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

VIA ELECTRONIC FILING

August 27, 2007

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First St., NE
Washington, DC 20426

RE: Biological Opinion for ESA Section 7 Consultation for the Operation of PacifiCorp and Cowlitz PUD's Lewis River Hydroelectric Projects (Merwin FERC No. 935, Yale FERC No. 2071, Swift No. 1 FERC No. 2111, and Swift No. 2 FERC No. 2213), Lewis River, Cowlitz, Clark, and Skamania Counties, Washington (NMFS Consultation No. 2005/05891)

Dear Secretary Bose:

Enclosed is the National Marine Fisheries Service's (NMFS) Biological Opinion on the Federal Energy Regulatory Commission's (FERC) issuance of licenses for the operation of PacifiCorp and Cowlitz PUD's Lewis River Hydroelectric Projects (Merwin FERC No. 935, Yale FERC No. 2071, Swift No. 1 FERC No. 2111, and Swift No. 2 FERC No. 2213). This responds to your September 30, 2005, letter requesting formal consultation under Section 7 of the Endangered Species Act of 1973 as amended (16 USC 1531 *et seq.*) and consultation under Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act.

In this Biological Opinion, NMFS determined that the Proposed Action is not likely to jeopardize the continued existence of the Lower Columbia River Chinook salmon (*Oncorhynchus tshawytscha*), Lower Columbia River coho salmon (*O. kisutch*), Columbia River chum salmon (*O. keta*), or Lower Columbia River steelhead (*O. mykiss*). NMFS also determined that the Proposed Action is not likely to destroy or adversely modify designated critical habitat for the above species[1]. The Opinion includes an incidental take statement covering the take expected to result from the Project, consistent with the Settlement Agreement on file in this matter.

Enclosed as Section 11 of the Biological Opinion is a consultation regarding essential fish habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267). NMFS finds that the Proposed Action will adversely affect EFH for Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*) and recommends that the terms and conditions of Section 9 of the Biological

[1] Critical Habitat has not yet been designated for Lower Columbia River coho salmon.

Opinion be adopted as EFH conservation measures. Under MSA §305(b)(4)(B) and 50 CFR 6000.920(j), Federal agencies are required to provide a written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations.

Comments or questions regarding this Biological Opinion and MSA consultation can be directed to Michelle Day at 503-736-4734 (Michelle.Day@noaa.gov) or Keith Kirkendall, FERC/Water Diversion Branch Chief, at 503-230-5431 (Keith.Kirkendall@noaa.gov).

Sincerely,

FOR

D. Robert Lohn
Regional Administrator

Cc: Service List

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

PacifiCorp	)	**Lewis River Hydroelectric Project**
	)	**Merwin FERC No. 935**
Cowlitz PUD	)	**Yale FERC No. 2071**
	)	**Swift No. 1 FERC No. 2111**
	)	**Swift No. 2 FERC No. 2213**

CERTIFICATE OF SERVICE

I hereby certify that I have this day served, by electronic mail, a letter to Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, from the National Marine Fisheries Service regarding Biological Opinion for ESA Section 7 Consultation for the Operation of PacifiCorp and Cowlitz PUD's Lewis River Hydroelectric Project (FERC Nos. 935, 2071, 2111, and 2213) and the foregoing document and this Certificate of Service has been served to each person designated on the official service list compiled by the Commission in the above captioned proceeding.

Dated on August 27, 2007

Bethany Downs

Bethany Downs, Secretary
FERC & Water Diversions Branch
Hydropower Division

Endangered Species Act
Section 7(a)(2) Consultation

Biological Opinion

and

Magnuson-Stevens Fishery Conservation and Management Act Consultation

Operation of PacifiCorp and Cowlitz PUD's Lewis River Hydroelectric Projects for 50 years from the new licenses issued date(s)

Merwin FERC No. 935
Yale FERC No. 2071
Swift No. 1 FERC No. 2111
Swift No. 2 FERC No. 2213

Lewis River, HUC 17080002
Cowlitz, Clark, and Skamania Counties, Washington

Action Agency:	Federal Energy Regulatory Commission
Consultation Conducted by:	National Marine Fisheries Service Northwest Region Hydropower Division
NMFS Log Number:	2005/05891

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TERMS AND ABBREVIATIONS

ACC	Aquatics Coordinating Committee
ADA	Americans with Disabilities Act
ALP	alternative licensing procedure
ATE	Adult Trap Efficiency
BE	Biological Evaluation
BPA	Bonneville Power Administration
BRT	Biological Review Team
CE	Collection Efficiency
CHART	Critical Habitat Analytical Review Team
CIT	Cowlitz Indian Tribe
Cowlitz PUD	Public Utility District No. 1 of Cowlitz County, Washington
CS	Collection Survival
DO	dissolved oxygen
CWT	coded wire tag
DPS	distinct population segment
DQA	Data Quality Act
EDT	Ecosystem Diagnosis and Treatment
EFH	essential fish habitat
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCC	Flow Coordination Committee
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
H&S Plan	Hatchery and Supplementation Plan
HPMP	Historic Properties Management Plan
HUC5	Hydrologic Unit Code at the fifth field scale
I & E	Interpretation and Education
ITS	incidental take statement
LCFRB	Lower Columbia Fish Recovery Board
LCR	Lower Columbia River
Licensees	Cowlitz PUD and PacifiCorp
LWD	large woody debris
MSA	Magnuson-Stevens Fishery Conservation and Management Act
msl	mean sea level
NMFS	National Marine Fisheries Service
ODS	Overall Downstream Survival
Opinion	this Biological Opinion
PCE	primary constituent element
PIT	passive integrated transponder
Project(s)	Lewis River Hydroelectric Project. Refers to one or all of the following: Yale (FERC No.2071), Swift No. 1 (FERC No. 2111), Swift No. 2 (FERC No. 2213), and Merwin (FERC No. 935)
Proposed Action	operation of the Lewis River Hydroelectric Projects under four new licenses for terms of 50 years consistent with the Lewis River Settlement Agreement

RPM	reasonable and prudent measure
RRMP	Recreation Resources Management Plan
SAS	Surge Arresting Structure
Services	National Marine Fisheries Service and U.S. Fish and Wildlife Service
TDG	total dissolved gas
TMDL	total maximum daily load
TRT	Technical Recovery Team
UPS	Upstream Passage Survival
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VSP	viable salmonid population
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of
WHMPs	Wildlife Habitat Management Plan
YN	Yakama Nation

1. INTRODUCTION

This is an interagency consultation between the Federal Energy Regulatory Commission (FERC) and the National Marine Fisheries Service (NMFS) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) and Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NMFS is responsible for administration of the ESA with respect to anadromous salmonids. NMFS is likewise responsible for administration of the MSA and consultations conducted pursuant to the MSA's essential fish habitat (EFH) consultation requirements.

Section 7(a)(2) of the ESA requires Federal agencies to ensure their actions avoid jeopardizing the continued existence of listed species or adversely modifying designated critical habitat. Section 305(b)(2) of the MSA requires Federal agencies to consult with NMFS if their actions may adversely affect EFH. The Federal Power Act authorizes FERC to license non-Federal hydroelectric projects. FERC conditions such licenses for the protection of and mitigation for damages to environmental resources, including ESA-listed species and designated critical habitat. Consequently, FERC must initiate consultation with NMFS if their actions may affect ESA-listed species, or may adversely affect EFH.

PacifiCorp and Public Utility District No. 1 of Cowlitz County Washington (Cowlitz PUD) (the Licensees) are seeking new licenses from FERC for the Yale (FERC No.2071), Swift No. 1 (FERC No. 2111), Swift No. 2 (FERC No. 2213), and Merwin (FERC No. 935) Hydroelectric Projects (Project or Projects) located on the Lewis River, Washington (Figure 1-1). The Yale, Swift No. 1, and Merwin Hydroelectric Projects are owned and operated by PacifiCorp. The Swift No. 2 Hydroelectric Project is owned by Cowlitz PUD and currently operated by PacifiCorp under a contract with Cowlitz PUD.

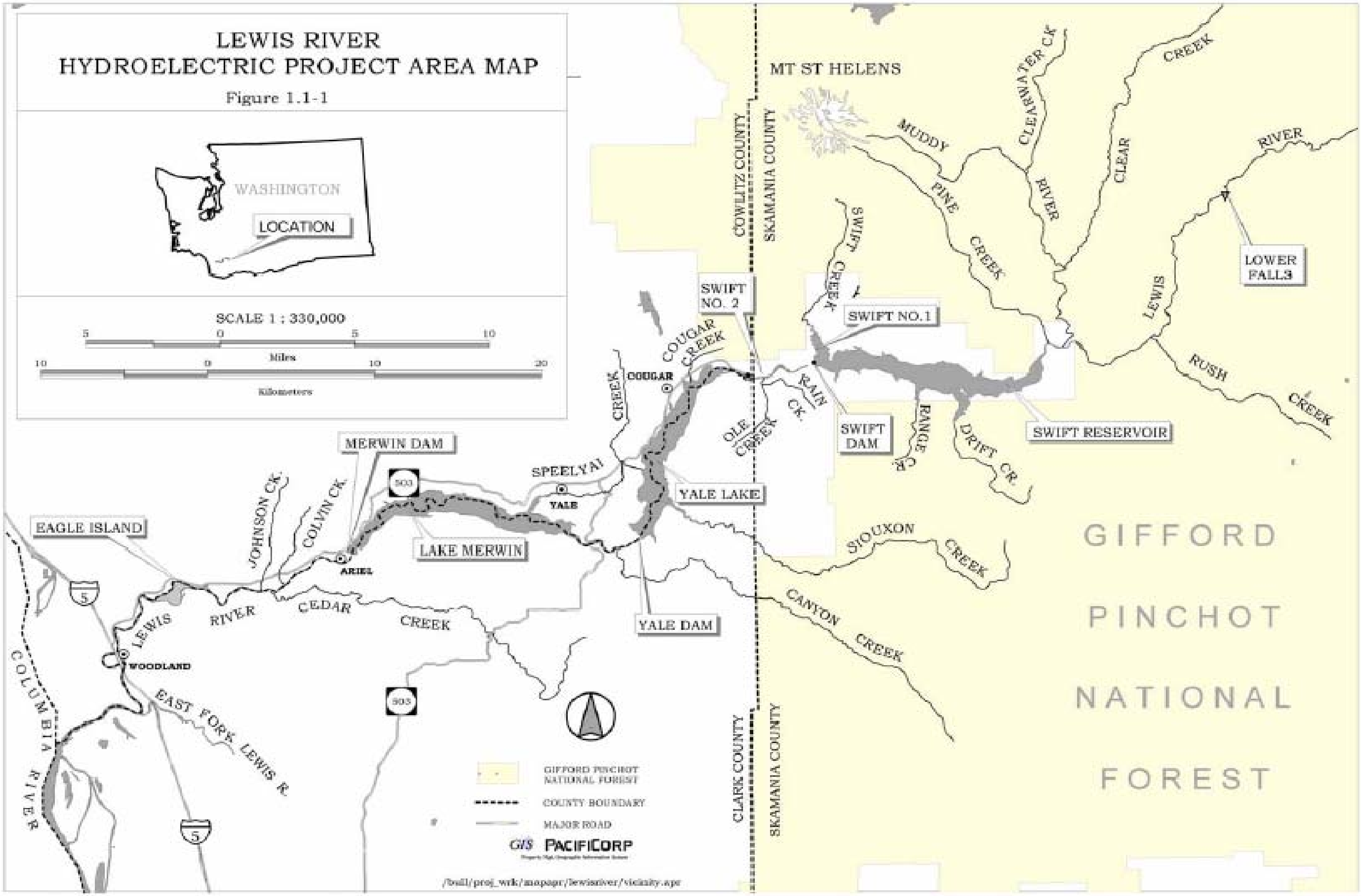
This Biological Opinion (Opinion) and the incidental take statement portion of this consultation were prepared by NMFS in accordance with Section 7(b) of the Endangered Species Act of 1973, as amended (16 USC 1531, et seq.), and implementing regulations at 50 CFR 402. The analysis in this Opinion is based on a review of the best available scientific and commercial information.

The essential fish habitat consultation was prepared in accordance with Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1801, et seq.) and implementing regulations at 50 CFR 600. The administrative record for this consultation is on file at the Portland, Oregon NMFS office.

1.1 History of FERC Relicensing

PacifiCorp and Cowlitz PUD have completed a collaborative FERC relicensing process for the Projects. They initiated the collaborative relicensing process in response to comments from resource agencies and others that all four Projects should be relicensed concurrently to better evaluate Project effects in light of the fact the Projects are operationally linked.

Figure 1-1. Lewis River Hydroelectric Projects Area Map



1.2 Lewis River Collaborative Process

In January 1999, PacifiCorp and Cowlitz PUD filed a request with FERC for approval to use FERC's alternative licensing procedures (ALP) and for the simultaneous and coordinated processing of the license applications for all four Projects. The purpose of ALP was to facilitate communication and collaboration among parties during the relicensing proceeding. On April 1, 1999, FERC approved the requested use of ALP and issued an order accelerating the expiration of the Merwin license to coincide with the other Projects (FERC 1999).

Upon securing FERC's approval for the use of ALP, PacifiCorp and Cowlitz PUD convened meetings on April 29-30, 1999, to initiate the collaborative process. After this initial meeting, a series of public meetings was held to establish the structure and ground rules of the process, and goals and objectives of the participants. Through these meetings, the participants established the Lewis River Hydroelectric Project Relicensing Steering Committee and Resource Workgroups.

The Steering Committee was responsible for overseeing the collaborative process and establishing work group goals and objectives. The Steering Committee established the following Resource Groups to study and address particular resource issues: (1) Aquatics, (2) Terrestrial/Land Use, (3) Flood Management, (4) Recreation/Aesthetics, (5) Socioeconomics, and (6) Cultural. The Resource Groups defined resource goals and objectives, developed an approach to achieve those goals and objectives, and provided recommendations to the Steering Committee. The Steering Committee acted on Resource Group recommendations and resolved outstanding issues. Initially, the Resource Groups devised studies to evaluate resource issues; later, the Groups devised conservation measures to address identified resource issues. In March 2002, Negotiating, Policy, and Legal groups were formed to develop the Lewis River Settlement Agreement for carrying out long-term conservation measures for the Projects. The Settlement Agreement was signed on November 30, 2004. The signed Settlement Agreement along with an explanatory statement (PacifiCorp and Cowlitz PUD 2004a) and supplemental Preliminary Draft Environmental Assessment were conveyed to FERC by PacifiCorp on December 1, 2004 and by Cowlitz PUD on December 3, 2004. On September 23, 2005, FERC published notice in the Federal Register of a draft Environmental Impact Statement for the Lewis River Hydropower Projects. By a November 21, 2005, letter, NMFS provided comments on the DEIS. NMFS filed with FERC preliminary fishway prescriptions which were developed specifically to implement the Settlement Agreement for the Lewis River Projects, pursuant to Section 18 of the Federal Power Act (16 U.S.C. §811), on February 4, 2005. After that, NMFS worked extensively with the license applicants and other Parties to the Settlement Agreement to agree on the precise wording of license articles which, in the minds of all Parties, would best reflect the intent of the Settlement Agreement. The license applicants filed these draft 20 license articles on November 23, 2005, as well as amendments to those articles on December 23, 2005, and January 6, 2006. On February 17, 2006, NMFS filed modified fishway prescriptions which were specifically developed to implement the Settlement Agreement.[1] FERC issued a notice of availability of the Final Environmental Impact Statement (FEIS) for the Lewis River Projects on March 24, 2006 (FERC 2006).

[1] The letters and filings listed in this paragraph are part of FERC's record and can be located via FERC's website under the applicable project numbers.

1.3 ESA Listings and Consultation History

The North Fork Lewis River contains the ESA-listed anadromous fish species[2] identified in Table 1-1 below. Currently, all of these species occur below Merwin Dam, but not above the dam as it is a barrier to migration.

Table 1-1. List of Anadromous Fish Species that Occur in the Action Area and Their Status Under the Endangered Species Act

SPECIES	ESU (SALMON) DPS (STEELHEAD)	STATUS	LISTING	CRITICAL HABITAT
Onchorynchus tshawytscha	Lower Columbia River Chinook salmon	Threatened	NMFS 1999a NMFS 2005a	NMFS 2005b
O. kisutch	Lower Columbia River coho salmon	Threatened	NMFS 2005a	Not Designated
O. keta	Columbia River chum salmon	Threatened	NMFS 1999b NMFS 2005a	NMFS 2005b
O. mykiss	Lower Columbia River steelhead	Threatened	NMFS 1998 NMFS 2006	NMFS 2005b

On September 2, 2005, NMFS designated critical habitat for the Lower Columbia River (LCR) Chinook salmon Evolutionarily Significant Unit (ESU), Columbia River chum salmon ESU and the Lower Columbia River steelhead distinct population segment (DPS) (NMFS 2005b). Critical habitat has not been designated for LCR coho salmon.

Washington's Lower Columbia Fish Recovery Board (LCFRB) developed a Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan. In February 2006, NMFS approved the plan as an Interim Regional Recovery Plan (LCFRB and NMFS 2006). It contains an articulation of goals, comprehensive assessment of limiting factors and threats, and identification of actions needed to address those threats. Such a plan is intended to lead to an ESA recovery plan but it is not yet complete, in this case because it addresses only a portion of the Lower Columbia River ESUs (i.e., those populations in Washington State). NMFS endorses use of the plan until a final plan, including populations in Oregon State, is complete. A final ESA plan is expected in 2008.

Section 7(a) (2) of the ESA requires Federal agencies to ensure their actions do not jeopardize listed species or destroy or adversely modify designated critical habitat. Each of the Lewis River Projects is licensed by FERC, and PacifiCorp and Cowlitz PUD must comply with license articles that direct Project operations and natural resource protection. FERC's issuance of new licenses for the Lewis River Hydroelectric Projects constitutes a Federal action triggering the need for Section 7 consultation. On October 14, 2004, FERC designated PacifiCorp and Cowlitz PUD as its non-Federal representatives under U.S. Fish and Wildlife Service/National Marine Fisheries Service ESA Section 7 regulations. PacifiCorp and Cowlitz PUD prepared a Biological

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[2] An "evolutionarily significant unit" (ESU) of Pacific Salmon (Waples 1991) and a "distinct population segment" (DPS) of steelhead (NMFS 2006) are considered to be "species" as defined in Section 3 of the ESA.

Evaluation (BE) (PacifiCorp and Cowlitz PUD 2005) in accordance with their designated ESA authority (see 50 CFR § 402.08). It addresses impacts from PacifiCorp's ownership and operation of the Merwin, Yale, and Swift No. 1 Projects; and Cowlitz PUD's ownership and operation of Swift No. 2. Cowlitz PUD has contracted with a third party (currently PacifiCorp) to perform certain operation functions.

PacifiCorp and Cowlitz PUD filed with FERC a Biological Evaluation for ESA consultation on January 14, 2005. Consultation for the relicensing of the Lewis River Projects was initiated by the Commission's letter (FERC 2005) to NMFS received on October 4, 2005, in accordance with Section 7 of the ESA and Section 305 of the MSA. On February 10, 2006, NMFS requested an extension from FERC to complete the Biological Opinion. On March 3, 2006, FERC granted this extension setting the Biological Opinion due date as May 5, 2006. On April 4, 2006, NMFS sent a letter to the Confederated Tribes and Bands of the Yakama Nation (YN) and the Cowlitz Indian Tribe (CIT) notifying them of this consultation and soliciting any information, traditional knowledge, or comments that the Tribes wished to provide. YN reviewed the Biological Opinion on March 16 and 20, 2007 providing comments on March 16 and 22, 2007. CIT provided comments on April 12 and 18, 2007. The Lewis River Settlement Agreement measures, FERC's FEIS, and the Washington Department of Ecology's 401 Water Quality Certifications, as amended, form the basis for the FERC actions that this Biological Opinion analyzes.

This Biological Opinion identifies conservation measures from the Settlement Agreement, the FEIS, and 401 Certifications that PacifiCorp and Cowlitz PUD propose to implement under the new FERC licenses. The primary goal of these proposed conservation measures is to provide PacifiCorp and Cowlitz PUD with ESA coverage. This Biological Opinion addresses impacts from PacifiCorp's ownership and role as licensee for operations of the Merwin, Yale, and Swift No. 1 Projects; and Cowlitz PUD's ownership and role as licensee for operations of the Swift No. 2 Project; and the designated operation functions PacifiCorp or another contractor performs pursuant to agreements with Cowlitz PUD for Swift No. 2.

1.4 Application of ESA Section 7(a)(2) Standards - Analytical Approach

This section reviews the approach used in this Opinion in order to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat as set forth in Section 7(a)(2) of the ESA and by 50 CFR §402.02 (the consultation regulations). Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, March 1998, issued jointly by NMFS and the USFWS (USFWS and NMFS 1998). In conducting analyses of actions under Section 7 of the ESA, NMFS takes the following steps, as directed by the consultation regulations:

- Identifies the action area based on the action agency's description of the proposed action, and describes the proposed action (Section 2).
- Evaluates the current status of salmon and steelhead at the ESU and DPS (hereafter referred to as salmon or steelhead species) levels with respect to biological requirements indicative of survival and recovery and the primary constituent elements (PCEs) of any designated critical habitat (Section 3).

- Evaluates the relevance of the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of any designated critical habitat (Section 4).
- Determines whether the proposed action reduces the abundance, reproduction, or distribution of the species, or alters any PCEs of designated critical habitat (Section 5).
- Determines and evaluates any cumulative effects within the action area (Section 6).
- Evaluates whether the effects of the proposed action, taken together with cumulative effects and the effects within the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or are likely to destroy or adversely modify their designated critical habitat (Section 7; see CFR §402.14(g)).

In completing the last step, NMFS determines whether the action under consultation is likely to jeopardize the ESA-listed species or adversely modify critical habitat. If so, NMFS must identify a reasonable and prudent alternative to the action as proposed that avoids jeopardy or adverse modification of critical habitat and meets other regulatory requirements (see CFR §402.02). In making these determinations, NMFS must rely on the best available scientific and commercial data.

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the primary constituent elements of that critical habitat. This analysis focuses on statutory provisions of the ESA, including those in Section 3 of the ESA that define "critical habitat" and "conservation;" in Section 4 of the ESA that describe the designation process; and in Section 7 in the ESA that set forth the substantive protections and procedural aspects of consultation. This Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. § 402.2. Instead, we have relied upon the standard articulated in the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete our analysis with respect to critical habitat.

2. PROPOSED ACTION

The proposed action for this consultation is the operation of the Lewis River Hydroelectric Projects (Yale Project FERC No. 2071, Swift No. 1 Project FERC No. 2111, Merwin Project FERC No. 935 and Swift No. 2 Project FERC No. 2213) under four new licenses for terms of 50 years consistent with the Lewis River Settlement Agreement (Proposed Action). FERC's FEIS (FERC 2006) includes modifications to the Settlement Agreement and incorporates measures from the draft Clean Water Act Section 401 Certifications, and recommends that each license issued for the Lewis River Projects include as conditions all applicable Settlement Agreement measures except for (1) the In Lieu Fund, (2) funding law enforcement, (3) improving five river access sites outside of the Merwin Project boundary, (4) providing funding to the Forest Service for managing dispersed camping sites outside of the Project boundaries, and (5) providing funding to the Forest Service for maintenance of Forest Road 90 (FERC 2006 at 2-55 to 2-56). FERC stated in its FEIS that PacifiCorp and Cowlitz PUD may elect to provide these measures as terms of the Settlement Agreement even though FERC does not recommend them as license conditions. (FERC 2006 at 2-55).

The ESA consultation regulations provide that NMFS must consider the direct and indirect effects of an action, as well as the effects of any interrelated or interdependent actions. "Indirect effects" are the effects of actions which are "caused by the proposed action and are later in time, but still are reasonably certain to occur." 50 CFR 402.02. The five specific Settlement Agreement measures listed above qualify as indirect effects: they are reasonably certain to occur, as evidenced by the commitments made by all signatories to the Settlement Agreement. Moreover, because most Settlement Agreement measures rely on the licenses being issued first, the measures are in effect caused by the Proposed Action and are later in time. Therefore, this Biological Opinion analyzes the effects of issuing new licenses for the Projects, in accordance with staff recommendations in the FEIS, the 401 Certification measures as amended as well as the five specific Settlement Agreement measures listed above as part of the effects analysis in Section 5.

The Proposed Action includes a comprehensive program of salmon protection and restoration measures and actions that will be implemented in a phased approach over the terms of the licenses. Passage elements will primarily benefit spring Chinook, winter steelhead, and late-run coho. There are also a suite of non-passage elements that will benefit all fish species.

The fish passage elements of the program will be subject to rigorous performance standards. These include overall quantitative survival standards, specific salmon life stage standards and facility design standards. These will assist in gauging program success and whether there is need for potential facility adjustments or ultimately, facility modifications.

The Settlement Agreement parties agreed that the overarching goal of the comprehensive program is to achieve genetically viable, self-sustaining, naturally reproducing, harvestable populations of these species above Merwin Dam at greater than minimum viable populations. Status checks are built into the program over time to monitor progress and adaptively manage the program as needed to maximize the expected benefits.

A central, significant feature of the comprehensive program involves reintroduction of extirpated salmon species into their historical range upstream of Merwin Dam. The program takes a comprehensive approach to salmon protection and reintroduction given the nature of reintroducing extirpated anadromous species into their native range after many decades have passed. A key premise of the program is that it will provide an estimated 174 miles of potential anadromous fish habitat above Merwin Dam. Of this, 117 miles of habitat above Swift No. 1 Dam will become available in the fourth year of the reintroduction program as fish are trapped at Merwin Dam and transported upstream to above Swift Creek Reservoir. In the fourth year, downstream passage will be constructed at Swift No. 1 Dam. Over the next 17 years, unless otherwise directed by NMFS and the U. S. Fish and Wildlife Service (USFWS) (the "Services"), each species will be reintroduced to Lake Merwin and Yale Lake via newly constructed upstream fish passage facilities at the Merwin, Yale and Swift Projects and downstream passage at Yale and Merwin Projects. Ultimately, this program will result in upstream and downstream fish passage for salmon and steelhead through each of the reservoirs associated with the Lewis River Projects.

The Lewis River Projects are high-head projects (e.g., Swift No. 1 is 512 feet high) that pose technological and behavioral challenges with respect to fish passage, particularly building ladders at the facilities. As a result, the Settlement Agreement includes many other important and complementary measures to underpin and strengthen the reintroduction effort. These include habitat preparation activities in the tributaries to the Project reservoirs prior to species reintroduction, funding for habitat protection and restoration projects on key tributary streams to the reservoirs, and supplementation using within-ESU/DPS hatchery fish over a period of years both to launch the reintroduction effort and provide support over time. The passage effort will include the best available technology and designs to address the specific characteristics of the Lewis Projects as high-head, high flow projects. Project operational changes also will be implemented to address impacts on species downstream.

Under the Proposed Action, it will likely take many years to reap the full benefits of all the measures and activities that will be undertaken and for the program to fully succeed:

- Active habitat restoration activities need to occur over a period of several years and natural processes are likely to take even longer before the habitat is fully functioning and productive.
- It will take several life cycles of salmon to determine whether the program is delivering anticipated benefits and to better understand potential outside impacts on the program, such as harvest.
- The program phases-in reintroduction into the three reservoirs so that experience and knowledge gained from reintroduction above Swift No. 1 Dam can be applied to reintroduction into Yale Lake and Lake Merwin subsequent efforts.
- It will take time to construct fish passage facilities and time to determine what is working or what needs to be modified based on established performance standards.
- An aggressive monitoring and evaluation program, overseen by a multi-party committee, will be undertaken over the life of the new licenses to collect new information and scientific data to implement an adaptive management approach to species restoration and protection.

As noted, the Proposed Action includes rigorous facility and fish survival performance standards and a monitoring and evaluation program to track progress. The program also includes built-in, major "status checks" in years 27 and 37 to provide for a detailed review of program measures and activities and to track progress. If reintroduction outcome goals are not being met in years 27 and 37, "limiting factors analyses" will be undertaken to more precisely determine whether performance and species goals have been met, whether other factors are undermining program performance, and whether other actions could be undertaken to provide biological benefits equivalent to any Project-related limiting factor.

In addition to the phased reintroduction of extirpated anadromous species and construction of fish passage facilities, the Proposed Action also includes hatchery and supplementation programs; flows in the Lewis River bypass reach; construction of an aquatic habitat channel; minimum flows below the Merwin Dam; plateau operation and ramping procedures at Merwin Dam; wildlife habitat acquisition, protection, and management; recreation upgrades and maintenance; cultural and historic resources protection measures; funding of law enforcement; and a visitor's center. All of these may provide indirect benefits to aquatic species including salmon and steelhead. The discussion below in Section 2.3 provides additional details regarding the Proposed Action to assist in the reader's understanding of its analysis in this Opinion; however, NMFS considers the Settlement Agreement to be the most complete description of the Proposed Action, and has been relied upon by NMFS in preparing this Opinion.

2.1 Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02(d)). The action area for the purposes of this evaluation is the Lewis River Basin from its confluence with the Columbia River to the headwaters of the North Fork Lewis River and its tributaries. This area encompasses all direct and indirect effects to listed species.

2.2 Projects Description

2.2.1 Basin Description

The North Fork Lewis River Basin lies on the flanks of the southern Cascade Mountains of Washington State (Figure 1-1). The river flows in a general southwesterly direction from its source on the slopes of Mount Adams and Mount St. Helens to the Columbia River 19 miles downstream of Vancouver, Washington. The mainstem river is 93 miles long and has a total drop of 7,900 feet, the greater part of which is in the upper reaches. From its mouth and up to the Lewis River Hatchery, the river stage is influenced by tides and subsequent backflow from the Columbia River. The area of the drainage basin is 1,050 square miles, with a mean elevation of 2,550 ft. mean sea level (msl). Slopes in the upper portions of the basin are generally steep, resulting from the incision of numerous streams and rivers into the geologically young landscape. Areas to the south of the Merwin Project and downstream along the river are less steep, represented by rolling hills and flat woodland bottomlands.

The basin has a complex geologic history, having undergone Tertiary volcanism, several glaciations, and interglacial erosion and deposition. Soils in the basin are predominantly well drained and medium-textured, and were derived from volcanic ash or were formed in sediments derived from mixed volcanic rocks and ash. Slopes, which are variable from gentle to steep, range from flat to more than 70 percent. Soil erosion hazard is dependent on slope and vegetation cover; the erosion hazard increases with increasing slope and extent of bare soil. Many areas in the upper reaches of streams flowing from Mount St. Helens have actively eroding hill slopes, which contributes fine sediment to the stream channels.

The Lewis River Basin has been subject to major natural landscape altering processes in the recent past. Debris avalanches, mudflows, and lahars, common on Mount St. Helens and Mount Adams, are rapidly moving slurries of water, rock, soil, and debris. Mudflows swept down Swift Creek, Pine Creek, and the Muddy River during the May 18, 1980 eruption of Mount St. Helens, carrying nearly 18 million cubic yards of water, mud, and debris into Swift Creek Reservoir (Tilling et al. 1990). These events altered the streambed and valley characteristics of affected drainages in a matter of hours, and have long-term effects of very high sediment load and altered channel characteristics. Streams affected by recent mudflows are continuing to process the sediment and woody debris and have changed from narrow channels into wide, braided, unstable channels with high sediment and wood loads. Riparian vegetation along these channels was lost, and is slowly recovering as sediment loads decrease with time.

The climate in the North Fork Lewis River Basin is influenced by the Pacific Ocean to the west and the Cascade Range to the east. Average annual precipitation varies from 45 inches near Woodland to over 140 inches on Mount Adams. The majority of the precipitation occurs during the rainy fall and winter months, with snow falling at higher elevations of the basin. Summers (July through mid-October) are generally drier. Snowfall is minimal at lower elevations, but exceeds 200 inches per year at elevations over 3,000 feet. In the warmest summer months, afternoon temperatures range from the middle seventies to the lower eighties, with nighttime temperatures in the fifties. Maximum temperatures exceed 90ºF on 5 to 15 days each summer. Temperatures in the foothills and higher elevations are slightly lower than those recorded in the valleys.

Basin lands provide winter range for deer and elk; mink and beaver are common in wetlands. Large numbers of amphibians have been observed in the basin, primarily in wetland and riparian/riverine habitats. Over 100 species of birds have also been observed, including waterfowl, raptors, and numerous species of passerines. The watershed also provides habitat for several salmonid species, including bull trout, cutthroat, and steelhead trout, Chinook, coho, and chum salmon, and whitefish. Other fish, such as sculpin and suckers are also common. Several exotic non-native fish species are also present and include brook trout, tiger muskellunge, and bass. Tiger muskellunge, a non-native sterile hybrid known to prey heavily on soft-rayed fishes, were introduced into Lake Merwin by the Washington Department of Fish and Wildlife (WDFW) in 1995. The goal of the program is to reduce the abundance of salmonid-eating northern pikeminnow and to provide a sport fishery for anglers. Northern pikeminnow are known to be one of the main predators on emigrating salmonids in the Columbia River Basin. The Lewis River Watershed is located in an area dominated by natural resources based land uses such as forestry, recreation, and agriculture. As a result, population densities are generally low within the basin. The largest urban center, the City of Woodland, is located near the mouth of the Lewis River, approximately 20 miles north of Vancouver, Washington. Woodland was originally established by settlers in the mid-1850s. Today, it has a population of about 3,875, although the number of people living in the greater Woodland area approaches 10,000 residents. In recent years, the community has experienced substantial growth, with an economy driven by industries such as fishing gear manufacturing, manufactured home production, and agriculture. Development in the Woodland area has adversely affected aquatic habitat in the lower Lewis River Basin. Residential and agricultural land uses have eliminated most of the riparian vegetation in the lower reaches, and the lower 7 miles of the Lewis River floodplain is almost entirely disconnected from the river due to extensive diking (Wade 2000). In the East Fork Lewis River, over 50 percent of the off-channel habitat and associated wetlands within the floodplains have been disconnected from the river.

Other towns in the Lewis River Basin include Cougar, Ariel, Yale, Chelatchie, Amboy, Yacolt and La Center. The small town of Cougar, located along the north shore of Yale Lake, was originally established to serve as a staging point for timber harvest activities. However, after hydroelectric development and the creation of the Mount St. Helens National Volcanic Monument, recreation services became the primary industry. The current population of Cougar is under 200. Because these towns were and are largely supported by natural resource extraction (logging), their ecological footprint or impact is much larger than the size of the town would indicate.

There are three private communities located around Swift Creek Reservoir. The largest of these is the 206-home Northwoods community on the eastern shore. Yale Lake has private development clustered primarily around the Beaver Bay area, the Town of Cougar, and near Speelyai Canal. Private land ownership is more common around Lake Merwin, where there are several large communities along the shoreline, including a 1,600-lot home/trailer development along the south shore. Scattered private lands are found along the Lewis River adjacent to State Route 503, increasing in number as one heads west to the City of Woodland.

2.2.2 The Utilities' North Fork Lewis River Hydroelectric Facilities

The following section describes all four hydroelectric Projects in the North Fork Lewis River Basin. The Projects begin approximately 10 miles east of Woodland, Washington. The upstream sequence of the Projects from the confluence of the Lewis and Columbia Rivers is as follows: Merwin, Yale, Swift No. 2, and Swift No.1. The Merwin, Yale, and Swift No.1 Projects represent a linked reservoir/powerhouse system covering over 30 miles of the Lewis. The Swift No. 2 Project does not include a dam and reservoir. It utilizes water directly from the tailrace of Swift No.1, which flows into a 3-mile-long canal that discharges through the Swift No. 2 powerhouse into Yale Lake.

The three-reservoir four-project system is operated in a coordinated fashion to achieve optimum benefits for power production, flood management, and to provide for natural resources in the basin such as fish, wildlife and recreation. The four Projects utilize the water resources within the North Fork Lewis River Basin from elevation 50 ft msl (Merwin Project tailwater) to 1,000 fmsl (Swift No. 1 normal pool). The total usable storage in the reservoirs is 814,000 acre-ft. The total installed capacity for the four Projects is 580 MW.

Merwin Dam and Reservoir

The Merwin Hydroelectric Project is a 136 MW plant owned and operated by PacifiCorp. It is the furthermost downstream project of the four operating on the North Fork Lewis River. Construction of the Merwin Project began in 1929 and was completed with a single unit in 1931. Two additional units were added in 1949 and 1958. Overall, the Project consists of a concrete dam, reservoir, powerhouse, substation, and two transmission lines.

Merwin Dam spans the North Fork Lewis River 19.5 miles upstream from the confluence with the Columbia River. It is a concrete arch structure with a total crest length of 1,300 feet and a maximum height above its lowest foundation of 314 feet. The dam consists of an arch section 752 feet in crest length, a 75-foot-long gravity thrust block, a 206-foot-long spillway section, a non-overflow gravity section 242 feet long, followed by a concrete core wall section 20 feet high and extending 25 feet into the bank. The spillway is equipped with four taintor gates 39 feet wide and 30 feet high, and one taintor gate 10 feet wide and 30 feet high. The taintor gates have been extended to an elevation of 240 ft above msl by the addition of 5-foot flashboards.

The reservoir formed by Merwin Dam is about 14.5 miles long with a surface area of approximately 4,000 acres at elevation 239.6 feet msl (full pool). At full pool, the reservoir has a gross storage capacity of approximately 422,800 acre-ft. Of this amount, 182,600 acre-ft of usable storage is available between elevation 190 and 239.6 ft msl, with an additional 81,100 acre-ft of usable storage available if the reservoir is lowered to its allowable minimum level of 165 ft msl.

<u>Penstocks and Powerhouse</u>: Three penstocks lead from Merwin Dam to the powerhouse, via separate intakes. The Merwin intakes are relatively deep (approx. 187 ft. below full pool), high-head intakes with design velocities ranging from between 10 and 20 fps. The intakes are protected from large debris by steel trash racks on approximately 4-inch spacing. The capacity of the three penstocks is different, with Unit Nos. 1 and 2 capable of carrying 3,790 cfs, and Unit No. 3 carrying of 3,890 cfs. The penstock inlet diameters and the minimum water surface elevation in Merwin Lake allow the intake system to pass more than 150 percent of the existing plant hydraulic capacity. A fourth penstock was originally constructed but is currently not utilized by the Project.

The powerhouse contains 3 semi-outdoor-type Francis turbine generator units, each with an installed capacity of 45,000 kW, and one 1,000 kW house unit, for a total installed capacity of 136,000 kW.

<u>Transmission and Auxiliary Equipment</u>: Power is transported from the Merwin Project by two 115 kV transmission lines. One of these extends in a westerly direction a distance of approximately 15.9 miles from the Project to the Bonneville Power Administration (BPA) Cardwell substation near Kalama, Washington. The other line runs in a southerly direction for 26.7 miles to the Clark County PUD View substation near Battleground, Washington and then into Portland, Oregon.

Yale Dam and Reservoir

The Yale Hydroelectric Project is a 134 MW plant owned and operated by PacifiCorp that lies directly upstream of the Merwin Project. Construction of the Yale Project began in 1951 and was complete by 1953. The Project consists of a main embankment dam, saddle dam, reservoir, penstocks, powerhouse, and transmission line. The Project is operated in coordination with the other three hydroelectric facilities on the North Fork Lewis River.

Yale Dam is located on the North Fork Lewis River approximately 34 miles upstream from the confluence with the Columbia River. Yale Dam is a rolled earthen fill embankment type dam with a crest length of 1,305 feet and a height of 323 feet above its lowest foundation point. Its crest elevation is 503-ft msl. The saddle dam is located $^1/_4$ mile west of the main dam and is approximately 1,600 feet long and 40 feet high with a crest elevation of 503 feet msl. The main dam has a chute-type spillway, located in the right abutment (looking downstream), with a capacity of 120,000 cfs through five 30-foot by 39-foot taintor gates at reservoir elevation 490 ft msl.

Yale Lake is approximately 10.5 miles long with a surface area of approximately 3,800 acres at elevation 490-ft msl (full pool). At full pool, the reservoir has a gross storage capacity of approximately 401,000 acre-ft. At the minimum pool elevation of 430-ft msl, the reservoir has a capacity of approximately 190,000 acre-ft.

<u>Tunnels/Penstocks and Powerhouse</u>: The Yale Project consists of two tunnels/penstocks leading from Yale Dam to the powerhouse. Water is delivered to the tunnels/penstocks via a common intake. The Yale intake is a relatively deep (approximately 90 ft. below full pool), high-head intake with design velocities ranging from between 10 and 20 fps. The intakes are protected from large debris by steel trash racks on approximately 4-inch spacing. The maximum diameter of each of the Yale tunnels/penstocks is 18.5 feet; the minimum diameter is 16 feet. Penstock velocities range from 18.2 fps in the tunnel to 24.3 fps in the penstocks' smallest sections. The Yale penstocks are each capable of passing a maximum of 4,880 cfs.

The Yale powerhouse contains two Francis-type generator units with a total installed capacity of 108,000 kW (nameplate). The powerhouse is located at the base of the earth embankment on the left side (facing downstream) of the old river channel. The generator units were originally installed in 1952. The turbines were rehabilitated coincident with generator rewinds in 1987 and 1988, respectively. In 1995, PacifiCorp installed a new runner in Yale Unit No. 2. A similar runner was installed in Unit No. 1 in 1996. The new runners increased Yale capacity to 134 MW.

<u>Transmission and Auxiliary Equipment</u>: Power generated at the Yale Project is transmitted 11.5 miles over a 115kV-transmission line (Lake Line) to a substation adjacent to the Merwin Project.

Swift Dam and Reservoir

The Swift No. 1 Hydroelectric Project is a 240 MW plant owned and operated by PacifiCorp. The Project is the furthermost upstream hydroelectric facility on the North Fork Lewis River, lying directly upstream of the Swift No 2 Hydroelectric Project. Construction of the Swift No. 1

Project began in 1956 and was completed in 1958. It consists of a main embankment dam, reservoir, penstocks, powerhouse, and transmission line, and is operated in coordination with the other three hydroelectric facilities on the North Fork Lewis River.

Swift Dam spans the North Fork Lewis River approximately 47.7 miles (the upstream end of Yale reservoir is at RM 44.5 and the canal is 3.2 miles) upstream from the confluence with the Columbia River and upstream of Yale Dam. It is an earthen fill, embankment type dam with a crest length of 2,100 feet and a height of 512 feet. Its overflow spillway, located in the left abutment, has a capacity of 120,000 cfs (at reservoir elevation 1000 feet msl) through two 50-foot by 51-foot taintor gates. The elevation at the top of the taintor gates is 1,001.6-ft msl.

The reservoir formed by Swift Dam is approximately 11.5 miles long with a surface area of approximately 4,680 acres at elevation 1,000-ft msl (full pool). At maximum pool, the reservoir has a gross storage capacity of approximately 755,000 acre-ft. At the minimum pool elevation of 878-ft msl, the reservoir has a capacity of approximately 447,000 acre-ft.

Tunnels/Penstocks and Powerhouse: Water is delivered from Swift Creek Reservoir to the powerhouse through a system containing a tunnel, a surge tank, and an outlet, which branches into three penstocks. The Swift No. 1 intake is a relatively deep (approximately 75 ft. deep at full pool), high-head intake with design velocities ranging from between 10 and 20 fps. The intakes are protected from large debris by steel trash racks on approximately 4-inch spacing. The Swift No. 1 surge tank is located approximately 1,196 feet downstream of the tunnel intake and about 482 feet upstream of the powerhouse. This surge tank is of the restricted orifice, non-overflow style, with a diameter of 55 feet and a top elevation of 1,035-ft msl. Downstream of the tank, individual penstocks for each generating unit branch from the main tunnel. Each of the Swift No. 1 penstocks is 13 feet in diameter. At maximum turbine flows, water in the penstocks reaches velocities of up to 23 fps. The Swift No. 1 penstocks are capable of passing a maximum of 9,120 cfs, combined.

The Swift No. 1 Powerhouse contains three Francis-type generator units with a total installed capacity of 240,000 kW (nameplate). The turbines were rewound in 1987 (unit No. 12), 1990 (unit No. 11) and 1991 (unit No. 13) resulting in a capacity upgrade from 204 MW to 240 MW. The powerhouse is located at the base of the dam on the left side (facing downstream) of the old river channel. The powerhouse is operated by remote control from the Hydro Control Center at Merwin Headquarters.

Transmission and Auxiliary Equipment: The Project is served by the 230kV Speelyai transmission line which extends from Swift No.1 to the Swift No. 2 switchyard and then to a BPA switching station near Woodland, Washington.

Swift No. 2 Hydroelectric Project

The Swift No. 2 Hydroelectric Project is a 70 MW development owned by Cowlitz PUD. The Project lies between the Swift No. 1 and Yale Hydroelectric Projects on the North Fork Lewis River. The Swift No. 2 Project consists of a power canal, intake structure, Surge Arresting Structure (SAS), penstocks, powerhouse, tailrace discharge channel, substation, and transmission line. The powerhouse is located 3 miles downstream from Swift No. 1. Construction of the

Swift No. 2 Project began in 1956 and was completed in 1958. Reconstruction of the Project was completed in 2006. It is operated in coordination with the other three hydroelectric facilities on the North Fork Lewis River.

Power Canal: The Swift No. 2 Power Canal begins at the tailrace of the Swift No. 1 Powerhouse and consists of an earthen-lined upper section (approximately 11,000 feet long) and a concrete-lined lower section (approximately 5,900 feet long). Water released from the Swift No. 1 Powerhouse immediately enters the 3 mile power canal and is conveyed to the Swift No. 2 Powerhouse. A gated check structure and ungated side-channel spillway/Wasteway exist as part of the canal facilities. The purpose of the check structure is to allow isolation of the canal for operation of Swift No. 1 when Swift No. 2 is out of service. The gates in the check structure immediately downstream of the Wasteway can be closed, to block flow, when, for example, the downstream section of the canal needs to be dewatered for maintenance activities including inspection. During normal operations, the Wasteway prevents canal flows from exceeding the Swift No. 2 hydraulic capacity and maintains the maximum level in the canal. Water may be released to the bypass reach over the Wasteway if flows in the canal exceed the Swift No. 2 hydraulic capacity or if the check structure gates are closed. A drain (Canal Drain) on the downstream side of the check structure may also be used to release water from the canal if needed. As a FERC Part 12 safety requirement for the Project, a Surge Arresting Structure is located adjacent to the intake structure to release water from the canal in the event there is a surge from a turbine generator trip at Swift No. 2 and excess flow must be released from the canal. The release valve at the terminus of the SAS consists of two cone valves.

Under normal operating conditions, the elevation of the canal waters at the Swift No. 2 intake structure range from 601 to 604 ft msl. The canal surface area is approximately 56 acres, and the canal holds approximately 922 acre-feet of water. The operating capacity of the power canal is 9,000 cfs.

