wild Salmon
Snake River Salmon Recovery Board
Trout Unlimited
Washington Trollers Association
Washington Federation of State Employees
Westport Charterboat Association
Wild Fish Conservancy
Wild Salmon Center

Libraries

Aberdeen Public Library
Astoria Public Library
Boardman Library
Boise Public Library, Main Library
Buena Vista Public Library
Burbank Library
Carpenter Memorial Library
City of Salem Central Library
Clallam Bay Library
Colfax Library
Coos Bay Public Library
Coos Bay Public Library
County of Tillamook Library
Del Norte County Library
Del Norte Library
East Wenatchee Public Library
Eugene City Library
Eugene Public Library
Eureka Library
Forks Memorial Library
Fossil Public Library
Grangeville Centennial Library
Hillsboro Main Public Library
Hood River County Library
Humboldt County Library
Jefferson County Library District
Kamiah Community Library
Kellogg Public Library
Lewiston City Library
McMinnville Public Library
Mendocino County Library
Moscow Public Library
Moses Lake Library
Multnomah County Library – Central Library
Newport Public Library
Okanogan Library
Olympia Timberland Library
Pierce Free Public Library
Prairie River Library
San Francisco Public Library – Main Branch
Stevenson Community Library
The Dalles – Wasco County Library
The Seattle Public Library, Main Library
Ukiah Library
Umatilla Public Library
Vancouver Community Library
Vancouver Island Regional Library
Wenatchee Public Library
Westport Timberland Library
Yakima Valley Regional Library

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*Individuals**

Bradley J. Johnson
David Lindbloom
Alice Perry Linker
Robert Ruedink
Sally A. Streeter
Will Atlas
Scott Hagen

* Additional individuals were contacted via email and sent an electronic link to the final EIS.

Science, Service, Stewardship

List of Preparers and Agencies Consulted

Chapter 8

1 # List of Preparers and Agencies Consulted

NAME/POSITION	AFFILIATION	EDUCATION
Bob Turner, NMFS Policy Lead	National Marine Fisheries Service (NMFS)	BA Economics and Finance, JD
James Dixon, NMFS Project Manager	NMFS	BS Fisheries Science
Margaret Spence, Contractor Project Manager, GIS, Water Quality and Quantity Support, Human Health Support	Parametrix	BS Mathematical Sciences, MS Applied Statistics-Biometry
Pamela Gunther, Contractor Project Manager, Other Fish Species	AMEC, Inc.	BS Wildlife Science, MA Biology
Allyson Purcell, Fish Support	NMFS	BS Biology, MS Fisheries and Allied Aquaculture
Thomas Wegge, Socioeconomics and Environmental Justice	TCW Economics	BA Urban Studies, MS Environmental Economics
Roger Trott, Socioeconomics and Environmental Justice	TCW Economics	BA Economics, MS Agricultural Economics
Greg Blair, Salmon and Steelhead	ICF International	BS Fisheries Science, MS Fisheries Science
Larry Lastelle, Salmon and Steelhead Harvest	Biostream Environmental	BS Fisheries Science, MS Fisheries Science
Gary Morishima, Salmon and Steelhead Harvest	MORI-ko LLC	BS Mathematics, PhD Quantitative Science and Environmental Management
Bernice Tannenbaum, Wildlife	SAIC	BS Zoology, PhD Ecology and Animal Behavior
Rob Jones, Policy support	NMFS	BS Fisheries Management, MS Fisheries Science
Craig Busack, Fish Support	NMFS	BS Genetics, MS Genetics, PhD Genetics
Patty Dornbusch, Project Management Support	NMFS	BA English, MA Regional and City Planning
Brian Allee, Fish Support	NMFS	BA Zoology, PhD Fisheries Science
Lars Mobrand, Salmon and Steelhead	ICF International	BS Chemistry, PhD Biomathematics
Mark Chilcote, Fish Support	NMFS	BS Fisheries, MS Fisheries and Genetics
Karen Cantillon, Technical Editing	Parametrix	BA English Literature
Ryan Scally, Word Processing	Parametrix	Associates Degree in Arts

NAME/POSITION	AFFILIATION	EDUCATION
Alix Smith, Graphics	NMFS	BA Communications, MS Communications
David Mayfield, Human Health	Parametrix	BS Biology, MS Environmental Health
Robert Sullivan, Fish Support	Parametrix	BS Fisheries Biology
Dan Warren, Contractor Project Manager	D.J. Warren and Associates, Inc.	BS Fisheries Science, MBA
Bruce Watson, Salmon and Steelhead	ICF International	BS Psychology, BS Zoology
Charles Wisdom, Water Quality and Quantity	Parametrix	BA Biology, PhD Chemical Ecology

During the development of the EIS, NMFS also consulted with the following agencies and organizations:

- NMFS Protected Resources Division
- NMFS Northwest Fisheries Science Center
- NMFS Sustainable Fisheries Division
- U.S. Fish and Wildlife Service (USFWS)
- Columbia River Inter-Tribal Fish Commission (CRITFC)
- Northwest Indian Fisheries Commission (NWIFC)
- Shoshone-Bannock Tribes
- Confederated Tribes of the Colville Reservation
- Cowlitz Indian Tribe
- Upper Columbia United Tribes
- Confederated Tribes of the Grand Ronde
- Oregon Department of Fish and Wildlife (ODFW)
- Washington Department of Fish and Wildlife (WDFW)
- Idaho Department of Fish and Game (IDFG)

Science, Service, Stewardship

Chapter 9

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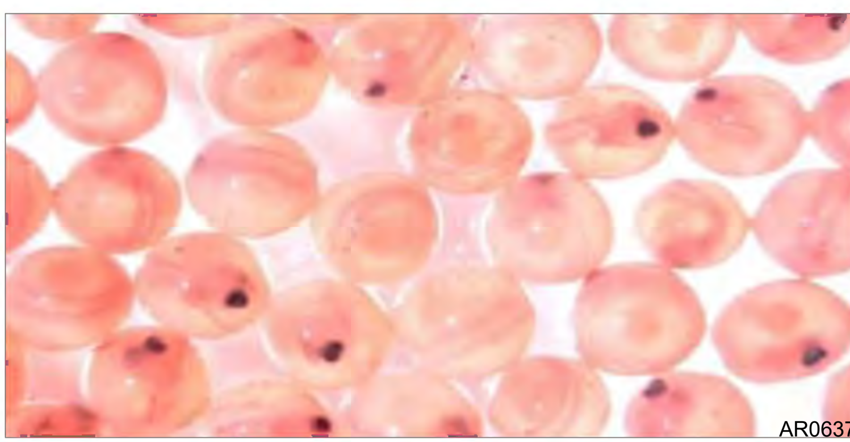

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