Penstocks and Powerhouse: Water is delivered from the Swift No. 2 intake structure to the powerhouse via two penstocks, one for each of two turbine generator units. The intakes to the penstocks are protected from large debris by steel trash racks with approximately 4-inch spacing. The Swift No. 2 powerhouse has two Francis-type turbines; each rated at 40,950 kW. Under contract with Cowlitz PUD, PacifiCorp currently operates the powerhouse via remote control from the Hydro Control Center at Merwin headquarters.

Transmission: The Project is served by the same 230 kV Speelyai transmission line that serves Swift No. 1 and that extends from the Swift No. 2 switchyard to a BPA switching station near Woodland, Washington.

2.3 Lewis River Settlement Agreement Terms

A summary of the measures included in the Lewis River Settlement Agreement with the potential to affect ESA-listed species is presented in Table 2-1. More detailed information describing some of these measures is provided in the subsequent sections. Also, refer to the Settlement Agreement for a complete set of measures and descriptions. The section numbers referred to in Table 2-1 correspond to sections of the Lewis River Settlement Agreement

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species[3]

RESOURCE AREA - SETTLEMENT AGREEMENT SECTION	RESOURCE COMPONENT	PROPOSED MEASURE	TIMING/DURATION[4]
Aquatics - Section 3	Anadromous Fish Reintroduction Outcome Goals	**3.1** Work to achieve genetically viable, naturally spawning, harvestable populations of Chinook, steelhead, and coho above Merwin Dam. Check status of fish populations related to the goals in Years 27 and 37 of new licenses. Possible actions to ameliorate deficit, if found.	Terms of the New Licenses
Aquatics - Section 4	Fish Passage	**4.1.4** Performance Standards for the upstream and downstream fish passage facilities.	When facilities are constructed and operated
	Upstream Fish Passage[5]	**4.2** Merwin Trap. Repair the fyke (adult fish). Reduce generation when personnel are working the trap. Improve efficiency and human safety of existing Merwin trap	By Year 2, modify trap
		4.3 Add a new sorting and truck loading facility. Truck adult spring Chinook, coho, steelhead from the Merwin sorting facility to Swift Creek Reservoir or Yale Lake, per Upstream Transport Plan (4.1.8.c). Some fish will be trucked to the Lewis River Hatchery. Truck bull trout to Yale Lake.	By Year 4, operate new collection and transport facility
		4.7 Upstream Passage at Yale Dam. Construct an upstream adult trap and sorting/trucking facility.	By Year 17
		4.8 Upstream Passage at the Swift Projects. Construct an upstream adult trap and sorting/trucking facility.	By Year 17
		4.9.1 Collect-and-Haul Programs. Net bull trout in Yale and Swift No. 2 tailraces and transport to Yale Lake or as directed by USFWS. Investigate alternative trapping methods.	Throughout the life of the licenses
		4.10.2 Bull Trout Passage in the Absence of Anadromous Fish Facilities. If 4.7 and/or 4.8 are not constructed, develop facility to collect bull trout at Yale and at Swift.	By Year 17 at Swift and Yale

[3] This table does not include actions already completed or that have no effect on fish. If there is even a possibility of ongoing or future effects on fish or their habitat, the action was included. Also, although the duration is specified for some measures and not for others, it is not to imply that the measures without duration information are only single-year items.
[4] Timing and duration are described differently for different actions as appropriate. Although the duration is specified for some measures and not others, it is not to imply that the measures without duration information are only single year items. Refer to the Settlement Agreement for complete timing and duration information.
[5] 4.1.8.b. There may be alternative fish transport technologies (such as fish trams, cable lifts, or other new technologies if certain criteria are met.

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

Aquatics - Section 4, cont'd.	Downstream Fish Passage[6]	**4.4** Downstream Transport at Swift No. 1 Dam. Install a floating surface collector system at Swift Dam. Collect anadromous fish, sort, mark a sub-sample, and truck to release pond below Lake Merwin. Release bull trout in Yale Lake or below Merwin, depending on developmental stage.	By Year 4.5
		4.4.2 Spring Chinook Satellite Collection Facility. If directed by NMFS, evaluate, design and install a satellite juvenile passage facility in Swift Creek Reservoir.	If Required
		4.4.3 Release Ponds. Construct release pond below Merwin Dam for downstream migrants.	By Year 4.5
		4.5 Downstream Passage at Yale Dam. Install passage facility or facilities. Collect fish, sort, mark a sub-sample, and truck to release pond below Lake Merwin. Bull trout will be returned to Yale Lake or transported to the downstream release pond, depending on development stage.	By Year 13
		4.6 Downstream Passage at Merwin Dam. Install passage facility or facilities. Collect fish, sort, mark a sub-sample, and truck to a release site below Lake Merwin. Release bull trout in Lake Merwin or as directed by USFWS.	By Year 17
		4.9.3 Yale and Merwin Bull Trout Entrainment Reduction. Evaluate and implement measures to reduce entrainment up to and until downstream floating collector is constructed.	By Year 1 at Yale; when directed by USFWS at Merwin
		4.10.1 Bull Trout Passage in the Absence of Anadromous Fish Facilities. If 4.5 and/or 4.6 not built, develop downstream facility to collect/transport bull trout.	By Year 13 at Yale; after Year 17 at Merwin
Aquatics - Section 5	Additional Aquatic Measures	**5.1** Yale Spillway modifications. Modify Yale spillway to improve downstream fish survival (including bull trout) during spill events.	By Year 4.5 of the Yale License
		5.2 Bull Trout Habitat Enhancement Measures. Manage existing conservation covenants to protect bull trout habitat into perpetuity.	Complete
		5.5 Bull Trout Limiting Factors Analysis. Conduct LFA on Merwin and Swift Creek Reservoir tributaries.	By 2nd anniversary of Effective Date
		5.7 Public Information Program to Protect Bull trout. Install signage and distribute flyers to inform public about bull trout in the Project area.	Within 6 months
Aquatics - Section 6	Bypass Flow	**6.1** Bypass Reach. Release flows to the reach of the Lewis River downstream of Swift No. 1 ending at Yale Lake.	Year 1
		6.1.1 Flow releases from Canal Drain. Release up to 47 cfs.	Upon completion of Swift No. 2 reconstruction

[6] 4.1.8.d. There may be bypass facilities in lieu of trap and transport by truck if certain criteria are met.

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

Aquatics - Section 6, cont'd.	Bypass Flow, cont'd.	**6.1.2** Construct Upper Release Point. Design and construct upper water release point.	Year 1
		6.1.3 Determine feasibility of constructed channel in bypass reach and fund construction.	Upon completion of upper release structure
		6.1.4 Flow Schedule. Develop an interim and final flow release schedule for the bypass reach	Start Year 1
	Merwin Flow	**6.2.1** Ramping Rates Below Merwin Dam. Up-ramping rates limited to 1.5 feet per hour, down-ramping limited to 2 inches per hour, with critical flow set at 8,000 cfs; no ramping from February 16 through June 15, one hour before/after sunrise or one hour before/after sunset.	Duration of new license
		6.2.2 Plateau Operations at Merwin Dam. Follow Plateau Operation procedures between February 16 and August 15. Changes in flow will be consistent with ramping restriction of 6.2.1 at or below flows of 8,000 cfs, and flow changes will be limited to no more than one change in any 24-hour period, and 4 times in any 7-day period, or 6 times in any calendar month, and no more than 20 times during February 16 through August 15.	Duration of new license
		6.2.3 Stranding Study and Habitat Evaluation. Conduct stranding study and habitat evaluation below Merwin Dam to evaluate operation effects on anadromous salmonids and their habitats.	Complete by Year 3
		6.2.4 Minimum Flows Below Merwin Dam. Minimum flows range from a high of 4,200 cfs (Nov 1 to Dec 15) to 1,200 cfs (July 31 to Oct 12)	Duration of new license
		6.2.5 Low Flow Procedures. During dry years convene Flow Coordination Committee to implement adaptive management; focused on fish needs, flood management, and reservoir recreational pool levels.	As Needed
Aquatic Habitat - Section 7	Habitat Enhancement Actions	**7.1** Large Woody Debris Program. Stockpile Large Woody Debris under direction of ACC for use by other entities for habitat projects.	Within 6 months of Swift No. 1 License; continue through duration of new license unless suspended per 7.1.4
		7.1.1 Funding. Provide $2,000 annually for qualified entities to use for Large Woody Debris (LWD) projects and $10,000 annually for the Aquatics Fund earmarked for LWD or habitat projects in the mainstem Lewis below Merwin.	Within 6 months of Merwin License
		7.1.2 LWD Study. Conduct a LWD study to identify and assess the potential benefits of LWD projects below Merwin Dam	Within 1st year of Merwin License
		7.2 Spawning Gravel Program. Develop spawning gravel monitoring and augmentation program below Merwin.	Start within 6 months of Effective Date

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

Aquatic Habitat – Section 7, cont'd.	Habitat Enhancement Actions, cont'd.	**7.3** Predator Study. Conduct one-time study of whether predation in Merwin is a limiting factor to anadromous salmonid survival.	Complete by Year 10
		7.4 Habitat Preparation Plan. Release adult salmon for 5 years into the reservoirs prior to passage to begin preparing the spawning habitat and to enhance nutrients.	Within 6 months of Effective Date
		7.5 Aquatic Enhancement Fund. Provide funding for aquatic enhancement projects; PacifiCorp to provide $5.2 million over 14 years, and Cowlitz PUD to provide $520,000 over 20 years.	PacifiCorp starts in 2005; Cowlitz PUD starts at end of Year 1
		7.6 In Lieu Fund. Establish In Lieu Fund if the Services determine salmonid introduction to Yale or Merwin is not required and passage facilities not built; PacifiCorp to provide up to a total of $30 million; funds to be spent on aquatic enhancement measures for anadromous salmonids.	Contributions in Years 11-13 and 14-17 of Yale; Years 14-17 of Merwin; Years 14-17 of Swift No. 1
Hatchery Program and Supplementation Section 8	Hatcheries	**8.2** Hatchery and Supplementation Plan. Develop a plan for hatchery operations, supplementation, and facilities.	By Year 1
		8.3 Anadromous Fish Hatchery Adult Ocean Recruit Target by Species. Anadromous Fish Hatchery Production. Licensees will produce 86,000 adult ocean recruits according to allocation in Section 8.3.1.	Start in Year 1
		8.4 Anadromous Fish Hatchery Juvenile Production. Juvenile production targets are defined in Table 8.4 for Years 1-3, 4-5, and 6-60.	Start in Year 1
		8.5 Supplementation Program. Licensees will supplement adult and juvenile salmon and steelhead according to allocation in Sections 8.5.1, 8.5.2, and 8.5.3.	Varies by species and reservoir
		8.6 Resident Fish Production. Stock 20,000 lbs. of rainbow annually in Swift Creek Reservoir. Stock 12,500 lbs. of kokanee annually in Lake Merwin.	Start in Year 1
		8.7 Hatchery and Supplementation Facilities, Upgrades, and Maintenances. Fund or undertake upgrades to existing hatcheries in collaboration with WDFW and the ACC.	Per Schedule 8.7
		8.8.1 Locate and install juvenile acclimation sites above Swift Creek Reservoir.	By Year 4
		8.8.2 Install juvenile acclimation sites in Yale Lake and Lake Merwin in tributary streams.	By Year 13
Monitoring - Section 9	Aquatic Monitoring and Evaluation	**9.1** Monitoring and Evaluation Plans. Develop monitoring and evaluation plans to evaluate the effectiveness of aquatic measures and assess achievement of the Reintroduction Outcome Goal. Prepare annual monitoring reports.	By 2nd anniversary of licenses

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

Monitoring - Section 9, cont'd.	Aquatic Monitoring and Evaluation, cont'd.	**9.2** Monitoring and Evaluation Related to Fish Passage. Monitor performance of upstream and downstream passage facilities according to performance criteria.	As Needed
		9.3 Wild Fall Chinook and Chum. Monitor spawners below Merwin.	Annually
		9.4 Water Quality Monitoring. Monitor water quality and fund NPDES compliance monitoring.	As Required
		9.5 Monitor Hatchery and Supplementation Program. Assess effectiveness of hatchery and supplementation efforts.	Report as Directed
		9.6 Bull Trout Monitoring. Monitor bull trout collection and test alternate passage facilities.	Start in Year 1
		9.7 Resident Fish Assessment. Monitor interaction between reintroduced anadromous salmonids and resident fish and the kokanee spawner population size in Yale Lake each year.	As Required
		9.8 Monitoring of Flows. PacifiCorp to fund monitoring of Merwin flows and ramping rates and flows in the bypass reach.	Report annually throughout life of the licenses
Terrestrial - Section 10	Land Acquisition	**10.1** Yale Land Acquisition and Habitat Protection Fund. Provide $2.5 million to purchase wildlife mitigation lands near the Yale Project.	In Years 1 and 2 of Effective Date
		10.2 Swift No. 1 and Swift No. 2 Land Acquisition and Habitat Protection Fund. Provide $7.5 million to purchase wildlife mitigation lands for the Swift No. 1 and Swift No. 2 projects.	Initiated within 18 months of Swift licenses
		10.3 Lewis River Land Acquisition and Habitat Protection Fund. Provide $2.2 million total and matching contributions annually not to exceed $100,000 or $500,000 in any ten consecutive years, to purchase wildlife mitigation lands in the Lewis River Basin.	Initiate in Year 4.5 of Yale License
		10.8 Wildlife Habitat Management Plan. Develop the Wildlife Habitat Management Plan to direct habitat conservation funds and provide effectiveness monitoring.	Start in Year 1
		10.8.4 Habitat Evaluation Procedures. Update HEP study of all WHMP lands.	Year 17
Recreation - Section 11	Recreation Resource Management Plan	Implement the RRMP that will include all of PacifiCorp's recreation measures.	In 3 phases beginning in Year 1
PacifiCorp Recreation Measures	Swift Creek Reservoir Measures		
		11.2.1.1 Swift Dispersed Shoreline Use Sites. Manage and maintain dispersed use sites on PacifiCorp and USFS land and within the FERC Project boundary.	Start in Year 1
		11.2.1.2 Eagle Cliff Trail. Develop trail from Eagle Cliff Park to USFS boundary.	Year 4
		11.2.1.3 Control of Swift Forest Camp. Acquire campground from WDNR or negotiate management agreement.	End of Year 1

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

PacifiCorp Recreation Measures, cont'd.	Swift Creek Reservoir Measures, cont'd.	**11.2.1.4** Swift ADA Accessibility Improvements. Evaluate ADA compliance at developed facilities at Swift Creek Reservoir and renovate as needed.	Years 1 through 7
		11.2.1.5 Swift Day Use Facilities. Provide a new picnic shelter at Swift Forest Camp; toilets, picnic area and day use renovations at Eagle Cliff Park.	Year 5 for Swift Camp; Year 11 for Eagle Cliff Park
		11.2.1.6 Swift Campground and Group Camp Expansion. Expand campground and improve facilities.	When needed
		11.2.1.7 Swift O&M. Operate and maintain Eagle Cliff Park and Swift Forest Camp.	Year 1
	Yale Lake Measures	**11.2.2.1** Yale Dispersed Shoreline Use Sites. Maintain and manage dispersed shoreline use sites.	Start in Year 1
		11.2.2.2 Yale/IP Road Phase I. Attempt to secure access to road and bridge.	By Year 4
		11.2.2.3 Yale/IP Road Phase II. Develop trail, parking, reservoir access and day use facilities.	When Phase I is complete.
		11.2.2.4 Yale/IP Road Phase III. Resurface trail.	Year 15 -16
		11.2.2.5 Yale Trails. Develop Saddle Dam trail segment, parking at Saddle Dam Park, management approach for Saddle Dam Park, trail from Cougar Park to Beaver Bay, and loop trail in Cougar.	Year 5
		11.2.2.6 ADA Accessibility Improvements. Evaluate ADA compliance at developed facilities at Yale Lake and renovate as needed.	Year 1 - 7
		11.2.2.7 Yale Park Boat Launch. Extend the ramp and replace the docks.	Year 4
		11.2.2.8 Beaver Bay Boat Launch. Replace the dock and repair bank erosion.	Year 4
		11.2.2.9 Beaver Bay Day Use Parking. Isolate parking area from wetland.	Year 4
		11.2.2.10 Yale Lake Day Use Facilities. Improve facilities at Yale Park, Beaver Bay and Cougar Park.	Year 7
		11.2.2.11 Cougar Day Use Restroom. Replace or renovate to meet ADA standards.	Year 6
		11.2.2.12 Beaver Bay Campground and Group Camps. Redesign campground and replace restrooms.	Year 13
		11.2.2.13 Cougar Campground. Renovate tent only camping area.	Year 14
		11.2.2.14 Cougar Campground and Group Camp. Expand facilities.	When needed
	Lake Merwin Measures	**11.2.3.1** Merwin Dispersed Shoreline Use Areas. Maintain dispersed shoreline use sites.	Year 1
		11.2.3.2 Merwin Trails. Provide information about area trails.	Year 5
		11.2.3.3 Marble Creek Trail. Improve trail and ADA accessibility.	Year 4
		11.2.3.4 South Shore Merwin Trail Access. Evaluate potential trail easement from County land to lake.	When needed

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

PacifiCorp Recreation Measures, cont'd.	Lake Merwin Measures, cont'd.	**11.2.3.5** Merwin ADA Accessibility Improvements. Renovate Lake Merwin facilities.	Years 1-7
		11.2.3.7 Yale Bridge Boating Access. Develop access for launching non-motorized watercraft.	Year 6
		11.2.3.8 Merwin Park Day Use Facilities. Provide new day use features.	Year 4
		11.2.3.9 Merwin Park Picnic Shelters. Construct new shelters and move tables.	Year 4
		11.2.3.10 Speelyai Park Restroom. Upgrade to meet ADA requirements.	Year 6
		11.2.3.11 Day Use Parking. Improve parking at Speelyai Bay Park.	Year 12
		11.2.3.12 Merwin O & M. Keep Cresap Bay Campground open through September. Maintain existing sites and shoreline day use sites.	Year 1
	Lower River Measures	**11.2.4.1** Lower Lewis River Vault Toilets. Provide new toilets at Cedar Creek, Merwin Hatchery, Johnson Creek, Lewis River Hatchery, and Island River access points.	Year 1 and by 2007 for Island River.
		11.2.4.2 Lower Lewis River Day Use Improvements. Provide picnic tables at 5 sites.	Year 11
	Project Area Measures	**11.2.5** Interpretation and Education Program (I&E program). Utilities collaborate to produce a single Project-wide I&E program.	Years 1-4
		11.2.6 Visitor Management Controls. PacifiCorp to implement controls to enhance safety and visitor enjoyment.	Year 1
		11.2.7 Communications on Recreation Facility Availability. PacifiCorp will inform public when recreation sites are at capacity.	Year 1
		11.2.8 Recreation Access to Project Lands. Non-motorized day use allowed on PacifiCorp lands.	Year 1
		11.2.9 Land Ownership Retention for Recreation. PacifiCorp retains Switchback property for future recreation development when needed.	Year 1
		11.2.10 Parking and Dispersed Shoreline Use at Yale and Swift Creek reservoirs. Overnight parking allowed at boat launches.	Year 1
		11.2.11 Campground Gate Access and Schedule. Close but not lock gates at campgrounds at night.	Year 1
		11.2.12 Dispersed Camping Funds to USFS. PacifiCorp provides $5,220 annually to USFS to manage dispersed camping on USFS land.	Year 1
		11.2.13 Vehicle Access and Use. Work to restrict dispersed upland camping and motorized use.	Year 1
		11.2.14 ADA-Accessible Fishing Sites. Assess feasibility of ADA-accessible bank fishing sites.	Year 7: Study Year 10: Implement

Table 2-1. Measures Proposed Under the Lewis River Settlement Agreement with the Potential to Affect ESA-listed Species, cont'd.

PacifiCorp Recreation Measures cont'd.	Project Area Measures, cont'd.	**11.2.15** Public Use of RV Dump Sites. Use of PacifiCorp's RV dump sites to be allowed.	Year 1
Cowlitz PUD Recreation Measures	Interpretation and Education Program; Recreational Access to Project Lands; and Dispersed Camping Mgmt Funds to USFS	**11.3.3** I & E Program. Collaborate with PacifiCorp to produce a single Project-wide I&E program.	Years 1 - 4
		11.3.4 Recreation Access to Project Lands. Non-motorized day use allowed on lands within the Swift No. 2 Project boundary.	Year 1
		11.3.5 Dispersed Camping Funds to USFS. Cowlitz PUD provides $780 annually to USFS to manage dispersed camping on USFS land.	Year 1
Flood Management - Section 12	High Runoff	**12.8** High Runoff Procedure. Implement revised high runoff procedures for all three Project reservoirs.	Year 1
Cultural - Section 13.1	Resource Management	**13.1** Cultural Resources. Finalize and Implement Historic Properties Management Plan for Merwin, Yale and Swift No. 1.	Year 1
		13.1 (2) Protect integrity of properties listed in the National Register of Historic Places.	Year 1
		13.1 (3) Preserve tribal access for traditional uses.	Year 1
		13.1 (4) Monitor and protect cultural resources	Year 1
		13.1.2 Cowlitz PUD Obligation for Cultural Resources. PUD will follow Unanticipated Discovery Plan and consult as needed for Section 106 compliance.	Year 1
Socioeconomics - Section 13.2	Law Enforcement; Forest Road 90; Pine Creek Work Center Communication Link; and Visitor Information Facility	**13.2.1** Fund two full time law enforcement officers and one full-time fish and wildlife officer to patrol in the North Fork Lewis River Basin.	Within 1.5 years
		13.2.2 Provide annual funding for the maintenance of Forest Road 90.	Begin in April 2005
		13.2.3 Pine Creek Work Center Communication Link. Continue funding support.	Ongoing
		13.2.4 Partially fund development of the Visitor Information Center or perform maintenance for the term of the new licenses.	As determined by USFS
Coordination and Decision Making - Section 14	Coordination Committees	**14.2** Technical Coordination Committees. Form one technical committee for terrestrial implementation and one for aquatic implementation.	Within 60 days

2.3.1 Fish Passage and Reintroduction Measures

Merwin Trap

Beginning on November 30, 2004, the Effective Date of the Lewis River Settlement Agreement, PacifiCorp will modify the existing adult fish trap located at the base of Merwin Dam as needed to improve worker safety and increase fish handling efficiency without introducing additional risk to fish[7]. Until construction of the Merwin Upstream Collection and Transport Facility is complete (described below), the upgraded Merwin Trap will be operated to collect hatchery fish returning from the ocean and to transport any bull trout to Yale Lake unless otherwise directed by the USFWS. Fish other than hatchery fish, anadromous fish destined for transport, and bull trout will be returned to the river below Merwin Dam.

Reintroduction Above Swift No. 1 Dam

Beginning 1 year prior to completion of a Swift downstream passage facility, the Licensees will begin to introduce adult salmon and steelhead into the basin upstream of Swift No. 1 Dam. This early effort is expected to provide juveniles as a result of spawning. The timing of the collection and transport of the resulting juvenile outmigrants will coincide with completion of downstream collection facilities at Swift No. 1 Dam (described below). An added benefit of these measures is (1) the addition of marine derived nutrients into the system that are expected to enhance the habitat and (2) the preparation of habitat (by the tilling of gravel by fish as they spawn) for future spawners.

Concurrent with implementing the supplementation program, PacifiCorp will begin a design, permitting, and construction phase for upstream passage at Merwin Dam and downstream passage at Swift No. 1 Dam. By 6 months after the fourth anniversary of the issuance of the new license for the Merwin Project, PacifiCorp will construct and begin operating an upstream trapping, sorting, and hauling facility at Merwin Dam[8], and PacifiCorp and Cowlitz PUD will construct and begin operating a downstream modular surface fish collector at Swift No. 1 Dam with sorting and hauling capabilities. PacifiCorp will also construct a stress release pond below Merwin Dam. All downstream migrating anadromous salmonids collected in the surface collector will be transported to that stress release pond where fish will be able to acclimate and recover from the transport efforts in a controlled, predator-free environment before being released into the mainstem Lewis River. These facilities will result in up and downstream passage of spring Chinook, winter steelhead, late-run coho, bull trout and sea-run cutthroat to and from natural spawning and rearing habitat above Swift Dam. A monitoring and evaluation program will be put in place at that time to allow for measurement of performance standards.

Beginning upon completion of the Swift downstream facility, the supplementation program described above will be expanded to include juvenile salmon and steelhead and will continue for a minimum of 15 years for spring Chinook and winter steelhead and 9 years for late-run coho.

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[7] PacifiCorp has repaired the fyke portion of the Merwin Trap to decrease the risk of injury to fish in the facility. To address safety of personnel working in the existing Merwin Trap, PacifiCorp has instituted a condition that when discharge from the generation facilities at Merwin Dam are greater than 5400 cfs, the Merwin trap is closed and all fish capture is moved downstream to the Lewis River hatchery. The Lewis River hatchery facility is being upgraded.

[8] When designing the facility, engineers will look at the full suite of possible options, including without limitation (a) a complete new facility and (b) incorporation of the Merwin Trap (as upgraded) into the new design.

Reintroduction Above Yale Dam

In addition to hauling adult salmon and steelhead collected below Merwin Dam to above Swift No. 1 Dam, PacifiCorp will haul a portion of collected fish to Yale Lake to prepare the habitat for future fish and to seed the tributaries to Yale Lake (the same early program described above for Swift No. 1 Dam). PacifiCorp will commence this supplementation as directed by the Aquatics Coordinating Committee[9] (ACC).

Concurrent with implementing the Yale supplementation program, PacifiCorp will begin a design, permitting, and construction phase for downstream passage at Yale Dam. On the thirteenth anniversary of the issuance of the new license for the Yale Project, PacifiCorp will begin operating a Yale downstream passage facility. All downstream migrating anadromous salmonids collected at Yale Dam will be transported to the stress release ponds (an area where fish will be protected from predators and allowed to acclimate and recover from transportation efforts before being released into the river) below Merwin Dam. A monitoring and evaluation program will be added for downstream passage at Yale Dam at that time to allow for measurement of passage parameters relative to the performance standards.

Upon completion of the Yale downstream facility, the supplementation program described above will be expanded to include placing juvenile salmon and steelhead into Yale Lake and will continue for a minimum of 15 years for spring Chinook and winter steelhead and 9 years for late-run coho.

Full Reintroduction and Connectivity Throughout the Lewis River Projects

PacifiCorp will haul adult salmon and steelhead to Lake Merwin to prepare the habitat for future fish and to seed the tributaries. PacifiCorp will commence this supplementation as directed by the ACC.

Concurrent with implementing the supplementation program, the Licensees will begin a design, permitting, and construction phase that will include downstream passage at Merwin and upstream passage at Yale and the Swift Projects. On the 17th anniversary of the issuance of the new license for the Merwin Project, PacifiCorp will begin operating a Merwin downstream collection facility (which will include sorting and hauling capabilities). On the 17th anniversary of the issuance of the new license for the Yale Project, PacifiCorp will begin operating a Yale upstream passage facility. On the 17th anniversary of the issuance of the new license for the Swift No. 1 or Swift No. 2 Project, whichever is later, PacifiCorp and Cowlitz PUD will begin operating a Swift upstream passage facility. All downstream migrating anadromous salmonids collected at these facilities will be transported to the stress release pond. Rather than trucking, there may be bypass facilities at the dams if certain criteria are met per the Settlement Agreement. Adding these facilities to the existing upstream facility at Merwin Dam and downstream facilities at the Swift Projects and Yale Dam will result in up and downstream passage of spring Chinook, winter steelhead, late-run coho, bull trout and sea-run cutthroat to and from natural spawning and rearing habitat throughout and above the Lewis River Projects. A monitoring and evaluation program will be added for the new facilities at that time to allow for measurement of performance standards.

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[9] The ACC is composed of representatives of the parties to the Settlement Agreement, including NMFS.

Beginning upon completion of the Merwin downstream facility, the adult supplementation program described above will be expanded to include placing juvenile salmon and steelhead into Lake Merwin and will continue for a minimum of 15 years for spring Chinook and winter steelhead and 9 years for late-run coho.

Spring Chinook Satellite Collection Facility
If NMFS concludes at any time that downstream passage at the Swift No. 1 Dam is not effective for collecting spring Chinook and that a satellite collection facility has a reasonable likelihood of more effectively collecting spring Chinook, then PacifiCorp will design and install such a facility.

Species Transported
Initially, for purposes of fish passage, the Licensees will only transport spring Chinook, winter steelhead, coho, bull trout and sea-run cutthroat. Any other species inadvertently collected will be returned to the river and not transported. Notwithstanding the preceding sentence, the Licensees, after consultation with the ACC, and if directed by the Services, will also transport fall Chinook or summer steelhead that enter the passage facilities.

Mode of Transport

1) Upstream Transport Before Full Adult Fish Passage – Unless and until alternative technologies are implemented (see paragraph 2, below), the Licensees will provide for the transport by truck of species collected at an upstream transport facility. Once the Merwin Upstream Transport Facility is completed, and for so long as trucks are used, the Licensees will provide for transport according to the Upstream Transport Plan described below.

2) Upstream Transport After Full Adult Fish Passage – On or before the 13th anniversary of the issuance of all new licenses, the Licensee responsible for each upstream transport facility (PacifiCorp for the Merwin Upstream Transport Facility and Yale Upstream Facility and PacifiCorp and Cowlitz PUD for the Swift Upstream Facility) shall evaluate whether alternative adult fish transport technologies (such as fish trams, cable lifts or other new technologies) at the facility will allow transportation of the fish with the least practicable amount of handling or other stress inducing actions, considering the need for sorting fish. If certain conditions are met[10], and if the Services determine that alternative transport technologies are suitable for meeting the Services' fish passage goals and the biological benefits are expected to be equal to or greater than the benefits of trap-and-transport by truck, then the Licensees will implement such alternative transport technologies for upstream transport. If alternative technologies are not used, the Licensees will continue to transport collected fish by truck.

3) Upstream Transport Plan – The Licensees will develop, in Consultation with the ACC and with the approval of the Services, a plan that will describe the frequency and procedures for upstream fish passage. The Licensees will provide for the transport of fish at a minimum frequency of once daily, or more if necessary to achieve safe, timely and effective passage.

[10] See Settlement Agreement section 4.1.8.b.

4) Downstream Transport – PacifiCorp will provide for the downstream transport of migrating transported species collected in the Swift Downstream Facility, the Yale Downstream Facility and the Merwin Downstream Facility by truck. Rather than trucking, there may be bypass facilities at the dams if certain criteria are met per the Settlement Agreement.

5) Downstream Transport Plan – PacifiCorp will develop, in consultation with the ACC and with the approval of the Services, a plan which will describe the frequency and procedures to achieve safe, timely and effective downstream transport.

Passage Design
In consultation with the ACC and subject to the final approval of the Services, PacifiCorp will develop and implement studies to inform the design of the fish passage facilities with the goal of improving the likelihood that the passage facilities will be successful as initially constructed. Needed information may include the hydraulic characteristics of the Swift No. 1, Yale, and Merwin forebays (e.g., a three-dimensional numerical flow-field analysis) and the behavior of juvenile salmonids.

The Licensees will design the fish passage facilities to meet the defined performance standard targets (described below). The Licensees will use the best available technology for the type of passage facility being constructed, and design the facility to provide flexibility for subsequent adjustments or modifications[11], if needed, to meet performance standards.

Overall Performance Standards for Salmonids
The Licensees will achieve the following overall performance standards for fish passage: Overall Downstream Survival (ODS) of greater than or equal to 80 percent until such time as the Yale Downstream Facility is built or the In Lieu Fund in lieu of Yale Downstream Facility becomes available to the Services, after which time the ODS will be greater than or equal to 75 percent, Upstream Passage Survival (UPS) of greater than or equal to 99.5 percent, and Adult Trap Efficiency[12] (ATE) to be established as described below. If these performance standards are not achieved, the Licensees will take the actions described below.

Passage Facility Design Performance Standards for Salmonids
PacifiCorp shall design and construct downstream fish passage facilities to achieve (1) a Collection Efficiency (CE) of equal to or greater than 95 percent; (2) a Collection Survival (CS)

[11] For purposes of the Settlement Agreement, a Facility Adjustment is a physical passage facility upgrade, improvement or addition that was part of the original design of the passage facility, or an adjustment to the fish passage facility or its operations. A Facility Modification is a physical alteration or addition to a physical passage facility that requires a new design.
[12] Adult Trap Efficiency is defined as the percentage of adult Chinook, coho, steelhead, bull trout, and sea-run cutthroat that are actively migrating to a location above the trap and that are collected by the trap.

of equal to or greater than 99.5 percent for smolts and 98 percent for fry, and (3) adult bull trout survival of equal to or greater than 99.5 percent. Design performance objectives for injury are less than or equal to 2 percent. The Licensees shall design and construct upstream fish passage facilities to achieve the UPS equal to or greater than 99.5 percent and the ATE as described below.

Adult Trap Efficiency for Anadromous Salmonid and Bull Trout
The Licensees, together with the Services, Washington Department of Fish and Wildlife, Yakama Nation, and the Cowlitz Tribe, and in consultation with the ACC, will develop an ATE performance standard target for the terms of each new license to ensure the safe, timely, and effective passage of adult anadromous salmonids. Until such time as the standard has been developed, the Licensees will use NMFS' existing fish passage guidelines (NMFS 2004a). The Parties will consider the following but are not limited to only these items: entry rate, fall back, crowding at the entrance, delay, and abandonment of the trap area.

Adjustments or Modifications to Passage Facilities
The Licensees will make facility adjustments or facility modifications to downstream passage facilities as follows:

1) If the ODS is not being met:
    a) If the CE is less than 95 percent and greater than or equal to 75 percent, or the CS for smolts is less than 99.5 percent and greater than or equal to 98percent, or if the CS for fry is less than 98 percent, and greater than or equal to 96 percent, or injuries to juvenile transported anadromous species caused by downstream collection and transport are greater than 2 percent but less than 4 percent, PacifiCorp will make facility adjustments directed by the Services to achieve the performance standard or standards that are not being met, but will not be required to make facility modifications; or
    b) If the CE is less than 75 percent, or the CS for smolts is less than 98 percent, or the CS for fry is less than 96 percent, or injuries to juvenile transported anadromous species caused by downstream transport are greater than or equal to 4 percent, PacifiCorp shall make the facility modifications directed by the Services to achieve the performance standard or standards that are not being met; provided that if the Services believe a facility adjustment will likely achieve the performance standard or standards that are not being met then PacifiCorp shall first make facility adjustments as directed by the Services. (refer to Table 2-2)

2) If the ODS is being met but CE is less than 95 percent, the CS for smolts is less than 99.5 percent, the CS for fry is less than 98 percent, or injury to juvenile transported anadromous species caused by downstream transport is greater than 2 percent, PacifiCorp will make facility adjustments directed by the Services to downstream facilities but shall not be required to make facility modifications to achieve the performance standard or standards that are not being met. (refer to Table 2-2).

3) For bull trout, PacifiCorp shall make facility adjustments or facility modifications to downstream passage facilities as follows:
   a) If the survival of bull trout is less than 99.5 percent and the survival is greater than or equal to 98 percent, or injuries caused by downstream collection and transport are greater than 2 percent but less than 4 percent, PacifiCorp shall make facility adjustments directed by the Services to achieve the performance standard or standards that are not being met, but shall not be required to make facility modifications.
   b) If the survival of bull trout is less than 98 percent, or injuries caused by downstream collection and transport are greater than or equal to 4 percent, PacifiCorp shall make the facility modifications directed by the Services to achieve the performance standard or standards that are not being met; provided that if the Services believe a facility adjustment will likely achieve the performance standard or standards that are not being met then Licensees shall make facility adjustments as directed by the Services.

4) For transported species, if UPS and/or ATE are not being met, then the Licensees (PacifiCorp for the Merwin Upstream Transport Facility and Yale Upstream Facility, and PacifiCorp and Cowlitz PUD for the Swift Upstream Facility) will make facility adjustments or facility modifications to upstream passage facilities as directed by the Services.

Except as otherwise provided in the Lewis River Settlement Agreement, the Licensees (PacifiCorp for Merwin, Yale and Swift No. 1 and Cowlitz PUD for Swift No. 2) will not be required to: (a) make structural or operational changes with respect to their generating facilities or Project reservoirs to achieve performance standards, (b) replace any fish passage facility with another passage facility, or (c) install additional collection and transport facilities or alternative fish passage facilities beyond those required by the Lewis River Settlement Agreement.

Table 2-2. Conditions When Adjustments or Modifications to Downstream Passage Facilities are Made for Anadromous Fish

Adjustments	If ODS is not being met and one of the following is true: • CE is <95% and ≥75% • CS for smolts is <99.5% and ≥98% • CS for fry is <98% and ≥96% • Injuries to transported juvenile fish are >2% and <4% OR If ODS is being met and one of the following is true: • CE is <95% • CS for smolts is <99.5% • CS for fry is <98% • Injuries to transported juvenile fish are >2%
Modifications	If ODS is not being met and one of the following is true: • CE is <75% • CS for smolts is <98% • CS for fry is <96% • Injuries to transported juvenile fish are ≥4%

In Lieu Fund

The Licensees will construct and operate the Yale and Merwin downstream facilities and the Yale and Swift upstream facilities as described above unless the Services, upon receiving new information and upon a review of new information relevant to reintroduction of fish passage into Yale Lake and Lake Merwin, determine (before 4 years prior to the operation date for a passage facility) that the facility should not be constructed. In lieu of construction of a passage facility, PacifiCorp will contribute to an In Lieu Fund as follows: $10 million in lieu of a juvenile surface collector at Yale Dam; $10 million in lieu of a juvenile surface collector at Merwin Dam; $5 million in lieu of an upstream adult fish passage facility at Yale Dam; and $5 million in lieu of an upstream adult fish passage facility in the vicinity of the Swift Projects. The In Lieu Fund will be used for Services-approved mitigation measures that collectively contribute to meeting the objective of achieving equivalent or greater benefits to anadromous fish populations as would have occurred if passage through Yale Lake and/or Lake Merwin had been provided. Measures may include additional habitat enhancement in the basin; habitat protection, or other appropriate actions that will benefit listed species. The Settlement Agreement includes a list of possible mitigation measures to be implemented with the In Lieu Fund (Schedule 7.6.2 to the Settlement Agreement). Examples of mitigation measures that PacifiCorp may implement with the In Lieu Fund include:

North Fork

- Assess and repair the highest priority culvert passage problems on Ross, Johnson, Colvin, Cedar, Beaver, John, and Brush creeks and an unnamed tributary to Cedar Creek
- Improve passage at the Grist Mill Dam on Cedar Creek including a sorting and handling facility and fund the monitoring program
- Remove dam on Bitter Creek or provide passage
- Remove dam on Colvin Creek including sediments and repair damage from slide
- Reconnect and enhance off-channel habitat along the lower reaches of the Lewis River where diking occurs
- Enhance floodplain habitat surrounding Eagle Island
- Identify and repair roads that are contributing excess sediments to streams in the basin
- Restore degraded riparian conditions along tributaries to the lower Lewis River
- Identify sources and reduce inputs of fine sediments to Cedar Creek
- Increase functional LWD structures in appropriate stream reaches
- Accelerate recruitment of conifers along stream reaches to provide future inputs of LWD
- Enhance pool habitat in Cedar Creek and other tributaries in the basin
- Fence livestock away from streams especially Cedar, Pup and Chelatchie creeks
- Repair slide upstream on Lewis River hatchery on the mainstem that buried chum spawning habitat
- Control farm run-off and biowaste streams
- Restore and enhance wetlands and springs
- Identify contributing causes and develop solutions to summer low flow conditions in Cedar Creek and other tributaries
- Identify and remove unauthorized diversions in Cedar Creek basin
- Remove invasive non-native vegetation along riparian corridors

East Fork

- Remove culverts from Brezee, McCormick, Mason, and Dean creeks
- Restore upper East Fork spawning and rearing habitat
- Create funding partnership to restore Stordahl gravel pits and potentially create chum spawning habitat
- Fund an East Fork Monitoring program
- Restore and enhance off-channel and floodplain habitat in the lower 10 miles of the mainstem East Fork
- Reconnect and enhance side channels and areas with upwelling to provide chum spawning habitat
- Stabilize erosion problems in the mainstem East Fork and tributaries
- Reduce turbidity caused by gravel mining operations
- Increase functional LWD structures in appropriate stream reaches
- Restore riparian corridors and forested wetlands
- Reduce livestock access to the river and its tributaries
- Restore and enhance wetlands and springs
- Enhance pool habitat for thermal refuge
- Identify unauthorized private diversions and/or withdrawals within the basin
- Control invasive non-native plant species along riparian corridors

The lists above are examples of the types of measures that will be funded and implemented with the In Lieu Fund. Any mitigation measures that are implemented will be reviewed and approved by the Services.

Reintroduction Outcome Goal Status Checks

The reintroduction outcome goal of the comprehensive aquatics program contained in Sections 4 through 9 of the Lewis River Settlement Agreement is to achieve genetically viable, self-sustaining, naturally-reproducing, harvestable populations of spring Chinook, winter steelhead and late-run coho above Merwin Dam at levels greater than minimum viable populations[13]. Here "harvest" includes all forms of harvest, including, without limitation, commercial, tribal, and recreational. The Licensees are not responsible for limiting factors that are not related to Project effects (e.g., harvest). The reintroduction outcome goals are separate from and have no relationship to the targets for numbers of returning hatchery fish (described below).

Phase I Status Check – Year 27: It is anticipated that it will take at least 10 years following the last step in fish passage implementation to allow all facilities to achieve their best possible performance and for supplementation to be completed. In addition, the full passage scenario needs time to allow for supplementation actions to have an effect and for adequate anadromous fish establishment to occur in the available habitat. This brings the program to what is known in the Lewis River Settlement Agreement as the Phase 1 Status Check. It is at this point that progress will be evaluated relative to the Reintroduction Outcome Goals.

On or after the later of the following (a) the twenty-seventh anniversary of issuance of the new licenses, or (b) the twelfth year after reintroduction of anadromous fish above Swift No. 1 Dam together with the operation of both the Merwin Upstream Transport Facility and the Swift Downstream Facility, the Services will determine whether the reintroduction outcome goal has been achieved for each North Fork Lewis River anadromous fish population that is being transported pursuant to the Lewis River Settlement Agreement ("Phase I Status Check"). The Services will consider the variability of the factors influencing the success of the program over time, such as cycles of ocean conditions, and will include an appropriate temporal component in developing and applying their evaluation methodology. If the reintroduction outcome goals are being met, then the Licensees will continue to operate the passage facilities and to seek improvements towards performance standards. If any reintroduction outcome goal is not being met, PacifiCorp will conduct a limiting factors analysis to determine the causes for sub-optimum performance. If it is determined that a significant limiting factor is attributable to Project effects, the Licensees will implement measures that will provide biological benefits adequate to thoroughly offset the impact of the Project-related limiting factor(s) for the North Fork Lewis River population of each affected species (e.g., habitat enhancement projects, continuing juvenile supplementation, etc.). Examples of factors not attributable to Project effects include, but are not limited to, harvest, upstream of (Merwin Dam) off-Project habitat conditions (e.g., degradations in habitat due to forest management practices and natural catastrophic events), and ocean conditions. The suite of possible remedies at the Phase I Status Check does not include, unless

[13] as defined by NMFS

by the licensees' choice: (1) structural or operational changes with respect to generating facilities or Project reservoirs to achieve standards, (2) replacement of any fish passage facility with another passage facility, or (3) installation of additional collection and transport facilities or alternative fish passage facilities.

Phase II Status Check – Year 37: After the Phase I Status Check, the Lewis River Settlement Agreement provides for an additional 10 years to evaluate whether any new remedies have had an impact on the outcome goal and to allow time for the fish populations to react to those remedies.

On or after the later of the following: (a) the thirty-seventh anniversary of issuance of the new licenses, or (b) the seventh year after the Phase I Status Check, the Services shall determine whether the reintroduction outcome goals have been achieved ("Phase II Status Check"). If the reintroduction outcome goals have been met, the Licensees will continue to implement the measures provided in Sections 4 through 9 of the Lewis River Settlement Agreement for the remainder of the license terms, including adjusting and modifying fish passage facilities as needed to meet performance standards as described above. If any of the reintroduction outcome goals have not been met, PacifiCorp will perform a limiting factors analysis to determine the causes for sub-optimum performance. If the limiting factors analysis concludes, for all reintroduction outcome goals not being met, that none of the significant limiting factors contributing to the failure to meet such goals are related to Project effects, the Licensees will continue implementation of the measures contained in Sections 4 through 9 of the Lewis River Settlement Agreement, including adjusting and modifying fish passage facilities as described above, but will not be obligated to implement any additional measures.

If the limiting factors analysis concludes that a Project effect is a significant limiting factor in the failure to meet any reintroduction outcome goal, in addition to continuing implementation of the measures contained in Sections 4 through 9 of the Lewis River Settlement Agreement, including facility adjustment and facility modifications, the Licensees will consult with the Services and determine what further actions would be necessary to meet the reintroduction outcome goals. Such actions may include, without limitation, consideration of structural or operational changes with respect to the generating facilities or Project reservoirs or construction of new or replacement passage facilities. In the event that the Services and the Licensees cannot reach agreement, the Services may exercise their applicable authorities and direct what actions should be implemented.

Rationale for Phased Approach to Passage

As described above, the Settlement Agreement provides for a phased approach to providing for and evaluating the success of fish passage above Merwin Dam. The primary purposes of this phased approach are to allow time for habitat to become adequately established with anadromous fish prior to reintroducing fish to other areas (there are limited numbers of fish with which to spread around), and to allow the Licensees and fish management agencies to learn from initial fish passage results prior to designing and constructing additional passage facilities. For example, after reintroduction begins above Swift No. 1 Dam, the Merwin upstream and Swift downstream passage facilities will be allowed to operate for approximately 5 years to allow for at least one complete life-cycle to be reached for each species and to allow adequate time for the habitat to become adequately established with anadromous fish. This also allows time for assessment of the first returns from ocean recruits. The end of that 5 year period will coincide with the beginning of the design process for the Yale downstream facility, which will incorporate any information learned in the previous reintroduction phase. Once the Yale downstream facility is operating, it will be allowed to operate for 2 years, during which time PacifiCorp and fish management agencies will evaluate its success prior to designing or constructing remaining fish passage facilities. Since the Yale and Merwin downstream facilities are expected to be configured differently than the Swift downstream collector, this evaluation is critical because it will allow PacifiCorp and fish management agencies time to develop the Yale downstream facility and establish the best operating conditions for fish collection before considering passage at Merwin.

The Phase I Status Check is set for the 27th anniversary after issuance of the new licenses because once fish are introduced into Lake Merwin, it is anticipated that it will take at least 10 years following the last phase in fish passage implementation for all facilities to be working at their best possible performance and for supplementation to be completed. In addition, the full passage scenario needs time to allow for supplementation actions to have an effect and for adequate anadromous fish establishment to occur in the available habitat. Once these actions have had an opportunity to occur, the success of the reintroduction program can be accurately evaluated.

2.3.2 Additional Aquatic Resources Measures

Yale Spillway Modifications
PacifiCorp will design, permit, and construct improvements to the Yale spillway within 6 months after the fourth anniversary of the issuance of the new license for Yale to improve fish survival over the spillway during spill events.

Bull Trout Habitat Enhancement Measures
PacifiCorp and Cowlitz PUD will maintain conservation easements for the protection of bull trout habitat.

TDG Testing
PacifiCorp will monitor total dissolved gas (TDG) at Swift No. 1 and Yale to determine compliance with the state water quality standard for TDG, and implement measures to minimize take of bull trout if standards cannot be met.

Bull Trout Limiting Factors Analysis
By the second anniversary of the Effective Date of the Settlement Agreement, and in consultation with the ACC, PacifiCorp will provide a limiting factors analysis for bull trout occurring in Lake Merwin and Swift Creek Reservoir tributary streams. The ACC may implement enhancement measures through the use of the Aquatics Fund (see Section 2.3.4 below) if warranted by the study results.

Signage

PacifiCorp will provide information signs at established angler access areas on land that PacifiCorp owns or leases describing bull trout and the need to protect this species. Flyers with the same information will be provided at each of PacifiCorp's park entrance booths and will also be provided to WDFW and USFWS enforcement personnel for distribution.

2.3.3 Flow Releases for Fish and Other Aquatic Species

Flow Releases in the Bypass Reach; Constructed Channel

PacifiCorp and Cowlitz PUD will release flow into the reach of the Lewis River downstream of Swift No. 1 ending at Yale Lake, which parallels the Swift No. 2 canal (the "bypass reach"), for the duration of the license terms. The annual release quantity will be allocated between two release points: (1) released from and as measured at the outflow from a water delivery structure to be constructed at the upstream end of the bypass reach; and (2) released to a constructed channel (described below) from and as measured at the existing Canal Drain that is located approximately one third of the length of the canal downstream of the Swift No. 1 tailrace. The monthly schedule of flow releases from these two release points is together referred to as the "combined flow schedule." The existing Swift No. 2 canal Wasteway may also be use to release water, up to the capacity of the canal, into the bypass reach.

Constructed Channel

The Licensees commissioned a study, conducted by Northwest Hydraulic Consultants, Inc., dated December 9, 2003, entitled "Swift Bypass Habitat Channel Reconnaissance Study," concerning the biological and technical feasibility of developing a constructed channel in the Bypass Reach downstream of the Swift No. 2 Canal Drain. The constructed channel is an existing, protected channel that starts about one-third the length of the canal downstream of the Swift No. 1 tailrace that runs parallel to the Swift No. 2 canal and receives water from an existing Canal Drain. This channel will be enhanced with instream structure and channel changes to create quality habitat that is hydraulically matched to the available flows. Unless the ACC determines that the constructed channel should not be built, the Licensees will construct and maintain a channel in the Bypass Reach to maximize the biological benefits of Canal Drain flows and to enhance connectivity with Yale Lake.

Combined Flow Schedule

In Washington Department of Ecology's (WDOE) 401 Certification as amended for the Swift No. 1 and Swift No. 2 Projects, the Licensees are required to provide combined flow releases from the Upper Release Point and the Canal Drain not to exceed 55,200 acre-feet in each year (55,349 acre-feet in each leap year). The combined flow releases shall comply with the following schedule unless and until altered in the future by mutual agreement of WDOE and the ACC. The schedule may be altered based on observations of flow releases in the Upper Release Channel or in the Canal Drain Constructed Channel, related biological considerations, significant physical changes in the channel, or changes in biological priorities. The maximum flow that may be scheduled for release from the Canal Drain to the constructed channel will be the maximum discharge capacity of the Canal Drain, without modification, estimated to be 47 cfs. Contrary to that described in Section 6.1.5.a. of the Settlement Agreement, the Licensees may not, at their discretion, stop instream flow releases through the Upper Release Point.

The Licensees shall provide the following instream flows from the "Upper Release Point" when construction of the Upper Release Point is completed.

Table 2-3. Upper Release Point Flows

November 1 to November 15	76 cfs
November 16 to November 30	56 cfs
December 1 to January 31	51 cfs
February 1 to February 28 (29 on leap years)	75 cfs (74 cfs only for 1st week in leap year)
March 1 to May 31	76 cfs
June 1 to September 30	54 cfs
October 1 to October 31	61 cfs

For the "Canal Drain" release, the instream flow will commence on the date specified in the Settlement Agreement and be 14 cfs.

Minimum Flows Below Merwin Dam

Minimum flows below Merwin Dam will be set as shown in Table 2-3.

Table 2-4. Minimum Flows in the North Fork Lewis River Below Merwin Dam.

SEASON	TIME PERIOD	PROPOSED ACTION MINIMUM FLOW REQUIREMENT
Fall	October 16 through October 31	2,500 cfs
	November 1 through December 15	4,200 cfs
Winter	December 16 through March 1	2,000 cfs
Spring	March 2 through March 15	2,200 cfs
	March 16 through March 30	2,500 cfs
	March 31 through June 30	2,700 cfs
Summer	July 1 through July 10	2,300 cfs
	July 11, through July 20	1,900 cfs
	July 21 through July 30	1,500 cfs
	July 31 through October 15	1,200 cfs

Low Flow Procedures

During dry years[14], PacifiCorp will convene a Flow Coordination Committee (FCC) in order to develop adaptive management measures for the particular circumstance. The FCC will consider fish needs (priority on ESA-listed species), flood control needs, and reservoir recreational pool levels when developing adaptive management measures.

[14] When PacifiCorp projects that sufficient water will not be available to appropriately balance the respective needs for fishery resources, recreation, flood management, and power production

Flow Fluctuations Below Merwin Dam

Commencing with the issuance of the new licenses, PacifiCorp will implement the following operational regime at Merwin Dam:

Plateau Operations at Merwin Dam: PacifiCorp will restrict daily fluctuation in flows below Merwin during the period February 16 through August 15 of each year by maintaining flow plateaus (periods of near-steady discharge[15]). Once a flow plateau is established, PacifiCorp will maintain the flow plateau for as long as practicable, but flow plateaus may be altered to a new level as a result of changes in natural flow or operational demands on the Lewis River power system.

Plateau Steps: A "Plateau Step" is defined as a down ramping in flow below Merwin Dam that will result in a change in river elevation of more than 0.2 foot at the Ariel Gage. A single Plateau Step event will begin when the elevation drops by more than 0.2 foot and be deemed complete when, (1) the elevation rises by more than 0.2 foot or (2) does not change by more than plus or minus 0.2 foot for more than 6 hours. Plateau Steps will be limited to no more than one change in any 24-hour period, no more than four in any seven-day period, or six in any calendar month. If PacifiCorp is required to release flows from Merwin Dam pursuant to the high runoff procedure, then down ramping to return to prior river levels will not be counted as a Plateau Step. During flood season, if there is less than 5 feet of storage capacity in addition to the required 17 feet of storage capacity under the high runoff procedure, then flow releases to restore the storage capacity will not count as Plateau Steps. Finally, if PacifiCorp is asked to lower flows below Merwin Dam for public safety reasons or to facilitate aquatics studies, such changes in river level will not be counted as Plateau Steps.

Plateau Changes: An accumulation of Plateau Steps will result in a "Plateau Change". PacifiCorp will limit Plateau Changes to no more than 20 during the period February 16 through August 15. When flows are greater than or equal to 3,500 cfs below Merwin Dam, a Plateau Change will occur when any series of consecutive Plateau Steps total 1 foot of down ramping. Any periods of up ramping during such period will be ignored in such calculations. When flows are less than 3,500 cfs below Merwin, a Plateau Change means a series of consecutive Plateau Steps totaling 0.5 feet. If a single Plateau Step in a series will cause the total to exceed 1 foot or 0.5 feet, respectively, the excess will be counted toward the next Plateau Changes. If a Plateau Step begins when flows are greater than 3,500 cfs and ends when flows are less than 3,500 cfs, the Plateau Change will be determined by adding the fractions of a Plateau Change occurring before and after the river discharge below Merwin Dam passes 3,500 cfs. For example, if a Plateau Step begins when flows are at 5,000 cfs and has measured 6 inches when flows reach 3,500 cfs (one half of a Plateau Change for flows above 3,500 cfs) and continues to decline an additional 3 inches ending at 3,000 cfs (one half of a Plateau Change for flows below 3,500 cfs), it will count as one full Plateau Change.

[15] does not change by more than plus or minus 0.2 foot for more than 6 hours

Ramping Rates Below Merwin Dam
PacifiCorp will limit the up-ramping rate to 1.5 feet per hour. The down-ramping rate will not exceed 2 inches per hour, as measured at the Ariel gage, when flows below Merwin Dam are at or less than 8,000 cfs, except between February 16 through June 15 when this ramping rate will still apply except that no down-ramping will occur (1) commencing 1 hour before sunrise until 1 hour after sunrise, and (2) commencing 1 hour before sunset until 1 hour after sunset.

Stranding Study and Habitat Evaluation
By the third anniversary of the issuance of the new license for Merwin Project, PacifiCorp (in consultation with the ACC and approval by the Services) will complete a stranding study and a habitat evaluation study below Merwin Dam to assess the potential effects of Project operations on steelhead, coho, Chinook, and chum salmon, and their habitats. The ACC may recommend measures to be taken to minimize stranding or enhance habitat based on study results. PacifiCorp will make reasonable good faith efforts to address such recommendations. If PacifiCorp determines not to implement the recommendations, because there would be significant impact on Project benefits, the ACC may elect to mitigate impacts by development of habitat enhancement projects through the use of the Aquatics Fund.

2.3.4 Aquatic Habitat Enhancement Actions

Large Woody Debris
After issuance of the new license for the Swift No. 1 Project and under direction of the ACC, PacifiCorp will stockpile LWD collected from Swift Creek Reservoir for use by other entities for LWD projects.

Funding
Within 180 days after issuance of the new license for the Merwin Project, PacifiCorp will provide $2,000 annually, which may be disbursed to qualified entities for costs of LWD transportation and placement (the "LWD Fund"), with the unspent balance carrying over to subsequent years. PacifiCorp will also contribute $10,000 per year to the Aquatics Fund (described below) that will be earmarked for LWD projects in the mainstem of the Lewis River below Merwin Dam to benefit anadromous fish. If there are not sufficient LWD projects, or if the LWD program is suspended, PacifiCorp, at the request of the ACC, will use the funds for other aquatic enhancement fund projects that benefit anadromous fish in the mainstem of the Lewis River below Merwin Dam and then for other projects in the basin below Merwin Dam.

LWD Study
PacifiCorp will hire a consultant, in consultation with the ACC, to develop and implement a LWD study to identify and assess the potential benefits of LWD projects below Merwin Dam. The final study plan will be completed 270 days after issuance of the new license for the Merwin Project. The results of the study will inform the use of the LWD Fund.

Spawning Gravel Program
Within 6 months after the Effective Date of the Settlement Agreement, PacifiCorp will hire a consultant, selected in consultation with the ACC, to develop and implement a spawning gravel study and, on the basis of the study results, develop a gravel monitoring and augmentation plan that maintains existing levels of gravel and includes a "trigger" for gravel augmentation. Pursuant to that plan, PacifiCorp will implement a monitoring program and gravel augmentation if the monitoring shows that the trigger is realized.

Predator Study
By the tenth anniversary of issuance of the new license for the Merwin Project, PacifiCorp will conduct (in consultation with the ACC and approval of the Services) a one-time study of whether predation in Lake Merwin is likely to be a limiting factor to the success of the anadromous salmonid reintroduction.

Habitat Preparation Plan
Within 6 months after the Effective Date of the Settlement Agreement, PacifiCorp will develop the "Habitat Preparation Plan" in consultation with the ACC to release live adult hatchery anadromous salmonids to "fertilize" the stream habitat (increase marine derived nutrients) and till the gravel (redistribute and aerate) as they attempt to spawn in preparation for the reintroduction of anadromous salmonids. Fish will be released for 5 years in each reservoir commencing five years prior to expected completion of the downstream fish passage facility from that reservoir.

Aquatics Fund
PacifiCorp and Cowlitz PUD will establish the Lewis River Aquatics Fund ("Aquatics Fund") to support resource protection measures and habitat projects. PacifiCorp will provide funds over a period of years totaling $5.2 million and Cowlitz PUD will provide funds over a period of years totaling $520,000. PacifiCorp's contributions will begin in 2005 and Cowlitz PUD's contributions will begin after the first anniversary of the issuance of the new license for the Swift No. 2 Project. Projects will be reviewed by the ACC and may be approved if they will benefit the Lewis River Basin related to project effects and are consistent with the Settlement Agreement's guidance. The use of the fund may include, without limitation, projects that enhance and improve wetlands, riparian, and riverine habitats; projects that enhance and improve riparian and aquatic species connectivity; and projects that increase the probability for a successful reintroduction program. The objective for the use of the fund is for projects that benefit fish recovery throughout the North Fork Lewis River, with priority to Federal ESA-listed species; support the reintroduction of anadromous fish throughout the basin; and enhance fish habitat in the Lewis River Basin, with priority given to the North Fork Lewis River. The Licensees will submit annual reports regarding projects reviewed, implemented, and monitored.

2.3.5 Hatchery Programs; Supplementation

This Opinion is considering the overarching hatchery and supplementation program identified in the Settlement Agreement. The specific details of how the program will be carried out will be developed in a plan (discussed below and called the Hatchery and Supplementation Plan [H&S Plan]). That H&S Plan will be subject to ESA consultation after it is completed.

As a component of the anadromous fish reintroduction program (Section 2.3.1), PacifiCorp and Cowlitz PUD, in consultation with the ACC and subject to the approval of the Services, will undertake a hatchery and supplementation program. The goals of the program are to support (1) self-sustaining, naturally-producing, harvestable native anadromous salmonid populations throughout their historical range in the North Fork Lewis River Basin; and (2) the continued harvest of resident and anadromous fish. The hatchery and supplementation program will be consistent with the priority objective of recovery of wild stocks in the basin to healthy and harvestable levels. The supplementation portion of the program will be limited to spring Chinook, steelhead and coho. The hatchery and supplementation program will be consistent with the ESA, applicable state and Federal fisheries policies, and regional recovery plans, and will address both anadromous and resident fish. The supplementation portion of the program will be part of the reintroduction program. The Licensees, in consultation with the ACC and approval of the Services, will develop a hatchery and supplementation plan to address hatchery operations, supplementation, and facilities. Once finalized, the Licensees shall submit this plan to WDFW and NMFS for incorporation into the applicable Hatchery and Genetic Management Plans for ESA consultation.

To ensure that the hatchery and supplementation program is meeting its goals, PacifiCorp and Cowlitz PUD, in consultation with the ACC and subject to the approval of the Services, will develop and implement a hatchery and supplementation plan to adaptively manage the program and guide its management. The following are mechanisms, targets, etc. identified in the Settlement Agreement. The specifics (including the operations, mechanisms, and targets, etc.) developed in the H&S Plan will meet the goals identified above and, therefore, may be modified, if necessary.

The H&S Plan will be designed to achieve the numeric Hatchery Targets provided in Table 2-4, and will be calculated in terms of adult hatchery ocean recruits (Ocean recruits mean total escapement [fish that naturally spawned above Merwin Dam and hatchery fish] plus harvest [including ocean, Columbia River, and Lewis River harvest]). PacifiCorp and Cowlitz PUD will use the existing Lewis River, Merwin, and Speelyai hatchery facilities to meet production obligations.

Table 2-5. Lewis River Hatchery Complex Targets.

	SPRING CHINOOK	STEELHEAD	COHO	TOTAL
Hatchery Target (adult hatchery ocean recruits)	12,800	13,200	60,000	86,000

When the number of natural returning ocean recruits (this is ocean recruits from spawning grounds) of any species exceeds the relevant natural production threshold(s) for that species (Table 2-5), then PacifiCorp and Cowlitz PUD will decrease the appropriate hatchery target(s) identified in Table 2-4 on a fish for fish (1:1) basis; however, PacifiCorp and Cowlitz PUD will not decrease the Hatchery Targets below the hatchery target floor specified in Table 2-5. If PacifiCorp and Cowlitz PUD reduce Hatchery Targets based on the number of returning natural ocean recruits, but the number of returning ocean recruits subsequently declines, then PacifiCorp and Cowlitz PUD will increase the Hatchery Targets on a fish for fish (1:1) basis provided that the increased Hatchery Targets will not exceed the Hatchery Targets in Table 2-4.

Table 2-6. Numbers Governing Modifications to Hatchery Targets (i.e., adult returns)

	SPRING CHINOOK	STEELHEAD	COHO	TOTAL
Natural Production Threshold for Hatchery Reduction	2,977	3,070	13,953	20,000
Hatchery Target Floor	2,679	2,763	12,558	18,000

To meet their obligation, each year, PacifiCorp and Cowlitz PUD will produce spring Chinook salmon smolts, steelhead smolts, and coho salmon smolts at the levels specified in Table 2.6. PacifiCorp and Cowlitz PUD, in consultation with the ACC, may adjust the juvenile production as needed to achieve the hatchery target subject to the hatcheries' capacity.

Table 2-7. Juvenile Production Targets.

SMOLT PRODUCTION	SPRING CHINOOK	STEELHEAD	COHO
Years 1 through 3 of the H&S Plan (or "H&S Plan Years 1 – 3")	1.35 million	275,000	1.8 million
H&S Plan Years 4 – 5	1.35 million	275,000	1.9 million
H&S Plan Years 6 – 50	1.35 million	275,000	2.0 million

Anadromous fish stocks used in the reintroduction program will be the most appropriate for the basin and will include a mixture of indigenous and hatchery stocks (Table 2-7). These stocks will be used unless modified by the Licensees as part of the Hatchery and Supplementation Plan.

Table 2-8. Broodstock Sources Used for Supplementation Above and Below Merwin Dam.

PROGRAM	STOCK SOURCE		
	Spring Chinook	**Steelhead**	**Coho**
Juveniles for Supplementation (release above Merwin)	Lewis River hatchery stock (with Cowlitz River hatchery stock as contingency)	Lewis River wild winter stock (with Kalama hatchery stock as contingency)	Lewis River hatchery early (type S) stock
Juveniles for adult Harvest (release below Merwin)	Uses same stock as for supplementation	Uses same stock as for supplementation plus existing Lewis River hatchery summer and winter stock	Uses same stock as for supplementation plus Lewis River hatchery late (type N) stock

If the Services determine that there are unacceptable impacts from hatchery production on the reintroduction program or fishery management objectives including, but not limited to, the recovery of wild stocks in the basin, then the Licensees, in consultation with the ACC, shall identify and consider options to mitigate or avoid such unacceptable impacts. In consultation with the ACC and at the direction of the Services, the Licensees shall implement options necessary to address such unacceptable adverse impacts, including, without limitation, modifying hatchery practices, reducing Hatchery Targets, or implementing other options that are identified.

Juvenile Salmonids Above Swift Dam

Subject to modification in the hatchery and supplementation plan, PacifiCorp and Cowlitz PUD will transport hatchery-origin juvenile anadromous salmonids to acclimation sites located above Swift Dam for the following periods of time:

1) Spring Chinook and Steelhead – PacifiCorp and Cowlitz PUD will transport juvenile spring Chinook and steelhead for a period of 15 years commencing upon completion of the Swift downstream passage facility; and
2) Coho – PacifiCorp and Cowlitz PUD will supplement hatchery-origin juvenile coho salmon for a period of 9 years commencing upon completion of the Swift downstream passage facility.

At the end of these time periods, the ACC will assess on a year-by-year basis whether to extend the transportation of juvenile salmonids. Upon ACC agreement and subject to the Services' approval, PacifiCorp and Cowlitz PUD will continue to transport juvenile salmonids.

Juvenile Salmonids to Yale Lake and Lake Merwin
PacifiCorp will, for the purposes of supplementation, transport juvenile salmonids to appropriate release sites in Yale Lake and Lake Merwin for the following periods of time:

1) Spring Chinook and Steelhead – PacifiCorp will transport juvenile spring Chinook and steelhead for a period of 15 years in Yale Lake after completion of the Yale Downstream passage facility; and for a period of 15 years in Lake Merwin after completion of the Merwin downstream passage facility.
2) Coho – PacifiCorp will transport juvenile coho salmon into Yale Lake for a period of 9 years after completion of the Yale downstream passage facility and into Lake Merwin for a period of 9 years commencing upon completion of the Merwin downstream passage facility.

At the end of these time periods, the ACC shall assess on a year-by-year basis whether to extend the supplementation of juvenile salmonids. Upon ACC agreement and subject to NMFS approval, PacifiCorp will continue to supplement juvenile salmonids. PacifiCorp will provide short term, temporary in-stream enclosures to confine juvenile salmonids in tributaries to Yale Lake and Lake Merwin after they are released for the purpose of allowing juveniles to adjust to the natural environment prior to being exposed to natural mortality factors such as predators.

Adult Anadromous Salmonids above Merwin Dam
PacifiCorp and Cowlitz PUD will commence the supplementation of adult fish beginning 1 year prior to completion of the Swift downstream passage facility. Throughout the terms of the new licenses, the PacifiCorp and Cowlitz PUD will transport and release supplementation stocks (Table 2-7) of adult spring Chinook, coho, and steelhead above Swift No. 1 as directed by the ACC. Throughout the terms of the new licenses, PacifiCorp shall transport and release supplementation stocks of adult spring Chinook, coho, and steelhead into Yale Lake and Lake Merwin as directed by the ACC. The ACC shall determine the timing for initiating supplementation into Yale Lake and Lake Merwin. The ACC, subject to the approval of the Services, may recommend discontinuing or recommencing the transportation of such supplementation stocks provided that any such recommendations are biologically based, and not contrary to the goals of the ESA.

Resident Fish Production
Each year, for the life of the licenses, PacifiCorp and Cowlitz PUD will produce no more than 20,000 pounds of resident rainbow trout (e.g., 800,000 juveniles with an estimated weight of 40 juvenile fish per pound). PacifiCorp and Cowlitz PUD will stock such rainbow trout in Swift Creek Reservoir. Resident trout are to be managed separately from steelhead and cannot significantly interfere with the recovery of self-sustaining, naturally producing, harvestable populations of native steelhead. PacifiCorp will also produce no more than 12,500 pounds of resident kokanee (e.g., 93,000 juveniles of various sizes equaling 12,500 pounds). PacifiCorp will plant such resident kokanee in Lake Merwin. The Licensees will modify resident rainbow trout and kokanee production in consultation with the ACC, and with approval of WDFW to address other management goals.

2.3.6 Aquatic Monitoring And Evaluation

Monitoring and Evaluation Plans

By the second anniversary of the issuance of the first of the new licenses, PacifiCorp and Cowlitz PUD will develop plans and methods in consultation with the ACC and approved by Services to monitor and evaluate the effectiveness of various aquatic measures and to access achievement of the Reintroduction Outcome Goals including monitoring of fish passage; adult anadromous salmonid migration, spawning, distribution, and abundance; water quality; hatchery supplementation programs; bull trout populations; and resident fish species. PacifiCorp and Cowlitz PUD will prepare annual monitoring reports.

2.3.7 Terrestrial Measures

Yale Habitat Fund

PacifiCorp will establish and maintain a fund for land acquisition to protect wildlife habitat in the vicinity of the Yale Project, with a total contribution of $2.5 million. The total of $2.5 million will be provided within 2 years of the Effective Date of the settlement agreement. Guidelines of the "Yale Fund" are to provide movement corridors for elk, acquire 660 acres of low elevation winter range, and 100 acres of elk forage land within the vicinity of the Yale Project.

Swift No. 1 and Swift No. 2 Land Acquisition and Habitat Fund

PacifiCorp and Cowlitz PUD will establish and maintain a fund with a total contribution by PacifiCorp of $7.5 million over several years. The purpose of the "Swift Fund" is to acquire land to protect wildlife habitat within 5 miles of the Swift Project boundaries or lands owned and managed by the Licensees that are associated with the Swift Projects (laterally and upstream, but not downstream).

Lewis River Habitat Fund

PacifiCorp will establish and maintain a fund to acquire or enhance wildlife habitat anywhere in the Lewis River Basin in the vicinity of the Projects, with a total contribution of $2.2 million over several years. In addition to the $2.2 million contribution, PacifiCorp will match the contributions of other entities for habitat projects in an amount not to exceed $100,000 per year, nor more than $500,000 in any 10 consecutive years.

Wildlife Habitat Management Plans

PacifiCorp and Cowlitz PUD, in consultation with the Terrestrial Coordination Committee, will develop Wildlife Habitat Management Plans (WHMPs) for their respective properties. The purpose of the WHMPs will be to benefit a broad range of fish, wildlife and native plant species, including, but not limited to, large and small game, amphibians, bats, forest raptors, neo-tropical birds, and culturally significant native plants. The WHMPs will include an effectiveness-monitoring component to measure progress toward reaching management objectives.

2.3.8 Recreation Measures

PacifiCorp Measures

Recreation Resources Management Plan***:*** PacifiCorp submitted a draft Recreation Resources Management Plan (RRMP) to the Commission as part of its Final Application for New License for the Swift No. 1, Yale, and Merwin Projects. The RRMP includes measures set forth in Section 11.2 of the Settlement Agreement. PacifiCorp will implement measures specified in the Settlement.

Swift Creek Reservoir Measures: PacifiCorp will maintain and manage dispersed shoreline use sites on its lands and those under U.S. Forest Service (USFS) jurisdiction within the FERC Project boundary. Facility improvements will be made at Eagle Cliff Park, and a trail will be developed that extends from the park to the USFS boundary. PacifiCorp will acquire or manage Washington State Department of Natural Resources' Swift Forest Campground, with improvements to the day use area, campsites, boat ramp and parking areas. Americans with Disabilities Act (ADA) accessibility will be an important component of all recreation improvements at Swift Creek Reservoir.

Yale Lake Measures: PacifiCorp will maintain and manage dispersed shoreline use sites on its lands, and where landowner agreement is obtained, on lands owned by other parties. Use sites will be hardened as appropriate, waste collection and disposal performed, and inappropriate sites signed for closure. Recreation improvements to the Yale/IP Road will be pursued, including securing access rights, completing bridge safety improvements, developing trailheads, formalizing reservoir access points, and installing toilets. Ultimately, a 12-mile segment of the road will be surfaced. Other multi-use trails in the Yale Lake area will be developed or improved, including a segment extending from the Saddle Dam parking area to the existing Saddle Dam trail, from Cougar Campground to Beaver Bay, and a new loop trail from Cougar to a reservoir overlook. Existing boat launches will be improved at Yale Park and Beaver Bay. Facility improvements at the Yale Park, Cougar, and Beaver Bay day use areas will be implemented, as will improvements to campgrounds at Cougar and Beaver Bay. ADA accessibility will be a component of all recreation improvements at Yale Lake.

Lake Merwin Measures: PacifiCorp will maintain and manage dispersed shoreline use sites on its lands, and where landowner agreement is obtained, on lands owned by other parties. Trail development in the Lake Merwin area will include improvements to the existing Marble Creek trail and evaluating a potential easement for a Clark County trail on the south shore of the lake. Boating facility improvements will be made at Speelyai Bay Park (ramp extension) and at Yale Bridge, where a launch site for non-motorized craft will be developed. At Merwin Park, day use facilities will be upgraded and new picnic shelters developed. At Speelyai Bay Park, the restroom will be upgraded to ADA standards and the parking area improved. At Cresap Bay Park, the use season will be extended through September. ADA accessibility will be a component of all recreation improvements at Lake Merwin.

Lower Lewis River Measures: PacifiCorp will install ADA-accessible vault toilets at the five Lewis River access sites (Cedar Creek, Merwin Hatchery, Johnson Creek, Lewis River Hatchery, and Island River). PacifiCorp also will be responsible for maintenance of these sites.

Basin-wide Measures: An Interpretation and Education program (I&E) will be developed in collaboration with Cowlitz PUD for developed sites throughout the Project area. A range of visitor management measures will be implemented to improve public safety and improve the quality of visitor's experiences. Measures include enforcing non-motorized access restrictions, regulating overnight parking, funding dispersed camping management by the USFS, allowing public use of RV dump stations, and assessing the feasibility of ADA-accessible bank fishing sites.

Cowlitz PUD Measures
Cowlitz PUD will develop an ADA-accessible bank fishing site (including parking and portable toilets) at Swift No. 2 Canal. Non-motorized recreation access will be allowed on lands within the Swift No. 2 Project boundary. Cowlitz PUD will develop and implement an I&E program for the Swift No. 2 Project. Cowlitz PUD will also provide $780 annually to the USFS to manage Project-related dispersed camping on National Forest System lands.

2.3.9 Cultural Measures

Cultural Resources
PacifiCorp will finalize and implement the Historic Properties Management Plan (HPMP) for the Merwin, Yale, and Swift No. 1 Projects. This plan will guide the treatment of known and yet to be discovered cultural and historic resources through the period of the new licenses. In addition, PacifiCorp will curate and interpret artifacts at a new Visitor Information Center in Cougar; protect the integrity of properties listed in the National Register of Historic Places; preserve tribal access for traditional uses; and monitor and protect cultural resources.

Cowlitz PUD will follow a previously established Unanticipated Discovery Plan and will consult with the CIT and YN about development actions, land acquisitions, or emergency response activities that would disturb areas greater than 0.1 acre. Cowlitz PUD will also allow tribal access to lands, not excluded for safety reasons, within the Swift No. 2 Project boundary.

2.3.10 Socioeconomic Measures

Law Enforcement
PacifiCorp will provide funding for three full-time-equivalent law enforcement officers to augment land and marine-based traditional law enforcement activities and patrols in the North Fork Lewis River Basin, provided by state and local government, as part of their responsibilities to protect public health, safety and welfare in the North Fork Lewis River Basin.

Forest Road 90
PacifiCorp will pay $7,474 and Cowlitz PUD will pay $2,626 to the USFS to assist in the repair of the Canal Bridge on Forest Road 90. PacifiCorp will pay $19,980 per year beginning in April 2005 to the USFS specifically for the maintenance of Forest Road 90. Cowlitz PUD will pay $7,020 annually to the USFS specifically for the maintenance of Forest Road 90 beginning in April of 2005. Each Licensee will pay appropriate use fees to the USFS for hauling heavy loads on Forest Road 90 on a case-by-case basis when that Licensee uses Forest Road 90 for heavy hauls.

Visitor Information Facility
PacifiCorp will allow the construction of a 1,000 to 1,200-square-foot Visitor's Information Facility on its property in Cougar, and the Licensees will provide matching funds, or the Licensees will perform periodic maintenance of the facility for the term of the new licenses. PacifiCorp's portion of matching contributions contribution will be $65,250 and Cowlitz PUD's portion will be $9,750.

Pine Creek Communication Works Center Link
PacifiCorp will provide support for the USFS radio-telephone link between Swift Dam and the Pine Creek Work Center.

3. RANGEWIDE STATUS OF LISTED SPECIES AND DESIGNATED CRITICAL HABITAT

In Step 1 of its analysis, NMFS considers the current rangewide status of the listed species, taking into account viability criteria (population size, productivity, population spatial structure, and diversity) (McElhany et al. 2000) and, if available, an assessment of population projections relative to survival and recovery criteria. To assess current status, NMFS starts with the determinations made in its decision to list for ESA protection the salmon and steelhead species considered in this Opinion, and also considers any new data that is relevant to the determination. The following sections briefly describe the current status of the species (listing status, general life history, and population dynamics) in a manner that is relevant to each species' biological requirements.

3.1 Rangewide Status of the Species

There are four ESA-listed salmon and steelhead species that may be affected by the Proposed Action (see Table 1-1). The listing status and critical habitat designations for each of the species that may be affected by the proposed action are identified in Table 1-1. Except for LCR coho salmon, critical habitat has been designated for all of the anadromous fish potentially affected by the proposed action.

3.2 Life Histories, Factors for Decline, and Population Trends

The biological requirements, life histories, migration timing, historical abundance, and factors contributing to the decline of the four salmon and steelhead species have been well documented. The following sections summarize the information contained in these documents although additional details are available in the BE, in NMFS' Status Reviews (Weitkamp et al. 1995, Busby et al. 1996, Johnson et al. 1997, Myers et al. 1998, and Good et al. 2005), in NMFS' listing determination (NMFS 2005a), in Willamette and Lower Columbia River technical recovery team (TRT) documents (McElhany et al. 2003, McElhany et al. 2004, McElhany et al. 2006, and Myers et al. 2006), and on NMFS' Northwest Region website: http://www.nwr.noaa.gov.

3.2.1 Lower Columbia River Chinook Salmon

ESU Description

The LCR Chinook salmon ESU includes all naturally spawned populations of Chinook salmon in tributaries to the Columbia River from a transition point located east of the Hood River, Oregon, and the White Salmon River, Washington, to the mouth of the Columbia River at the Pacific Ocean and in the Willamette River below Willamette Falls, Oregon (excluding spring Chinook salmon in the Clackamas River). Not included in this ESU are stream-type spring Chinook salmon found in the Klickitat River (which are considered part of the Middle Columbia River spring-run Chinook ESU) or the introduced Carson spring Chinook salmon strain. Tule fall Chinook salmon in the Wind and Little White Salmon rivers are included in this ESU, but not introduced upriver bright fall Chinook salmon populations in the Wind, White Salmon, and Klickitat rivers. The Cowlitz, Kalama, Lewis, Washougal, and White Salmon rivers constitute the major systems on the Washington side; the lower Willamette and Sandy Rivers are foremost on the Oregon side. Most of this ESU is currently represented by fall populations; there is some question whether any natural-origin spring Chinook salmon persist in this ESU.

Seventeen artificial propagation programs releasing hatchery Chinook salmon are considered part of the LCR Chinook salmon ESU. All of these programs are designed to produce fish for harvest, and three of these programs are also intended to augment naturally spawning populations in the basins where the fish are released. These three programs integrate naturally produced spring Chinook salmon into the broodstock in an attempt to minimize the genetic effects of returning hatchery adults that spawn in the wild (by minimizing differences between hatchery and wild fish).

Life History Types

The LCR Chinook salmon ESU exhibits three major life history types: fall-run ("tules"), late fall-run ("brights"), and spring-run. Spring Chinook salmon on the Lower Columbia River, like those from coastal stocks, enter fresh water in March and April, well in advance of spawning in August and September. Historically, the spring migration was synchronized with periods of high rainfall or snowmelt to provide access to upper reaches of most tributaries, where spring stocks would hold until spawning.

Fall Chinook salmon predominate in the Lower Columbia River salmon runs. Tule-type fall Chinook salmon, differentiated from bright fall Chinook salmon by their dark skin coloration and advanced state of maturation at the time of freshwater entry, begin returning to the Columbia River in mid-August and spawn within a few weeks. Bright fall Chinook salmon populations typically return to the fresh water later than tule fall Chinook salmon and spawn between late September and early November. Most fall Chinook salmon emigrate to the marine environment as subyearlings. Adult fall tule Chinook salmon return to tributaries in the Lower Columbia River at 3 and 4 years of age, compared to 4 to 5 years for bright Chinook salmon and spring-run fish. Marine coded-wire-tag recoveries for LCR stocks tend to occur off the British Columbia and Washington coasts, although a small proportion of the tags are recovered in Alaskan waters. LCR Chinook salmon in the Lewis River are early fall (tules), late fall (bright), and spring-run.

Current Viability

Individual populations were assessed according to the four viable salmon population (VSP) criteria: abundance, growth rate/productivity, spatial structure, and diversity (Good et al. 2005). The West Coast Salmon Biological Review Team (BRT) found moderately high risk for all VSP categories for this ESU (Good et al. 2005). Many populations within the LCR Chinook salmon ESU exhibited pronounced increases in abundance 2001 through 2004, possibly due to improved ocean conditions. Abundance estimates of naturally spawned populations have been uncertain until recently due to a high (about 70 percent) fraction of naturally spawning hatchery fish. Abundance estimates of naturally produced spring Chinook salmon have improved since 2001 due to the marking of all hatchery spring Chinook salmon releases (compared to a previous marking rate of only 1 to 2 percent), which allows for the separation in counts at weirs and traps and on spawning grounds. Despite recent improvements, long-term trends in productivity are below replacement for the majority of populations in the ESU. Of the 31 historical populations, 8 to 10 have been extirpated or nearly extirpated. Although about 35 percent of historical habitat has been lost behind impassable barriers, the ESU exhibits a broad spatial distribution in a variety of watersheds and habitat types. Natural production currently occurs in about 20 populations, although only one population has a mean spawner abundance exceeding 1,000 fish. The West Coast Salmon BRT expressed concern that most of the extirpated populations are spring-run, and the disproportionate loss of this life history type represents a risk to ESU diversity (Good et al. 2005). Additionally, of the four hatchery spring-run Chinook salmon populations considered part of the ESU, two are propagated in rivers that, although they are within the historical geographic range of the ESU, probably did not support spring-run populations. High hatchery production poses genetic and ecological risks to the natural populations and complicates assessments of their performance. The BRT also expressed concern over the introgression[16] of out-of-ESU hatchery stocks.

Limiting Factors

According to NMFS (2005c), the major factors limiting the species' recovery are:

- Reduced access to spawning/rearing habitat in tributaries,
- Hatchery impacts,
- Loss of habitat diversity and channel stability in tributaries,
- Excessive sediment in spawning gravel,
- Elevated water temperatures in tributaries, and
- Harvest impacts to fall Chinook.

3.2.2 Lower Columbia River Coho Salmon

ESU Description

The Lower Columbia River coho ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers, and includes the Willamette River to Willamette Falls, Oregon. Additionally, 25 artificial propagation programs are considered to be part of the ESU: Grays River, Sea Resources Hatchery, Peterson Coho Project, Big Creek Hatchery, Astoria High School (STEP) Coho Program, Warrenton High School (STEP) Coho Program, Elochoman Type-S Coho Program, Elochoman Type-N Coho Program, Cathlamet High School FFA Type-N Coho Program, Cowlitz Type-N Coho Program in the Upper and Lower Cowlitz Rivers, Cowlitz Game and Anglers Coho Program, Friends of the Cowlitz Coho Program, North Fork Toutle River Hatchery, Kalama River Type-N Coho Program, Kalama River Type-S Coho Program, Lewis River Type-N Coho Program, Lewis River Type-S Coho Program, Fish First Wild Coho Program, Fish First Type-N Coho Program, Syverson Project Type-N Coho Program, Washougal River Type-N Coho Program, Eagle Creek NFH, Sandy Hatchery, and the Bonneville/Cascade/Oxbow complex coho hatchery programs. NMFS determined that these artificially propagated stocks are no more genetically divergent relative to the local natural population(s) than would be expected for closely related natural populations within the ESU and thus included them as part of the ESU (NMFS 2005a).

[16] The entry or introduction of a gene from one gene complex into another

Life Histories
Adult LCR coho salmon typically migrate through the Lower Columbia River from September through November. Juveniles migrate to the ocean as yearlings from mid-April through the end of May with the peak migrations in the Lower Columbia River during May.

Current Viability
The BRT (Good et al. 2005) had major concerns for this ESU in all of the VSP risk categories. McElhany et al. (2004) identified a total of 21 extant, demographically independent populations in three major population groups in this ESU: Coastal, Cascade, and Gorge. There are only two extant populations in the LCR coho salmon ESU with appreciable natural productivity, those in the Clackamas and Sandy Rivers, down from an estimated 23 historical populations. NMFS (2005a) stated that although adult returns in 2000 and 2001 for the Clackamas and Sandy River populations exhibited moderate increases, the recent 5-year mean of natural-origin spawners for both populations represents less than 1,500 adults. It also stated that the Sandy River population has exhibited recruitment failure in 5 of 10 recent years and a poor response to reductions in harvest. During the 1980s and 1990s, natural spawners were not observed in the tributaries farther downstream. Coincident with the 2000-2001 abundance increases in the Sandy and Clackamas populations, a small number of coho salmon spawners of unknown origin have been surveyed in some lower tributaries. Short- and long-term trends in productivity are below replacement meaning that productivity levels are too low to replace every fish as it spawns and dies.

The lack of naturally produced spawners is contrasted by the very large number of hatchery-produced adults. The abundance of hatchery coho salmon returning to the Lower Columbia River in 2001 and 2002 exceeded 1 million and 600,000 fish, respectively. The BRT (Good et al. 2005) expressed concern that the magnitude of hatchery production continues to pose significant genetic and ecological threats to the extant natural populations in the ESU. However, these hatchery stocks collectively represent a significant portion of the ESU's remaining genetic resources. The 21 hatchery stocks considered to be part of the ESU, if appropriately managed, may prove essential to the restoration of more widespread naturally spawning populations. Several of these risks have recently begun to be addressed by improvements in hatchery practices. Out-of-ESU broodstock is no longer used, and almost 100 percent of hatchery fish are marked to improve monitoring and evaluation of broodstock and hatchery- and natural-origin returns.

NMFS' assessment of the effects of artificial propagation on ESU extinction risk concluded that hatchery programs collectively mitigate the immediacy of extinction risk for the LCR coho salmon ESU in the short term, but these programs do not substantially reduce the extinction risk of the ESU in the foreseeable future. At present, within-ESU hatchery programs significantly increase the abundance of the ESU. Without adequate long-term monitoring, the contribution of ESU hatchery programs to the productivity of the ESU is uncertain. The hatchery programs are widely distributed throughout the Lower Columbia River, reducing the spatial distribution of risk to catastrophic events.

Limiting Factors
The major factors limiting the species' recovery are:

- No access to approximately 40 percent of historical habitat,
- Loss of naturally spawning populations,
- Low abundance of extant populations,
- Diminished diversity, and
- Fragmentation and isolation of the remaining naturally produced fish.

3.2.3 Columbia River Chum Salmon

ESU Description
The Columbia River chum ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon (NMFS 1999b). Additionally, three artificial propagation programs are considered to be part of the ESU: Chinook River (Sea Resources Hatchery), Grays River, and Washougal River/Duncan Creek chum hatchery programs. NMFS determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (NMFS 2005a).

Life Histories
Adult CR chum salmon typically return to the Lower Columbia River from mid-October through December, and spawn from mid-November through December. Juvenile Columbia River chum salmon migrate to the estuary as fry between February and May.

Current Viability
The BRT had substantial concerns about every VSP element (Good et al. 2005). Approximately 90 percent of the historical populations in the Columbia River chum ESU are extirpated or nearly so. During the 1980s and 1990s, the combined abundance of natural spawners for the Lower and Upper Columbia River Gorge, Washougal, and Grays River populations was below 4,000 adults. In 2002, however, the abundance of natural spawners exhibited a substantial increase evident at several locations in the ESU. The preliminary estimate of natural spawners is approximately 20,000 adults. This dramatic increase in abundance coincided with the first returns from the Grays River hatchery program, but improved ocean conditions, improved flow management at Bonneville Dam, favorable freshwater conditions, and increased survey sampling effort may all have contributed to the elevated 2002 abundance. Despite the high returns in 2002, long- and short-term productivity trends for the ESU are at or below replacement. The loss of off-channel habitats and the extirpation of approximately 17 historical populations increase the ESU's vulnerability to environmental variability and catastrophic events. The populations that remain are still low in abundance compared to historical levels, and have limited distributions and poor connectivity (NMFS 2005a).

There are now three artificial propagation programs producing chum salmon considered to be part of the Columbia River chum ESU. These are conservation programs designed to support natural production. The Sea Resources program has begun to provide benefits to ESU spatial structure through reintroductions of chum salmon into restored habitats in the Chinook River. The Washougal Hatchery artificial propagation program provides juvenile chum salmon for reintroduction into recently restored habitat in Duncan Creek, Washington. This program also serves as a genetic reserve[17] for the naturally spawning population in the mainstem Columbia River below Bonneville Dam, which can access only a portion of spawning habitat during low hydrologic years. The other two programs are designed to augment natural production in the Grays River and the Chinook River in Washington. All these programs use naturally produced adults for broodstock. These programs were only recently established (1998–2002).

NMFS' assessment of the effects of artificial propagation on ESU extinction risk concluded that these hatchery programs collectively do not substantially reduce the extinction risk of the ESU in-total (NMFS 2005a). The Columbia River chum hatchery programs have only recently been initiated, and, as described above, are beginning to provide benefits to ESU abundance. The contribution of ESU hatchery programs to the productivity of the ESU in-total is uncertain. These three programs have a neutral effect on ESU diversity. Collectively, artificial propagation programs in the ESU provide a slight beneficial effect to ESU abundance and spatial structure.

Limiting Factors
According to NMFS (2005c), the major factors limiting the species' recovery are:
- Altered channel form and stability in tributaries,
- Excessive sediment in tributary spawning gravels,
- Altered stream flow in tributaries and mainstem Columbia,
- Loss of some tributary habitat types, and
- Harassment of spawners in tributary and mainstem.

3.2.4 Lower Columbia River Steelhead

ESU Description
The LCR steelhead DPS includes all naturally produced steelhead in tributaries to the Columbia River between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon, excluding steelhead in the upper Willamette River above Willamette Falls (Upper Willamette DPS) (Busby et al. 1996). Steelhead in this DPS belong to the coastal genetic group (Schreck et al. 1986, Reisenbichler et al. 1992, Chapman et al. 1994) and include both winter steelhead (Cowlitz, Toutle, Coweeman, Kalama, Washougal, Sandy, Hood, Clackamas and Wind Rivers) and summer steelhead (Kalama, Lewis, Hood, Wind, and Washougal Rivers). The Willamette/Lower Columbia River Technical Recovery Team identified 23 historical populations within the DPS (Myers et al. 2006). Hatchery programs using endemic natural stocks of winter steelhead have been developed in the Cowlitz, Sandy, Kalama, and Hood River basins since the listing and are considered to be part of the DPS (NMFS 2006).

Life Histories
In the Lower Columbia Basin, migrating adult steelhead can occur in the Columbia River year-round, but peaks in migratory activity and differences in reproductive ecotype lend themselves to classifying steelhead into two races: summer and winter steelhead. Summer steelhead return to fresh water from May to October, and enter the Columbia in a sexually immature condition, requiring several months in fresh water to reach sexual maturity and spawn. Winter steelhead

[17] A genetic resource in case of catastrophic loss to the populations below Bonneville Dam.

enter fresh water from November to April, and return as sexually mature individuals that spawn shortly thereafter. Spawning occurs from January through May, and precise spawn timing is related to stream temperature. Adult steelhead, unlike salmon, do not necessarily die after spawning but return to the ocean (kelts). Generally, fry emergence occurs from March into July, with peak emergence time generally in April and May. Steelhead exhibit a great deal of variability in smolt age and ocean age. Outmigrating steelhead smolts in the Lower Columbia River are predominately age two. In the Lower Columbia River, outmigration of steelhead smolts generally occurs from March to June, with peak migration usually in April or May.

Current Viability
Of the 25 populations discussed in McElhany et al. (2004), three of these populations were at a very high risk of extinction, 16 were at a high risk of extinction, and six were at a moderate risk of extinction. While some anadromous populations in the Lower Columbia ESU, particularly summer-run populations, have shown increases in abundance in the past few years, abundance levels remain low. Only half of the historical populations currently exhibit appreciable natural production. Spatial distribution of the DPS remains relatively good, despite loss of approximately 35 percent of historical habitat (much of the lost habitat contained historically important spawning areas). Genetic diversity is a concern due to high proportions of hatchery-origin spawners, releases of non-native hatchery stocks in some watersheds, and disproportionate declines in the summer steelhead life history (NMFS 2004b).

Limiting Factors
According to NMFS (2005c), the major factors limiting the species' recovery are:

- Degraded floodplain and stream channel structure and function,
- Reduced access to spawning/rearing habitat,
- Altered streamflow in tributaries,
- Excessive sediment and elevated water temperatures in tributaries, and
- Hatchery impacts.

3.3 Critical Habitat

NMFS has designated critical habitat for three of the four salmon and steelhead species that would be affected by the Proposed Action.[18] Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line.[19] Within these areas, the PCEs essential for the conservation of these species are those sites and habitat components that support one or more life stages, including:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.

[18] Critical habitat has not been designated for LCR coho salmon.
[19] In areas where ordinary high-water line has not been defined, the lateral extent is the bankfull elevation (i.e., the level at which water begins to leave the channel and move into the floodplain, generally reached at a discharge with a 1- to 2-year recurrence interval).

- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

NMFS determines the importance of the populations associated with an area to the recovery of their respective ESUs and DPS', and the contribution of the area to the conservation (i.e., recovery) of each population through either its current or potential productivity. The Critical Habitat Analytical Review Teams (CHARTs) rated occupied fifth field hydrologic units (referred to as HUC5s or watersheds) in the Columbia River Basin. The CHARTs gave each of these occupied HUC5s a high, medium, or low rating. High-value watersheds/areas are those with a high likelihood of promoting conservation, while low value watersheds/areas are expected to contribute relatively little. Conservation value was determined by considering the factors listed in Table 3-1.

Table 3-1. Factors considered by Columbia Basin CHARTs to Determine the Conservation Value of Occupied HUC5s.

FACTORS	CONSIDERATIONS
PCE quantity	Total stream area or number of reaches in the HUC5 where PCEs are found; compares to both distribution in other HUC5s and to probable historical quantity within the HUC5
PCE quality – current condition	Existing condition of the quality of PCEs in the HUC5
PCE quality – potential condition	Likelihood of achieving PCE potential in the HUC5, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility
PCE quality – support of rarity/importance	Support of rare genetic or life history characteristics or rare/important types in the HUC5
PCE quality – support of abundant populations	Support of variable-sized populations relative to other HUC5s and the probably historical levels in the HUC5
PCE quality – support of spawning/rearing	Support of spawning or rearing of varying numbers of populations (i.e., different run-timing or life history types within a single ESU and or different ESUs)

For LCR Chinook, LCR steelhead, and Columbia River chum species, of the 50 occupied HUC5s, 44 were assigned a high conservation value rating, four a medium rating, and two a low rating. Ratings for the LCR coho salmon ESU are under development.

Many factors, both human-caused and natural, have contributed to the decline of salmon over the past century. Salmon habitat has been altered through activities such as urban development, logging, grazing, power generation, and agriculture. These habitat alterations have resulted in the loss of important spawning and rearing habitat and the loss or degradation of migration corridors (Table 3-2).

Table 3-2. Major Factors Limiting the Conservation Value of Designated Critical Habitat by Species (NMFS 2005c).

SPECIES	MAJOR LIMITING FACTORS
LCR Chinook salmon	▪ Reduced access to spawning/rearing habitat in tributaries ▪ Loss of habitat diversity and channel stability in tributaries ▪ Excessive sediment in spawning gravel ▪ Elevated water temperature in tributaries
LCR steelhead	▪ Degraded floodplain and stream channel structure and function ▪ Reduced access to spawning/rearing habitat ▪ Altered streamflow in tributaries ▪ Excessive sediment and elevated water temperatures in tributaries
CR chum salmon	▪ Altered channel form and stability in tributaries ▪ Excessive sediment in tributary spawning gravels ▪ Altered streamflow in tributaries and mainstem Columbia ▪ Loss of some tributary habitat types ▪ Harassment of spawners in tributary and mainstem

4. ENVIRONMENTAL BASELINE

In Step 2 of this analysis, NMFS evaluates the relevance of the environmental baseline to the species' current and future status. Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as “the past and present impacts of all Federal, state, or private actions and other human activities in the action area, including the anticipated impacts of all proposed Federal projects in the action area that have undergone Section 7 consultation and the impacts of state and private actions that are contemporaneous with the consultation in progress.” It is an analysis of the effects of past and ongoing human and natural factors affecting the current and future status of the species, its habitat, and ecosystems within the action area, including effects on the status of designated critical habitat. “It does not include the effects of the action under review in the consultation” (ESA Section 7 Consultation Handbook [USFWS and NMFS 1998] p. 4-22).

As described in Section 2.1, the action area is defined as the Lewis River Basin from its confluence with the Columbia River to the headwaters of the North Fork Lewis River. In the following sections, NMFS describes historical Project effects and the effects of other factors on the status of populations and critical habitat in the action area. Historical Project effects are included because they are partly responsible for current conditions. The continuing Project effects that are the subject of the proposed action are not in the environmental baseline. Only those effects resulting from past operations or existence of the Projects are included in the baseline. The future existence of the Projects is not assumed, and future Projects effects include all effects of issuing new Project licenses.

4.1 Status of Populations within the Action Area

The information in the following sections came from LCFRB and NMFS (2006) unless stated otherwise.

4.1.1 North Fork Lewis River Chinook

Spring Chinook

Adults enter the Lewis River from March through June with spawning occurring between late August and early October (peak in mid-September). The dominant age classes for adults are 4- and 5-year-olds but range from 3-year-old jacks to 6-year-old adults. Fry emerge between December and January and juveniles rear for a full year before migrating out in their second spring.

It is estimated that historically the North Fork Lewis River produced from 10,000 to 50,000 adult Chinook. It is estimated that current spawning returns range from 200 to 1000 and are almost entirely hatchery produced fish. Chinook historically spawned in the upper North Fork Lewis River above the Merwin Dam. At least 3,000 spring Chinook entered the upper Lewis River prior to the completion of Merwin Dam in 1931 (Smoker et al. 1951). Only remnant spring Chinook runs existed on the Lewis by the 1950s. Current spawning is limited to the first 2 miles below Merwin Dam and in Cedar Creek. Production from natural spawning is presumed to be low.

The North Fork Lewis spring Chinook have a 60 percent extinction risk within 100 years corresponding to an estimated viability of very low. As described in the Interim Regional Recovery Plan (LCFRB and NMFS 2006), a combination of Federal and state agencies, tribes, and local governments, nonprofit organizations, the business sector (e.g., the Licensees), and citizens actions will be needed to restore spring Chinook to a "high" level of viability to meet regional recovery objectives. This means a population that is productive, abundant, exhibits multiple life history strategies and utilizes significant portions of the subbasin. In the North Fork Lewis River, spring Chinook recovery can only occur in the upper portion above Merwin Dam because that is where the suitable habitat exists for that population.

LCFRB and NMFS (2006) identified the most critical lifestages and the habitat factors affecting those lifestages. For spring Chinook the most critical lifestage is egg incubation and the primary limiting factors affecting it are channel stability and sediment; key habitat[20] was secondary. The second critical lifestage is 0-age summer rearing and the primary factors affecting it are competition (with hatchery-origin juveniles) and habitat diversity. Secondary factors for this lifestage are food, predation, and key habitat. The third critical lifestage is fry colonization and the primary factors affecting it are flow, food, habitat diversity, predation, and sediment.

The LCFRB and NMFS (2006) list the most immediate key priorities for recovery of species in the upper North Fork Lewis River as: (1) to provide upstream and downstream passage throughout the Lewis River hydrosystem, (2) to protect intact forests in headwater basins, (3) to manage forest lands to protect and restore watershed processes, (4) to manage growth and development to protect watershed processes and habitat conditions, (5) to align hatchery priorities with conservation objectives, (6) to manage fishery impacts so they do not impede progress toward recovery, and (7) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

Late (Bright) Fall Chinook

Adults enter the Lewis River from September through October with spawning occurring between late October and January (peak in mid-November). The dominant age class for adults is 4 with significant numbers of 5-year-olds, but age ranges from 2-year-old jacks to 6-year-old adults. Fry emerge between March and August (peak usually in April) and fry spend the spring/early summer in fresh water, and migrate out in the summer as sub-yearlings. The North Fork Lewis fall Chinook have a 20 percent extinction risk within 100 years corresponding to an estimated viability of medium plus.

It is estimated that historically the North Fork Lewis River produced from 18,000 to 20,000 adult fall Chinook. Current natural spawning returns range from 3,200 to 18,000 and there are no hatchery releases in the North Fork Lewis. The North Fork Lewis fall Chinook population has exceeded WDFW's escapement goal of 5,700 adults in all years except 1999. This is the only stock in the Lower Columbia River to maintain a healthy wild population with little hatchery

[20] habitat to support that lifestage

influence. Chinook historically spawned in the upper North Fork Lewis River above the Merwin Dam up to the Yale Dam site. Current spawning is restricted to the 4-mile reach between Merwin Dam and the Lewis River Salmon Hatchery and some spawning is observed in Cedar Creek.

As described in the Interim Regional Recovery Plan (LCFRB and NMFS 2006), a combination of Federal and state agencies, tribes, and local governments, nonprofit organizations, the business sector (e.g., the Licensees), and citizens actions will be needed to restore fall Chinook to above "high viability" to meet regional recovery objectives. This means a population that is productive, abundant, exhibits multiple life history strategies and utilizes significant portions of the subbasin. In the North Fork Lewis River, fall Chinook recovery efforts will be in the lower portion below Merwin Dam.

LCFRB and NMFS (2006) identified the most critical lifestages and the habitat factors affecting those lifestages. For fall Chinook the most critical lifestage is egg incubation and the primary limiting factors affecting it is sediment and flow, with channel stability and harassment being secondary factors. The second critical lifestage is fry colonization and the primary factors affecting it are habitat diversity and predation. A secondary factor is channel stability. The third critical lifestage is 0-age summer rearing and the primary factor affecting it is key habitat. Secondary factors are competition (with hatchery-origin juveniles) and habitat diversity.

The LCFRB and NMFS (2006) lists the most immediate priorities for recovery of species in the lower North Fork Lewis River as: (1) to manage regulated stream flows through the hydropower system, (2) to restore floodplain function, riparian function and stream habitat diversity, (3) to manage the growth and development of human populations to protect watershed processes and habitat conditions, (4) to manage forest lands to protect and restore watershed processes, (5) to restore passage at culverts and other artificial barriers, (6) to address immediate risks with short-term habitat fixes, (7) to align hatchery priorities consistent with conservation objectives, (8) to manage fishery impacts so they do not impede progress toward recovery, and (9) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

The TRT has classified the Lewis River spring- and late fall-run populations as "core" populations for the LCR Chinook ESU (historically abundant and "may offer the most likely path to recovery") and the Lewis River late fall-run and Salmon Creek/Lewis River fall-run populations as genetic legacy populations (some of "the most intact representatives of the genetic character of the ESU") (McElhany et al. 2003).

4.1.2 North Fork Lewis River Coho Salmon

It is estimated that historically the North Fork Lewis River produced from 7,500 to 85,000 adult coho. The Lewis River had both early and late stocks with early primarily spawning in the upper Lewis River. Today natural spawning is limited to the mainstem and tributaries below Merwin Dam and the population is a fraction of its historical size.

The North Fork Lewis coho have a 60 percent extinction risk within 100 years corresponding to an estimated viability of "very low." As described in the Interim Regional Recovery Plan (LCFRB and NMFS 2006), a combination of Federal and state agencies, tribes, and local governments, nonprofit organizations, the business sector (e.g., the Licensees), and citizens actions will be needed to restore the Lewis River coho population to a level where it contributes to meeting regional recovery objectives including a stratum-wide average of medium viability. In the North Fork Lewis River, the focus of recovery is both above and below Merwin Dam.

LCFRB and NMFS (2006) identified the most critical lifestages and the habitat factors affecting those lifestages. For lower Lewis River coho the most critical lifestage is 0-age summer rearing and the primary limiting factor affecting it is habitat diversity with competition (hatchery), with predation being secondary factors. The second critical lifestage is fry colonization and the primary factor affecting it is habitat diversity. The secondary factors affecting this lifestage are channel stability, flow, and predation. The third critical lifestage is 1-age summer rearing and the primary factors affecting it are competition (hatchery), flow, and habitat diversity while the secondary factor is pathogens.

For upper Lewis River coho the most critical lifestage is egg incubation and the primary limiting factors affecting it are channel stability and sediment. The second critical lifestage is 0-age summer rearing and the primary factor affecting it is habitat diversity. The secondary factors affecting this lifestage are food, competition (hatchery), predation, and temperature. The third critical lifestage is 0-age winter rearing and the primary factor affecting it is habitat diversity. The secondary factor is flow.

The LCFRB and NMFS (2006) lists the most immediate priorities for recovery of species in the lower North Fork Lewis River as: (1) to manage regulated stream flows through the hydropower system, (2) to restore floodplain function, riparian function and stream habitat diversity, (3) to manage growth and development to protect watershed processes and habitat conditions, (4) to manage forest lands to protect and restore watershed processes, (5) to restore passage at culverts and other artificial barriers, (6) to address immediate risks with short-term habitat fixes, (7) to align hatchery priorities consistent with conservation objectives, (8) to manage fishery impacts so they do not impede progress toward recovery, and (9) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized. For the upper North Fork Lewis River, the LCFRB and NMFS lists as its priorities: (1) to provide upstream and downstream passage throughout the Lewis River hydrosystem, (2) to protect intact forests in headwater basins, (3) to manage forest lands to protect and restore watershed processes, (4) to manage growth and development to protect watershed processes and habitat conditions, (5) to align hatchery priorities with conservation objectives, (6) to manage fishery impacts so they do not impede progress toward recovery, and (7) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

4.1.3 North Fork Lewis River Chum Salmon

It is estimated that, historically, the entire Lewis River Basin produced from 120,000 to 300,000 adult chum. The current population has less than 100 spawners. Chum were reported to historically ascend the mainstem above the current location of Merwin Dam and spawn in the area that is now inundated by the reservoir. Chambers (1957) reported 96 chum spawning just downstream of Merwin Dam in November of 1955 (although some of the live fish may have also been counted in the carcass number, resulting in some over-counting). Chum were sighted occasionally during 1998 fall Chinook spawning surveys and four adult carcasses were observed in Cedar Creek. In addition, 403 juvenile chum were captured during seining operations related to a smolt residual study in 1998 (WDFW 2002). All of these fish were believed to be of natural origin since hatchery supplementation in the Lewis River has not occurred since 1940 (NPPC 1990).

The lower North Fork chum have a 70 percent extinction risk within 100 years corresponding to an estimated viability of very low (LCFRB and NMFS 2006). Myers et al. (2006) identified a single ecological zone (Cascade) containing one historical demographically independent population in this subbasin (Lewis River). The TRT has classified this as a "core" population (historically abundant and "may offer the most likely path to recovery") (McElhany et al. 2003).

As described in the Interim Regional Recovery Plan (LCFRB and NMFS 2006), a combination of Federal and state agencies, tribes, and local governments, nonprofit organizations, the business sector (e.g., the Licensees), and citizens actions will be needed to restore chum to a high level of viability to meet regional recovery objectives. This means a population that is productive, abundant, exhibits multiple life history strategies and utilizes significant portions of the Lewis River Basin. The lower North Fork Lewis River chum population is a subset of the larger Lewis River population which is considered a primary population in the State's recovery scenario. In the North Fork Lewis River, recovery efforts will be in the portion of the river below Merwin Dam.

LCFRB and NMFS (2006) identified the most critical lifestages and the habitat factors affecting those lifestages. The most critical lifestage for chum in the lower Lewis River is prespawning holding. Habitat diversity and harassment are the primary factors affecting it with key habitat and temperature being secondary factors. The second critical lifestage is spawning, the primary limiting factors are flow, habitat diversity, and harassment with temperature being the secondary factor. The third critical lifestage is egg incubation and the primary limiting factor is flow while the secondary factors are channel stability, harassment, and temperature.

The LCFRB and NMFS (2006) lists the most immediate priorities for recovery of species in the lower North Fork Lewis River as: (1) to manage regulated stream flows through the hydropower system, (2) to restore floodplain function, riparian function and stream habitat diversity, (3) to manage growth and development to protect watershed processes and habitat conditions, (4) to manage forest lands to protect and restore watershed processes, (5) to restore passage at culverts and other artificial barriers, (6) to address immediate risks with short-term habitat fixes, (7) to align hatchery priorities consistent with conservation objectives, (8) to manage fishery impacts so they do not impede progress toward recovery, and (9) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

4.1.4 North Fork Lewis Steelhead

Myers et al. (2006) identified a single ecological zone (Cascade) containing one summer-run (North Fork Lewis River) and one winter-run (North Fork Lewis River) historical demographically independent populations in this subbasin. The TRT has classified the North Fork Lewis River winter-run steelhead as a "core" population (historically abundant and "may offer the most likely path to recovery") (McElhany et al. 2003).

Summer Steelhead
It is estimated that the North Fork Lewis River historically produced up to 20,000 adult summer steelhead. Current natural returns are presumed to be very low. Summer steelhead historically migrated to the upper North Fork Lewis River above the Merwin Dam to tributaries that now go into Merwin Lake. Current spawning is in the lower North Fork Lewis River and tributaries (most notable is Cedar Creek) below Merwin Dam. Hatchery summer steelhead from the Merwin Hatchery are not considered to be part of the DPS (NMFS 2006).

Naturally produced adults enter the Lewis River from May through November with spawning occurring between early March through early June. Fry emerge between April and July and juveniles usually spend 2 years in fresh water, and migrate out between March and May (peak in early May).

The North Fork Lewis summer steelhead have a 80 percent extinction risk within 100 years corresponding to an estimated viability of "very low." As described in the Interim Regional Recovery Plan (LCFRB and NMFS 2006), the recovery goal, based on a combination of Federal and state agencies, tribes, and local governments, nonprofit organizations, the business sector (e.g., the Licensees), and citizens actions, for summer steelhead in the North Fork Lewis River is to have a stabilizing population. This means a population that is protected from further deterioration and maintained at current levels. In the North Fork Lewis River, the recovery efforts for summer steelhead will occur below Merwin Dam.

The LCFRB and NMFS (2006) lists the most immediate key priorities for recovery of species in the lower North Fork Lewis River as: (1) to manage regulated stream flows through the hydropower system, (2) to restore floodplain function, riparian function and stream habitat diversity, (3) to manage growth and development to protect watershed processes and habitat conditions, (4) to manage forest lands to protect and restore watershed processes, (5) to restore passage at culverts and other artificial barriers, (6) to address immediate risks with short-term habitat fixes, (7) to align hatchery priorities consistent with conservation objectives, (8) to manage fishery impacts so they do not impede progress toward recovery, and (9) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

Winter Steelhead
It is estimated that historically the North Fork Lewis River produced from 6,000 to 24,000 adult winter steelhead. Current natural spawning returns are presumed to be very low and are limited to mainstem and tributaries below Merwin Dam. Winter steelhead historically spawned in the

upper North Fork Lewis River above the Merwin Dam. The construction of Merwin Dam in 1931 blocked approximately 80 percent of the spawning and rearing habitat. Hatchery winter steelhead currently released into the Lewis River from Merwin Hatchery are not considered to be part of the DPS (NMFS 2006).

Adults enter the Lewis River from December through April with spawning occurring generally between early March to early June. It is believed that most winter steelhead in the Lewis River are 4 year olds. Fry emerge between March and May and juveniles generally spend 2 years in fresh water, and migrate out between April and May (peak in early May).

The North Fork Lewis winter steelhead have a 50 percent extinction risk within 100 years corresponding to an estimated viability of "low." As described in the Interim Regional Recovery Plan (LCFRB and NMFS 2006), the recovery goal, based on a combination of Federal and state agencies, tribes, and local governments, nonprofit organizations, the business sector (e.g., the Licensees), and citizens actions, is for winter steelhead to be a contributing population to meet regional recovery objectives. This means a population that needs some level of improvement to achieve a stratum-wide average of "medium viability." In the North Fork Lewis River, the focus of recovery for winter steelhead is both above and below Merwin Dam.

LCFRB and NMFS (2006) identified the most critical lifestages and the habitat factors affecting those lifestages. For lower Lewis River winter steelhead the most critical lifestage is 0-age summer rearing and the primary limiting factors affecting it are temperature and pathogens with competition (hatchery) and predation being secondary factors. The second critical lifestage is 1-age summer rearing and the primary factor affecting it is temperature. The secondary factors affecting this lifestage are competition (hatchery), flow, predation, habitat diversity, and pathogens. The third critical lifestage is egg incubation and the primary factor affecting it is temperature while the secondary factor is channel stability. For upper Lewis River winter steelhead the most critical lifestage is egg incubation and the primary limiting factor affecting it is sediment with temperature being the secondary factor. The second critical lifestage is 0-age summer rearing and the primary factors affecting it are habitat diversity and competition (hatchery). The secondary factor affecting this lifestage is predation. The third critical lifestage is 1-age winter rearing and the primary factor affecting it is competition (hatchery) while the secondary factors are food, habitat diversity, and predation.

The LCFRB and NMFS (2006) lists the most immediate priorities for recovery of species in the lower North Fork Lewis River as: (1) to manage regulated stream flows through the hydropower system, (2) to restore floodplain function, riparian function and stream habitat diversity, (3) to manage growth and development to protect watershed processes and habitat conditions, (4) to manage forest lands to protect and restore watershed processes, (5) to restore passage at culverts and other artificial barriers, (6) to address immediate risks with short-term habitat fixes, (7) to align hatchery priorities consistent with conservation objectives, (8) to manage fishery impacts so they do not impede progress toward recovery, and (9) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized. The most immediate priorities for recovery of species in the upper North Fork Lewis River are listed as: (1) to provide upstream and downstream passage throughout the Lewis River hydrosystem, (2) to protect intact forests in headwater basins, (3) to manage forest lands to protect and restore watershed processes, (4) to manage growth and development to protect watershed processes and habitat conditions, (5) to align hatchery priorities with conservation objectives, (6) to manage fishery impacts so they do not impede progress toward recovery, and (7) to reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

4.1.5 Factors Affecting the Status of Populations in the North Fork Lewis River

The Lewis River ecosystem has undergone considerable change since the arrival of Euro-Americans. In the North Fork Lewis River, the three Project dams (Merwin, Yale and Swift) and the bypass reach (between about RM 44.5 and RM 47.7) represent a major modification of the river's salmonid habitat and the ecological processes that form and maintain salmonid habitat. The historical and ongoing effects of the Projects include:

- Limited access of anadromous salmonids to the lower 20 miles of the watershed, preventing access to as much as 174 miles of potential historical habitat.
- Converted 39 miles of mainstem river into reservoirs inundating high quality habitat for salmonids.
- Diverted all river flow (except during spill events) from a 3-mile-long reach of the Lewis River above Yale Lake.
- Altered temperature and flow regimes in the mainstem Lewis River below Merwin Dam.
- Limited the downstream transport of habitat building materials (gravels, sediment, and LWD).
- Loss of marine derived nutrients (from salmon carcasses) above Merwin Dam for over 70 years.
- Shifted the natural salmonid production system to a heavy reliance on artificial propagation (with the exception of fall Chinook).

Other land uses, such as residential, commercial, and industrial development, agriculture, and natural resource extraction industries, such as gravel mining and timber harvest, have also had significant historical effects on the Lewis River Basin and continue to impact the environment today. These land uses have:

- Drastically reduced floodplain and off-channel habitat connectivity in the lower Lewis River, primarily due to extensive diking.
- Degraded riparian habitats throughout the basin, which has likely increased sedimentation and erosion, increased water temperatures, and impacted LWD recruitment potential.
- Increased road density and drainage network patterns, which have altered hydrology, increased fine sediment inputs to streams, and blocked fish passage due to impassable culverts.

4.1.6 Summary: Status of Populations in the Action Area

North Fork Lewis spring Chinook have a 60 percent extinction risk within 100 years corresponding to an estimated viability of very low. The North Fork Lewis coho have a 60 percent extinction risk within 100 years corresponding to an estimated viability of "very low." The lower North Fork chum have a 70 percent extinction risk within 100 years corresponding to an estimated viability of very low. The North Fork Lewis summer steelhead have a 80 percent extinction risk within 100 years corresponding to an estimated viability of "very low." The North Fork Lewis winter steelhead have a 50 percent extinction risk within 100 years corresponding to an estimated viability of "low."

For the threatened species that occur within the action area, existing habitat conditions are severely degraded and do not meet the species' biological requirements. Improvements to their habitat will be necessary to recover these species. Through recovery planning, NMFS has identified certain improvements that will contribute to recovery, such as providing access to habitat above the Project dams. Access alone will not be sufficient, however, to successfully recover these species, and the recovery plan identifies a variety of steps that must be taken within and outside of the action area by governmental, public, and private entities to assist in the recovery of LCR Chinook, steelhead and coho and their habitat.

4.2 Status of Primary Constituent Elements of Designated Critical Habitat within the Action Area

The rangewide extent, nature, and conservation value of the PCEs of the critical habitat that has been designated for each species are discussed in Section 3.3. In the following sections, NMFS identifies and discusses the status of the PCEs that are within the action area for this consultation.

4.2.1 Primary Constituent Elements of Designated Critical Habitat within the North Fork Lewis River

NMFS determined that the following occupied areas of North Fork Lewis River portion of the Lewis Subbasin Unit of critical habitat contain PCEs (as described below) for the LCR Chinook salmon ESU, CR chum salmon ESU, and LCR steelhead DPS (NMFS 2005d and NMFS 2005b):

- LCR Chinook salmon – below Merwin Dam there are 19.2 miles of PCEs for spawning/rearing, 18.3 miles for rearing/migration, and 8.1 miles for migration/presence; the conservation value of the designated area is "high"; the unoccupied habitat above Merwin Dam may be essential for conservation, but NMFS does not have enough information to warrant designation as critical habitat at this time.
- CR chum salmon – below Merwin Dam there are 27.1 miles of PCEs for migration/presence; the conservation value of the designated area is "high".
- LCR steelhead – below Merwin Dam there are 34.1 miles of PCEs for spawning/rearing, 1 mile for rearing/migration, and 42.5 miles for migration/presence; the conservation value of the designated is "high"; the unoccupied habitat above Merwin Dam may be essential for conservation, but NMFS does not have enough information to warrant designation as critical habitat at this time.

4.2.2 Factors Affecting the Status of Primary Constituent Elements of Designated Critical Habitat within the North Fork Lewis River

As discussed in Section 4.1.5, the Projects block access to spawning and rearing upstream of Merwin Dam, alter flows downstream of Merwin Dam, and limit the downstream transport of habitat building blocks. They also alter the habitat above Merwin Dam by creating reservoirs, altering flows and temperatures, limiting transport of habitat building blocks, and causing the loss of over 70 years of marine derived nutrients. Other human activities in the North Fork Lewis subbasin have drastically reduced floodplain and off-channel habitat connectivity, degraded riparian areas, increased sedimentation, increased water temperatures, decreased LWD recruitment potential, altered hydrology, and created passage barriers including impassable culverts.

The Matrix of Pathways and Indicators (NMFS 1996) of habitat quality lists the pathways (significant environmental features) and the indicators of whether PCEs are in a condition suitable for salmon conservation (i.e., recovery). The matrix can be divided into six pathways by which natural conditions and human activities affect habitat suitability:

- Water Quality
- Habitat Access
- Habitat Elements
- Channel Condition and Dynamics
- Water Quantity (flow/hydrology)
- Watershed Condition

Each pathway is further broken down into indicators, which are generally of two types: (1) numerical metrics (e.g., six pools per stream mile), and (2) narrative descriptions.

Table 4.-1 summarizes the condition of PCEs within the North Fork Lewis River. Many of the habitat indicators are not in a condition suitable for salmon conservation. In most cases, this is the result of the past operation and the continuing effects of the existence of the Projects or the effects of other human activities (e.g., development, agriculture, and logging). However, to the extent these conditions would be perpetuated by future operations or existence of the Project, only the past impacts and Project existence are included in the baselin

Table 4-1. Matrix of Pathways and Indicators for the Condition of Primary Constituent Elements of Designated Critical Habitat in the North Fork Lewis River under the Environmental Baseline. The table is based on information from PacifiCorp and Cowlitz PUD (2005).

PCE	PATHWAY	INDICATOR	CONDITION	LIMITING FACTORS
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Water Quality	Temperature	Area below Merwin does not exceed 15.5 degrees Celsius.	Degraded riparian areas due to timber harvest, agriculture, and development; water diversions; and reservoir stratification.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Water Quality	Total Suspended Solids/Turbidity	Vast areas of the upper river landscape were devastated by the Mount St. Helens eruption in 1980. Heavy rain and high runoff conditions create high turbidity in the streams and reservoirs. Land use activities have also increased total suspended solids.	Effect of the Mt. St. Helens eruption and continuing erosion in areas degraded by the eruption; timber harvest and related road construction.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Water Quality	Chemical Contamination/Nutrients	No 303(d) listed river or stream reaches are present in the action area.	None currently identified.

Table 4-1. Matrix of Pathways and Indicators for the Condition of Primary Constituent Elements of Designated Critical Habitat in the North Fork Lewis River under the Environmental Baseline, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	LIMITING FACTORS
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Water Quality	Dissolved Oxygen (DO)	Three low DO readings out of 183 readings have been observed in the action area. Also, reservoir stratification can result in lower DO in the deep layers, but these areas are unoccupied under the environmental baseline. Past monitoring in the Merwin tailrace has not shown low DO readings.	Merwin, Yale, and Swift Dams.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Water Quality	Total Dissolved Gas (TDG)	Some Washington Department of Ecology TDG exceedences have occurred in Project waters but the affected reaches are all above Merwin Dam and thus outside of the area designated as Critical Habitat.	Operation of Swift No. 1 and Yale.
Freshwater Migration Corridors	Habitat Access	Physical Barriers	Merwin Dam blocks all upstream passage so that fish are restricted to the lower 20 miles (~20%) of historical habitat, but NMFS has not designated Critical Habitat above Merwin Dam.	Merwin Dam is a migration barrier; impassible Project and non-Project culverts.
Freshwater Spawning Sites	Habitat Elements	Substrate	Merwin Dam interrupts sediment (gravel) transport, but below Merwin Dam, there are currently good quality spawning gravels. Land use activities have increased sedimentation deposition.	Merwin, Yale, and Swift Dams; Mt. St. Helens eruption; other activities (such as gravel mining, forest practices and road construction).

Table 4-1. Matrix of Pathways and Indicators for the Condition of Primary Constituent Elements of Designated Critical Habitat in the North Fork Lewis River under the Environmental Baseline, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	LIMITING FACTORS
Freshwater Rearing Sites Freshwater Migration Corridors	Habitat Elements	Large Woody Debris	Low levels of LWD in the lower Lewis River below Merwin Dam.	Downstream LWD transport blocked by Project dams; timber harvest, agriculture, diking, and development have degraded riparian areas; historic removal of LWD and logjams.
Freshwater Rearing Sites Freshwater Migration Corridors	Habitat Elements	Pool Frequency and Quality	Pool frequency and quality in the Lewis River below Merwin Dam is low due to absence of pool forming elements such as LWD.	Downstream LWD transport blocked by Project dams; sediment inputs primarily derived from Mt. St. Helens eruption, roads, channel scour, land uses such as timber harvest, and diking in the lower river.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Habitat Elements	Off-channel Habitat	Poor connectivity (generally absent or extremely limited) to off-channel habitat in lower river.	Diking, dredging, and human development.
Freshwater Spawning Sites Freshwater Rearing	Channel Conditions and Dynamics	Width/Depth Ratio	Channel form in the lower watershed has been restricted by dikes and by loss of LWD; reservoir operations have restricted some channel forming processes.	Mt. St. Helens eruption; dikes; reduced LWD; Lewis River Project reservoirs and reservoir operations.

Table 4-1. Matrix of Pathways and Indicators for the Condition of Primary Constituent Elements of Designated Critical Habitat in the North Fork Lewis River under the Environmental Baseline, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	LIMITING FACTORS
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Channel Conditions and Dynamics	Streambank Condition	Streambanks do not support natural floodplain function in the lower river.	Mt. St. Helens eruption; diking; residential and agricultural land uses; timber harvest; reservoir operations.
Freshwater Rearing Freshwater Migration Corridors	Channel Conditions and Dynamics	Floodplain Connectivity	The lower Lewis River is disconnected from its historical floodplain by dikes and flood control operations that have reduced peak flows.	Dikes; Project operations.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Water Quantity (Flow/Hydrology)	Change in Peak/Base Flow	Lower Lewis River hydrology affected by seasonal reservoir drafting and refilling, flood control operations, and power production. Peak flows are lower and base flows are higher than unregulated river flows. Also, flows rise and fall more frequently with more gradual increases and more rapid decreases than in the unregulated river condition.	Project operations.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Watershed Conditions	Road Density and Location	High road densities exist in the Lewis River Basin below Merwin Dam, and many roads exist in valley bottoms.	Timber harvest; urban, agricultural, and industrial development.

Table 4-1. Matrix of Pathways and Indicators for the Condition of Primary Constituent Elements of Designated Critical Habitat in the North Fork Lewis River under the Environmental Baseline, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	LIMITING FACTORS
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Watershed Conditions	Disturbance History	Disturbance is frequent below Merwin Dam.	Industrial logging; grazing; fires; and Mt. St. Helens eruption.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Watershed Conditions	Riparian Reserves	Heavily impacted and impaired within the basin below Merwin Dam.	Timber harvest; Mt. St. Helens eruption; fire; floods; and urbanization.

4.3 Summary of the Environmental Baseline

Existing habitat conditions do not appear to meet the biological requirements of ESA-listed salmon and steelhead or the conservation value of their designated critical habitat in the action area. Currently, populations are greatly depressed from historical sizes and critical habitat has become degraded. The effects of historical activities, including the past existence and operation of the Projects, and of natural conditions, have all contributed to this condition.

5. EFFECTS OF THE ACTION

5.1 Effects of the Action on Listed Species

Effects of the action are defined in 50 CFR §402.02 as "the direct and indirect effects of an action on the species, together with the effects of other activities that are interrelated or interdependent with the action, that will be added to the environmental baseline." Direct effects occur at the Project site and may extend upstream or downstream based on the potential for impairing important habitat elements. Indirect effects are defined as “those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.” They include the effects on listed species of future activities that are induced by the proposed action and that occur after the action is completed. Interrelated actions are “those that are part of a larger action and depend on the larger action for their justification.” Interdependent actions are “those that have no independent utility apart from the action under consideration.” Future Federal actions that are not a direct effect of the action under consideration (and not included in the environmental baseline or treated as indirect effects) are not considered in this analysis.

In Step 3 of its analytical approach, NMFS evaluates the effects of the Proposed Action on the environment, including the geographic distribution, nature, intensity, timing, frequency, and/or duration of the effect. NMFS then looks at the effects of the action on individual fish and populations and on the primary constituent elements of critical habitat within the action area.

5.1.1 Direct Project Effects on Anadromous Fish and Habitat

The primary limiting factors to salmonid populations associated with past Project operations (as summarized in Table 4-1 of the Environmental Baseline description) include:

1) Barriers to upstream and downstream migration of salmonids resulting in the loss of spawning and rearing habitat.
2) Reservoir inundation.
3) Modified flow regimes in the Lewis River below the Projects.
4) Blocked downstream movement of substrate and LWD.

Except as identified herein, effects from past Project operations which were defined in the Environmental Baseline Section of this Opinion are expected to continue. In other words, NMFS expects past impacts to recur or continue into the future if they are not explicitly modified by the new licenses.

5.1.1.1 Fish Passage and Reintroduction Measures

The Proposed Action is intended to make available approximately 117 miles of spawning, rearing, and migration habitat upstream of Swift Dam and potentially 57 miles of spawning, rearing, and migration habitat upstream of Merwin and Yale Dams for Chinook, coho, and steelhead. According to the Interim Regional Recovery Plan (LCFRB and NMFS 2006), making this upstream habitat available in the North Fork Lewis River is one of the most substantial salmon recovery measures that can be implemented in the Lower Columbia region. This is especially true since Lewis River spring Chinook salmon and steelhead are considered core[21] populations.

Under the Proposed Action, the Licensees will reintroduce spring Chinook, coho, and late-winter steelhead into the upper Lewis River Basin above Merwin, Yale, and Swift dams. Upstream (collection and transport [truck or alternative transport facilities per the Settlement Agreement]) and downstream fish passage (modular surface collector and transport [truck or bypass facilities per the Settlement Agreement]) facilities will be installed at all three dams[22]. The fish passage program will follow a phased approach, incorporating the principles of adaptive management, to achieve genetically viable, self-sustaining, naturally reproducing, harvestable populations of these species. Access to habitat located upstream from Swift Dam will be provided in the fourth year of the reintroduction program as fish are trapped at Merwin and transported upstream to Swift Creek Reservoir. Fish will be placed in Yale Lake in year 13 and in Lake Merwin in year 17. Upstream facilities will be constructed in year 17 at Yale Dam and the Swift facility. Modular surface collectors will be installed to collect downstream migrants prior to their reintroduction. Ultimately, this program will result in connectivity via upstream fish passage through all three of the reservoirs associated with the Lewis River Projects. For the safety of the downstream migrants and to increase the likelihood of success of the reintroduction program, the downstream migrants will continue to be transported by truck to a stress release pond located below Merwin Dam unless the decision is made to bypass downstream migrants so that they pass through each reservoir.

The fish passage program will be subject to rigorous fish passage facility performance standards including overall quantitative survival standards, specific salmon life stage standards, and facility design standards. These will help gauge program success and determine if there is need for facility adjustments or facility modifications. The program will also include two “status checks” in years 27 and 37 to allow a detailed review of program measures and to track progress toward the program goals. If goals have not been met at each status check, PacifiCorp will perform a “limiting factors analysis” to more precisely determine whether performance standards and species goals have been met. If not, additional measures as described in the Settlement Agreement may be required. Additional details describing major program goals and implementation of the phased fish passage program are provided in Section 2.3.1.

Providing upstream and downstream fish passage at Merwin, Yale, and Swift Dams will allow Chinook, coho, and steelhead to be transported to and from an estimated 174 miles of potentially accessible anadromous fish habitat including tributaries (Table 5-1) (PacifiCorp and Cowlitz PUD 2004b). Access to approximately 117 miles of habitat located above Swift No. 1 Dam will be provided in the fourth year of the reintroduction program, as fish are trapped at Merwin Dam and transported upstream to Swift Creek Reservoir. Over the next 17 years, unless otherwise directed by the Services, the remaining 57 miles of habitat, including tributaries, between Merwin Dam and Swift No. 1 Dam will be made accessible to anadromous species.

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[21] The populations represented the substantial portion of the species’ abundance or contained life-history strategies that were specific to the species.
[22] The trap at Merwin Dam will either be an upgrade of the existing facility or a completely new facility.

Table 5-1. Length of Potentially Accessible Anadromous Fish Habitat, Including Tributaries, and the Percent of Total Accessible Habitat in the Three Reaches of the Lewis River Upstream of Merwin Dam.

REACH NAME*	LENGTH OF POTENTIALLY ACCESSIBLE HABITAT (MILES)	PERCENT OF TOTAL ACCESSIBLE HABITAT (BY LENGTH)
Lake Merwin**	29.4	17
Yale Lake	27.3	16
Swift Creek Reservoir	117.1	67
Grand Total	173.8	100

*The Lake Merwin reach extends from Merwin Dam to the base of Yale Dam; the Yale Lake reach extends from Yale Dam to the base of Swift Dam; and the Swift Creek Reservoir reach extends from Swift Dam to the lower falls approximately RM 69 on the North Fork Lewis River.
**Estimates of habitat for Merwin include all of Speelyai Creek since historically it did not flow into the Yale Lake area.
Source: Based on estimates developed for the EDT analysis (Mobrand Biometrics, Inc. 2004).

While the actual production potential of the blocked aquatic habitat is unknown, results of Ecosystem Diagnosis and Treatment (EDT) modeling (Mobrand Biometrics, Inc. 2004) predict that together, all three reaches could produce 2,014 adult spring Chinook, 12,253 adult coho, and 2,005 adult steelhead in their current condition (assuming greater than 95 percent survival past the dams and no harvest) (Table 5-2). The vast majority of adult production (76 percent) will result from tributaries located upstream from Swift Dam and will occur early in the period of the new licenses, 17 percent will result from tributaries to Yale Lake, and 7 percent will result from tributaries to Lake Merwin.

It is important to note that these values were generated through a modeling exercise using EDT. The numbers can be used as an indicator, but cannot be relied upon for definite production numbers. The EDT may be good at looking at the relative differences among hypothesized restoration actions, but it does not reliably predict absolute fish production. The model is based on a large number of parameters, some of which were derived from professional judgment and the inclusion of a high level of detail creates an unjustified sense of accuracy (Salmon Recovery Science Review Panel 2000). In the Lewis River case, the numbers developed by the model are far lower (often by an order of magnitude) than values generated by other methods, such as run-reconstructions that apply actual historical fish abundance data, rather than expert opinion about habitat conditions. With effective fish passage facilities in place, coupled with habitat restoration and sound supplementation strategies, the potential abundance of coho salmon, spring Chinook salmon, and steelhead could be far greater than the numbers presented here. However, it is also possible that the actual abundance could be less than that predicted by any of the methods.

Table 5-2. EDT-derived Estimates of Adult Abundance under Current Habitat Conditions for Spring Chinook, Coho, and Steelhead by Geographic Area (Introduction Reach) and Low Smolt-to-Adult Return Rates (3 percent for spring Chinook, 5 percent for coho, and 6 percent for steelhead).[1]

SPECIES/STOCK	ADULT ABUNDANCE BY INTRODUCTION REACH			TOTAL ABUNDANCE
	Swift	Yale	Merwin	
Spring Chinook	1,893	121	0	2,014
Coho	8,866	2,500	887	12,253
Steelhead	1,680	154	171	2,005
Percent of Total Adult Abundance by Introduction Reach	76%	17%	7%	

[1] Adult abundance is the number of adults entering the mouth of the Lewis River.

The increase in salmon and steelhead production associated with the reintroduction program in the Lewis River Basin will contribute to the recovery of Lower Columbia River Chinook, steelhead, and coho by allowing these species to access more habitat, and to increase adult productivity, within-population diversity, and spatial structure (elements of population viability). Spatial structure (distribution throughout the area) is important because it aids a population's ability to withstand localized environmental perturbations. Also, the wider geographic distribution of reintroduced anadromous fish will provide the opportunity for genetic diversity and fitness to improve these stocks. Naturally-produced fish will be better adapted to the Lewis River and its tributaries and, theoretically, will exhibit higher smolt-to-adult survival rates than their hatchery-origin counterparts. Monitoring data will allow an analysis of the phased approach to fish passage and the year 27 and 37 status checks will evaluate the effectiveness of the reintroduction measures and will allow the consideration of other limiting factors influencing the success of the program. As an added benefit, the reintroduction of anadromous salmonids may benefit bull trout, cutthroat trout, and other aquatic species by increasing primary productivity through the addition of marine derived nutrients.

Phased Approach to Fish Passage

For the first 3 years, anadromous fish will continue to be collected at the Merwin trap but will not be transported to the upper watershed. These fish will either be returned to the lower Lewis River to spawn or contribute to the fishery, or be used for broodstock in both the hatchery production and supplementation programs. In addition, adult salmon and steelhead will be transported to above Swift Dam to fertilize habitat and till-gravel as they attempt to spawn in preparation for future introductions. Juveniles produced by the out-plants will not be collected until the Swift downstream collector is in place. Once the Swift downstream collector is in place, spring Chinook, winter steelhead and late-run coho will be collected at Merwin and transported to above Swift Dam. Based on the experiences of other operators, such as Portland General Electric on the Deschutes River and Tacoma Power on the Cowlitz River, collection and transport of adult anadromous salmonids can be conducted in a manner that results in low handling mortality. Portland General Electric found that direct and delayed handling mortality was less than 1 percent historically (PGE 2004). In the initial years, the fish transported will essentially be surplus hatchery broodstock that would normally either be removed from the system or allowed to spawn naturally in the river below Merwin Dam. Later, it is anticipated that the collected and transported fish will be of natural-origin. These fish will be subject to "natural" mortality once released into the upper watershed. This mortality could include predation by mammals, and pre-spawning mortality due to disease or other unknown causes. Steelhead kelts will be collected at the downstream collectors and transported to the river below Merwin Dam. There are likely to be mortalities given the physical condition of these kelts once they are collected, but the collection facilities will be designed for safe, timely, and effective passage. Juvenile fish collection and transport around the Projects is expected to cause losses to the downstream migrant component of the naturally spawned salmonids in the upper watershed. However, capture, survival, injury and transport standards are established to protect the downstream migrants and will be monitored for fish passage effectiveness.

As anadromous fish are collected and transported to Yale Lake during the second phase of the reintroduction program, similar toll and additional benefits will accrue to the overall Chinook, steelhead, and coho populations (although possibly on a smaller scale given the amount of habitat available in Yale Lake compared to upstream of Swift Dam). Adult and juvenile fish are expected to experience effects similar to those described for the Swift facilities.

Once adults are placed into Lake Merwin, there will be upstream passage at each dam. Adults collected at the Merwin trapping and sorting facility will be either trucked or transported via alternate technology to Lake Merwin. They will either remain and spawn there or swim through Lake Merwin to the Yale adult fish collector. Some fish that remain in Lake Merwin will experience natural mortality in the form of predation by mammals or other causes. Adults placed in Yale Lake will either remain and spawn there or swim through Yale Lake to the Swift adult fish collector. Some adults remaining in Yale Lake will experience natural mortality in the form of predation by mammals, or other causes. Adult fish that are collected and sorted at the Swift Upstream trap will be either transported via truck or alternate technology to Swift Creek Reservoir where they can access the upper watershed tributaries. Natural sources of mortality will be similar to those experienced between Swift and Yale.

Downstream Fish Passage Facility Performance Standards

As is the case with all downstream fish passage facilities, mortalities are expected among some downstream migrating salmon and steelhead smolts (and potential adult fallbacks) as they move through the Project reservoirs and downstream fish passage facilities and are transported to a release pond below Merwin Dam. Mortalities can occur through sorting, handling, and marking, injury caused by the collection and transfer equipment, or from crowding within the holding facility prior to transport. There is also loss from not collecting all the downstream migrants (residualization; mortality through turbines or spillways, etc.). This expected loss will ultimately reduce the numbers and distribution of fish destined for the lower river. Passage survival performance standards (e.g., ODS, CE, and CS,) have been set by the Services for each facility at levels that are expected to allow for sustainable populations above the dams. The ODS target at Swift No. 1 is 80 percent until downstream passage is implemented at Yale, at which point ODS goal at Swift and Yale will be reduced to 75 percent due to increased production capacity due to habitat access from Yale. The Licensees will develop and implement studies at each Project dam to ensure that the fish passage facilities will meet the passage performance standards. It is likely, though, that it will take some time to achieve the ODS of 80 or 75 percent. The CE performance standard for each downstream passage facility is equal to or greater than 95 percent and the CS is equal to or greater than 99.5 percent for smolts and 98 percent for fry. If monitoring indicates that performance standards are not being met, the Licensees will make adjustments or modifications to the facilities as directed by the Services in an effort to achieve the targets. In addition, if NMFS concludes at any time that downstream passage at the Swift No. 1 Dam is not effective for collecting spring Chinook, and that a satellite collection facility has a reasonable likelihood of more effectively collecting spring Chinook, then PacifiCorp will design and install such a facility.

Although the CE of the downstream passage facilities will not be known until the facilities are constructed and evaluated, the CE of the Baker River gulper system on Baker Lake, upon which the proposed downstream fish passage facility system designs may be based, has been estimated at between 53 percent (from mark-recapture studies) and 71 percent (from hydro-acoustic studies) (PSE 2005). These are efficiencies before the Baker new design is in place; after which we expect higher efficiencies. Because the Swift, Yale, and Merwin floating surface collectors will benefit from experience at the existing Baker system and other surface collectors in the Pacific Northwest, it is reasonable to expect that its Collection Efficiency will meet or exceed the high end of the Baker gulper efficiency. In addition, the Army Corps of Engineers estimates that average seasonal direct survival for collection and transportation is 98 percent (NMFS 2000a). Given these efficiency and survival targets, floating surface collectors at Swift, Yale, and Merwin dams will continue to result in entrainment of juveniles and cause mortality; however, the mitigation measures will reduce potential Project entrainment through turbines and spillways, increase passage survival, and thus facilitate fish passage past the Projects as compared to the current situation.

Fish passage facility monitoring studies and sorting activities are expected to adversely affect individual fish as a result of tagging injury or mortality, but will be adjusted and modified until they meet performance standards. Any injury or mortality associated with this action is considered in this Opinion (refer to Sections on Monitoring and Evaluation, below).

Release Pond

All juvenile anadromous salmonids collected at the Swift, Yale, and Merwin downstream fish passage facilities will be transported directly to a stress release pond located downstream of Woodland[23]. After acclimating in the pond, they will be released to the lower Lewis River to continue their migration to the ocean. This measure will help to alleviate transportation stress and will likely increase juvenile survival. Survival data for juvenile anadromous salmonids transported from Cowlitz Falls Project fish collection facility to release ponds at the Cowlitz Salmon Hatchery in 2005 show that survival exceeded 99 percent over the migration season (WDFW 2005). It is anticipated that survival rates at the Lewis River Projects will be similar to that observed at the Cowlitz Falls Project. Locating the release ponds near the mouth of the Lewis River will minimize any potential negative interactions with naturally produced Lewis River fall Chinook (i.e., predation and competition). The configuration of the release pond is yet to be decided, but the facility will likely function in a similar manner to that on the Cowlitz River

[23] Unless bypass facilities are used instead of trucking per the Settlement Agreement.

(operated similarly and we expect similar results). The facility will not be built in-water, but rather will likely be constructed on top of the existing dike. The area will be fenced to protect the fish and facility from vandalism. The water supply is likely to be provided from the Lewis River using a screened pump. Released fish and water will flow back the Lewis River. Short-term construction impacts will be minimized through best management practices and construction measures.

Upstream Fish Passage Facility Performance Standards
PacifiCorp and Cowlitz PUD will use safe, timely, and effective methods to collect and transport adult Chinook, coho and steelhead to habitat located upstream of Merwin, Yale, and Swift dams. If monitoring at the proposed Project facilities indicates that upstream passage performance standards are not being met, the Licensees will make changes to the facilities as directed by the Services. Fish passed upstream via collection and transport will be adversely affected by trapping injury or mortality and some natural mortality will occur as mentioned in previous paragraphs. The probability of attaining the proposed 99.5 percent adult UPS target at each facility is high, based on the survival measured at other facilities in the Pacific Northwest. Data from the first 9 years of anadromous salmonid reintroduction efforts into the upper Cowlitz River Basin indicate that trap and transport has been successful in resulting in overall increasing yields of anadromous salmonid smolts, especially for coho salmon (WDFW 2005). This indicates reintroduction efforts are working to re-establish production. The Pelton trap and transport facility (Pelton Round Butte Hydroelectric Project) has been operating nearly continuously since 1956, with many thousands of fish captured, sorted, and transported. Mortality rates at this facility are less than 1 percent (PGE 2004).

When the upstream fish passage facilities are constructed at Yale and Swift dams (in year 17 of the new licenses), adult upstream migration through all three Project reservoirs and the two additional fish upstream passage facilities would increase the potential for injury, delay, or mortality, especially for adult Chinook, coho and steelhead bound for habitat located upstream of Swift Dam. However, benefits include, but are not limited to, increased within-population spatial distribution and fertilization of tributaries to those reservoirs. Reintroduction into Yale and Merwin will occur, unless at the ninth and thirteenth anniversaries of the Licenses being issued the Services decide passage into these areas is inappropriate and instead the In Lieu Funds should be used for other measures to benefit the anadromous populations.

Species Interactions
Reintroduction of Chinook, coho and steelhead above Merwin, Yale, and Swift dams may displace resident rainbow, coastal cutthroat trout, and kokanee[24] from preferred habitats that have been colonized in the absence of anadromous species. Although, this is not expected to result in adverse effects to the ESA-listed species (PacifiCorp and Cowlitz PUD 2004c), the productivity of reintroduced individuals may be limited by interactions with (competition, predation) the existing resident populations. PacifiCorp will monitor to detect these interactions, if they take place.

[24] For kokanee this is only possible in Yale as there is limited kokanee spawning in Merwin and no kokanee present in Swift.

Coho salmon and bull trout (the latter is also listed as Threatened under the ESA) have similar run timing and spawning habitat requirements, and generally bury eggs at the same depth. It is uncertain how these two species will affect each other. However, the number of bull trout currently present in the system is very small compared to the potential salmon and steelhead production numbers and is not likely to have a major affect on the reintroduction success.

Predation Study
To address uncertainties about predation rates from tiger musky and northern pikeminnow, PacifiCorp will conduct a study of whether predation in Lake Merwin is likely to limit the success of the anadromous salmonid reintroduction program. If the study determines that predation is likely to limit the success of the reintroduction, PacifiCorp may identify steps that could be undertaken to control predation.

In Lieu Fund
If the Services determine that reintroduction should not occur at Lake Merwin or Yale Lake because it is inappropriate, PacifiCorp will contribute to an In Lieu Fund as follows: $10 million in lieu of a juvenile surface collector at Yale Dam; $10 million in lieu of a juvenile surface collector at Merwin Dam; $5 million in lieu of an upstream adult fish passage facility at Yale Dam; $5 million in lieu of an upstream adult fish passage facility in the vicinity of the Swift Projects. The In Lieu Fund will be used for mitigation measures that collectively contribute to meeting the objective of achieving equivalent or greater benefits to the viability of the anadromous fish populations as would have been gained by passage through Yale Lake and/or Lake Merwin. Measures may include habitat enhancement, habitat protection, or other actions that will benefit the listed species. Section 2.3.1 lists examples of the kinds of mitigation measures that would be implemented with the In Lieu Fund. Implementation of those or similar mitigation measures is expected to alleviate certain passage problems by removing small dams or replacing culverts, opening up currently unavailable spawning, incubation and rearing habitat; reconnecting and enhancing off-channel and floodplain habitats along the lower reaches of the mainstem Lewis River, improving rearing conditions for listed species; enhancing floodplain and side channel habitat around Eagle Island, improving rearing habitat for the listed species; restoring degraded riparian conditions along tributaries to the lower Lewis River, improving early rearing conditions; increasing functional LWD structures, or similar natural structures, in appropriate stream reaches, which will improve rearing and holding conditions and increase spawning gravel retention; and restoring and enhancing wetlands, springs, and seeps in the sub-basin which will assist in improving water quality conditions in the basin and its tributaries. The list of potential projects provided in Section 2.3.1 illustrates some projects that qualify as mitigation measures under the In Lieu Fund, which are based on conditions as of the Effective Date of the Settlement Agreement. In addition, some of the measures identified may already have been completed when (or if) the In Lieu Funds become available. Although there may be some short term negative effects from construction or implementation of these projects, there will be best management practices carried out to limit the effects and the projects are expected to have significant positive effects on the listed salmonid populations in the Lewis River Basin.

Reintroduction Outcome Goal Status Checks

The overarching goal of the anadromous fish reintroduction program is to achieve genetically viable, self-sustaining, naturally reproducing, harvestable populations of these species above Merwin Dam at greater than minimum viable populations. The two reintroduction program status checks (year 27 and year 37) and their associated analysis of limiting factors will allow the resource managers to determine whether the reintroduction outcome goal has been achieved for each of the affected anadromous fish populations. If program goals are not being met in year 27, and it is determined that a significant limiting factor is attributable to the Projects, the Licensees will implement measures to provide biological benefits adequate to thoroughly offset the impact of the Project-related limiting factor (e.g., habitat enhancement projects, continuing juvenile supplementation, etc.). If the program goals are still not being met in year 37 and it is determined that the primary limiting factors analysis concludes that a Project effect is a significant limiting factor in any reintroduction outcome goal not being met then the Licensees shall consult with the Services to determine what further actions by Licensees would be necessary to meet reintroduction outcome goals. Such actions may include, without limitation, consideration of structural or operational changes with respect to the generating facilities or Project reservoirs or construction of new or replacement passage facilities. The effects of these checks and the potential additional actions is to provide greater assurance that reintroduction will be successful. In the event that the Services and the Licensees cannot reach agreement on implementing such further actions, the Services may exercise their applicable authorities to direct the licensees to implement actions, subject in some cases to the approval of the Commission.

Construction Activities

Construction of the proposed fish passage facilities has the potential to cause short-term adverse effects on water quality, such as increased turbidity. Although water quality may be affected temporarily during construction through increased erosion and sedimentation, these effects will be minimized and avoided by implementing best management practices (e.g., installing silt fencing and other sediment trapping devices on land, silt curtains in water, and covering exposed soil until permanently stabilized). PacifiCorp and Cowlitz PUD will be required by Federal, state, and county regulations to develop sediment and erosion control plans as part of the construction process. Chemical spills could also occur during construction, but development of a pollution prevention plan in accordance with appropriate Federal, state, and county requirements will minimize the effects of such an occurrence. Typically, a pollution prevention plan specifies areas for equipment maintenance and refueling, spill prevention and emergency response strategies, and requirements for keeping emergency response spill containment kits onsite and for having trained personnel present onsite during construction. PacifiCorp and Cowlitz PUD currently have Spill Prevention Containment and Control programs in place that address these activities. Construction impacts related to the passage facilities are likely to create short-term effects such as turbidity and disturbance around in-water activities. These impacts are not expected to result in significant losses to the listed species either locally or regionally. Through the construction permitting process, plans will be developed to minimize and avoid temporary construction-related effects to the extent feasible using best management practices. No long-term negative effects on aquatic resources are anticipated from construction of new fish passage facilities. Overall, it is anticipated that effects from construction of new fish passage facilities will be short-term and minimized by the use of best management practices.

5.1.1.2 Additional Aquatic Resources Measures

Yale Spillway Modifications

In its current configuration, the Yale Dam spillway is steep and terminates on rough bedrock. There have been no tests of spillway mortality at Yale Dam; however, there is concern that these conditions can cause injury or mortality due to fish colliding with the boulder outcrop at the tail of the spillway or through spill hitting the embankment opposite the spillway tail. Under the proposed action, PacifiCorp will implement improvements to the Yale Dam spillway to improve fish survival during spill events (to be completed within 4 years of the issuance of the new licenses). Although this measure is designed primarily to provide greater protection for any bull trout lifestage that attempts to migrate downstream during the spill season, this measure will also improve conditions for juvenile Chinook, coho, and steelhead that happen to pass over the spillway (after the reintroductions begins). Construction activities associated with the modification of the spillway will include excavating a large amount of rock. These activities have the potential to temporarily generate suspended sediment that could be carried downstream, increasing turbidity below the Yale Dam. The operation of heavy machinery needed to modify the spillway will also temporarily increase the risk of fuel and other toxic chemical spills into Lake Merwin. The likelihood, duration, and extent of these effects will be reduced through the implementation of erosion control measures and best management practices regulating the storage, use, and disposal of toxic materials. As a result, construction-related changes in water quality such as turbidity or unexpected oil or chemical spills are unlikely, but will be short term and limited in extent. Because the work will be completed before the anadromous fish reintroduction has started, any habitat effects will have dissipated before fish are present.

TDG Testing

Elevated TDG levels resulting from power generation in the Swift No. 1, Yale, and Merwin tailraces have the potential to adversely affect fish rearing, migrating, or spawning in Yale Lake, Lake Merwin, and below Merwin Dam. As a component of the Lewis River Settlement Agreement and the 401 Water Quality Certification, PacifiCorp will monitor TDG at the Swift No. 1, Yale, and Merwin tailraces to determine compliance with state water quality standards (110 percent TDG), and implement measures to minimize effects on ESA-listed species if the standards cannot be met.

Conservation Covenants

PacifiCorp currently owns lands in the Cougar/Panamaker Creek area, and both Utilities own land along the Swift Creek arm of Swift Creek Reservoir. Under the Lewis River Settlement Agreement, PacifiCorp and Cowlitz PUD propose to maintain the existing conservation covenants on those lands to protect and conserve habitat for bull trout, cutthroat trout, and other aquatic species (included reintroduced ESA-listed anadromous species) into perpetuity. The covenant will include a 500-foot buffer along each side of Cougar Creek and a 200-foot buffer along each side of Panamaker Creek. Along the Swift Creek Arm, the covenants and buffers will extend along the east side of the Devil's Backbone from the high water mark to the upper bench where a road currently exists. The proposed conservation covenants will result in increased protections for the adjacent riparian zone beyond that required by the Washington Forest Practices Act and associated regulations. The proposed width of these covenants will protect the intact riparian zone, preserve the function and provide a significant buffer to the riparian zone.

Protection of these riparian areas will preserve and enhance spawning and rearing habitat for bull trout in Cougar Creek and the Swift Creek Arm of Swift Reservoir by reducing the effects of upslope activities. In addition to benefiting bull trout, these covenants will maintain high quality habitat for Chinook, coho and steelhead. The effect of this action is to improve the future survival of Chinook, coho, and steelhead by avoiding additional losses of this important habitat.

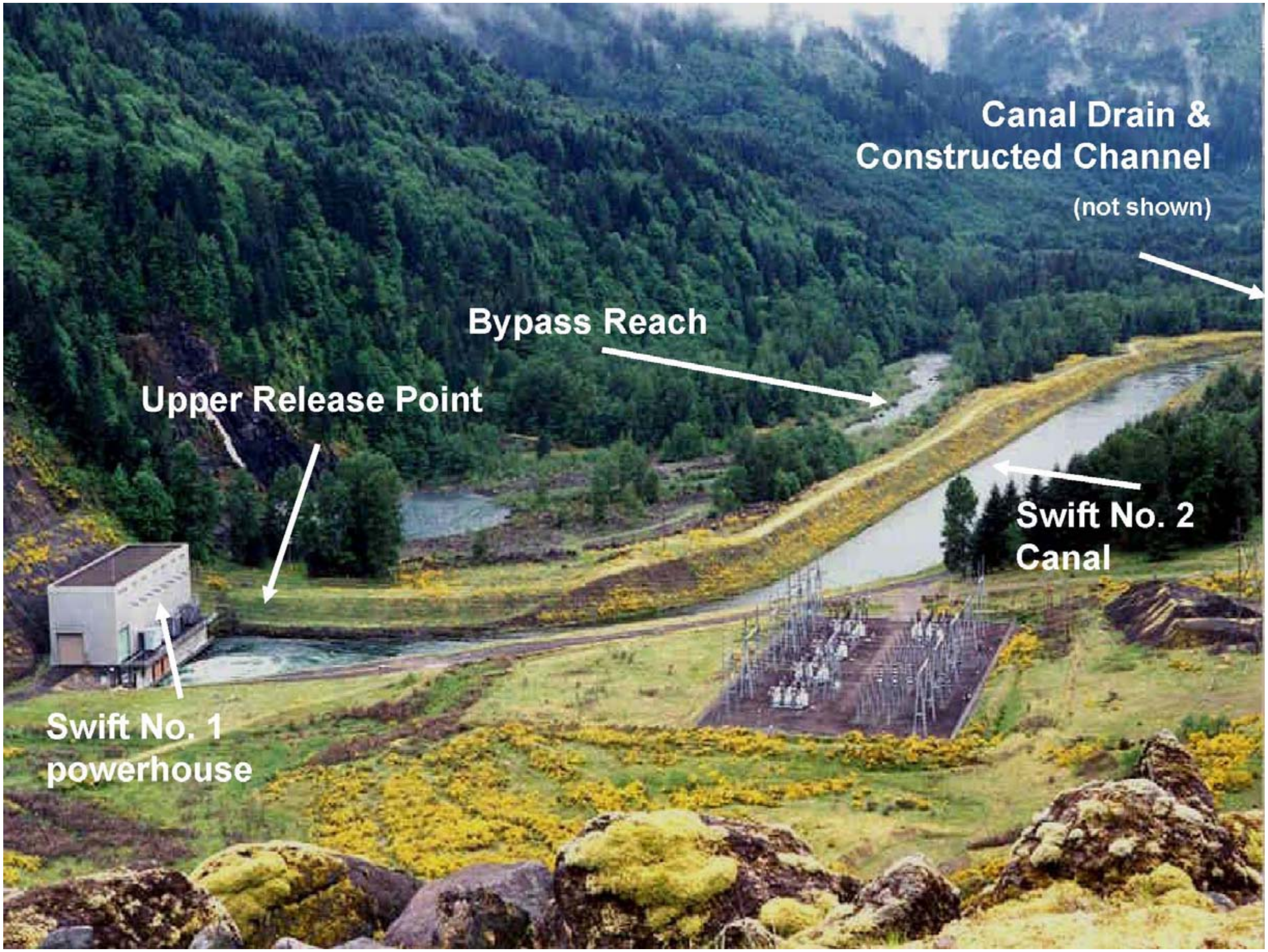
5.1.1.3 Flow Releases for Listed Fish and Other Aquatic Species

Flows in the Lewis River Bypass Reach

Under the Proposed Action, minimum instream flows will be released into the Lewis River bypass reach from two points, a water release structure located at the upstream end of the bypass reach (Upper Release Point) and a Canal Drain located approximately 1 mile downstream of the Swift No. 1 tailrace (lower release point). Flow releases will vary by season and will range from 60 to 100 cfs. The objective of also providing flow releases at the Upper Release Point is to maintain some level of connectivity between large pools that exist in the upper bypass reach (upstream from the Canal Drain). The maximum flow release at the lower release point is estimated to be 47 cfs, which is the maximum capacity of the valve.

Unless the ACC determines otherwise, PacifiCorp and Cowlitz PUD will also design and construct an “improved habitat channel” between the lower release point and Yale Lake that runs from the Swift No. 2 power canal to the bypass reach (in Figure 5-1, the bypass reach is labeled as the Lewis River Channel) (Figure 5.1 - picture of the relevant area). This would build upon an existing channel. Conceptual design of this approximately 1,500-foot-long channel incorporates placement of large woody debris and boulders to increase velocity and depth in the reach. Focusing habitat improvement efforts in this off-channel area will maximize the benefits of the engineered channel and this off-channel area will have reduced adverse impacts associated with spill events in the main bypass reach. Any fish residing in the existing channel will need to be removed from the area and placed in the lower bypass reach prior to construction to minimize loss associated with dewatering the channel for construction. In-channel work will include some excavation, placement of LWD and potentially gravel, and flow control structures. Once completed, the channel will be re-watered. At that time, high turbidity will likely occur for a short period until the channel is completely watered and stabilized. Fish will not be present during this high turbidity period since they will be removed prior to construction. The proposed action’s minimum instream flow regime will improve aquatic habitat connectivity, reduce summer water temperatures, and increase the amount of habitat area for Chinook, coho, and steelhead (once fish passage is implemented)(PacifiCorp and Cowlitz PUD 2004d). If a collection and transport facility is eventually installed at or near Swift No 2 tailrace, the increased flows in the bypass reach will also have the potential to attract migrating anadromous fish that are bound for habitat located above Swift Dam away from the collection facility. Any such delay in reaching the collection entrance could decrease the survival of these upstream migrants. However, the proposed bypass flows are a fraction of the outflow from the tailrace (where the collection facility will likely be installed) and not likely to deter the majority of fish attempting to migrate upstream away from the collection facility. Also, this type of issue will be considered and minimized during the design phase of the collection facility.

Figure 5-1. Lewis River Channel



There will be little change to stream morphology in the bypass reach associated with the Proposed Action's flow regime, as there will not be enough flow to alter channel form, but the wetted channel will be somewhat wider and deeper and will be more persistent throughout the year. While the amount of instream habitat (wetted perimeter) will increase substantially in the bypass reach compared to existing conditions, periodic high flows (>25,000 cfs) (spill events) will continue to transport wood and gravel particles from the reach, limiting the amount of spawning gravel and instream cover. The same very large flows will scour redds and wash out encroaching riparian brush and shrubs from within the high water channel. The periodic loss of redds is expected to be off-set by the additional production gained from fish having access to the Yale area including successful spawning in this area during years when there are not high flow events. Due to the high flow events, it is likely that spawning and rearing habitat in the main bypass reach will continue to be limited by a lack of gravel and instream cover. The constructed channel will generally be less affected by these events, especially in the upper section where it is separate from the main bypass reach. As a result, aquatic habitat will be maintained in the constructed habitat channel even after high flow events.

Regarding juvenile outmigrants, high flow events at the Lewis River Projects occur during the winter (November to February) outside of the outmigration period for the species and stocks that could be affected. Therefore, it is likely that effects on salmonids will be minimal.

Swift No. 2 Canal

Cowlitz PUD will examine the integrity of the canal on a periodic basis. This examination may require dewatering the canal or could use other means such as divers. In the event of dewatering, if any salmon, steelhead, or bull trout were present in the canal, they would be recovered and released in coordination with the NMFS, USFWS, and WDFW in a location determined by NMFS and USFWS. The "improved habitat channel" in the bypass reach could also potentially be affected by dewatering the canal because the intake for the existing water source (Canal Drain) is currently located in the portion of the canal that could be dewatered and inspected. The Proposed Action provides for development and implementation of plans for expeditious installation and operation of temporary replacement facilities for delivery of flows from the Canal Drain in the event maintenance activities (e.g., dewatering of the canal for inspection) reduce or interrupt flows to the habitat channel.

A limited number of fish (listed salmon, steelhead and bull trout) may be present in the Swift No. 2 canal after installation of the floating surface collector system in Swift Creek Reservoir, although trout that may be planted in the canal prior to fishing season and therefore may be present in higher numbers than the other species,. The floating surface collector at Swift No. 1 will be designed to preclude entrainment of fish into the Swift No. 2 canal, but some listed salmonids may be able to migrate past the floating surface collector system, because these facilities may not be 100 percent effective. Thus, there is potential to entrain some fish into the Swift No. 2 canal. However, entrainment potential would be substantially reduced under the Proposed Action compared to the current conditions where no system is in place. Salmon, steelhead, and bull trout that do enter the canal will be rescued if the canal is dewatered and released into a location determined by NMFS and USFWS. This action provides an opportunity for those salmon and steelhead surviving turbine entrainment at Swift No. 1 and entering the Swift No. 2 canal to be salvaged into Yale Lake, the area above Swift No. 1, or the Lewis River downstream of Merwin. Through monitoring of the downstream passage system, along with any facility adjustments or modifications deemed necessary through the monitoring process (as specified in the Lewis River Settlement Agreement), entrainment into the Swift No. 2 canal would likely be minimized.

There are four features at the Swift No. 2 Canal that are unique to the Lewis River hydroelectric Projects. These are the Upper Release Point, Wasteway, Canal Drain, and Surge Arresting Structure. The purpose of the Upper Release Point and Canal Drain is to release water into the Bypass Reach to meet minimum flow requirements. The Canal Drain is an existing open, lined pipe with a short drop at its outlet and is considered compatible to any fish wanting to safely exist the Canal via this structure. The Upper Release Point is a new facility and will be designed and built to accommodate fish that want to safely exit the Canal.

The Wasteway is an overflow weir and provides a safe exit for any fish wanting to exit the canal. The Utilities anticipate using the Wasteway for high flow events, operational reasons, or during emergency circumstances as provided in the Settlement Agreement Section 6.1.5.a. NMFS does not anticipate any negative effects to fish from the operation of the Wasteway and, in fact, view the operation of the Wasteway as a mechanism for fish to safely exit the canal and return to the natural environment.

The Surge Arresting Structure was designed and constructed during the Swift No. 2 Canal rebuild to allow for an outlet at the Swift No. 2 intake for quick release of water in the event of an unexpected outage at the Swift No. 2 power plant. The SAS is set to open automatically and release flow in the equivalent of one turbine unit capacity (about 4,500 cfs) into Yale Lake. The SAS can also pass flow when one or more Swift No. 2 turbines are off-line. It will also be used for planned outages such as maintenance and providing maximum spinning reserve capability at the Swift No. 1 Project. Since the SAS releases water through a cone-type valve, fish are not expected to survive going through this structure. The SAS is expected to be used an average of 10 hours per month. The SAS would not affect all fish that have entered the Power Canal because some would leave the canal through the Upper Release Point, the Wasteway, or the Canal Drain or all three routes. Also, the downstream passage system at Swift No. 1 is expected to limit the number of salmonids in the Power Canal.

Minimum Flows in the Lewis River below Merwin Dam

Flows in the Lewis River downstream of Merwin Dam are affected by the coordinated operation of the three upstream Project reservoirs. Flows in this reach are highest during the winter, decrease gradually in the spring, and are lowest during summer months (Figure 5-2 Daily Flow Exceedance Curve for the Lewis River at Ariel pre-Project and post-Project). This flow regime has resulted in more wetted habitat area in the Lewis River downstream from Merwin Dam during the summer and early fall months than prior to construction of the Projects, inundating more aquatic habitat and more side channel habitat. Operation of the Projects has also reduced the frequency of flows in the 10,000-20,000 cfs range and changed the shape of the mid-range flow fluctuations. A reduction in peak flows has resulted in a more stable channel with less scour of redds and less fine sediment transport than prior to Project operation. The reduced frequency and size of some high flow events have changed some of the channel forming dynamics, but there will be evaluation of potential LWD projects in the area and a gravel evaluation and augmentation program. These are intended to

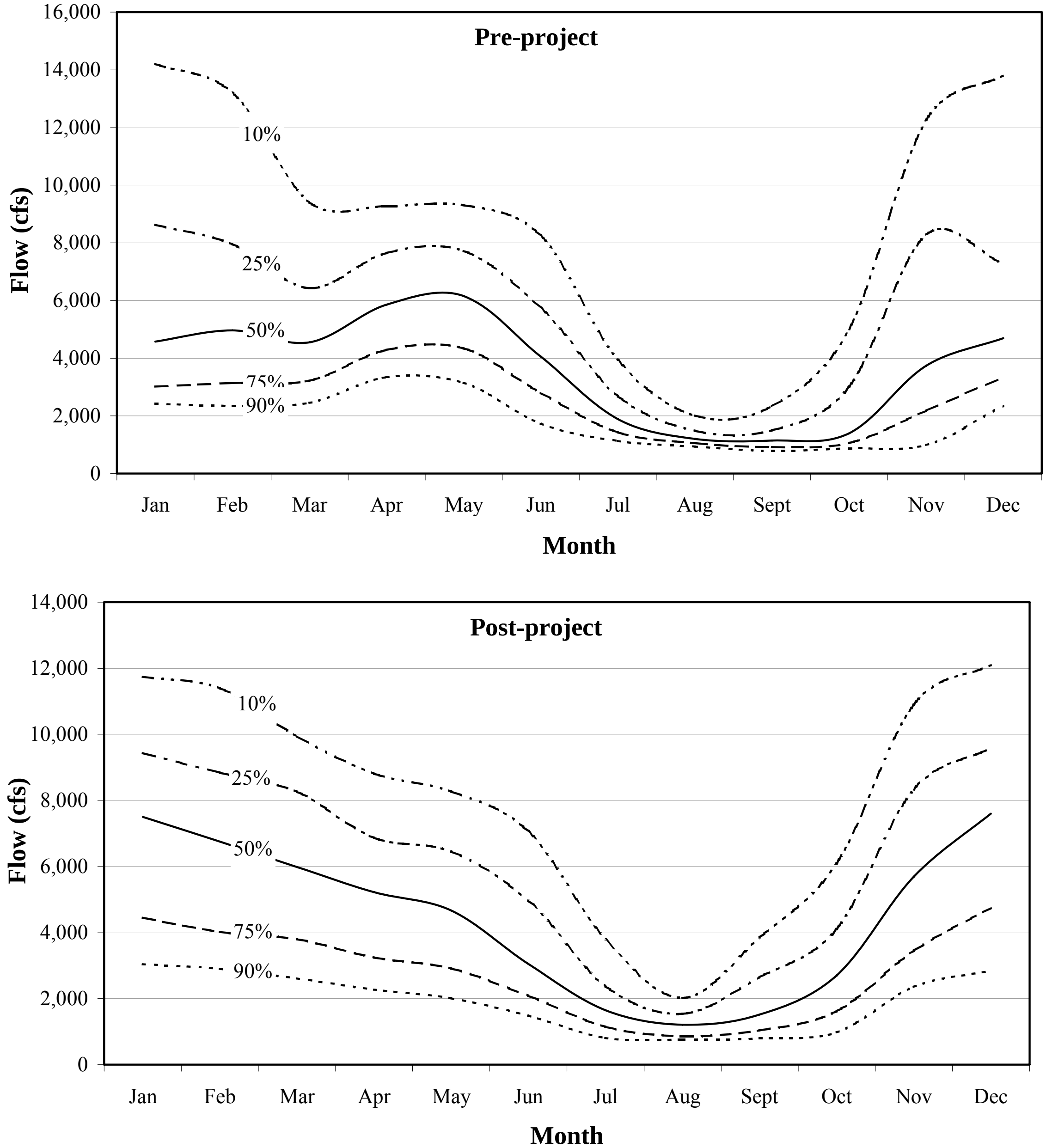


Figure 5-2. Daily Flow Exceedance Curve for Lewis River at Ariel (below Merwin Dam). USGS Gage 14220500: pre-Project data are from 1909 through 1930 and post-Project data are from 1932 through 1998. Daily flow from 1910 through 1923 was estimated based on Lewis River flow at USGS Gage 14219500 near Amboy.

influence the channel forming dynamics. Lower flows during the spring may affect juvenile salmonid migration rates, as their survival appears to increase with increasing river flows (Cada et al. 1994). The causal mechanisms for this increased survival are poorly understood, but are speculated to be related to water temperature, change in predation rates due to changes in turbidity, and the timing of juvenile arrival in the Columbia River Estuary. The Settlement Agreement calls for higher flows during the early outmigration period and flows similar to existing flow requirements in the spring and early summer. This regime will likely benefit early outmigrants and will continue to provide spring flows that were originally developed to benefit fall Chinook rearing and outmigration but will also likely benefit the other anadromous species in the lower river.

Proposed minimum flows in the mainstem Lewis River below Merwin Dam are shown in Table 2-3. A flow of 4,200 cfs from November 1 through December 15 was determined by WDFW to provide the "maximum amount of spawning area" for bright fall Chinook during their peak spawning period (November and early December). Under the Proposed Action, the existing 5,400 cfs minimum flow in December will be reduced to 4,200 cfs to minimize the difference between the highest sustained flow during the peak spawning period and the lowest flow during egg incubation, while maintaining ample spawning habitat for Chinook, coho, and chum. By minimizing the difference between spawning flows and incubation flows, redd dewatering will be minimized, increasing Chinook, coho, and chum egg and alevin survival. Any action that reduces the likelihood of dewatering is likely to benefit production.

To further minimize redd dewatering risk, the minimum flow in January and February will be increased from 1,500 cfs under existing conditions to 2,000 cfs, and in March from 2,000 cfs under the existing condition to 2,500 cfs. Actual flows during these time periods will be considerably higher (because there can be more flow than the minimum moving through the Projects) except during very rare winter droughts. Minimum flows in July will be slowly reduced to mimic a similar reduction in natural flows; however, flows will be slightly higher than under existing conditions to reduce potential adverse effects (redd dewatering) on emerging steelhead fry. Flows in September and October will be similar to existing conditions increasing the amount of rearing habitat compared to pre-Project conditions. Flows of 1200 cfs during July 31 to October 15 are expected to adequately support rearing salmon and steelhead.

Compared to existing conditions, the proposed action flow regime will reduce the difference between the Chinook, coho, and chum spawning and incubation flows, and will slightly increase minimum flows in July (to protect emerging steelhead fry). While these actions may continue to result in redd dewatering and reduced species survival, the Proposed Action will help to reduce that potential.

During years when PacifiCorp projects that sufficient water will not be available to achieve minimum flow levels, to fill or maintain Project reservoirs for recreation purposes, or when it appears likely that redds will be dewatered below Merwin Dam, PacifiCorp will convene a Flow Coordination Committee consisting of representatives from PacifiCorp, NMFS, USFWS, WDFW, Yakama Nation, and Cowlitz Indian Tribe. The FCC will independently evaluate available data regarding water availability during the projected low flow period and decrease the minimum flows to levels that consider the needs of fish species, with a priority on ESA-listed species, including, without limitation, consideration for keeping redds watered. This action will minimize potential adverse effects on Chinook, coho, chum and steelhead.

Plateau Operations in the Lewis River below Merwin Dam
Under the Proposed Action, PacifiCorp will restrict daily flow fluctuations below Merwin during the period of February 16 through August 15 of each year by maintaining flow plateaus (periods of near-steady discharge – see Section 2 for more detail). Once a flow plateau is established, the plateau will be maintained for as long a duration as practicable, but flow plateaus may be altered to a new level as a result of changes in natural flow or operational demands on the Lewis River power system, subject to the limitations of the ramping restrictions and a limit on the number of plateau changes, described below.

Plateau operations have been designed to limit flow fluctuations on a daily to monthly basis, as opposed to ramping rate restrictions that have been designed to limit flow fluctuations on an hourly basis (discussed below). Daily to monthly flow fluctuations have been shown to reduce benthic macroinvertebrate diversity and total biomass and can change invertebrate species composition. A study on the Skagit River, Washington, found that flow fluctuations had a greater adverse effect on the aquatic invertebrate community than a stable diel flow pattern (Gislason 1985).

A reduction in the aquatic invertebrate forage base can negatively affect fish production potential. Flow fluctuations have been observed to affect aquatic invertebrates through stranding (similar to fish stranding), increased drift response, and reduction in aquatic invertebrate forage (Hunter 1992). It is anticipated that by implementing plteau operations impacts to macroinvertebrates caused by flow fluctuations will be reduced. Therefore, while the Proposed Action will still impede macroinvertebrate production in the Lewis River downstream of Merwin Dam, the mitigation measures will improve production problems. This will represent an increase in anadromous fish forage, benefiting ESA-listed species.

Ramping Rates in the Lewis River below Merwin Dam
Rapid changes in river flow associated with hydroelectric project operations (i.e., on an hourly basis) have the potential to adversely affect aquatic resources. Adverse effects can include the stranding of fish in shallow, low-gradient areas and side-channel habitat (causing immediate or delayed mortality); temporary loss of habitat or loss of habitat access; and dewatering of fish redds, aquatic insects, detritus, and algae (Hunter 1992). Rapid changes in stream flow (both increases and decreases) also can affect fish behavior resulting in reduced survival or growth.

Limits governing the rate and timing of project-induced river stage changes (ramping rates) are often established to protect aquatic organisms from these project-related effects. A ramping rate is the rate of change in stage resulting from regulated discharges and is usually measured in inches per hour. Ramping rates should be gradual enough and have a smooth transition in flow to allow fish and other mobile aquatic organisms to move out of shallow rearing areas, to avoid becoming stranded when flows decrease (Hunter 1992). In most cases, ramping rates that are similar to those that occur under natural, unregulated conditions are adequate to protect fish and other aquatic organisms.

Ramping rate restrictions included in the Proposed Action are 1.5 feet per hour for upramping below Merwin Dam during all periods when flows are at or less than the hydraulic capacity of the Merwin turbines (currently 11,400 cfs). Upramping limitations focus on public safety for those using the river below the Project and will not negatively impact anadromous fish. Downramping will be limited to no more than 2 inches per hour below Merwin Dam for all periods when flows are at or less than 8,000 cfs. No downramping will be allowed from February 16 through June 15, between 1 hour before and 1 hour after sunset and 1 hour before and 1 hour after sunrise each day (crepuscular hours[25]) and during the other hours, the down-ramping rate will be limited to 2 inches per hour. These are the times of day when juveniles are expected to be more heavily concentrated near the shoreline. A critical ramping flow will be set at 8,000 cfs (measured at the Ariel gage). That is, ramping criteria will be imposed at flows less than the critical flow, and no ramping restrictions will be required when flows were equal to or greater than the critical flow. The critical flow was set at 8,000 cfs because it was determined that a flow greater than or equal to 8,000 cfs substantially wetted gravel bars to the point that stranding was unlikely (PacifiCorp and Cowlitz PUD 2004e).

The most widely studied biological impact associated with project downramping is stranding. Stranding is the separation of fish and other aquatic organisms from flowing surface water as a result of decreasing river elevation or stage. Stranding is a function of flow, rate of change, and the structure of the channel margins. It is not exclusively associated with substantial dewatering of a river and can occur in unregulated as well as regulated river systems. In addition to hydropower operations, stranding can occur as a result of other events, including natural decreases in flow, ship wash, municipal water withdrawals, and irrigation withdrawals. In most cases, the faster the reduction in water surface elevation (or stage), the more likely fish and other aquatic organisms are to be stranded or adversely affected. Fish stranding associated with hydropower operations has been widely documented in the Pacific Northwest and has been documented in the Lewis River downstream of Merwin Dam (WDF 1973). Stranding mortality can occur many miles downstream of a powerhouse, and stranding mortality can be difficult to estimate. The fish species and life stage, substrate type, channel morphology, ramping rate and range, critical flow, ramping frequency, season, and time of day all affect the incidence of stranding.

Implementing the downramping restrictions contained in the Proposed Action will limit the potential for entrapment and stranding of juvenile Chinook, coho, steelhead, chum, and other aquatic organisms. In addition, a study will be conducted to further evaluate fish stranding potential under the Proposed Action, which will provide information that may lead to additional measures to minimize stranding. The potential for stranding tends to be greatest shortly after emergence, when young-of-year fish inhabit and are reluctant to leave shallow areas near channel margins. This period extends from around mid-February through mid-June in the Lewis River. The elimination of downramping during crepuscular hours will minimize this potential for stranding.

In addition to the above measures, PacifiCorp has finished mechanical upgrades to provide back-up power and additional alarms to prevent future losses of anadromous salmonids from mechanical failures. Past emergency shutdowns have de-watered the adult fish trap at Merwin

[25] Twilight hours

Dam and a portion of downstream river channels. It was estimated that the June 1999 shutdown killed 101 adult salmonids in the Merwin trap and that the loss of juvenile salmonids downstream, due to stranding, was equivalent to 1,500 adult fall Chinook. To prevent this type of catastrophic event in the future, a series of alarms and a video system to observe the tailrace area have been installed to aid the operator to manage shutdowns. In addition, secondary and tertiary power back-up systems have been installed to allow automatic gate openings to maintain river flows.

5.1.1.4 Aquatic Habitat Enhancement Actions

Under existing conditions, Swift Creek Reservoir, Yale Lake, and Lake Merwin intercept virtually all LWD and gravel generated in upstream areas. The loss of LWD will continue to inhibit the formation of isolated, low-velocity, pool-type habitats in the Lewis River. These habitat types are very important for rearing juvenile stream-type anadromous fish (e.g., spring-run Chinook salmon, steelhead, and coho salmon). By providing a collection and funding program to supplement LWD in the lower Lewis River, the Proposed Action will enhance both juvenile rearing and adult resting habitat and habitat-forming processes throughout the life of the Licenses. This measure is expected to enhance juvenile survival, benefiting listed Chinook salmon, steelhead, and coho salmon populations that spawn in the Lewis River and its tributaries.

The Aquatics Fund included in the Proposed Action may be used to fund resource projects such as: road abandonment and restoration, which will reduce fine sediment input to tributaries, resulting in better spawning and incubation conditions, increased macroinvertebrate production, and additional cover in the substrate; strategic placement of LWD and gravel, which will enhance cover and rearing conditions; and riparian restoration, including coniferous planting, bank stabilization and elimination of non-native, invasive species, all of which will improve shading, stream temperatures and future LWD input. The Aquatics Fund may also be used for constructed channel improvements or repairs, habitat improvements specific to bull trout, and potential measures to address reservoir survival. All aquatic resource projects will be reviewed and approved by the ACC.

The Proposed Action also includes a measure to develop and implement a spawning gravel study downstream from Merwin Dam. Based on this study, PacifiCorp will develop and implement a spawning gravel monitoring and augmentation plan. It is likely that any gravel placed in the Lewis River downstream from Merwin Dam will become redistributed and may be transported out of the reach; however, areas of suitable spawning gravel deposition are expected to persist for a sufficient length of time to facilitate Chinook, coho, chum, and steelhead spawning activity. If, in the future, monitoring shows gravel levels have reached a trigger for gravel augmentation, then this measure will enhance spawning opportunity in the Lewis River. As a result, it will provide long-term (i.e., throughout the license term) benefits to Chinook salmon, coho, chum, and steelhead salmon populations.

Northern pikeminnow are known to be a predator to salmonids and can be found in large numbers in Project reservoirs, bypass systems, and tailraces. Because of their preference for stillwater habitat, it is likely that northern pikeminnow occurred in the lower Lewis River Basin prior to the construction of the Lewis River Projects. Following the creation of substantial reservoir habitat, northern pikeminnow populations in Lake Merwin increased dramatically. In partial response to the increased northern pikeminnow population, WDFW has implemented a tiger musky program to help control the northern pikeminnow population. Tiger musky (a hybrid cross between northern pike and muskellunge) are known predators of soft-rayed fishes like salmonids and northern pikeminnow. Northern pikeminnow are documented predators of bull trout (Schmetterling 2001), so there is reason to believe muskies will prey on bull trout and introduced salmon and steelhead.

As a component of the proposed action, PacifiCorp will conduct a one-time study of whether predation in Lake Merwin is likely to be a limiting factor to the success of the anadromous salmonid reintroduction program. If warranted by study results, PacifiCorp may identify steps that could be undertaken to control predation. The objective of this program will be to increase the survival rate of juvenile salmonids within the Project area. Northern pikeminnow predation of juvenile anadromous salmonids is a well-documented occurrence in the Columbia River Basin (NMFS 2000b). Since 1990, numerous northern pikeminnow control programs have been implemented in the Columbia River. These programs have met with some success, reducing the overall rate of predation of northern pikeminnow on juvenile salmon (NMFS 2000b). If predation is found to be a limiting factor in Lake Merwin and steps are taken to reduce predator populations in Lake Merwin, salmon productivity will likely increase.

5.1.1.5 Hatchery and Supplementation Program

Under the Proposed Action, as described in detail in Section 2 of this Opinion, PacifiCorp and Cowlitz PUD will develop and implement an H&S plan to adaptively manage and guide a hatchery and supplementation program. The plan will be subject to approval by NMFS and likely require formal ESA consultation. The Settlement Agreement specifies that the hatchery and supplementation program must be consistent with the ESA, applicable state and Federal fisheries policies, and regional recovery plans, and should be consistent with recommendations of the Hatchery Science Review Group and the Northwest Power Planning Council's Hatchery Review (Artificial Production Review & Evaluation) to the extent practicable. One of the primary goals of the program is to support self-sustaining, naturally-producing, harvestable native anadromous salmonid species throughout their historical range in the North Fork Lewis River Basin.

Although hatchery production is often a successful strategy for maintaining fish runs, the release of millions of hatchery fish into a river system, as planned here, can negatively impact native fish populations in several ways, including but not limited to:

1) Competition for food and space: Adverse effects of competition may result from hatchery fish directly interacting with the naturally produced fish inhibiting their access to limited resources, or simply by consuming a limited resource and reducing its availability (SIWG 1984). The potential for adverse effects of hatchery salmonid competition on naturally produced Chinook, coho and steelhead is considered high (SIWG 1984).

2) Predation: Risks to naturally produced salmonids from predation may be attributed to direct predation by hatchery fish on naturally produced juveniles or by hatchery releases attracting other predatory species.

3) Disease: Interactions between hatchery fish and natural fish in the environment may result in the transmission of disease pathogens, and hatchery effluent has the potential to further transport pathogens present in a hatchery to the river, exposing natural fish to infection.

4) Genetic alteration: Ongoing hatchery operations can lead to loss of diversity among and within populations, genetic drift, inbreeding depression, and changes in the quantity, variety and combination of alleles as a result of selection in the hatchery environment (domestication selection).

5) Harvest: Commercial and recreational fisheries that target hatchery fish may intercept listed salmon and steelhead.

Each of these types of impacts of hatcheries on natural populations (competition, predation, disease, genetic alteration and harvest) may result in the loss or reduction of wild native fish population abundance, productivity, and diversity. In addition, the operation of the hatchery facilities themselves has the potential to adversely affect salmonids through hatchery facility failure (power or water loss leading to catastrophic fish losses); hatchery water intake impacts (stream de-watering and fish entrainment); and hatchery effluent discharge effects (deterioration of downstream water quality). Broodstock collection can affect listed salmonids by delaying or displacing spawning; causing fallback; injuring or killing fish (broodstock fish); physically harming fish during capture, holding, and handling procedures; and increasing their susceptibility to displacement downstream and predation during the recovery period. Monitoring and evaluation of hatchery programs may require some intentional take of listed fish.

Despite the potential for adverse effects, the conceptual, comprehensive hatchery and supplementation program is an integral component to re-establish self-sustaining, naturally producing, harvestable native anadromous salmonid species throughout their historical range in the North Fork Lewis River Basin. Moreover, many of these potential adverse effects can be substantially minimized through implementation of best management practices and conservation measures, which will be detailed in the hatchery and supplementation plan, which will be submitted for review and approval by NMFS. Through its approval authority, NMFS will ensure that final plans (1) are consistent with the Settlement Agreement's goal of supporting self-sustaining, naturally producing, harvestable native anadromous salmonid populations, (2) do not impede the continued survival and recovery of listed salmon and steelhead species in the wild, and (3) include measures to minimize the effect of any incidental take resulting from the hatchery and supplementation program. PacifiCorp owns the Merwin Hatchery, PacifiCorp and Cowlitz PUD own the Speelyai Hatchery, and WDFW owns the Lewis River Hatchery. WDFW operates all of these facilities. Programs of operation will be provided to NMFS in HGMPs and subject to the ESA Section 4(d) consultation (NMFS 2005a and NMFS 2006).

5.1.1.6 Aquatic Monitoring and Evaluation

Under the Proposed Action, numerous measures will be implemented to protect and enhance salmon and steelhead populations and their habitat in the Lewis River Basin. These measures include the reintroduction of spring Chinook, coho, and steelhead above Merwin, Yale and Swift dams, the construction of upstream and downstream fish passage facilities, hatchery supplementation programs, and several habitat enhancement measures. These altered environmental conditions will affect the distribution and abundance of Chinook, coho, chum, and steelhead, and other native and non-native species.

According to LCFRB and NMFS (2006), future monitoring and analysis of Lower Columbia salmon and steelhead recovery programs is of utmost importance because, without sufficient data, it will be impossible to determine whether remedial actions are helping. Fish habitat and population monitoring is often conducted to determine if environmental measures, like those included in the proposed action, provide the desired level of protection and enhancement for target fish species and aid in the development of responsive adaptive management strategies.

Under the Proposed Action, PacifiCorp and Cowlitz PUD will monitor and evaluate the effectiveness of various aquatic measures including fish passage compared to performance standards; adult anadromous salmonid migration, spawning, distribution, and abundance; water quality; and hatchery supplementation programs. PacifiCorp and Cowlitz PUD will prepare annual monitoring reports. Work will be conducted by PacifiCorp, Cowlitz PUD, or those hired by the Licensee(s) to conduct the work (their contractors).

Monitoring is a necessary tool for providing data critical to adaptive management. Its implementation will allow for the improvement of salmonid spawning and rearing habitat and for the long-term protection of habitat for aquatic species in the Lewis River Basin by ensuring that managers have information to determine the effectiveness of the proposed aquatic measures. This monitoring information will also allow adaptive management decisions to be made to ensure the long-term persistence of listed fish species in the Lewis River Basin, as well as the ability to respond to significant changes in environmental conditions.

Some adverse effects are expected during monitoring activities. These include potential injury or mortality due to handling and/or marking. Fish that enter a collection facility are subject to handling by one or more people depending upon the scope of each monitoring activity. There is an immediate risk of injury or mortality and a potential for delayed mortality due to mishandling. The number of fish subjected to this impact is expected to be small because the handlers will be trained and will follow protocols established to protect fish. Those same fish that survive initial handling may also be subject to tag insertion or physical clipping for identification purposes during monitoring activities. There is an expected 1 percent loss of juveniles associated with tagging (PacifiCorp and Cowlitz PUD 2004b). Adult losses due to tagging and marking are expected to be considerably less based on years of reporting under ESA Section 10 research permits.

The primary effects the proposed monitoring activities would have on the threatened species will be in the form of incidental "take"("Take" is defined in Section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in any such conduct), a major portion of which takes the form of harassment. Harassment generally leads to stress and other sub-lethal effects and is caused by observing, capturing, and handling fish. The ESA does not define harassment nor has NMFS defined this term through regulation. However, the USFWS defines harassment as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding, or sheltering" [50 CFR 17.4]. For the purposes of this analysis, NMFS adopts this definition of harassment.

The various monitoring and evaluation activities for anadromous fish measures would cause many types of take, and while there is some uncertainty between what constitutes an activity (e.g., electrofishing) and what constitutes a take category (e.g., harm), it is important to keep the two concepts separate. The reason for this is that the effects being measured here are those which the activity itself has on the listed species. They may be expressed in terms of the take categories (e.g., how many salmonids are harmed, or harassed, or even killed), but the actual mechanisms of the effects themselves (i.e., the activities) are the causes of whatever take arises and, as such, they bear examination. Therefore, the first part of this section is devoted to a discussion of the general effects known to be caused by the general potential proposed activities—regardless of where they occur or what species are involved.

The following subsections describe the types of activities that may be proposed. Each is described in terms broad enough to apply to every relevant plan. The activities would be carried out by trained professionals using established protocols and have widely recognized specific impacts. PacifiCorp and Cowlitz PUD would not receive approval unless their activities (e.g., electrofishing) incorporate NMFS' uniform, pre-established set of minimization measures. These measures will be included in the plan or NMFS' approval of the plan if they are different than what is in the accompanying incidental take statement (ITS).

Observation

For some monitoring, listed fish will be observed in-water (i.e., snorkel surveys). Direct observation is the least disruptive and simplest method for determining presence/absence of the species and estimating their relative abundance. Its effects are also generally the shortest-lived among any of the monitoring activities discussed in this section. Typically, a cautious observer can obtain data without disrupting the normal behavior of a fish. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge behind rocks, vegetation, and deep water areas. In extreme cases, some individuals may temporarily leave a particular pool or habitat type when observers are in their area. Observers minimize the amount of disturbance by moving through streams slowly thus allowing ample time for fish to escape to cover; though it should be noted that the monitoring may at times involve observing adult fish—which are more sensitive to disturbance. During some of the activities discussed below, redds may be visually inspected, but no redds will be walked upon. Harassment is the primary form of take associated with these observation activities, and few if any injuries or deaths are expected to occur—particularly in cases where the observation is to be conducted solely by observers on the stream banks rather than in the water. There is little an observer can do to minimize the effects associated with observation activities because those effects are so minimal. In general, all they can do is move with care and attempt to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves.

Capture/Handling

Capturing and handling fish causes them stress. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18 C or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps that are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

Based on prior experience with the techniques and protocols that would be used to conduct the proposed monitoring, no more than 5 percent of the juvenile salmonids encountered are likely to be killed as an unintentional result of being captured and handled. In most cases, mitigation measures will be employed, thereby keeping adverse effects to a minimum. Finally, any fish unintentionally killed by the monitoring activities in the proposed permits may be retained as reference specimens or used for other purposes.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them—thus making them easy to capture. It can cause a suite of effects ranging from simple harassment to actually killing the fish. The amount of unintentional mortality attributable to electrofishing may vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Electrofishing can have severe effects on adult salmonids. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The long-term effects electrofishing has on both juveniles and adult salmonids are not well understood, but long experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration.

The effects electrofishing may have on the threatened species would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river (see the previous subsection for more detail on capturing and handling effects). Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) found a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Fredenberg 1992; Snyder 1992, 1995; Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996, Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

NMFS' electrofishing guidelines (NMFS 2000c) will be followed in all surveys using this procedure. The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. Electrofishing is used only when other survey methods are not feasible. All areas for stream and special needs surveys are visually searched for fish before electrofishing may begin. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Operators work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them. Working in pairs also allows the operators to net fish before they are subjected to higher electrical fields. Only DC units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. Due to the low settings used, shocked fish normally revive instantaneously. Fish needing to be revived will receive immediate, adequate care.

The preceding discussion focused on the effects of using a backpack unit for electrofishing and the ways those effects will be mitigated. It should be noted, however, that in larger streams and rivers electrofishing units are sometimes mounted on boats. These units often use more current than backpack electrofishing equipment because they need to cover larger (and deeper) areas and, as a result, can have a greater impact on fish. In addition, the environmental conditions in larger, more turbid streams can limit the operators' ability to minimize impacts on fish. For example, in areas of lower visibility it is difficult for operators to detect the presence of adults and thereby take steps to avoid them. Because of its greater potential to harm fish, and because NMFS has not published appropriate guidelines, boat electrofishing has not been given a general authorization under NMFS' ESA Section 4(d) rules. In any case, all evaluators intending to use boat electrofishing will use all means at their disposal to ensure that a minimum number of fish are harmed.

Tagging/Marking

Techniques such as passive integrated transponder (PIT) tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without evaluators having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore any persons engaged in such activities will follow the conditions listed in the ITS accompanying this Opinion (as well as any plan-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987, Jenkins and Smith 1990, Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically- or surgically-implanted sham radio tags (similar in size and weight to radio tags with a PIT tag embedded rather than an actual radio transmitter) or PIT tags. Additional studies have shown that growth rates among PIT tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Conner et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific Northwest salmon. The tag is injected into the nasal cartilage of a salmon and therefore causes little direct tissue damage (Bergman et al. 1968, Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon; however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987, Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

In order for evaluators to be able to determine later (after the initial tagging) which fish possess CWTs, it is often necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem because evaluators generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead) or from carcasses collected after the fish has died.

The other primary method for tagging fish is to implant them with radio tags. There are two main ways to accomplish this and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways.

The second method for implanting radio tags is to place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985, Mellas and Haynes 1985).

Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. As with the other forms of tagging and marking, evaluators will keep the harm caused by radio tagging to a minimum by following the conditions in the permits as well as any other permit-specific requirements.

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Marks can also be made by punching holes or cutting notches in fins, or severing individual fin rays (Kohlhorst 1979, Welch and Mills 1981). Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly—especially those caused by partial clips.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it. Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100 percent recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are removed. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality but other studies have been less conclusive.

Regardless, any time evaluators clip or remove fins, it is necessary that the fish be handled. Therefore, the same safe and sanitary conditions required for tagging operations also apply to clipping activities.

Stomach Flushing

Knowledge of the food and feeding habits of fish are important in the study of aquatic ecosystems. However, in the past, food habit studies required evaluators to kill fish for stomach removal and examination. Consequently, several methods have been developed to remove stomach contents without injuring the fish. Most techniques use a rigid or semi-rigid tube to inject water into the stomach to flush out the contents.

Few assessments have been conducted regarding the mortality rates associated with nonlethal methods of examining fish stomach contents (Kamler and Pope 2001). However, Strange and Kennedy (1981) assessed the survival of salmonids subjected to stomach flushing and found no difference between stomach-flushed fish and control fish that were held for 3 to 5 days. In addition, when Light et al. (1983) flushed the stomachs of electrofished and anesthetized brook trout, survival was 100 percent for the entire observation period. In contrast, Meehan and Miller (1978) determined the survival rate of electrofished, anesthetized, and stomach flushed wild and hatchery coho salmon over a 30-day period to be 87 percent and 84 percent respectively.

Sacrifice

In some instances, it is necessary to kill a captured fish in order to gather whatever data a study is designed to produce. In such cases, determining effect is a very straightforward process: the sacrificed fish, if juveniles, are forever removed from the listed species' gene pool; if the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed, but so are all their potential progeny. Thus, killing pre-spawning adults has the greatest potential to affect the listed species. Because of this, NMFS rarely allows it to happen. And, in almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery—thereby greatly decreasing the potential harm posed by sacrificing the adults. Clearly, there is no way to minimize the effects of outright sacrifice to an individual fish.

Benefits of Monitoring and Evaluation
NMFS will not approve a monitoring plan if it operates to the disadvantage of the endangered and/or threatened species that is/are the subject of the plan. In addition, NMFS does not approve monitoring plans unless the proposed activities are likely to result in a net benefit to the listed species; benefits accrue from the acquisition of scientific information.

For more than a decade, research and monitoring activities conducted with anadromous salmonids in the Pacific Northwest have provided resource managers with a wealth of important and useful information on anadromous fish populations. For example, juvenile fish trapping efforts have enabled the production of population inventories, PIT-tagging efforts have increased the knowledge of anadromous fish migration timing and survival, and fish passage studies have provided an enhanced understanding of fish behavior and survival when moving past dams and through reservoirs. By approving plans, NMFS will cause information to be acquired that will enhance resource manager's ability to make more effective and responsible decisions to sustain anadromous salmonid populations that are at risk of extinction, to mitigate impacts to endangered and threatened salmon and steelhead, and to implement recovery efforts. The resulting data continue to improve the knowledge of the respective species' life history, specific biological requirements, genetic make-up, migration timing, responses to anthropogenic impacts, and survival in the river system.

Summary of Proposed Aquatics Measures
Based on the conservation measures in the Proposed Action to be implemented, current operation of the Merwin, Yale, and Swift No. 1 and Swift No. 2 Hydropower Projects will, among other effects, (1) expand the range of listed species by providing access to approximately 174 miles of habitat; (2) maintain or improve water quality, temperature, and ecological productivity in the project area; (3) protect listed species and their progeny from stranding as a result of rapid flow fluctuations; and (4) preserve and protect juvenile and adult habitat.

The benefits accrue to the listed aquatic species for the following reasons:

1) Upstream habitat is made available that the anadromous species have not had access to for over 70 years
2) Overall population numbers will increase over present levels due to increased production from new areas
3) The habitat that currently exists will be improved or maintained through aquatic enhancement funded projects, the LWD program, the spawning gravel program, or the proposed changes to operations (e.g., instituting a new flow regime below Merwin Dam and bypass reach flows) or a combination of such.

5.1.1.7 Terrestrial Measures

The proposed terrestrial measures consist of providing funds to purchase and enhance wildlife mitigation lands and to develop wildlife management plans, along with effectiveness monitoring. These measures will benefit aquatic habitats to the extent that protecting upland habitat and riparian corridors preserves watershed process that influence the aquatic environment, such as preserving natural storm water runoff patterns and reducing hill slope erosion. Therefore, the proposed terrestrial measures will likely benefit Chinook, coho, steelhead, and chum habitat in the Lewis River Basin.

5.1.1.8 Recreation Measures

Expansion and improvement of recreation facilities under the Proposed Action may increase human presence in several locations in the basin, increasing angling pressure in the mainstem, reservoirs, and tributary streams. Increased angling pressure has the potential to result in an increase in mortality of ESA-listed salmonids. This mortality can occur through unintentional capture and release of fish that subsequently die from hooking injury or mishandling and from poaching which illegally captures and removes fish from the population. Funding three full time law enforcement officers, one of who will be a full time wildlife officer, will lessen this risk by providing presence that is expected to deter some from illegal activities. While only one officer will be dedicated to wildlife and fish issues within the Lewis River Basin, all three will coordinate and provide presence likely to discourage some from illegal behavior.

Construction of new recreational facilities under the proposed action has the potential to cause short-term adverse effects, such as increasing turbidity. Even though most of the recreation improvements occur on dry land, potential erosion, dust or spills may temporarily affect the aquatic environment. These effects are not expected to result in injury or death to the listed aquatic species due to the use of best management practices. For example, water quality may be affected temporarily during construction, primarily through increased erosion and sedimentation, and these effects will be minimized and avoided by implementing best management practices (e.g., installing silt fencing and other sediment trapping devices on land and silt curtains in water) and covering exposed soil until permanently stabilized. PacifiCorp will be required by Federal, state, and county regulations to develop sediment and erosion control plans as part of the construction process. Chemical spills could also occur during construction. These spills may enter the waterways and cause temporary displacement, injury or even mortality depending on the extent of the spill, but development of a pollution prevention plan in accordance with appropriate Federal, state, and county requirements will minimize the effects of such an occurrence. Typically, a pollution prevention plan will specify areas for equipment maintenance and refueling, spill prevention and emergency response strategies, and requirements for keeping emergency response spill containment kits onsite and for having trained personnel present onsite during construction. PacifiCorp currently has a Spill Prevention and Containment Control program in place that addresses these activities.

Through the construction permitting process, plans will be developed to minimize and avoid temporary construction-related effects to the extent feasible using best management practices that are similar, but not limited to, the previously mentioned actions. These plans will be reviewed and approved by the permitting agencies. No long-term negative effects on aquatic resources are anticipated to result from construction of new recreational facilities.

5.1.1.9 Socioeconomic Measures

Under the Proposed Action, socioeconomic measures include providing funding for the maintenance of Forest Road 90 and funding development of the visitor center in Cougar. Funding the maintenance of Forest Road 90 will likely reduce impacts to the aquatic environment by maintaining the road in good working order, which will limit sedimentation and erosion into streams. Construction related impacts such as potential erosion, dust or spills may temporarily affect the aquatic environment. These effects are not expected to result in injury or death to the listed aquatic species because the effects will be minimized to the necessary level to avoid such by use of best management practices. Such impacts resulting from the new visitor center in Cougar will be minimized or avoided by following best management practices as listed previously.

5.1.2 Indirect Project Effects on Anadromous Fish

Indirect effects are caused by or result from the Proposed Action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action.

Recreation Including Funding to Forest Service for Managing Dispersed Camping Sites Outside of the Project Boundaries

Localized and dispersed recreational use within the Lewis River Basin has the potential to affect ESA-listed anadromous salmonids. People that use this recreational area are drawn to water and engage in activities that may adversely affect salmon and steelhead populations and habitat. Recreationists take part in a variety of activities, including camping, hiking, boating, fishing, and swimming in areas that may affect salmon and steelhead. The effects include large wood removal by recreationists for firewood, and changes in streambank conditions due to trampling along streams. These impacts will be addressed through the proposed improvements to recreation sites including dispersed camp sites where these types of impacts are likely to occur.

In Lieu Fund

Pursuant to the Settlement Agreement, if the Services determine that reintroduction should not occur at Lake Merwin or Yale Lake because it is inappropriate, PacifiCorp will contribute to an In Lieu Fund as follows: $10 million in lieu of a juvenile surface collector at Yale Dam; $10 million in lieu of a juvenile surface collector at Merwin Dam; $5 million in lieu of an upstream adult fish passage facility at Yale Dam; $5 million in lieu of an upstream adult fish passage facility in the vicinity of the Swift Projects. The In Lieu Fund will be used for mitigation measures that collectively contribute to meeting the objective of achieving equivalent or greater benefits to the viability of the anadromous fish populations as would have been gained by passage through Yale Lake and/or Lake Merwin. Measures may include habitat enhancement, habitat protection, or other actions that will benefit the listed species. Section 2.3.1 lists examples of the kinds of mitigation measures that would be implemented with the In Lieu Fund. Implementation of those or similar mitigation measures is expected to alleviate certain passage problems by removing small dams or replacing culverts, opening up currently unavailable spawning, incubation and rearing habitat; reconnecting and enhancing off-channel and floodplain habitats along the lower reaches of the mainstem Lewis River, improving rearing conditions for listed species; enhancing floodplain and side channel habitat around Eagle Island, improving rearing habitat for the listed species; restoring degraded riparian conditions along tributaries to the lower Lewis River, improving early rearing conditions; increasing functional LWD structures, or similar natural structures, in appropriate stream reaches, which will improve rearing and holding conditions and increase spawning gravel retention; and restoring and enhancing wetlands, springs, and seeps in the sub-basin which will assist in improving water quality conditions in the basin and its tributaries. The list of potential projects provided in Section 2.3.1 illustrates some projects that qualify as mitigation measures under the In Lieu Fund, which are based on conditions as of the Effective Date of the Settlement Agreement. In addition, some of the measures identified may already have been completed when (or if) the In Lieu Funds become available. Although there may be some short term negative effects from construction or implementation of these projects, there will be best management practices carried out to limit the effects and the projects are expected to have significant positive effects on the listed salmonid populations in the Lewis River Basin.

Funding Law Enforcement and Improving Five River Access Sites Outside the Merwin Project Boundary

Expansion and improvement of recreation facilities under the proposed action may increase human presence in several locations in the basin, increasing angling pressure in the mainstem, reservoirs, and tributary streams. Increased angling pressure has the potential to result in an increase in mortality of ESA-listed salmonids. This mortality can occur through unintentional capture and release of fish that subsequently die from hooking injury or mishandling and from poaching which illegally captures and removes fish from the population. Funding three full time law enforcement officers, one of who will be a full time wildlife officer, will lessen this risk by providing presence that is expected to deter some from illegal activities. While only one officer will be dedicated to wildlife and fish issues, all three will coordinate and provide presence likely to discourage some from illegal behavior.

Construction of new recreational facilities under the Proposed Action has the potential to cause short-term adverse effects, such as increasing turbidity. Even though most of the recreation improvements occur on dry land, potential erosion, dust or spills may temporarily affect the aquatic environment. These effects are not expected to result in injury or death to the listed aquatic species due to the use of best management practices. For example, water quality may be affected temporarily during construction, primarily through increased erosion and sedimentation, and these effects will be minimized and avoided by implementing best management practices (e.g., installing silt fencing and other sediment trapping devices on land and silt curtains in water) and covering exposed soil until permanently stabilized. PacifiCorp will be required by Federal, state, and county regulations to develop sediment and erosion control plans as part of the construction process. Chemical spills could also occur during construction. These spills may enter the waterways and cause temporary displacement, injury or even mortality depending on the extent of the spill, but development of a pollution prevention plan in accordance with appropriate Federal, state, and county requirements will minimize the effects of such an occurrence. Typically, a pollution prevention plan will specify areas for equipment maintenance and refueling, spill prevention and emergency response strategies, and requirements for keeping emergency response spill containment kits onsite and for having trained personnel present onsite during construction. PacifiCorp currently has a Spill Prevention and Containment Control program in place that addresses these activities.

Through the construction permitting process, plans will be developed to minimize and avoid temporary construction-related effects to the extent feasible using best management practices that are similar, but not limited to, the previously mentioned actions. These plans will be reviewed and approved by the permitting agencies. No long-term negative effects on aquatic resources are anticipated to result from construction of new recreational facilities.

Roads including Funding Forest Service for maintenance for Forest Road 90 –
When considering the effects of logging and logging roads on sediment, roads contribute more sediment to streams than any other land management activity (Gibbons and Salo 1973), and most of the land management activities are dependent on roads. Road-related mass soil movements can continue for decades after roads have been constructed (Furniss et al. 1991). In the past, roads have been recognized as a long term source of sediment even after erosion control measures have been implemented for a number of reasons including that they have been poorly designed, improperly placed, or inadequately maintained (Furniss et al.1991). Removing vegetation and ditch rock can increase downstream sedimentation. Lack of adequate culvert cleaning before winter storms can result in major mass wasting and extreme sedimentation for miles downstream. Such habitat alterations can adversely affect all life-stages of fishes, including migration, spawning, incubation, emergence, and rearing (Furniss et al. 1991). PacifiCorp is currently working on a road management plan to minimize the potential for detrimental effects to aquatic habitat on Project lands. This plan will be approved by the Terrestrial Coordination Committee established by the Settlement Agreement.

Under the Proposed Action, socioeconomic measures include providing funding for the maintenance of Forest Road 90. Funding the maintenance of Forest Road 90 will likely reduce impacts to the aquatic environment by maintaining the road in good working order, which will limit sedimentation and erosion into streams. Construction related impacts such as potential erosion, dust or spills may temporarily affect the aquatic environment. These effects are not expected to result in injury or death to the listed aquatic species because the effects will be minimized to the necessary level to avoid such by use of best management practices.

5.1.3 Effects of the Proposed Action on Designated Critical Habitat

The North Fork Lewis River below Merwin Dam has been designated as critical habitat for LCR Chinook, CR chum, and LCR steelhead. The PCEs identified in this portion of critical habitat include sites for spawning, rearing, and migration. Table 5.3 shows the anticipated effects of the proposed action to the PCE

Table 5-3. Matrix of Pathways and Indicators for the Effects of the Proposed Action on Conservation Value of Designated Critical Habitat.

PCE	PATHWAY	INDICATOR	CONDITION	EFFECTS OF THE PROPOSED ACTION
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Water Quality	Temperature	Area below Merwin does not exceed 15.5 degrees Celsius.	No effect.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Water Quality	Total Suspended Solids/Turbidity	Vast areas of the upper river landscape were devastated by the Mount St. Helens eruption in 1980. Heavy rain and high runoff conditions create high turbidity in the streams and reservoirs. Land use activities have also increased total suspended solids.	The Projects will continue to trap high sediment loads resulting from the Mt. St. Helens eruption (a positive effect) and will block movement of large particles (including gravel) downstream; gravel monitoring and augmentation in the mainstem Lewis River below Merwin Dam is expected to maintain current gravel levels, as needed.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations	Water Quality	Chemical Contamination/Nutrients	No 303(d) listed river or stream reaches are present in the action area.	Spill prevention plans will be in place to minimize and avoid contamination. The Habitat Preparation Plan will aid in adding marine derived nutrients to the areas above Merwin by placing anadromous fish up there before the reintroduction program. Later, the reintroduction of anadromous fish in these areas will continue the increase in marine derived nutrients to the system.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Water quality	Dissolved Oxygen (DO)	Three low DO readings out of 183 readings have been observed in the action area. Also, reservoir stratification can result in lower DO in the deep areas, but these areas are unoccupied under the environmental baseline. Past monitoring in the Merwin tailrace has not shown low DO readings.	The proposed action will not alter this condition. Monitoring will continue.

Table 5-3. Matrix of Pathways and Indicators for the Effects of the Proposed Action on Conservation Value of Designated Critical Habitat, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	EFFECTS OF THE PROPOSED ACTION
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Water Quality	Total Dissolved Gas (TDG)	Some Washington Department of Ecology TDG exceedences have occurred in Project waters but the affected reaches are all above Merwin Dam and thus outside of the area designated as Critical Habitat.	No effect.
Freshwater Migration Corridors	Habitat Access	Physical Barriers	Merwin Dam blocks all upstream passage so that fish are restricted to the lower 20 miles (~20%) of historical habitat, but NMFS has not designated Critical Habitat above Merwin Dam.	No Effect.
Freshwater Spawning Sites	Habitat Elements	Substrate	Merwin Dam interrupts sediment (gravel) transport, but below Merwin, there are currently good quality spawning gravels. Land use activities have increased sedimentation deposition.	Under the proposed action, gravel monitoring and augmentation will maintain current gravel levels in the area below Merwin Dam.
Freshwater Rearing Sites Freshwater Migration Corridors	Habitat Elements	Large Woody Debris	Low levels of LWD in the lower Lewis River below Merwin Dam.	Under proposed action, LWD will be stockpiled and PacifiCorp will make funding available to entities for LWD projects in the lower Lewis River and its tributaries below Merwin Dam.

Table 5-3. Matrix of Pathways and Indicators for the Effects of the Proposed Action on Conservation Value of Designated Critical Habitat, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	EFFECTS OF THE PROPOSED ACTION
Freshwater Rearing Sites Freshwater Migration Corridors	Habitat Elements	Pool Frequency and Quality	Pool frequency and quality in the Lewis River below Merwin Dam is low due to the absence of pool forming elements such as LWD.	Habitat enhancement measures under the proposed action may improve the condition of pool frequency and quality. Because specific improvements cannot be described at this time, NMFS makes a conservative assumption that the proposed action will not appreciably change pool conditions.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Habitat Elements	Off-channel Habitat	Poor connectivity (generally absent or extremely limited) to off-channel habitat in lower river.	Habitat enhancement measures under the proposed action may improve the condition of off-channel habitat. Because specific improvements cannot be described at this time, NMFS makes a conservative assumption that the proposed action will not appreciably change off-channel habitat conditions.
Freshwater Spawning Sites Freshwater Rearing	Channel Conditions and Dynamics	Width/Depth Ratio	Channel form in the lower watershed has be restricted by dikes and by loss of LWD; reservoir operations have restricted some channel forming processes.	Reservoirs reduced peak flows from the Projects, limiting pool formation below Merwin Dam. These effects will continue under the proposed action. However, LWD projects that create pools may be funded under the Proposed projects, which may offset these effects to some degree. Conservatively, NMFS assumes that the proposed action will not degrade pool quality, but will also not appreciably enhance pool quality by placement of LWD.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migration Corridors	Channel Conditions and Dynamics	Streambank Condition	Streambanks do not support natural floodplain function in the lower river.	Habitat enhancement funds may be used to improve streambank condition. Because specific improvements cannot be described at this time, NMFS makes a conservative assumption that the proposed action will not appreciably change streambank conditions.

Table 5-3. Matrix of Pathways and Indicators for the Effects of the Proposed Action on Conservation Value of Designated Critical Habitat, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	EFFECTS OF THE PROPOSED ACTION
Freshwater Rearing Freshwater Migration Corridors	Channel Conditions and Dynamics	Floodplain Connectivity	The lower Lewis River is disconnected from its historical floodplain by dikes and flood control operations that have reduced peak flows.	Dikes prevent connection to lower river floodplain (non-Project effects). Habitat enhancement funds may be used to improve off-channel habitat by conducting dike set-back projects. Because specific improvements cannot be described at this time, NMFS makes a conservative assumption that the proposed action will not appreciably change floodplain connectivity.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Water Quantity (Flow/Hydrology)	Change in Peak/Base Flow	Lower Lewis River hydrology affected by seasonal reservoir drafting and refilling, flood control operations, and power production. Peak flows are lower and base flows are higher than unregulated river flows. Also, flows rise and fall more frequently with more gradual flow increases and more rapid flow decreases than in the unregulated river condition.	Under the proposed action, the lower Lewis River hydrology will continue to be affected by seasonal reservoir drafting and refilling, and flood management operations; peaks that remain are lower. However, high flows greater than 50,000 cfs (base flow of approx. 6,000 cfs) do occur so expect to still get occasional channel forming flows during wet years. Summer base flow will remain higher than historical flows. Plateau operations limit the negative impacts from frequent flow changes and there are mechanisms (e.g., Low Flow Committee) for consideration of impacts to fish while developing a flow regime during drought conditions. Down ramping will be limited to 2 inches per hour and up-ramping to 1.5 feet per hour below Merwin Dam, and no ramping will be allowed between 1 hour before and after the sunrise and sunset in the winter and spring in order to minimize the potential for fish stranding. PacifiCorp will implement stranding study under the proposed action and identify additional stranding measures if needed.

Table 5-3. Matrix of Pathways and Indicators for the Effects of the Proposed Action on Conservation Value of Designated Critical Habitat, cont'd.

PCE	PATHWAY	INDICATOR	CONDITION	EFFECTS OF THE PROPOSED ACTION
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Watershed Conditions	Road Density and Location	High road densities exist in the Lewis River Basin below Merwin Dam, and many roads exist in valley bottoms.	Implementation of Road Maintenance and Abandonment Plan on utility-owned lands is expected to reduce road density, habitat fragmentation and sediment inputs; however, utility roads comprise a small amount of the overall roads affecting density and location parameters. Conservatively, NMFS estimates no change from baseline conditions.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Watershed Conditions	Disturbance History	Disturbance is frequent below Merwin Dam.	The proposed action will not change the disturbance conditions.
Freshwater Spawning Sites Freshwater Rearing Freshwater Migrations Corridors	Watershed Conditions	Riparian Reserves	Heavily impacted and impaired within the basin below Merwin Dam.	No effect.

Water management to maximize power production and manage floods will continue to negatively affect designated critical Habitat in the mainstem Lewis River downstream from Merwin Dam through seasonal flow reductions and increases and flow fluctuations. However, through minimum flows and ramping rate restrictions, those effects will be minimized. Increasing minimum spawning and incubation flows, and reducing ramping rates has increased juvenile salmon survival and salmon spawner abundance downstream of hydropower project (Connor and Pflug 2004). PacifiCorp proposes to implement an adaptive management program, which will help identify any real-time inadequacy in the flow program and define appropriate remedial actions.

Gravel monitoring and augmentation and the LWD stockpile and funding program will offset effects of the Projects blocking transport of substrate and LWD, and the resulting effects on habitat elements (substrate, LWD, pool frequency and quality, off-channel habitat) and channel morphology. It is unlikely that the function of already impaired habitat below the Projects will be reduced through the implementation of these programs. NMFS expects that these programs will result in an improvement in habitat condition downstream of Merwin Dam, but there may be temporary negative effects from construction activities and fish habitat improvement projects (see Section 5). These effects will be minimized and/or avoided by implementing the project-specific best management practices identified by agencies such as WDOE, WDFW, and the U.S. Army Corps of Engineers through the construction permitting process NMFS believes that the Settlement Agreement's fish passage and aquatic enhancement measures provide significant protections for coho habitat. NMFS has not yet designated critical habitat for Lower Columbia River coho. Should we designate critical habitat for coho in the action area, we will review the PCEs and determine whether the effects of the Projects are substantially different than those described for LCR Chinook and LCR steelhead critical habitat. If we find that the effects to coho habitat would likely be the same as the effects to Chinook and steelhead critical habitat articulated in this Opinion, then we may describe that conclusion as an amendment. If not, reinitiation of consultation would be required.

6. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR § 402.02 as "those effects of future State, tribal, local or private actions, not involving Federal activities, that are reasonably certain to occur in the action area." Future Federal actions, including the ongoing operation of hatcheries, fisheries, and land management activities, are not considered within the category of cumulative effects for ESA purposes because they require separate consultations pursuant to Section 7 of the ESA, after which they become part of the environmental baseline. Potential cumulative effects within the action area (the Lewis River Basin from its headwaters downstream to its confluence with the Columbia River) including urban and rural development, timber harvest on private lands, exotic fish transplants, road building on private forest lands, and increased fish harvest and are likely to have an effect on the future recovery of listed species.

Expansion of the local economy and diversification will likely contribute to population growth. This growth will likely result in increased demand for electricity, water, and buildable land in the action area which will, in turn, increase demand for transportation, communication and other social infrastructure. These actions will affect habitat features such as water quality and quantity which will directly affect the listed aquatic species. The Total Maximum Daily Load (TMDL) process, administered by the Washington Department of Ecology, will help alleviate some of the daily fluctuation in water quality. Beyond that, NMFS cannot specify what those effects will be nor how they will be minimized.

7. CONCLUSION

This section presents NMFS' Biological Opinion regarding whether the effects of the factors analyzed under the environmental baseline (Section 4), the effects of the Proposed Action (Section 5), and the cumulative effects (Section 6) in the action area, when taken together and viewed against the current rangewide status of the species (Section 3), are likely to jeopardize the continued existence of the listed species considered in this Opinion. To "jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (CFR §402.02). Consequently, NMFS' conclusions concerning jeopardy include separate findings regarding listed species' chances of both survival and recovery. This section also represents NMFS' Biological Opinion regarding whether the Proposed Action is likely to result in the destruction or adverse modification of critical habitat.

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the Proposed Action, and cumulative effects, it is NMFS' Biological Opinion that the Proposed Action is not likely to jeopardize the continued existence of these species or to destroy or adversely modify the critical habitat designated for three of the species. In reaching this opinion, NMFS has relied on the best available scientific and commercial information. Furthermore, these conclusions are based on the considerations within this document as summarized below.

Implementation of the measures included in the Proposed Action will be beneficial to listed Chinook, steelhead, coho, and chum salmon in the Lewis River by providing access to historical habitat located upstream of Merwin Dam[26], improving seasonal flow conditions and reducing ramping rates below Merwin Dam, and increasing habitat protection and enhancement over existing conditions. Providing access to the areas upstream of Merwin Dam is a measure identified as a substantial salmon recovery measure for LCR Chinook, LCR steelhead, and identified as important to the recovery of LCR coho (LCFRB and NMFS 2006). Studies and ongoing monitoring activities (i.e., fish passage efficiency and trap efficiency; adult anadromous salmonid migration, spawning, distribution, and abundance; water quality; and hatchery supplementation programs) also will ensure that these measures achieve their objectives. The Proposed Action will increase the likelihood of conditions that meet fish needs.

While the overall effect of the Proposed Action will likely be beneficial to the listed species and their habitat, the risk of incidental adverse effect to individual fish cannot be entirely eliminated. For example, the potential for entrainment cannot be completely eliminated at the Projects and some small level of Chinook, coho, steelhead and chum salmon handling mortality is unavoidable under any fish passage facility scenario. Other adverse effects may include juvenile harm or mortality caused by stranding below Merwin Dam and delay or injury during adult and juvenile passage at the Project dams. Future construction activities (e.g., juvenile collectors, habitat restoration, etc.) may also cause short-term impacts including, but not limited to, disruption to the waterway and introduction of sediment and other materials. However, best management practices including work windows will minimize these Project effects and the

[26] Chum will not be transported above since their habitat is limited to areas below Merwin.

actions will substantially benefit the species in the long term. The Proposed Action contains measures to protect or improve the critical habitat PCEs that are below Merwin Dam and that are affected by the Projects. Therefore, based on NMFS' consideration of the rangewide status of the species and their designated critical habitat, the effects of the action, and any cumulative effects, NMFS concludes that the Proposed Action will not appreciably reduce the likelihood of the survival and recovery of listed species or destroy or adversely modify the designated critical habitat of the ESA-listed species considered in this opinion.

8. REINITIATION OF CONSULTATION

As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the Licensee(s) must consult with NMFS to determine whether specific actions will be taken to address such events including but not limited to ceasing or modifying the causal activity.

9. INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits any taking (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to Section 4(d) of the ESA extend the prohibition to threatened species. Harm is further defined to include significant habitat modification or degradation that results in death of or injury to listed species by significantly impairing behavioral patterns such as spawning, rearing, feeding, and migrating (50 CFR §222.102; NMFS 1999c). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by a Federal agency or applicant (50 CFR §402.02). Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA, provided that such taking is in compliance with the terms and conditions of the incidental take statement.

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures. The measures described in this section are nondiscretionary. If FERC fails to include these conditions in the licenses or PacifiCorp or Cowlitz PUD fails to assume and implement the terms and conditions of this incidental take statement, the protective coverage of Section 7(a)(2) may lapse. To monitor the effect of incidental take, PacifiCorp and Cowlitz PUD must report the progress of the action and its effect on each listed species to NMFS, as specified in this incidental take statement (50 CFR §402.14(i)(3)).

9.1 Amount or Extent of Take

FERC's proposed action to grant licenses to PacifiCorp for Merwin, Yale, and Swift No. 1 and to Cowlitz PUD for Swift No. 2 consistent with the Settlement Agreement, the FEIS and the 401 water certifications as amended is designed to minimize the incidental take of LCR Chinook, LCR coho, CR chum, and LCR steelhead considered in this Opinion.

In Section 5, NMFS described the mechanisms by which ESA-listed anadromous fish species would likely be affected (taken) by continued existence and operation of the Projects, construction activities, or conservation measures (e.g., fish passage measures or other proposed aquatic measures) implemented under the proposed action. Theses mechanisms include, without limitation:

- Juvenile mortality associated with entrainment through Project features or spill over Project dams
- Harm to adults and juveniles caused by handling or sampling fish for monitoring, evaluation, passage and hatchery operations
- Egg mortality caused by flow fluctuations, construction activities, and in-water habitat enhancement actions
- Fry and juvenile mortality caused by flow fluctuations and impoundment

- Mortality and harm caused by Project maintenance activities (i.e., dewatering canal)
- Stranding in some reaches caused by emergency conditions
- Delay or injury during adult and juvenile passage at dams
- Juvenile mortality from predation

NMFS anticipates that individual juvenile and adult LCR Chinook salmon, LCR coho, CR chum[27], and LCR steelhead will be captured (e.g., during operation of the fish passage facilities). NMFS expects the number of individuals to be injured or killed to be low, consistent with the adaptive management process for making facility adjustments and modifications relating to performance standards and as provided in the Settlement Agreement. For example:

- Overall Performance Standards for Salmonids[28]
- Passage Facility Design Performance Standards for Salmonids[29]
- Adult Trap Efficiency for Anadromous Salmonid[30]

Until the Project mitigation features are constructed and operating effectively to achieve the performance standards, it is impossible to set a numeric limit on incidental take. Therefore, the incidental take up until Project features are meeting the performance standards is the take that occurs as a result of Project operations, construction of Project features, and other measures to implement the Settlement Agreement. Incidental take during this time period will be exceeded if the licensees fail to implement any relevant Settlement Agreement measure. Once the standards have been achieved, however, the Settlement Agreement requires that those standards become binding on Project operations.

Therefore, from the time the Overall Downstream Survival standard has been met, juvenile mortality associated with entrainment through features or spill over Project dams would be considered incidental if the mortality rate is not greater than 25 percent of downstream migrants, after all actions required by the Settlement Agreement have been taken.

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[27] It is possible that some chum will enter the adult trap at Merwin Dam (though these are not a species that will be transported above Merwin, they will need to be released back into the Lewis River).

[28] The Licensees will achieve the following overall performance standards for fish passage: Overall Downstream Survival (ODS) of greater than or equal to 80% until such time as the Yale Downstream Facility is built or the In Lieu Fund in lieu of Yale Downstream Facility becomes available to the Services, after which time the ODS will be greater than or equal to 75%, Upstream Passage Survival (UPS) of greater than or equal to 99.5%, and Adult Trap Efficiency[28] (ATE) to be established as described below. If these performance standards are not achieved, the Licensees will take the actions described in the Settlement Agreement.

[29] PacifiCorp shall design and construct downstream fish passage facilities to achieve (i) a Collection Efficiency (CE) of equal to or greater than 95% and (ii) a Collection Survival (CS) of equal to or greater than 99.5% for smolts and 98% for fry, and (iii) adult bull trout survival of equal to or greater than 99.5%. Design performance objectives for injury are less than or equal to 2%. The Licensees shall design and construct upstream fish passage facilities to achieve the UPS equal to or greater than 99.5% and the ATE as described below.

[30] The Licensees, together with the Services, Washington Department of Fish and Wildlife, Yakama Nation, and the Cowlitz Tribe, and in consultation with the ACC, will develop an ATE performance standard target for the terms of each new license to ensure the safe, timely, and effective passage of adult anadromous salmonids. Until such time as the standard has been developed, the Licensees will use NMFS' existing fish passage guidelines (NMFS 2004a). The Parties will consider the following but are not limited to only these items: entry rate, fall back, crowding at the entrance, delay, and abandonment of the trap area.

Regarding incidental take through injury, once the injury standard has been achieved, adult injury associated with passage around Project features or spill over Project dams would be considered incidental take if the injury rate is not greater than 2 percent of fish, after all actions required by the Settlement Agreement have been taken.

Regarding incidental take through trapping of adult migrants, once the Adult Trap Efficiency standard has been established and subsequently met at the Project, take resulting from failure to pass adult migrants will be considered incidental if the Adult Trap Efficiency standard is being met.

Regarding incidental take through handling of fish, there is no firm standard which will apply upon completion and effective operation of the mitigation measures. As with other measures, take from handling may vary greatly until the mitigation features are in place, and incidental take will be that resulting from the failure to adhere to the Settlement Agreement. However, it is anticipated that take from the effects of handling will be in the vicinity of 5 percent once the Project's features are constructed and fully operational. Therefore, from the time this standard is being met, take by handling will be considered incidental if the rate of injury or mortality from handling effects does not significantly exceed 5 percent.

Take is also anticipated in the form of harm to the species. However, because the relationship between habitat conditions and the distribution and abundance of fish in the action area is imprecise, a specific number of individuals taken cannot be practically estimated. In such circumstances, NMFS uses the predicted extent of habitat modification to describe the extent of take, based on the causal relationship between habitat function and the behaviors linked to that habitat function. Since the Proposed Action was developed with the intent of minimizing impacts to fish, the extent of incidental take anticipated in this incidental take statement is very small. The Settlement Agreement contains a suite of measures designed to reduce take incidental to operation of the Project, as well as thorough monitoring to ensure that the licensees are continually adapting measures to achieve the agreed-upon survival and performance standards.

Consequently, take from harm to species (or habitat) (as distinguished from take through other methods and quantified above) is estimated to be that amount which occurs despite the various efforts to reduce such effects. This incidental take authorized by this statement will be exceeded when the licensees fail to implement measures in strict accordance with the Settlement Agreement which limit the authorized amount and extent of habitat modification, including full implementation of adaptive management and related monitoring programs.

9.2 Effect of Take

NMFS has determined that the extent of anticipated take from the Proposed Action (analyzed in Section 5) is not likely to jeopardize the species' survival and recovery or to adversely modify or destroy designated critical habitat. The effects of the Proposed Action will be minimized to the extent possible through measures incorporated into the Settlement Agreement.

9.3 Reasonable and Prudent Measures and Terms and Conditions

NMFS believes that the following reasonable and prudent measures and terms and conditions are necessary and appropriate to minimize or to monitor the incidental take of the ESA-listed species resulting from the proposed action which includes operation of the North Fork Lewis River Hydroelectric Projects. In order to be exempt from the prohibitions of Section 9 of the ESA, FERC must ensure that PacifiCorp and Cowlitz PUD comply with all of the reasonable and prudent measures and terms and conditions set forth below.

1) Minimize the likelihood of incidental take from the operation of the Projects by requiring that PacifiCorp and Cowlitz PUD follow all of the items in the Settlement Agreement relating to anadromous fish.

2) Minimize incidental take from general construction by applying best management practices to the Proposed Action that avoid or minimize adverse effects to water quality, riparian, and aquatic systems.

3) Minimize incidental take from general Monitoring and Evaluation activities by applying conditions to the Proposed Action that avoid or minimize adverse effects to fish.

4) FERC shall require PacifiCorp and Cowlitz PUD to report all observations of dead or injured salmon or steelhead adults or juveniles coincident with carrying out the licenses (noting whenever possible the species of these individuals) to NMFS within 2 days of their observance, and include a concise description of the causative event (if known), and a description of any resultant corrective actions taken (if any) to reduce the likelihood of future mortalities or injuries.

9.3.1 Terms and Conditions

To be exempt from the prohibitions of Section 9 of the ESA, FERC must fully comply with conservation measures described as part of the Proposed Action and the following terms and conditions that complete the reasonable and prudent measures (RPMs) described above. In order to be exempt from the take prohibitions of Section 9 of the ESA and regulations issued pursuant to Section 4(d) of the ESA, FERC must include in the licenses and PacifiCorp and Cowlitz PUD must implement the following terms and conditions, which implement the RPMs listed above. These terms and conditions are non-discretionary. NMFS may amend the provisions of this ITS consistent with its statutory and regulatory authorities.

1) All Settlement Agreement provisions that relate to anadromous fish (including, but not limited to, provisions related to passage, provisions that affect habitat conditions (e.g., flows) or provisions related to monitoring) for these Projects must be followed by PacifiCorp and Cowlitz PUD and enforced by FERC. This applies to those Settlement Agreement articles that relate to salmon, their habitat, and implementation of those measures including adaptive management. Some key provisions include, but are not limited to:
   Settlement Agreement:

Section 3: Anadromous Fish Reintroduction Outcome Goals
Section 4: Fish Passage Measures,
Section 6: Flow Releases for Fish and Other Aquatic Species,
Section 7: Aquatic Habitat Enhancement Actions,
Section 8: Hatchery and Supplementation Program, and
Section 9: Aquatic Monitoring and Evaluation.

2) In all proposed actions involving construction in or near waterways, FERC must require PacifiCorp and Cowlitz PUD to follow the construction best management practices described below to control sediment, disturbance, and other potential detrimental effects to listed salmonids.

a. Minimum area. Construction impacts will be confined to the minimum area necessary to complete the project.

b. Alteration or disturbance of the streambanks and existing riparian vegetation will be minimized to the greatest extent possible.

c. No herbicide application should occur as part of this action. Mechanical removal of undesired vegetation and root nodes is permitted.

d. All existing vegetation within 150 ft of the edge of bank should be retained to the greatest extent possible.

e. Timing of inwater work. Work below the bankfull elevation will be completed during the State of Washington's or the Corps' preferred inwater work period as appropriate for the project area, unless otherwise approved in writing by NMFS.

f. Cessation of work. Construction project activities will cease under high flow conditions that may result in inundation of the project area, except for efforts to avoid or minimize resource damage. All materials, equipment, and fuel must be removed if flooding of the area is expected to occur within 24 hours.

g. Fish screens. All water intakes used for a construction project, including pumps used to isolate an inwater work area, will have a fish screen installed, operated, and maintained according to NMFS' fish screen criteria.

h. Fish passage. Passage must be provided for any adult or juvenile salmonid species present in the Project area during construction, unless otherwise approved in writing by NMFS, and maintained after construction for the life of the Project. Passage will be designed in accordance with NMFS' "Anadromous Salmonid Passage Facility Guidelines and Criteria" (2004) (ATTACHMENT 1). Upstream passage is required during construction if it previously existed.

i. Construction activities associated with habitat enhancement and erosion control measures must meet or exceed best management practices and other performance standards contained in the applicable state and Federal permits.

j. Pollution and Erosion Control Plan. Prepare, in consultation with NMFS, and carry out a Pollution and Erosion Control Plan to prevent pollution caused by survey, construction, operation, and maintenance activities. The Plan will be available for inspection upon request by FERC or NMFS.
   i. Plan Contents. The Pollution and Erosion Control Plan will contain the pertinent elements listed below, and meet requirements of all applicable laws and regulations.
      1. The name and address of the party(s) responsible for accomplishment of the Pollution and Erosion Control Plan.
      2. Practices to prevent erosion and sedimentation associated with access roads, decommissioned roads, stream crossings, drilling sites, construction sites, borrow pit operations, haul roads, equipment and material storage sites, fueling operations, and staging areas.
      3. Practices to confine, remove, and dispose of excess concrete, cement, and other mortars or bonding agents, including measures for washout facilities.
      4. A description of any regulated or hazardous products or materials that will be used for the Project, including procedures for inventory, storage, handling, and monitoring.
      5. A spill containment and control plan with notification procedures, specific cleanup and disposal instructions for different products, quick response containment and cleanup measures that will be available on the site, proposed methods for disposal of spilled materials, and employee training for spill containment.
      6. Practices to prevent construction debris from dropping into any stream or water body, and to remove any material that does drop with a minimum disturbance to the streambed and water quality.
      7. Erosion control materials (e.g., silt fence, straw bales, aggregate) in excess of those installed must be available on site for immediate use during emergency erosion control needs.
      8. Temporary erosion and sediment controls will be used on all exposed slopes during any hiatus in work exceeding 7 days.
   ii. Inspection of erosion controls. During construction, the operator must monitor instream turbidity and inspect all erosion controls daily, or as required by Washington Department of Ecology’s Construction stormwater general permit, or as determined by NMFS at the time of construction.
      1. If monitoring or inspection shows that the erosion controls are ineffective, mobilize work crews immediately to make repairs, install replacements, or install additional controls as necessary.
      2. Remove sediment from erosion controls once it has reached one-third of the exposed height of the control.

k. Construction discharge water. Treat all discharge water created by construction (e.g., concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids) as follows:
   i. Water quality. Design, build, and maintain facilities to collect and treat all construction discharge water using the best available technology applicable to site conditions. Provide treatment to remove debris, nutrients, sediment, petroleum hydrocarbons, metals, and other pollutants likely to be present.
   ii. Discharge velocity. If construction discharge water is released using an outfall or diffuser port, velocities will not exceed 4 fps, and the maximum size of any aperture will not exceed 4 fps.
   iii. Spawning areas, submerged estuarine vegetation. Do not release construction discharge water within 300 ft upstream of spawning areas or areas with submerged estuarine vegetation. Clean construction discharge may be released.
   iv. Pollutants. Do not allow pollutants, including green concrete, contaminated water, silt, welding slag, or sandblasting abrasive to contact any wetland or the 2-year floodplain, except cement or grout when abandoning a drill boring or installing instrumentation in the boring.

l. During completion of habitat enhancement activities, no pollutants of any kind (sewage, waste spoils, petroleum products, etc.) should come in contact with the water body or wetlands nor their substrate below the mean high-high water elevation or 10-year flood elevation, whichever is greater.

m. Treated wood.
   i. Projects using treated wood that may contact flowing water or that will be placed over water where it will be exposed to mechanical abrasion or where leachate may enter flowing water will not be used, except for pilings installed following NMFS' guidelines.
   ii. Projects that require removal of treated wood will use the following precautions:
      1. Treated wood debris. Use the containment necessary to prevent treated wood debris from falling into the water. If treated wood debris does fall into the water, remove it immediately.
      2. Disposal of treated wood debris. Dispose of all treated wood debris removed during a project, including treated wood pilings, at an upland facility approved for hazardous materials of this classification. Do not leave treated wood pilings in the water or stacked on the streambank.

n. Preconstruction activity. Complete the following actions before significant alteration of the Project area:
   i. Marking. Flag the boundaries of clearing limits associated with site access and construction to prevent ground disturbance of critical riparian vegetation, wetlands, and other sensitive sites beyond the flagged boundary. Construction activity or movement of equipment into existing vegetated areas must not begin until clearing limits are marked.

ii. Emergency erosion controls. Ensure that the following materials for emergency erosion control are on site: A supply of sediment control materials (e.g., silt fence, straw bales), and an oil-absorbing, floating boom whenever surface water is present.
iii. Temporary erosion controls. All temporary erosion controls will be in place and appropriately installed downslope of project activity within the riparian buffer area until site rehabilitation is complete.

o. Temporary access roads.
   i. Steep slopes. Do not build temporary roads mid-slope or on slopes steeper than 30 percent.
   ii. Minimizing soil disturbance and compaction. Low-impact, tracked drills will be walked to a survey site without the need for an access road. Minimize soil disturbance and compaction for other types of access whenever a new temporary road is necessary within 150 ft of a stream, water body, or wetland by clearing vegetation to ground level and placing clean gravel over geotextile fabric, unless otherwise approved in writing by NMFS.
   iii. Temporary stream crossings.
      1. Do not allow equipment in the flowing water portion of the stream channel where equipment activity could release sediment downstream, except at designated stream crossings.
      2. Minimize the number of temporary stream crossings.
      3. Design new temporary stream crossings as follows:
         a) Survey and map any potential spawning habitat within 300 ft downstream of a proposed crossing.
         b) Do not place stream crossings at known or suspected spawning areas, or within 300 ft upstream of such areas if spawning areas may be affected.
         c) Design the crossing to provide for foreseeable risks (e.g., flooding and associated bedload and debris) to prevent the diversion of stream flow out of the channel and down the road if the crossing fails.
         d) Vehicles and machinery will cross riparian buffer areas and streams at right angles to the main channel wherever possible.
      4. Obliteration. When the project is completed, obliterate all temporary access roads, stabilize the soil, and revegetate the site. Abandon and restore temporary roads in wet or flooded areas by the end of the inwater work period.

p. Vehicles.
   i. Choice of equipment. When heavy equipment will be used, the equipment selected will have the least adverse effects on the environment (e.g., minimally sized, low ground pressure equipment).
   ii. Vehicle staging. Fuel, operate, maintain, and store vehicles as follows:
      1. Complete vehicle staging, cleaning, maintenance, refueling, and fuel storage, except for that needed to service boats, in a vehicle staging area placed 150 ft or more from any stream, water body, or wetland, unless otherwise approved in writing by NMFS.

2. Inspect all vehicles operated within 150 ft of any stream, water body, or wetland daily for fluid leaks before leaving the vehicle staging area. Repair any leaks detected in the vehicle staging area before the vehicle resumes operation. Document inspections in a record that is available for review on request by FERC or NMFS.
3. Before activities begin and as often as necessary during construction activities, steam clean all equipment that will be used below the bankfull elevation until all visible external oil, grease, mud, and other visible contaminates are removed. Any washing of equipment must be conducted in a location that will not contribute untreated wastewater to any flowing stream or drainage area.
4. Diaper all stationary power equipment (e.g., generators, cranes, stationary drilling equipment) operated within 150 ft of any stream, waterbody, or wetland to prevent leaks, unless suitable containment is provided to prevent potential spills from entering any stream or water body.
5. At the end of each work shift, vehicles must not be stored within or over the waterway.

q. Site preparation. Conserve native materials for site rehabilitation.
   i. If possible, leave native materials where they are found.
   ii. If materials are moved, damaged, or destroyed, replace them with a functional equivalent during site rehabilitation.
   iii. Stockpile any large wood, native vegetation, weed-free topsoil, and native channel material displaced by construction for use during site rehabilitation.

r. Isolation of inwater work area. If adult or juvenile fish are reasonably certain to be present, or if the work area is less than 300 ft upstream of spawning habitats, completely isolate the work area from the active flowing stream using inflatable bags, sandbags, sheet pilings, or similar materials, unless otherwise approved in writing by NMFS.

s. Capture and release. Before and intermittently during pumping to isolate an inwater work area, attempt to capture and release fish from the isolated area using trapping, seining, electrofishing, or other methods as are prudent to minimize risk of injury.
   i. The entire capture and release operation will be conducted or supervised by a fishery biologist experienced with work area isolation and competent to ensure the safe handling of all ESA-listed fish.
   ii. If electrofishing equipment is used to capture fish, comply with NMFS' electrofishing guidelines, listed below.
      1. Do not electrofish near adult salmon in spawning condition or near redds containing eggs.
      2. Keep equipment in good working condition. Complete manufacturers' preseason checks, follow all provisions, and record major maintenance work in a log.
      3. Train the crew by a crew leader with at least 100 hours of electrofishing experience in the field using similar equipment. Document the crew leader's

experience in a logbook. Complete training in waters that do not contain listed fish before an inexperienced crew begins any electrofishing.

4. Measure conductivity and set voltage as follows:

Conductivity (µS/cm)	Voltage
Less than 100	900 to 1100
100 to 300	500 to 800
Greater than 300	150 to 400

5. Use direct current (DC) at all times.
6. Begin each session with pulse width and rate set to the minimum needed to capture fish. These settings should be gradually increased only to the point where fish are immobilized and captured. Start with pulse width of 500µs and do not exceed 5 milliseconds. Pulse rate should start at 30Hz and work carefully upwards. In general, pulse rate should not exceed 40 Hz, to avoid unnecessary injury to the fish.
7. The zone of potential fish injury is 0.5 meters from the anode. Care should be taken in shallow waters, undercut banks, or where fish can be concentrated, because in such areas the fish are more likely to come into close contact with the anode.
8. Work the monitoring area systematically, moving the anode continuously in a herringbone pattern through the water. Do not electrofish one area for an extended period.
9. Have crew members carefully observe the condition of the sampled fish. Dark bands on the body and longer recovery times are signs of injury or handling stress. When such signs are noted, the settings for the electrofishing unit may need adjusting. End sampling if injuries occur or abnormally long recovery times persist.
10. Whenever possible, place a block net below the area being sampled to capture stunned fish that may drift downstream.
11. Record the electrofishing settings in a logbook along with conductivity, temperature, and other variables affecting efficiency. These notes, with observations on fish condition, will improve technique and form the basis for training new operators.

iii. Do not use seining or electrofishing if water temperatures exceed 18°C.

iv. Handle ESA-listed fish with extreme care, keeping fish in water to the maximum extent possible during seining and transfer procedures, to prevent the added stress of out-of-water handling.

v. Transport fish in aerated buckets, tanks, or sanctuary nets that hold water during transfer. Release fish into a safe release site as quickly as possible, and as near as possible to capture sites.

vi. Do not transfer ESA-listed fish to anyone except NMFS or USFWS personnel, unless otherwise approved in writing by them.

vii. Obtain all other Federal, state, and local permits necessary to conduct the capture and release activity.

viii. Allow NMFS or the USFWS or its designated representative to accompany the capture team during the capture and release activity, and to inspect the team's capture and release records and facilities.

t. Earthwork. Complete earthwork (including drilling, excavation, dredging, filling, and compacting) as quickly as possible.
   i. Excavation. Material removed during excavation will only be placed in locations where it cannot enter sensitive aquatic resources. Whenever topsoil is removed, it must be stored and reused on site to the greatest extent possible. If culvert inlet/outlet protecting riprap is used, it will be class 350 metric or larger, and topsoil will be placed over the rock and planted with native woody vegetation.
   ii. Drilling and sampling. If drilling, boring, or jacking is used, the following conditions apply.
      1. Isolate drilling activities in wetted stream channels using a steel pile, sleeve, or other appropriate isolation method to prevent drilling fluids from contacting water.
      2. If it is necessary to drill through a bridge deck, use containment measures to prevent drilling debris from entering the channel.
      3. If directional drilling is used, the drill, bore, or jack hole will span the channel migration zone and any associated wetland.
      4. Sampling and directional drill recovery/recycling pits, and any associated waste or spoils, will be completely isolated from surface waters, off-channel habitats, and wetlands. All drilling fluids and waste will be recovered and recycled or disposed to prevent entry into flowing water.
      5. If a drill boring conductor breaks and drilling fluid or waste is visible in water or a wetland, all drilling activity will cease, pending written approval from NMFS to resume drilling.
   iii. Site stabilization. Stabilize all disturbed areas, including obliteration of temporary roads, following any break in work, unless construction will resume within 4 days.
   iv. Source of materials. Obtain boulders, rock, woody materials, and other natural construction materials used for the project outside the riparian buffer area.

u. Implementation monitoring. For projects undertaken by or funded by PacifiCorp or Cowlitz PUD, PacifiCorp or Cowlitz PUD will include the status of a project or a description of the completed project in the annual report. This annual report will submitted to FERC and NMFS describing the success in meeting the RPMs and associated terms and conditions of the Opinion and will include the following.
   i. Project identification.
      1. Project implementor name, project name, detailed description of the project.
      2. Project location by 5th or 6th field HUC and by latitude and longitude as determined from the appropriate U.S. Geological Survey 7-minute quadrangle map.
      3. Starting and ending dates for the work completed.
   ii. Photo documentation. Photo documentation of habitat conditions at the project site before, during, and after project completion.
      1. Include general views and close-ups showing details of the project and project area, including pre- and post-construction.

2. Label each photo with date, time, project name, photographer's name, and documentation of the subject activity.

iii. Other data. Additional project-specific data, as appropriate, for individual projects.

1. Work cessation. Dates work ceased because of high flows, if any.
2. Fish screen. Compliance with NMFS' fish screen criteria.
3. Pollution and Erosion Control Plan. A summary of pollution and erosion control inspections, including any erosion control failures, contaminant releases, and correction efforts.
4. Description of site preparation.
5. Isolation of inwater work area, capture, and release.
   a) Supervisory fish biologist's name and address.
   b) Methods of work area isolation and take minimization.
   c) Stream conditions before, during, and within 1 week after completion of work area isolation.
   d) Means of fish capture.
   e) Number of fish captured by species.
   f) Location and condition of all fish released.
   g) Any incidence of observed injury or mortality of listed species.
6. Streambank protection.
   a) Type and amount of materials used.
   b) Project size - one bank or two, width, and linear feet.
7. Site rehabilitation. Photo or other documentation that site rehabilitation performance standards were met.

NMFS will be reviewing the detailed construction plans submitted to advise FERC regarding whether or not those plans are likely to meet the "best management practices" articulated in this incidental take statement terms and conditions, or such additional best management practices that NMFS deems appropriate.

3) Conditions for research for the monitoring and evaluation identified in the November 30, 2004 Lewis River Settlement Agreement. Not all of these conditions may apply to the specific actions authorized by this ITS. Nonetheless, failure to adhere to any condition that does apply may cause NMFS to revoke the ITS.

a. All Monitoring and Evaluation plans associated with anadromous fish developed under the November 30, 2004 Lewis River Settlement Agreement must meet NMFS' satisfaction and must be approved by NMFS. Work will be conducted by PacifiCorp, Cowlitz PUD, or those hired by the Licensee(s) to conduct the work.
To ensure that the monitoring and evaluation plan will provide a benefit to listed species, and provide useful information on the effectiveness of various aquatic measures as well as achievement of the Reintroduction Outcome Goals, PacifiCorp and Cowlitz PUD will develop plan(s) and methods to monitor aspects of the various aquatic measures, including:

- Fish passage
- Adult anadromous salmonid migration, spawning, distribution, and abundance
- Water quality
- Hatchery supplementation programs
- Resident fish species

The Licensees' plan(s), among other items, will thoroughly describe of all methods that will be used to capture fish and how fish will be handled; details such as sampling locations and dates; and invasive procedures such as tagging, taking tissue samples, or sacrifice and will explain the purpose of each. Each plan will include estimates of the number of each species and life stage that will be handled and/or killed for that study. In addition, the plans will include methods by which they will be modified if empirical evidence indicates that negative effects on a species/life stage are greater than expected. The Licensees' will provide NMFS with annual reports, which NMFS will use to determine whether or not to authorize the next year's work under a multiyear plan. NMFS must approve all plans in writing before they are implemented.

b. The evaluator must ensure that listed species are taken only at the levels, by the means, in the areas, and for the purposes stated in the plans developed, and according to the conditions in this permit.

c. The evaluator must not intentionally kill or cause to be killed any listed species unless the plan specifically allows intentional lethal take.

d. The evaluator must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the researcher must process listed fish first to minimize handling stress.

e. The evaluator must stop handling listed juvenile fish if the water temperature exceeds 70° F at the capture site. Under these conditions, listed fish may only be visually identified and counted.

f. If the evaluator anesthetizes listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

g. The evaluator must use a sterilized needle for each individual injection when PIT-tags are inserted into listed fish.

h. If the evaluator unintentionally captures any listed adult fish while sampling for juveniles, the adult fish must be released without further handling and such take must be reported.

i. The evaluator must exercise care during spawning ground surveys to avoid disturbing listed adult salmonids when they are spawning. Evaluators must avoid walking in salmon streams whenever possible, especially where listed salmonids are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when just determining fish presence.

j. The evaluator must use the other applicable terms and conditions in this ITS including, but not limited to, term and condition 2.s.

k. The evaluator must obtain approval from NMFS before changing sampling locations or research protocols.

l. The evaluator must notify NMFS as soon as possible but no later than 2 days after any authorized level of take is exceeded or if such an event is likely. The evaluator must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

m. The evaluator is responsible for any biological samples collected from listed species as long as they are used for research purposes. The evaluator may not transfer biological samples to anyone not listed in the application without prior written approval from NMFS.

n. The person(s) actually doing the evaluation must carry a copy of this ITS and the applicable plan while conducting the authorized activities.

o. The evaluator must allow any NMFS employee or representative to accompany field personnel while they conduct the evaluation activities.

p. The evaluator must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

q. The evaluator must obtain all other Federal, state, and local permits/authorizations needed for the evaluation activities.

r. Every year, the evaluator must submit to NMFS a post-season report in the prescribed form (ATTACHMENT 2) describing the evaluation activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the monitoring results. This report may be included in the annual report identified in the SA and required by this ITS. Falsifying annual reports or permit records is a violation of this ITS.

s. If the evaluator violates any permit condition they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the permit and the requirements of the ESA or if NMFS determines that its ESA findings are no longer valid.

t. Listed fish mortalities and tissue samples will be returned to the capture site.

4) Within 2 days of observance, reports of dead or injured salmon or steelhead shall be sent to:

Lewis Hydro Projects Staff Lead
HydroPower Division
National Marine Fisheries Service
1201 NE Lloyd Blvd., Suite 1100
Portland, Oregon 97232

Include a concise description of the causative event (if known), and a description of any resultant corrective actions taken (if any) to reduce the likelihood of future mortalities or injuries.

10. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary measures that NMFS believes are consistent with an Action Agencies' obligation. NMFS has no conservation recommendations to make at this time.

11. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

11.1 Background

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

The Pacific Fishery Management Council designated EFH for groundfish (PFMC 1998a), coastal pelagic species (PFMC 1998b), and Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). The Proposed Action and action area for this consultation are described in Sections 3 and 4 (Proposed Action and Environmental Baseline, respectively) of this document. The action area includes areas designated as EFH for various life-history stages of Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*).

Based on information provided in the Biological Evaluation incorporated by referenced by the FEISand the analysis of effects presented in the ESA portion of this document, NMFS concludes that Proposed Action will have the adverse effects on EFH designated for Pacific Coast salmon described in Section 5 (Effects of the Action).

11.2 EFH Conservation Recommendations

The NMFS understands that the measures described in the new licenses will be implemented by PacifiCorp and Cowlitz PUD and enforced by FERC. Although these Settlement Agreement measures are designed to protect and enhance EFH over the term of the licenses, we still anticipate some adverse impacts to EFH. However, the four terms and conditions in the incidental take statement (Section 9 of this Opinion) are applicable to designated EFH for Chinook and coho salmon and will minimize these adverse effects. Consequently, NMFS hereby adopts all of the terms and conditions in its incidental take statement as its EFH recommendations.

11.3 Statutory Response Requirement

Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations [50 CFR 600.920(j) (1)]. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse affects of the activity on EFH. If the response is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations. The reasons must include the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

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

11.4 Supplemental Consultation

FERC must reinitiate EFH consultation with NMFS if the Proposed Action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations [50 CFR 600.920(k)].

12. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

Utility

This document records the results of an interagency consultation. The information presented in this document is useful to two agencies of the Federal government (NMFS and FERC), the Licensees (PacifiCorp and Cowlitz PUD), and the general public. These consultations help to fulfill multiple legal obligations of the named agencies. The information is also useful and of interest to the general public as it describes the manner in which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information and has been improved through interaction with the consulting agency.

This consultation will be posted on the NMFS Northwest Region website (http://www.nwr.noaa.gov). The format and name adhere to conventional standards for style.

Integrity

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

Objectivity

<u>Information Product Category:</u> Natural Resource Plan.

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

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

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

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

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ATTACHMENT 1: Anadromous Salmonid Passage Facility Guidelines and Criteria (2004)

ATTACHMENT 2: Post-Season Monitoring and Evaluation Form

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ATTACHMENT 1

Anadromous Salmonid Passage Facility Guidelines and Criteria (2004)

1-31-04 external review draft

ANADROMOUS SALMONID PASSAGE FACILITY GUIDELINES AND CRITERIA

Developed by
National Marine Fisheries Service
Northwest Region
Portland, Oregon

FOREWORD

The task involved in successfully passing fish upstream or downstream of an in-river impediment is a dynamic integration of fish behavior, physiology and bio-mechanics with hydraulic analysis, hydrologic study and engineering. Installing a fish passage structure does not constitute providing satisfactory fish passage, unless all of the above components are adequately factored into the design. The following document provides criteria, rationale, guidelines and definitions for the purpose of designing proper fish passage facilities for the safe, timely and efficient upstream and downstream passage of anadromous salmonids at impediments created by man-made structures, natural barriers (where provision of fish passage is consistent with management objectives), or altered in-stream hydraulic conditions. This document provides regional guidance for the National Marine Fisheries Service (NOAA Fisheries) fishway policies and guidelines, and is to be used for actions pertaining to the various authorities and jurisdictions of NOAA Fisheries (including Section 18 of the Federal Power Act), and for consultation under the Endangered Species Act and the Magnuson-Stevens Act. Section 12 (Juvenile Fish Screen and Bypass Criteria) supercedes previous criteria published by NOAA Fisheries, including Juvenile Fish Screen Criteria (February 16, 1995) and Juvenile Fish Screen Criteria for Pump Intakes (May 9, 1996). If passage facilities are designed and constructed in a manner consistent with these criteria, adverse impacts to migration will be minimized.

Instances will occur where a fish passage facility may not be a viable solution for correcting a passage impediment, due to biologic, sociologic, or economic constraints. In these situations, removal of the impediment or altering operations may be a suitable surrogate for a constructed fish passage facility. In other situations, accomplishing fish passage may not be an objective of NOAA Fisheries because of factors such as limited habitat, or lack of naturally occurring runs of anadromous fish upstream of the site. To determine whether NOAA Fisheries will use its various authorities to promote or to prescribe fish passage, NOAA Fisheries will rely on a collaborative approach, considering the views of other fisheries resource agencies, Native American Tribes, non-government organizations, and citizen groups, and will strive to accomplish the objectives in sub-basin plans for fisheries restoration and enhancement.

In general, NOAA Fisheries requires volitional passage, as opposed to trap and haul, for all passage facilities. This is primarily due to the risks associated with the handling and transport of migrant salmonids, in combination with the long term uncertainty of funding, maintenance and operation of the trap and haul program. However, there are instances in which trap and haul may be the only viable option for upstream and/or downstream fish passage at a particular site.

The fish passage facilities described in this document include various *fish ladders*[1], *exclusion barriers*, trap and haul facilities, fish handling and sorting facilities, in-stream structures and road crossings structures such as culverts or bridges, juvenile fish screens, tide gates, infiltration gallery, upstream juvenile passage facilities, and specialized criteria for mainstem Columbia and Snake River passage facilities. Passage facilities for projects under NOAA Fisheries jurisdiction should be consistent with the details described in this document, with the facility design developed in close coordination with NOAA Fisheries fish passage specialists.

This document does not address any aspect of design other than those that provide for safe and timely fish passage. Structural integrity, public safety and other aspects of facility design are the responsibility of the principal design engineer, who should ensure that the final facility design meets all other requirements in addition to the fish passage criteria and guidelines contained in this document.

Proponents of new, unproven fish passage designs (i.e. not meeting the criteria and guidelines contained in this document) shall provide to NOAA Fisheries: 1) development of a biological basis for the concept; 2) demonstration of favorable fish behavioral response in a laboratory setting; 3) an acceptable plan for evaluating the prototype installation; and 4) an acceptable alternate plan developed concurrently for a fish passage design satisfying these criteria, should the prototype not adequately protect fish. Additional information on the NOAA Fisheries approval process for unproven fish passage devices can be found in Section 17.

Since these criteria are general in nature, there may be cases where site constraints or extenuating biological circumstances dictate that certain criteria be waived or modified without delaying or otherwise adversely impacting anadromous fishes. It is the responsibility of the applicant to provide compelling evidence in support of any proposed waiver. Conversely, where NOAA Fisheries deems there is a need to provide additional protection for fish, more restrictive site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis. In addition, there may be instances where NOAA Fisheries provides written approval for use of alternative passage criteria, if NOAA Fisheries determines that the alternative criteria provides equal or superior protection as compared to the criteria listed herein,
for a particular site or for a set of passage projects within the Northwest Region.

Criteria are design, maintenance or operational standards that can not be changed without a written waiver from NOAA Fisheries. For the purposes of this document, a criterion is described by the word “shall”. A guideline is a recommended design, maintenance or operational feature that will generally result in safe and efficient *fishway* facility design, and for the purposes of this document are described by the word “should”. A waiver from NOAA Fisheries is not required

[1] Words printed in *italics* are defined in Section 2.

to deviate from a guideline. However, if the designer is unable to follow a guideline, the designer shall describe for the NOAA Fisheries administrative record the site specific circumstances that led to the chosen alternative. Where new or updated information suggests a different standard (criterion or guideline) provides better fishway passage, operation or maintenance this document will be periodically updated.

Existing facilities may not adhere to the criteria and guidelines listed in this document. However, that does not mean these facilities must be modified specifically for compliance with this document. The intention of these criteria and guidelines is to assure future compliance in the context of fish passage facilities major upgrades and new designs.

The following document is hereby designated as NOAA Fisheries Northwest Regional guidance for fish passage design responsibilities under the ESA, FPA and Magnusen-Stevens Act, for the purpose of providing project proponents with NOAA Fisheries' perspective on properly designed fish passage facilities. This document was developed by Hydro Division Fish Passage Engineers, in a collaborative process with many interested regional parties. This guidance is considered to be a working document, thus as new knowledge in fish passage is gained, these guidelines and criteria will be updated as necessary. Suggested changes, additions or questions should be directed to Bryan Nordlund of NOAA Fisheries at (360) 534-9338, for consideration in updating this document. Assistance from NOAA Fisheries fish passage specialists can be obtained by contacting the Hydro Division at (503) 230-5414.

Adopted,

Regional Administrator

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Section 1. Upstream Passage Impediments

1.1 An **upstream passage impediment is defined** as any manmade structural feature or project operation that causes adult or juvenile fish to be injured, killed, blocked or delayed on their upstream migration, to a greater degree than in a natural river setting. Manmade impediments require a design to utilize conservative criteria, because the natural complexity that usually provides fish passage has been substantially altered.

This definition is provided for the purpose of describing situations in which NOAA Fisheries will use these criteria in reviewing mitigative measures aimed at improving fish passage at an impediment. Any upstream passage impediment requires approved structural and/or operational measures to mitigate for adverse impacts to *upstream fish passage*. In addition, this criteria is applicable where passage over a natural barrier is desired, consistent with sub-basin or recovery plans.

1.2 It is important to note that not every *upstream passage facility* can fully compensate for an unimpeded natural channel. As such, additional mitigation measures could be required and will be established on a case-by-case basis.

1.3 Examples of upstream passage impediments include, but are not limited to:

1.3.1 Permanent or intermittent dams where either adult or juvenile upstream migrants are present, if fish cannot readily pass at any streamflow.

1.3.2 *Static head* over a manmade instream structure in excess of 1.5 feet.

1.3.3 *Weir*s, *aprons*, hydraulic jumps or other hydraulic features that produce shallow depth (less than 10 inches), high flow velocity (greater than 12 ft/s) for over 90% of the stream channel cross section, or exceed the hydraulic criteria specified for culvert length specified in Section 8.5.6.

1.3.4 Diffused or braided flow that impedes the approach to the impediment.

1.3.5 Road crossing culverts not achieving the criteria specified in Section 8.

1.3.6 Project operations that lead upstream migrants to impassable routes or cause excess migration delays.

1.3.7 Improperly designed fish passage (see Section 5) or fish collection facilities (see Sections 6 and 7).

1.3.8 Headcut control or improperly designed bank stabilization measures.

1.3.9 Insufficient *bypass reach* flows to induce upstream migrants to move upstream into the *bypass reach* adjacent to a powerhouse or *wasteway* return.

1.3.10 Degraded *bypass reach* discharge water quality, relative to that downstream of the confluence of *bypass reach* and return discharges.

1.3.11 Instream or *bypass reach* ramping rates that delay or strand fish.

1.3.12 Return discharges to the stream that may be detected and ascended by fish, with no certain means of continuing their upstream migration

1.3.13 Return discharges to the stream that are attractive to upstream migrating fish (eg. turbine draft tubes, shallow *aprons* and flow discharges) that have the potential to cause

injury.
1.3.14 Water diversions.

Section 2. Definition of Key Terms

Terms defined in this section are identified in *italics* throughout the document**.**

Active screens - juvenile fish screens equipped with a cleaning system with proven cleaning capability, and which are automatically cleaned as frequently as necessary to keep the screens free of any debris that will restrict flow area. An active screen is the required design in most instances.

Approach velocity - the vector component of *true velocity* that is perpendicular to and in front of the screen face, calculated by dividing the maximum diverted flow amount by the *effective screen area*.

Apron - a flat, usually slightly inclined slab below a flow control structure that provides for erosion protection and produces hydraulic characteristics suitable for energy dissipation or in some cases fish exclusion.

Attraction flow - the flow that emanates from a *fishway entrance* in sufficient quantity and location to attract upstream migrants into the *fishway*. Attraction flow consists of gravity flow from the fish ladder, plus auxiliary water system flow added in the lower ladder.

Auxiliary water system - a hydraulic system that augments *fish ladder* flow at various points in the *upstream passage facility*. Typically, large amounts of auxiliary water flow are added in the *fishway entrance pool* in order to increase the attraction of the *fishway entrance*.

Backwash - Providing debris removal by pressurized wash, opposite the normal flow direction.

Bankfull - The minimum elevation of a point on a streambank at which overflow into the *floodplain* begins. The *floodplain* is a relatively flat area adjacent to the channel constructed by the stream and overflowed by the stream at a recurrence interval of about one to two years. If the *floodplain* is absent or poorly defined, other indicators may identify bankfull. These include the height of depositional features, a change in vegetation, slope or topographic breaks along the bank, a change in the particle size of bank material, undercuts in the bank, and stain lines (the lower extent of lichens and moss on boulders). Field determination of bankfull should be calibrated to known stream flows or to regional relationships between bankfull flow and watershed drainage area.

Baffles - physical structures placed in the flow path designed to dissipate energy, or to re-direct flow for the purpose of achieving more uniform flow conditions.

Bedload - Sand, silt, gravel, or soil and rock debris transported by moving water. The particles of this material have a density or grain size that prevents movement far above or for a long distance out of contact with the streambed under natural flow conditions.

Bifurcation (*Trifurcation*) pools - pools where two or three sections of *fish ladder*s join.

Brail - a device that moves upward (vertically) through the water column, crowding fish into an area for collection.

Bypass reach - the portion of the river between the point of flow diversion and the point of flow return to the river.

Bypass System - the component of a downstream passage facility that transports fish from the diverted water back into the body of water from which they originated, usually consisting of a bypass entrance, a bypass conduit and a bypass outfall.

Coarse trash rack - a rack of vertical bars designed to catch large debris and preclude it from entering the *fishway*, while providing sufficient opening to allow the passage of fish.

Conceptual design - an initial design concept, based on the site conditions and biological needs of the species intended for passage.

Crowder - a combination of static and/or movable picketed and/or solid leads installed in a *fishway* for the purpose of moving fish into a specific area for sampling, counting, broodstock collection, or other purposes.

Diffuser - typically, a set of horizontal or vertical bars designed to introduce flow into a *fishway* in a nearly uniform fashion, but could also be of different geometry.

Distribution flume - a channel used to route fish to various points in a fish trapping system.

Effective screen area - the total submerged screen area (excluding major structural members). For rotating drum screens, this is the area that projects onto a vertical plane.

End-of-pipe screens - juvenile fish screening devices attached directly to the intake of a diversion pipe.

Exclusion barriers - upstream passage facilities that prevent upstream migrants from entering areas with no upstream egress, or areas that could lead to fish injury.

Exit control section - the upper portion of an *upstream passage facility* that serves to provide suitable passage conditions to accommodate varying *forebay* water surfaces, through means of pool geometry, *weir* design and the capability to add or remove flow at specific locations.

False weir - a device that adds pressurized flow to the top of a denil or steeppass ladder, normally used in conjunction with a *distribution flume* that routes fish to a specific area for management or other purposes.

Fish ladder - the structural component of an *upstream passage facility* that dissipates the potential energy into discrete pools or uniformly dissipates energy in a baffled chute to provide passage for upstream migrants.

Fish lift - a mechanical component of an upstream passage system that provides fish passage by lifting fish in a water-filled *hopper* or other lifting device into a conveyance structure that delivers upstream migrants past the passage impediment.

Fish lock - a mechanical and hydraulic component of an upstream passage system that provides fish passage by attracting or crowding fish into the lock chamber, activating a closure device to prevent fish from escaping, introducing flow into the enclosed lock, and raising the water surface to *forebay* level, and then opening a gate to allow the fish to exit.

Fish weir (or *picket weir*) - a device with closely spaced pickets to allow passage of flow, but not targeted adult fish. This device is commonly used in conjunction with an adult fish trap, for the purpose of broodstock collection. It is also used for the sorting of both wild and hatchery adult fish in the trap. This is not a *weir* in the hydraulic sense.

Fishway - the set of facilities, structures, devices, measures, and project operations that together constitute, and are critical to the success of, any upstream or downstream fish passage system.

Fishway entrance - the component of an *upstream passage facility* that discharges *attraction flow* into the *tailrace*, where upstream migrant fish enter (and flow exits) the *fishway*.

Fishway exit - the component of an *upstream passage facility* where flow from the *forebay* enters the *fishway*, and where fish exit into the *forebay* upstream of the passage impediment.

Fishway entrance pool - the pool immediately upstream of the *fishway entrance*(s).

Fishway entrance weir - a term frequently used to describe the partition between adjacent pools in a *fishway*.

Flood frequency - the frequency with which a flood of a given discharge has the probability of recurring. For example, a "100-year" frequency flood refers to a flood discharge of a magnitude likely to occur on the average of once every 100 years, or, more properly, has a one-percent chance of being exceeded in any year. Although calculation of possible recurrence is often based on historical records, there is no guarantee that a "100-year" flood will occur at all within the 100- year period or that it will not recur several times.

Floodplain - the area adjacent to the stream that is inundated during periods of high flow. The *floodplain* area is constructed by the river.

Flow duration curve - a statistical summary of river flow information over a period of time that describes cumulative percent of time for which flow exceeds specific levels (exceedance flows), exhibited by a cumulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded. *Flow duration curve*s are usually based on daily streamflow and describe the flow characteristics of a stream throughout a range of discharges without regard to the sequence of occurrence. If years of data are plotted, the annual exceedance flows can be determined.

Flow egress weir - a *weir* used to route excess flow (without fish) from a fish facility.

Forebay - the water body impounded immediately above a dam.

Freeboard - the height of a wall or other structure that extends above the maximum water surface elevation.

Hatchery supplementation - a hatchery propagation approach utilizing the progeny of local wild broodstock. Typically, the progeny are released into acclimation ponds at underused habitat locations.

Headloss - the loss of energy through a hydraulic structure.

Hopper - a device used to lift fish (in water) from a collection or holding area, for release upstream of the impediment.

Hydraulic drop - the energy difference between an upstream and downstream water surface, considering potential (elevation) and kinetic energy (*velocity head*). Also referred to as the "total energy head differential" as defined by Bernoulli's equation.

Off-ladder trap - A trap that is adjacent to a *fish ladder*, located in a sample loop which is separate from the normal *fish ladder* route - allows fish to either pass the ladder, or be routed into the trap

Ordinary high water mark - The mark along the bank or shore up to which the presence and action of the water are common and usual, and so long continued in ordinary years as to leave a natural line impressed on the bank or shore and indicated by erosion, shelving, changes in soil characteristics, destruction of terrestrial vegetation, or other distinctive physical characteristics.

Passive screens - juvenile fish screens with no automated cleaning system.

Picket leads - a set of vertically inclined flat bar or circular slender columns (pickets), designed to lead fish to a specific point of passage.

PIT tag detector - a device that passively scans a fish for the presence of a passive integrated transponder (PIT) tag.

Plunging flow - flow over a *weir* that falls into the receiving pool with a water surface elevation below the *weir* crest elevation. Generally, flow at the receiving pool water surface is in the upstream direction.

Porosity - the percent flow-through open area of a mesh, screen or rack relative to the entire gross area.

Rating curve - the graphed data depicting the relationship between water surface elevation and flow amount.

Redd - deposition of fish eggs in gravel.

Screen media - the screen face material that provides a physical exclusion barrier to reduce the probability of entraining fish.

Section 10 and 404 Regulatory Programs - The principal Federal regulatory programs, carried out by the U.S. Army Corps of Engineers, affecting structures and other work below mean high water. The Corps, under Section 10 of the River and Harbor Act of 1899, regulates structures in, or affecting, navigable waters of the U.S. as well as excavation or deposition of materials (e.g., dredging or filling) in navigable waters. Under Section 404 of the Federal Water Pollution Control Act Amendments (Clean Water Act of 1977), the Corps is also responsible for evaluating application for Department of the Army permits for any activities that involve the placement of dredged or fill material into waters of the United States, including adjacent wetlands.

Static head - the upstream-to-downstream difference in water surface elevation over a hydraulic control structure (also referred to sometimes as *hydraulic drop*).

Streaming flow - flow over a *weir* which falls into a receiving pool with water surface elevation above the *weir* crest elevation. Generally, flow at the receiving pool water surface is in the downstream direction.

Sweeping velocity - the vector component of *true velocity* that is parallel and adjacent to the screen face.

Tailrace - the river immediately downstream of an instream structure.

Total project head - the difference in water surface elevation from upstream to downstream of an impediment such as a dam. Normally, *total project head* encompasses a range based on river flows and/or the operation of flow control devices.

Thalweg - the line connecting the deepest parts of a stream channel

Tide Gate - a gate used in coastal areas to regulate tidal intrusion into protected areas.

Transport Channel - a hydraulic conveyance designed to pass fish between different sections of a fish passage facility.

True velocity - the velocity of flow in a water diversion, usually parallel to the bankline.

Turbine intake screens - partially screened turbine intakes on the mainstem Columbia and Snake River dams, which guide fish up a gatewell and into a collection and transport or bypass system.

Upstream fish passage - fish passage relating to upstream migration of adult and/or juvenile fish.

Upstream passage facility - a *fishway* system designed to pass fish upstream of a passage impediment, either by volitional passage or non-volitional passage.

Velocity head - the energy of flow contained by the water velocity.

Vertical barrier screens - screens that dewater flow from *turbine intake screens*, thereby concentrating fish for passage into a bypass system.

Wasteway - a channel (or other conveyance) which returns water originally diverted from an upstream location back to the diverted stream, whether for agricultural, power, or other uses.

Weir - a hydraulic term for an obstruction over which water flows (see also *fish weir* and *fishway entrance weir*).

Section 3. Preliminary Design Development

3.1 In cases such as (but not limited to) applications for a FERC license, ESA consultation, ESA Section 9 Enforcement activity, or ESA permit, a preliminary design for an *fish passage facility* shall be developed in an interactive process with NOAA Fisheries Hydro Program staff. For all *fish passage facility* projects, the preliminary design should be developed on the basis of a synthesis of the required site and biological information listed below. In general, NOAA Fisheries will review fish facility designs in the context of how the required site and the biological information was integrated into the design. Submittal of all information discussed below may not be required in writing for NOAA Fisheries review. However, the applicant should be prepared to describe how the biological and site information listed below was included in the development of the preliminary design. NOAA Fisheries will be available to discuss these criteria in general or in the context of a specific site. The applicant is encouraged to initiate coordination with NOAA Fisheries fish passage specialists early in the development of the preliminary design to facilitate an iterative, interactive, and cooperative process.

3.2 Site Information: The following site information should be provided for the development of the preliminary design.

3.2.1 Functional requirements of the proposed fish passage facilities as related to all anticipated operations and river flows. Describe median, maximum, and minimum monthly diverted flow rates, plus any special operations (eg. use of flash boards) that modify *forebay* or *tailrace* water surface elevations.

3.2.2 Site plan drawing showing location and layout of the proposed *fishway* relative to existing project features facilities.

3.2.3 Topographic and bathymetric surveys, particularly where they might influence locating *fishway entrance*s and exits, and personnel access to the site.

3.2.4 Drawings showing elevations and a plan view of existing flow diversion structures, including details showing the intake configuration, location, and capacity of project hydraulic features.

3.2.5 Basin hydrology information, including daily and monthly streamflow data and flow duration exceedence curves at the proposed *fish passage facility* site based on the entire period of available record. Where stream gage data is unavailable, or if a short period of record exists, appropriate synthetic methods of generating flow records may be used.

3.2.6 Project operational information that may affect fish migration (e.g., powerhouse flow capacity, period of operation, etc.)

3.2.7 Project *forebay* and tailwater *rating curve*s encompassing the entire operational range.

3.2.8 River morphology trends - If the *fish passage facility* is proposed at a new or modified diversion, determine the potential for channel degradation, meander or channel migration that may alter tailwater geometry and compromise *fishway* performance. Prepare to address potential adverse effects of stream channel gradient changes in this reach. Describe whether the river channel is stable or meandering, and how much recent meandering has occurred. Also, describe what effect the proposed *fish passage facility* may have on river alignment and the potential for future meandering.

3.2.9 Special sediment and/or debris problems - Describe conditions that may influence design of the *fish passage facility*, or present potential for significant problems.

3.3 Biological Information: The following biological information should be provided for the development of the preliminary design.

3.3.1 Type, life stage and run size of anadromous species present.

3.3.2 Run size, period of migration, spawning location, spawning timing and run duration for each life stage and species present at the site.

3.3.3 Identify other species present at the proposed fish passage site (including life stage), that may impact the facility design, particularly if state or Federally listed species are present.

3.3.4 High and low design passage flow for periods of *upstream fish passage* (see Section 4).

3.3.5 Identify any known fish behavioral aspects that affect salmonid passage. For example, most salmonid species pass readily through orifices, but other species unable to pass through orifices may impede salmonid passage.

3.3.6 Identify what is known and what needs to be researched about fish migration routes approaching the site.

3.3.7 Document, or estimate, minimum streamflow required to allow migration around the impediment during low water periods (based on past site experience).

3.3.8 Predation/poaching - describe the degree of human activity in immediate area and the need for security measures.

3.3.9 Identify water quality factors that may affect fish passage at the site. Fish may not migrate if water temperature and quality are marginal, instead seeking holding zones until water quality conditions improve.

3.4 Design Development Phases: A description of steps in the design process is presented here to clarify the *preliminary design* as it contrasts with often-used and related terms in the design development process. The following are commonly used terms (especially in the context of larger facilities) by many public and private design entities. NOAA Fisheries engineering staff may be consulted for all phases of design; required reviews are described in 3.4.5.

3.4.1 A reconnaissance study is typically an early investigation of one or more sites for suitability of design and construction of some type of facility.

3.4.2 A conceptual alternatives study lists types of facilities that may be appropriate for accomplishing objectives at a specific site, and does not entail much on-site investigation. It results in a narrowed list of alternatives that merit additional assessment.

3.4.3 A feasibility study includes an incrementally greater amount of development of each design concept (including a rough cost estimate), which enables selection of a most-preferred alternative.

3.4.4 The preliminary design includes additional and more comprehensive investigations and design development of the preferred alternative, and results in a facilities layout (including some section drawings), with identification of primary feature sizes and discharges. Cost estimates are also considered to be more accurate. Completion of the preliminary design commonly results in a preliminary design document that may be used for budgetary and planning purposes, and as a basis for soliciting (and subsequent collating) design review comments by other reviewing entities. The preliminary design is commonly considered to be at the 20% to 30% completion stage of the design process.

3.4.5 The detailed design phase uses the preliminary design as a springboard for preparation of the final design and specifications, in preparation for the bid solicitation (or negotiation) process. Once the detailed design process commences, NOAA Fisheries shall have the opportunity to review and provide comments at the 50% and 90% completion stages. These comments usually entail refinements in the detailed design that will lead to operations, maintenance, and fish safety benefits. Electronic drawings accompanied by eleven by seventeen inch are the preferred review medium.

Section 4. Design Flow Range

4.1 **Description, purpose and rationale:** The design streamflow range constitutes the operational bounds of the *fish passage facility*. Each *fish passage facility* shall be designed to pass migrants throughout a design streamflow range, bracketed by a designated high and low design passage flow. Within this range of streamflow, migrants should be able to pass safely and quickly. Outside of this flow range, fish shall either not be present or not be actively migrating, or shall be able to pass safely without need of a *fish passage facility*. Site-specific information is critical to determine the design time period and river flows for the passage facility - local hydrology may require that these design streamflows be modified for a particular site. In addition, the *fish passage facility* should be of sufficient structural integrity to withstand the maximum expected flow. It is beyond the scope of this document to specify structural criteria for this purpose.

Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

4.2 **Low Fish Passage Design Flow** is the mean daily average stream discharge that is exceeded 95% of the time during periods when migrating fish are normally (i.e. historically) present at the site, as determined by a flow-duration curve summarizing at least the previous 25 years of daily discharges, or by an appropriate artificial streamflow duration methodology if discharge records are not available. The low passage design flow is the lowest stream discharge for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage. This could also be the minimum instream flow, as determined by state regulatory agencies, ~~or~~ by ESA consultations with NOAA Fisheries, or by an article in a FERC license.

4.3 **High Fish Passage Design Flow** is the mean daily average stream discharge that is exceeded 5% of the time during periods when migrating fish are normally (historically) present at the site, as determined by a flow-duration curve summarizing at least the previous 25 years of daily discharges, or by an appropriate artificial streamflow duration methodology if discharge records are not available. This is the highest stream discharge for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage.

4.4 The *fishway* design should have sufficient river *freeboard* to minimize overtopping by 50 year flood flows. *Fishway* operations may include shutdown of the facility at very high flow or flood flow, in order to allow the facility to quickly return to proper operation when the river drops to within the range of passage design flows. Other mechanisms to protect *fishway* operations after floods will be considered on a case by case basis. In no case shall a *fishway* be inoperable for a period greater than 7 days during the migration period for any anadromous salmonid species.

4.5 The *fishway* design shall allow for safe, timely and efficient fish passage throughout the entire range of operations of the diversion structure causing the passage impediment. If the *fishway* can not be operated, the diversion structure should be shut down.

Section 5. Upstream Passage System Criteria

5.1 Types of *fish ladder*s

5.1.1 **Description, purpose and rationale:** The intent of this section is to identify potential pitfalls of a particular ladder type given specific site conditions, and to provide additional criteria for use with a specific type of *fish ladder*.

Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

There are three basic categories of types of fish ladder. The most widely used is the pool-type ladder, characterized by a series of pools separated by fishway weirs that break the *total project head* into passable increments. Nearly all of the energy from upstream pools is dissipated in the downstream pool volume, resulting in a series of relatively quiescent pools that migrating fish can use to rest, stage and ascend upstream. Four examples of a pool-type ladder are a vertical slot (section 5.1.2), a pool and weir ladder (section 5.1.3), a weir and orifice ladder (section 5.1.4), and full width stream weirs (section 5.1.5). A second category of fish ladder is the roughened chute ladder, which consists of a hydraulically roughened channel with continuous energy dissipation throughout its length. Four examples of a roughened chute style of ladder are a steeppass, denil, a roughened stream channel and a pool-chute fish ladder (section 5.1.5).

In addition to describing the configuration and application of the particular styles of fish ladders, this section identifies general criteria and guidelines for use in completing the remainder of the upstream passage facility design.

5.1.2 **Vertical slot ladder -** The vertical slot configuration is a pool type of *fish ladder* widely used for the passage of salmon and steelhead. The passage corridor typically consists of 1 to 1.25 foot-wide vertical slots between *fishway* pools. However, narrower slots have been used in applications for other fish species and slots can be wider in designs (or two slots can be used per weir) where there is no *auxiliary water system* (see section 5.4). For anadromous salmonids, slots should never be less than one foot in width. This type of ladder is suitable for passage impediments which have *tailrace* and *forebay* water surface elevations that fluctuate at approximately the same rate. Maximum head differential (typically associated with lowest river flows) establishes the design water surface profile, which is on average, parallel to the fishway floor gradient. Vertical slot ladders require fairly intricate forming for concrete placement, so initial construction costs are somewhat higher than for other types of ladders.

Insert Drawing showing pool dimensions, slot orientation/dimensions and slot geometry

5.1.3 **Pool and weir ladder -** The pool and weir *fish ladder* passes the entire, nearly constant fishway flow through successive *fishway* pools separated by overflow *weir*s that break the *total project head* into passable increments. This design allows fish to ascend to a higher elevation by passing over a *weir,* and provides resting zones within each pool. Pools are sufficiently sized to allow for the flow energy to be nearly fully dissipated in the form of turbulence within each receiving pool. This type of *fish ladder* cannot accommodate much, if any, water surface elevation fluctuation in the forebay pool, since ladder flow and pool turbulence would excessively fluctuate. If forebay or tailwater fluctuates, this type of *fish ladder* is often designed with an auxiliary water supply and flow regulating section, as described in 5.4 and 5.8.

Insert Drawing

5.1.4 **Weir and orifice fish ladder** - The weir and orifice *fish ladder* passes the fishway flow from forebay through successive *fishway* pools connected by overflow weirs and orifices, that divide the *total project head* into passable increments. The Ice Harbor ladder is an example of a weir and orifice *fish ladder*. This ladder design was initially developed for use at Ice Harbor Dam (Lower Snake River) in the mid-1960's. The *weir* consists of two orifices, centered and directly below two *weir*s - one on each side of the longitudinal centerline of the ladder. Between the *two weir*s is a slightly higher non-overflow wall, with an upstream projecting flow baffle at each end. Half- Ice Harbor ladder designs consist of one *weir*, one orifice and a non-overflow wall between *fishway* pools. This type of ladder cannot accommodate much, if any, water surface elevation fluctuation in the forebay pool, since *fish ladder* flow and pool turbulence would fluctuate excessively. If forebay or tailwater fluctuates, this type of *fish ladder* is often designed with an auxiliary water supply and flow regulating section, as described in 5.4 and 5.8.

5.1.5 **Full Width Stream Weirs** - Full stream width weirs are *fishway*s are used in small stream systems to incrementally backwater an impassable barrier or impediment. These structures span the entire width of the stream channel and convey the entire stream flow, breaking the *hydraulic drop* into passable increments. This is accomplished by incrementally stepping down the water surface elevation from the barrier to intersect the natural stream gradient downstream.

Unlike many of the *fishway*s described herein, these structures are not designed with auxiliary water supply systems, trashracks, or a great deal of operational complexity. *Weir*s may be constructed from reinforced concrete, or in limited applications boulders or logs. Design of each *weir* shall concentrate flow into the center of the downstream pool, and/or direct flow toward the downstream thalweg. This concentration is accomplished by providing a slight *weir* crest elevation decrease from each bank to the center (flow notch). Typically, the flow notch will be designed to pass the minimum instream flow, while higher stream flows pass over the entire *weir* crest. Pool volumes should be designed per the pool volume criteria specified in section 5.6.7, but natural *bedload* movement will fill in pools providing a scour pool area below the flow notch, and shallower fringe areas.

Scour is a critical and often underestimated design issue. If sills and *weir*s are not anchored on bedrock, a means of preventing undermining is required. If a pool lining technique (riprap, concrete, etc) is selected to prevent undermining of the *fishway*, a minimum 4 feet of depth should be provided in each pool and in the *tailrace* below the *fishway*. This allows for a fish to stage or hold below each *weir* before proceeding upstream. In addition, the *tailrace* area should be protected from scour to prevent lowering of the streambed, and should be monitored after high flows occur to ensure the facility remains passable

Insert Ice Harbor Drawing

5.1.6 **Roughened Channels** - These types of ladders have excellent fish attraction characteristics while using relatively low *attraction flow* amounts, and are widely used in fish trap designs (steeppass) or closely monitored sites with low streamflow (denil). Baffled chute type *fish ladder*s entail a sloped channel that has a constant discharge for a given normal depth, chute gradient, and baffle configuration and spacing. Energy is dissipated gradually (based on channel roughness) and results in a constant velocity compatible with the swimming ability and behavior of targeted fish. The passage corridor consists of a high velocity chute flow between the *baffles*. There are no resting locations within a given length of chute. Once fish start to ascend a length of baffled chute, they must either pass or fall back which will likely cause injury. Intermediate resting pools are used between component lengths of chute to minimize fallback by weaker swimming fish. Denil and steeppass baffled chutes shall not be used in areas where downstream passage occurs, or where even minor amounts of debris are expected. Usually, these types of ladders are only used where they can be closely monitored because of debris concerns.

Denil and steeppass *fishway*s are examples of baffled chute ladders, and are of similar design. The denil *fishway* generally is designed with slopes up to 20%, and has higher flow capacity and less roughness than a steeppass *fishway*. Steeppass *fishway*s can be used at slopes up to 28%. For either *fishway*, the average chute design velocity should be less than 5 ft/s. For a *upstream passage facility* utilizing a denil or a steeppass ladder, the horizontal distance between resting pools should be less than 25 feet. Resting pool volumes shall adhere to volume requirements specified in section 5.6.7. The minimum flow depth shall be 2 feet, and shall be consistent throughout the length of the ladder for all ladder flows. Designs shall be developed to minimize fallback of fish to limit injury potential.

Insert Drawing

Rock channels are often proposed as a passage alternative. Design of this type of facility varies widely. Criteria for this type of ladder design are still evolving, and proposals for this type of ladder will be assessed on a site-specific basis.

Pool and Chute - Pool and chute type *fish ladder*s may a more desirable alternative to the previous options when migrating fish must pass through a greater range of streamflow. During low streamflow, the ladder can operate in the pool ladder mode. When streamflow is greater, improved attraction to the ladder can be attained by routing a proportionately higher discharge through the ladder, which acts as a cross between pool and baffled chute ladders. However, this typically requires manual adjustment of stoplogs, an operation that is cumbersome and could be dangerous. Criteria for this type ladder design are still evolving, and proposals for this type ladder will be assessed on a site-specific basis.

5.2 ***Fishway entrance*** **design criteria**

5.2.1 Description, purpose and rationale: The *fishway entrance* is composed of an entrance gate or slot, through which *fishway attraction flow* is discharged and through which fish enter the *upstream passage facility*; it is possibly the most critical component in the design of an upstream passage system. Placing a *fishway entrance* in the correct location(s) will allow a passage facility to provide a good route of passage throughout the design range of passage flows; optimal *fishway entrance* hydraulic characteristics and geometry are key design parameters. The most important aspects of a *fishway entrance* design are the 1) location of the entrance, 2) shape and amount of flow emanating from the entrance, 3) approach channel immediately downstream of the entrance, and 4) flexibility in operating the entrance flow to accommodate variations in *tailrace* elevation, stream flow conditions, and project operations.

5.2.2 The *fishway entrance* gate configuration and operation will vary based on site specific project operations and streamflow characteristics. Entrance gates are usually operated in either a fully open or fully closed position, with the operating entrance dependent on *tailrace* flow characteristics. Sites with limited tailwater fluctuation may not require an entrance gate to regulate the entrance head. Adjustable *weir* gates that rise and fall with tailwater elevation may also be used to regulate the *fishway entrance* head. Other sites may accommodate maintaining proper entrance head by regulating auxiliary water flow through a fixed geometry entrance gate.

5.2.3 *Fishway entrances* shall be located at points where fish can easily locate the *attraction flow* and enter the *fishway*. When choosing an entrance location, high velocity and turbulent zones in a powerhouse or spillway *tailrace* should be avoided, in favor of relatively tranquil zones adjacent to theses areas. At locations where the *tailrace* is wide, shallow and turbulent, excavation to create a deeper, less turbulent holding zone adjacent to the *fishway entrance*(s) may be required.

5.2.4 *Attraction flow* from the *fishway entrance* should be between 5% and 10% of high design passage flows for streams with mean annual discharges exceeding 1000 cfs. For smaller streams, where feasible use larger percentages (up to 100%) of streamflow. Generally speaking, the higher percentage of total river flow used for attraction into the *fishway*, the more effective the facility will be in providing upstream passage.

5.2.5 The *fishway entrance* head (*hydraulic drop*) shall be maintained between 1 to 1.5 feet, and designed to operate from 0.5 to 2.0 feet of *hydraulic drop*.

5.2.6 The minimum *fishway entrance* width should be four feet, and the entrance depth should be at least six feet, although the shape of the entrance is dependent on *attraction flow* requirements. Also, see requirements for mainstem Columbia and Snake rivers in section 10.

5.2.7 If the site has multiple zones where fish accumulate, each *tailrace* accumulation location will require a minimum of one entrance. For long powerhouses, additional entrances are required. Since *tailrace* hydraulic conditions usually change with project operations and hydrologic events, it is often necessary to provide two or more *fishway entrance*s.

5.2.8 Closure gates shall be provided to provide flow to the appropriate entrance gate, and shall not conflict with any potential path of fish migration. *Fishway entrance*s shall be closed by downward-closing slide gates, unless otherwise approved by NOAA Fisheries.

5.2.9 *Fishway entrance*s can be either adjustable submerged *weir*s, vertical slots, orifices, or other shapes provided that the hydraulic requirements specified in 5.2.3, 5.2.4 and 5.2.5 are achieved. It is noted that some non-salmonid species will avoid using orifices.

5.2.10 The desired entrance *weir* and/or slot discharge jet hydraulic condition is streaming, not plunging, for submerged *weir* discharges. *Plunging flow* induces jumping and can cause injuries, and it presents hydraulic condition some species may not pass.

5.2.11 In general, low flow entrances should be oriented more or less perpendicular to streamflow, and high flow entrances should be oriented more or less parallel to streamflow. Site-specific assessments are required.

5.2.12 The *fishway entrance* design shall include staff gages to allow for a simple determination of whether entrance head criterion (see 5.2.4) is being met. Staff gages shall be located in the entrance pool and in the tailwater just outside of the *fishway entrance*, in an area visible from an easy point of access. Care should be taken in the design when placing staff gages, being sure to avoid turbulent areas and areas where velocity is increasing in front of the *fishway entrance*. Gages should be readily accessible to facilitate in-season cleaning.

5.3 ***Fishway entrance pool*** **criteria**

5.3.1 Description, purpose and rationale: The *fishway entrance pool* is at the lowest elevation of the upstream passage system. It discharges flow into the *tailrace* through the entrance gates for the purpose of attracting upstream migrants. In many *fish ladder* systems, the entrance pool is the largest and most important pool, in terms of providing proper guidance of fish to the ladder section of the *upstream passage facility*. It combines ladder flow with *auxiliary water system* flow through *diffuser* gratings to form entrance *attraction flow* (see 5.4). The entrance pool shall be configured to readily guide fish toward ladder *weir*s or slots.

5.3.2 The minimum transport velocity (between entrance and first *fishway weir*, and over submerged *fishway weir*s) is 1.5 ft/s.

5.3.3 The *fishway entrance pool* shall be designed to optimize attraction to the lower *fishway weirs*. This can be accomplished by angling vertical AWS *diffuser*s toward and terminating near the lowest ladder *weir*.

5.4 ***Auxiliary Water System*** **(AWS) Criteria**

5.4.1 Description, purpose and rationale: AWS flow is usually routed from the *forebay* through a trash rack or intake screen, a back set flow control gate, an energy dissipation zone, energy *baffles*, and *diffuser*s, and into the *fishway*. An AWS provides flow to the entrance pool and/or area upstream of *weir*s that on occasion become back-watered, and usually provides the bulk of the *attraction flow* through *fishway entrance*s. In addition, the AWS is used to provide make-up flows to various transition pools in the ladder such as *bifurcation* or *trifurcation* pools, trap pools, *exit control section*s, or counting station pools.

5.4.2 *Vertical diffuser*s should consist of non-corrosive, vertically-oriented flat-bar grates, and shall have a maximum one-inch clear horizontal spacing.

5.4.3 The maximum AWS *diffuser* velocity shall be less than 1.0 ft/s for vertical *diffuser*s and 0.5 ft/s for horizontal *diffuser*s, based on total *diffuser* panel area.

5.4.4 The design shall provide access for debris removal from each *diffuser*.

5.4.5 All *diffuser* edges and surfaces exposed to fish shall be rounded during fabrication to reduce the potential for contact injury.

5.4.6 Vertical AWS *diffuser*s shall have a top elevation at or below the low design entrance pool water surface elevation.

5.4.7 A trash rack shall be provided at the AWS intake with clear space between the vertical flat bars of less than one inch, and maximum velocity of less than 1 ft/s. The support structure for the trash rack shall not interfere with cleaning requirements, and shall consider access, debris raking and debris removal. Where possible, the trash rack should be installed at a 1:5 (horizontal:vertical) slope (or flatter) for ease of cleaning. The trash rack design shall allow for easy maintenance, considering access for personnel, travel clearances for manual or automated raking, and removal of debris

5.4.8 In instances where the majority of the instream flow passes through the AWS during periods of juvenile out-migration, the AWS intake should be screened to NOAA Fisheries Juvenile Fish Screen Criteria (see Section 12). Trip gates or alternate intakes can be included in the design to ensure that AWS flow targets are achieved if the screen reliability is uncertain at higher flows. Debris and sediment issues may preclude the use of juvenile fish screen criteria for AWS intakes at certain sites.

5.4.9 AWS flow control can consist of a control gate, turbine intake flow control, or other flow control systems, located sufficiently far away from the AWS intake to ensure uniform flow distribution at the AWS trash rack at all AWS flows. AWS flow control is required to ensure that the correct quantity of AWS flow is discharged at the appropriate location during a full range of *forebay* water surface elevations.

5.4.10 Excess energy shall be dissipated from AWS flow prior to passage through add-in *diffuser*s (5.4.3). This is necessary to minimize surging and to induce relatively uniform velocity distribution (± 10%) at the *diffuser*s. Surging and non-uniform velocities may cause adult fish jumping and associated injuries or excess migration delay. Examples of methods to dissipate excess AWS flow energy include: 1) routing flow into the pool with adequate volume (see 5.4.11), then through a baffle system (*porosity* less than 40%) to reduce surging through entrance pool *diffuser*s, 2) passing AWS flow through a turbine, or 3) passing AWS flow through a pipeline with concentric rings or other hydraulic transitions designed to induce *headloss*.

5.4.11 An energy dissipation pool in an AWS should be a minimum volume established by the following formula:

$$V \geq \frac{\gamma Q H}{(16 \text{ ft-lb/s})/\text{ft}^3}$$

where: V = pool volume, in ft^3
γ = unit weight of water, 62.4 pounds (lb) per ft^3
Q = AWS flow, in ft^3/s
H= *Velocity head* of AWS flow, in feet

5.4.12 Staff gages shall be installed to indicate head differential across the AWS intake trash rack, and shall be located to facilitate observation and cleaning. Head differential across the AWS intake shall not exceed 0.3 feet.

5.4.13 AWS intake trash racks shall be of sufficient structural integrity to avoid the permanent deformation associated with maximum occlusion.

5.4.14 To facilitate cleaning, the AWS shall be valved or gated to provide for easy shut-off during maintenance activities, and subsequent easy re-set to proper operation.

5.4.15 At locations where *bedload* can cause accumulations at the AWS intake, sluice gates or other simple *bedload* removal devices are required.

5.5 ***Transport Channel*s**

5.5.1 Description, purpose and rationale: A *transport channel* conveys flows between different sectors of the *upstream passage facility*, providing a route for fish to pass.

5.5.2 The range of *transport channel* velocities shall be between 1.5 and 4 ft/s, including flows over or between *weir*s inundated by high tailwater.

5.5.3 The *transport channel*s should be a minimum of 5 feet deep.

5.5.4 The *transport channel*s should be a minimum of 4 feet wide.

5.5.5 The *transport channel*s shall be of open channel design.

5.5.6 Ambient natural lighting should be provided in all *transport channel*s, if possible. Otherwise acceptable artificial lighting is to be used, as described in 5.10.2.

5.5.7 Care shall be taken in design to avoid hydraulic transitions or lighting transitions, in order to reduce the possibility of excess migration delay.

5.6 ***Fish ladder* design criteria**

5.6.1 Description, Purpose and Rationale: A *fish ladder* converts the *total project head* at the passage impediment into passable increments, by providing suitable conditions for fish to hold, rest, and ultimately pass upstream. The criteria provided in this section have been developed to provide conditions to pass all anadromous salmonid species upstream with minimal delay and injury.

5.6.2 The maximum *hydraulic drop* per pool shall be 12 inches.

5.6.3 Ladder overflow *weir*s shall be designed to provide at least 12 inches of flow depth over the weir crest. The depth shall be indicated by locating a single staff gage (with the zero reading at the overflow *weir* crest elevation) in an observable, hydraulically stable location.

5.6.4 The pool dimensions should be a minimum of 8 feet long (upstream to downstream), 6 feet wide, and 5 feet deep. However, specific ladder designs will require specific pool dimensions that are greater than the minimums specified here.

5.6.5 Turning pools (i.e. where the *fishway* bends more than 90°) should be at least double the length of a standard *fishway* pool, as measured along the centerline of the fishway flowpath. Special consideration shall be given for the direction of the flow path from the upstream weir to assure that passage through the downstream weir is not compromised.

5.6.6 Additional guidance and criteria for application of specific ladder types is located in Section 5.1.

5.6.7 The *fishway* pool volume shall be a minimum of:

$$V \geq \frac{\gamma\, Q\, H}{(4\text{ft-lb/s})/\text{ft}^3}$$

where: V = pool volume, in ft^3
γ = unit weight of water, 62.4 pounds (lb) per ft^3
Q = *fish ladder* flow, in ft^3/s
H = energy head of pool-to-pool flow, in feet

under every expected design flow condition.

5.6.8 The dimensions of orifices should be at least 15 inches high by 12 inches wide, with the top and sides champhered 0.75 inches on the upstream side, and champhered 1.5 inches on the downstream side of the orifice.

5.6.9 The *freeboard* of the ladder pools shall be at least 3 feet at high design flow.

5.6.10 Ambient lighting is preferred throughout the *fishway*, and in all cases abrupt lighting changes shall be avoided.

5.6.11 At locations where the flow changes direction more than 60 degrees, 45 degree vertical miters or 2-foot vertical radius of curvature shall be included at the outside corners of *fishway* pools.

5.7 Counting Window Stations

5.7.1 Description, Purpose and Rationale: A counting station provides a location to observe and enumerate fish utilizing the fish passage facility. Although not always required, a counting station is often included in a *fishway* design to allow fishery managers to assess fish populations, make observations on fish health, or conduct scientific research. Other types of counting stations (such as submerged cameras, adult *PIT tag detector*s, or orifice counting tubes) may be acceptable, but they shall not interfere with the normal operation of the ladder or increase fish passage delay.

5.7.2 Counting stations shall be located in a hydraulically stable, low velocity (i.e. the lower end of velocity range specified in 5.5.2) accessible area of the *upstream passage facility*.

5.7.3 The counting window shall be designed for complete, convenient cleaning of sufficient frequency to ensure sustained visibility and accurate counts. The counting window material shall be of sufficient abrasion resistance to allow frequent cleaning.

5.7.4 Counting windows shall be vertically oriented.

5.7.5 The counting window sill should be positioned to allow full viewing of the passage slot.

5.7.6 The counting window shall include sufficient indirect artificial lighting for satisfactory fish identification at all hours, so as not to retard upstream passage due to excessive light intensity in the path of upstream migrants.

5.7.8 The minimum observable width (i.e. upstream to downstream dimension) of the counting window shall be 5 feet, and the minimum height (depth) should be full water depth (also see 5.7.11).

5.7.9 A *crowder* may be required in the design to move fish closer to the counting window to accommodate observation during turbid water conditions. If required, the minimum counting station slot width between the counting window and vertical counting window *crowder* surface should be 18 inches and shall be adjustable. The counting window slot width should be maximized as water clarity allows, and when not actively counting fish.

5.7.10 To guide fish onto the counting window slot, a downstream *picket lead* shall be included in the design, with orientation at a flow deflection angle of 45° relative to *fishway* flow direction. An 45° upstream *picket lead* shall also be provided. Picket orientation, picket clearance, and maximum allowable velocity shall conform to specifications for *diffuser*s specified in section 5.4. Flat picket bars shall be oriented parallel to flow. Circular pickets may also be used. Maximum head differential through each set of pickets shall be less than is 0.3 feet above the clean condition differential. Both upstream and downstream picket leads will be equipped with “witness marks” to verify correct position when picket leads are installed in the fishway. A one foot square opening in the upstream picket should be provided in the upstream picket to allow escape if fish pass through the downstream picket.

5.7.11 To minimize flow separations that may impede passage and induce fallback behavior at the counting window, transition ramps shall be included that provide gradual transitions between walls, floors and the count windows. As general guidance, these transitions should be more than 1:8 (i.e. one foot horizontally or vertically per eight feet in the direction of flow). The water surface over a counting window slot shall not be covered.

5.7.12 The pool downstream of the counting station shall extend at least two standard *fishway* pool lengths from the downstream end of the *picket lead*s. The pool upstream of the counting station shall extend at least one standard *fishway* pool length from the upstream end of the *picket lead*s. Both pools shall be straight and in line with the counting station.

5.8 *Fishway exit* section

5.8.1 Description, purpose and rationale: The *fishway exit* section provides a flow channel to provide fish with egress from the *fishway* and continue on their upstream migration. The exit section of *upstream fish passage* facilities can be composed of the following features: add-in auxiliary water valves and/or *diffuser*s, exit pools with varied flow, exit channels, coarse exit channel trash rack (for fish passage), and fine auxiliary water trash racks and control gates. One function of the exit section is to attenuate *forebay* water surface elevation fluctuations to ensure hydraulic conditions suitable for fish passage are maintained in ladder pools. Other functions should include minimizing the entrainment of debris and sediment into the *fish ladder*. Different types of ladder designs (see Section 6) require specific *fish ladder* exit design details.

5.8.2 The *exit control section hydraulic drop* per pool should range from 0.25 to 1.0 feet.

5.8.3 The length of the exit channel upstream of the *exit control section* should be a minimum of two standard ladder pools.

5.8.4 Exit section design shall utilize the requirements for auxiliary water *diffuser*s, channel geometry, and energy dissipation as specified in 5.4, 5.5 and 5.6.

5.8.5 The ladder exit should be located along a shoreline and in a low velocity zone (less than 4 ft/s), sufficiently far enough upstream of a spillway, sluiceway or powerhouse to minimize the risk of fish non-volitionally falling back through these routes. Distance depends on bathymetry near the dam spillway or crest, and associated longitudinal river velocities. Public access near the ladder exit should not be allowed.

5.9 *Fishway Exit* Trash Rack and Debris Management

5.9.1 Description, purpose and rationale: *Coarse trash rack*s should be included at the *fishway exit*, to minimize the entrainment of debris into the *fishway*. Floating debris can occlude passage corridors, potentially creating hazardous passage zones and/or blocking fish passage. Other types of debris, such as *bedload* transport into the *fishway*, can also adversely affect the operation of the facility.

5.9.2 The maximum allowable velocity through a clean trash rack is 1.5 ft/s.

5.9.3 The minimum submerged trash rack depth is 5 feet.

5.9.4 Where possible, the trash rack should be installed at 1:5 (horizontal:vertical) slope (or flatter) for ease of cleaning. The trash rack design shall allow for easy maintenance, considering access for personnel, travel clearances for manual or automated raking and removal of debris

5.9.5 Debris booms, curtain walls, or other provisions are required if coarse floating debris is expected.

5.9.6 If debris accumulation is expected to be high, the design should include an automated mechanical debris removal system. If debris accumulation potential is unknown, the design should include features to allow the simple retrofit of an automated mechanical debris removal system, should the need arise.

5.9.7 The *fishway exit* trash rack should have a minimum clear space between vertical flat bars of 10 inches if chinook are present, and 8 inches otherwise. Lateral support bar spacing shall be a minimum of 24 inches, and shall be sufficiently back set of the trash rack face to allow full trash rake tine penetration. Trash racks shall extend to the appropriate elevation to allow easy removal of raked debris.

5.9.8 The *fishway* trashrack shall be oriented at a deflection angle greater than 45° relative to the direction of river flow.

5.9.9 The *fishway exit* should be designed to minimize entrainment of sediment.

5.9.10 For AWS trashrack design information, see section 5.4

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5.10 Miscellaneous considerations

5.10.1 *Fishways* should be secured to discourage vandalism and poaching and to provide public safety.

5.10.2 Ambient lighting shall be provided throughout the *fishway*. Where this is not possible (such as in tunnels), artificial lighting should be provided in the blue-green spectral range. Lighting shall be designed to operate under all environmental conditions at the installation.

5.10.3 Personnel access shall be provided to all areas of the *fishway*, to facilitate operational and maintenance requirements. Walkway grating should allow as much ambient lighting into the *fishway* as possible.

5.10.4 All metal edges in the flow path used for fish migration shall be ground smooth to minimize risk of lacerations. Concrete surfaces shall be finished to ensure smooth surfaces, with one-inch wide 45° corner chamfers.

5.10.5 Protrusions (such as valve stems, bolts, gate operators) shall not extend into the flow path of the *fishway*.

5.10.6 All control gates exposed to fish (such as at entrances in the fully-open position) shall have a shroud or be recessed to minimize or eliminate fish.

Section 6. ***Exclusion Barriers***

6.1 **Description, purpose and rationale:** *Exclusion barriers* are designed to minimize the attraction and stop the migration of upstream migrating fish into an area where there is no upstream egress or suitable spawning area, and to guide fish to an area where upstream migration can continue. *Exclusion Barriers* can also be used to restrict movement of undesirable species into habitat. *Exclusion barriers* are designed to minimize the potential for injury of fish that are attracted to impassable routes.
Some examples of the use of *exclusion barriers* include:

- preventing fish from entering return flow from an irrigation ditch
- preventing fish from entering the *tailrace* of a power plant
- guiding fish to a trap facility for upstream transport, research or broodstock collection
- guiding fish to a counting facility
- preventing fish from entering a channel subject to sudden flow changes
- preventing fish from entering turbine draft tubes
- preventing fish from entering channels with poor spawning gravels, poor water quality or insufficient water quantity.

The two primary categories of *exclusion barriers* are picket barriers and velocity barriers. Another type of exclusion barrier is a vertical drop structure, which provides a jump height that exceeds the vertical leaping ability of fish. Other types of barriers, such as electric and acoustic fields, have very limited application because of inconsistent results most often attributed to varying water quality (turbidity, specific conductance).

Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

6.2 **Picket Barrier - Description**: Picket barriers diffuse nearly the entire streamflow through pickets extending the entire width of the impassable route, sufficiently spaced to provide a physical barrier to upstream migrant fish. This category of exclusion barrier includes a fixed bar rack and a variety of hinged floating *picket weir* designs. Picket barriers usually require removal for high flow events, increasing the potential to allow passage into undesirable areas.

In general, since the likelihood of impinging fish is very high, these types of barriers can not be used in waters containing species listed under the ESA, unless they are continually monitored by personnel on-site, and have a sufficient operational plan and facility design in place to allow for timely removal of impinged or stranded fish prior to the occurrence of injury. Since debris and downstream migrant fish must pass through the pickets, sites for these types of *exclusion barriers* must be carefully chosen. Picket barriers shall be continually monitored for debris accumulations, and debris shall be removed before it concentrates flow and violates the criteria established below. As debris accumulates, the potential for the impingement of downstream migrants (e.g., juvenile salmonids, kelts, adult salmon that have overshot their destination, or resident fish) increases to unacceptable levels. Debris accumulations will also concentrate flow through the remainder of the open picket area, increasing the attraction of upstream migrants to these areas and thereby increasing the potential for jumping injury or successful passage into areas without egress.

Picket barrier design criteria include the following:

6.2.1 The maximum clear opening between pickets and between pickets and abutments is one inch.

6.2.2 Pickets shall be comprised of flat bars aligned with flow, or round columns of steel, aluminum or durable plastic.

6.2.3 The picket array shall have a minimum 40% open area.

6.2.4 Picket barriers should be sited where there is a relatively constant depth over the entire stream width.

6.2.5 The average design velocity through pickets should be less than 1.0 ft/s for all design flows, with maximum velocity less than 1.25 ft/s, or half the velocity of adjacent river flows whichever is lower. The average design velocity is calculated by dividing the flow by the total submerged picket area over the design range of stream flows. When river velocities exceed these criteria, the picket barrier shall be removed.

6.2.6 The maximum head differential across the pickets should be 0.3 feet. If this differential is exceeded, the pickets shall be cleaned as soon as possible.

6.2.7 A debris and sediment removal plan is required that anticipates the entire range of conditions expected at the site. Debris shall be removed before accumulations develop that violate the criteria specified in 6.2.5 and 6.2.6.

6.2.8 The minimum picket extension above the water surface at high fish passage design flow is two feet.

6.2.9 The minimum submerged depth at the picket barrier at low design discharge shall be two feet for at least 10% of the river cross section at the barrier.

6.2.10 Pickets barriers shall be designed to lead fish to a safe passage route. This can be achieved by angling the picket barrier toward a safe passage route, providing nearly uniform velocities through the entire length of pickets, and providing sufficient *attraction flow*s from a safe passage route that minimizes the potential for false attraction to the picket barrier flows.

6.2.11 A uniform concrete sill, or an alternative approved by NOAA Fisheries Hydro Program staff, should be provided to ensure that fish do not pass under the picket barrier.

6.2.12 Picket panels should be of sufficient structural integrity to withstand high streamflows.

6.3 **Velocity Barrier - Description:** A velocity barrier consists of a *weir* and concrete *apron* combination that prevents upstream passage by producing a shallow flow depth and high velocity on the *apron*, followed by an impassable vertical jump over the *weir*. A velocity barrier does not have the fore-mentioned problems of a *picketed weir* barrier, since flow passes freely over a *weir*, allowing the passage of debris and downstream migrant fish. However, since this type of barrier creates an upstream impoundment, the designer must consider backwater effects that may induce loss of power generation or property inundation.

Velocity barrier design criteria include the following:

6.3.1 The minimum *weir* height relative to the maximum *apron* elevation is 3.5 feet.

6.3.2 The minimum *apron* length (extending downstream from base of *weir*) is 16 feet.

6.3.3 The minimum *apron* downstream slope is 16:1 (horizontal:vertical).

6.3.4 The maximum head over the *weir* crest is two feet.

6.3.5 The elevation of the downstream end of the *apron* shall be greater than the *tailrace* water surface elevation corresponding to the high design flow.

6.3.6 Other combinations of *weir* height (6.3.1) and *weir* crest head (6.3.4) may be approved by NOAA Fisheries Hydro Program staff on a site-specific basis.

6.3.7 The flow over the weir must be fully and continuously vented along the entire length, to allow a fully aerated nappe to develop between the weir crest and the apron.

6.4 **Vertical Drop Structures** - Description: A vertical drop structure can function as an exclusion barrier by providing *total project head* in excess of the leaping ability of the target fish species. These can be a concrete monolith, rubber dam, or approved alternative.

Vertical drop structure criteria include the following:

6.4.1 The minimum height for vertical drop structure shall be 10 feet relative to the *tailrace* high design flow elevation.

6.4.2 To minimize the potential for leaping injuries, a minimum of two feet of cantilevered ledge shall be provided.

6.4.3 Provision shall be made to ensure that fish jumping at the drop structure flow will land in a minimum five foot deep pool, without contacting any solid surface.

6.5 **Bottom Hinged Leaf Gates** - Description: A bottom-hinged leaf gate is a device that can be elevated to provide an exclusion barrier by providing *total project head* in excess of the leaping ability of the target fish species. These can be mounted on a concrete base, where the leaf gate is raised into position by a hydraulic cylinder, pneumatic bladders, or other means.

Bottom-hinged leaf gate criteria include the following:

6.5.1 The minimum vertical head drop (*forebay* to tailwater) shall be 10 feet at high design flow.

6.5.2 Provision shall be made to ensure that fish jumping at flow over the structure will land in a minimum five foot deep pool, without contacting any solid surface.

6.6 **Horizontal Draft Tube *diffuser*s** - Description: A horizontal draft tube *diffuser* is a device used below a powerhouse at the turbine draft tube outlet to prevent fish from accessing the turbine runners, where injury is likely. Even if draft tube velocities are sufficiently high to prevent fish access during normal operations, ramping flow rates during turbine shut-down or start-up create velocities low enough to allow fish to swim up the draft tubes and impact turbine runners.

Horizontal Draft Tube *diffuser* criteria include the following:

6.6.1 Average velocity of flow exiting the *diffuser* grating shall be less than 1.25 ft/s, and distributed as uniformly as possible. Maximum velocity should not exceed 2 ft/s.

6.6.2 Clear spacing between *diffuser* bars and any other pathway from the *tailrace* to the turbine runner shall be less than one inch.

6.6.3 *Diffuser*s shall be submerged a minimum of two feet for all tailwater elevations.

Section 7. Adult Fish Trapping Systems

7.1 Description, purpose and rationale: In general, NOAA Fisheries requires volitional passage, as opposed to trap and haul, for upstream passage facilities. This is primarily due to the risks associated with the handling and transport of adult upstream migrants, in combination with the long term uncertainty of funding, maintenance and operation of the trap and haul program. However, there are instances where trap and haul may be the only viable option for a particular site. In particular, at high head dams where thermal stratification occurs in the reservoir, temperature differentials in the *fishway* (as opposed to water temperatures below the dam) may dissuade fish from utilizing volitional passage facilities.

This section addresses design aspects of adult fish trapping systems. The operations and design criteria and guidelines are dependent on each other, since the management objectives for trap operation define the facility functional design and must be stipulated before the trap design development can be proceed.

In many cases, NOAA Fisheries will not require retrofit of existing facilities to comply with criteria listed herein. It is emphasized that these criteria and guidelines are viewed as a starting point for design development of new, or upgraded, trapping facilities. This section does not directly apply to existing trapping programs/facilities, unless specifically required by NOAA Fisheries.

Consistent with the terminology used throughout this document, criteria are specified by the word “shall” and guidelines are specified by the word “should”. Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

Adult fish trapping systems can either be included in the initial design of a proposed *upstream passage facility*, or in some cases can be retro-fitted to an existing *fishway*. Traps should be designed to utilize known or observed fish behavior to benignly route fish into a trap holding pool that precludes volitional exit. From the trap holding pool, fish can be loaded for transport and/or examined for research and management purposes. Traps can be used as the terminus of volitional *upstream fish passage* followed by transport to specific sites, or as a parallel component of a *fish ladder* where fish can either be routed into an adjacent trapping loop or if the trap is closed allow to fish pass unimpeded through the *fishway*.

7.2 Trap Design Scoping
Trap new-construction or major upgrade proposals shall address and describe the consideration of (at least) the following issues:

- Objective of trapping - count, handle, collect, interrogate for tags, etc.
- Number of fish targeted and total number potentially present
- Target species
- Other species likely to be present at the trap
- Environmental conditions during trap operation such as water and air temperature, flow conditions (lows and peaks), debris load, etc.
- Operation location, duration and scale
- Fish routing and ultimate destination
- Maximum duration of delay or holding within the trapping system for target and non-target fish.
- Security mechanisms

Note: It is also permissible to attach a Hatchery and Genetic Management Plan (HGMP), 4(d) Limit 7 Scientific Research and Take Authorization application, or Section 10 (a) (1) (A) permit application if it contains some of this information**.**

7.3 Fish Handling Guidelines
7.3.1 The following general fish handling guidelines should be utilized for design of new or updated facilities.

7.3.2 Use of nets to capture or move fish shall be minimized or eliminated. If nets are used they shall be sanctuary type nets, with solid bottoms to allow minimal dewatering of fish. Fish shall be handled with extreme care.

7.3.3 Fish should be anesthetized before being handled.

7.3.4 New or upgraded trapping facilities shall be designed to enable non-target fish to bypass the anesthetic tank.

7.3.5 Fish shall be removed from traps at least daily - more often when either environmental (eg. water temperature extremes or high debris load) or biological conditions (eg. migration peaks) warrant.

7.3.6 Individuals handling fish shall be experienced or trained to assure fish are handled safely.

7.3.7 Fish ladders shall not be completely dewatered during trapping operations, and should not experience any reduction in fishway flow.

7.4 General Trap Design System Criteria

7.4.1 Primary trapping system components usually include:

- in-ladder removable *diffuser*s or gates to block passage within the ladder and guide fish into the trap
- an off-ladder holding pool including a transition channel or port and trapping mechanism (through which *attraction flow* is discharged via one of the devices described in 7.6)
- a gate to prevent fish from entering the trap area during crowding operations
- a holding pool fish *crowder* (for encouraging adult egress from the off-ladder holding pool to sorting/loading facilities)
- separate holding pool inflow and outflow facilities
- *distribution flume* (used with *false weir* or steeppass to enable fish entry to and/or egress from the holding pool)
- and a lock or lift for truck-loading fish.

Insert trap drawing

General trap design system criteria include:

7.4.2 *Fish ladder*s are the preferred means of upstream passage at impediments, unless site conditions preclude their use. This is due to the preference that fish be allowed to pass at their inclination, rather than that of a human operator. Factors to be considered include the adverse effects of holding trapped fish in a potentially high-density holding pool for an excessive period, the long-term uncertainty of maintaining funding and trained personnel, exposure to poaching or predation in the trap, injuries from jumping, facility failures (e.g., loss of water supply), and cumulative handling and holding stresses.

7.4.3 In general, *fish ladder*s should not be designed or retrofitted with either in-ladder traps or loading facilities. Rather, trap/holding and loading facilities should be in an adjacent, off-ladder location where fish targeted for trapping purposes can be routed. This allows operational flexibility to readily switch from passage to trapping operational modes.

7.4.4 A wetted *distribution flume* shall be used if, after trapping, fish are to be routed to anesthetic/recovery tanks, pre-transport holding tanks, *forebay* return, etc. The flume shall have smooth joints, sides and bottom, and no abrupt vertical or horizontal bends. Circular pipes with smooth joints can also be used. Provision of continuous wetted surfaces (to minimize abrasions) is required.

7.4.5 Holding pool water quality should not be less than the ambient waters from which the fish are trapped. For example, the water temperature, oxygen content and pH should not deviate substantially. Fish shall be provided with a safe, healthy environment.

7.4.6 Trap inflow shall be routed through an upstream *diffuser* conforming with Section 5.3 , with maximum 1.0 fps average velocity. Baffling should be used to assure against excessive turbulence and surging, which could induce adult jumping within the trap.

7.4.7 Anesthetized fish shall be routed to a recovery pool to allow monitoring of fish to ensure full recovery from anesthetic effects prior to release. Fish recovering from anesthesia shall not be routed directly back to the river where unobserved mortality can occur. Recovery pool inflow shall satisfy the specified water quality guidelines (see 7.4.5). Recovery tank hydraulic conditions shall not result in partially or fully anesthetized fish being carried onto an outflow screen/grating, or any other hazardous area. The recovery pool shall be designed so that fish, once fully recovered, can exit volitionally.

7.5 Trap Holding Pool Guidelines and Criteria

For single-pool traps, refer to Section 7.9.

For trap holding pools at multi-pool ladders:

7.5.1 For new or existing *fish ladder*s, fish shall not be trapped and held within the ladder for intermittent sampling or truck-loading. Rather, an *off-ladder trap* system is required. This type of system allows normal unimpeded ladder passage during non-trapping periods, and intermittent trapping of fish for target collection or sampling, as required. The intent is to minimize adverse impacts (such as delay and elevated jumping injury/mortality) of fish trapping by allowing rapid transition from one operational mode to the other.

7.5.2 Trap holding pools, for both *off-ladder trap*s and trap and haul facilities, shall be sized to hold a predetermined maximum number of fish (i.e. trap capacity, as specified by NOAA Fisheries biologists) with a minimum allowable volume of 0.25 ft^3 per pound of average fish size weight times the maximum number of fish.

7.5.3 *Off-ladder trap* holding pools shall be designed with a separate water supply and drain system. Trap holding pool design water supply capacity shall be at least 0.5 gallons per minute per pound of adult fish for the predetermined adult salmon trap holding capacity.

7.5.4 Trap holding pool designs shall include provisions to minimize adult jumping which can result in injury or mortality. Examples include (but are not limited to): high *freeboard* on holding pool walls; covering to keep fish in a darkened environment; providing netting over the pool strong enough to prevent adults from breaking through the mesh fabric; sprinkling the holding pool water surface to diffuse the ability of fish to see movement above the trap pool.

7.5.5 Off-ladder holding pools should include intake and exit *diffuser*s designed to prevent adult egress and to conform with Section 5.4, and with an adjustable exit overflow *weir* to control holding pool water surface elevation.

7.5.6 Removable *diffuser*s within the ladder (that are lowered/installed to block fish ascent within the ladder when fish are to be routed into an *off-ladder trap*ping pool) shall be angled toward the *off-ladder trap* entrance location, and shall comply with Sections 5.4.2, 5.4.3, 5.4.4, 5.4.5 and 5.4.6. *Diffuser*s shall be completely removed from the ladder when not actively trapping.

7.5.7 Off-ladder holding pool *crowder*s should have a maximum clear bar spacing of 7/8 inch. Side gap tolerances shall not exceed one inch, with side and bottom seals sufficient to allow *crowder* movement without binding and to prevent fish movement behind the *crowder* panel.

7.5.8 Where *false weir*s and steeppass ladders are used to route fish into or out of a trap holding pool, *distribution flume*s or pipes are used. The *distribution flume* invert shall be wetted to minimize friction between fish and flume invert surfaces. Where there are horizontal and vertical bends in the *distribution flume*, a continuous spray shall be used to minimize friction between fish and side walls. Horizontal and vertical bends shall be gradual to minimize risk of fish strike injuries.

7.5.9 The minimum inside width (or diameter) of the *distribution flume* shall be 15 inches.

7.5.10 The minimum sidewall height in the *distribution flume* shall be 24 inches.

7.6 Trapping Mechanism Criteria and Guidelines

The trap holding pool trapping mechanism (e.g., finger weir, vee-trap, *false weir*, steeppass ladder) allows fish to enter, but not volitionally exit, the holding pool. Fish will not volitionally stay within a confined area if they can find an exit. Design criteria and guidelines include:

7.6.1 All components exposed to fish shall have all welds and sharp edges ground smooth, with other features as required to minimize injuries.

7.6.2 Bars and spacings shall conform with Section 5.4. Circular bars should be used to improve fish safety.

7.6.3 Trapping mechanisms shall allow temporary closure to avoid spacial conflict with *brail* crowding and loading operations.

7.6.4 Trapping mechanisms should be designed to safeguard against fish entry into an unsafe area such as behind a *crowder* or under floor *brail*.

7.6.5 A gravity (i.e. not pumped) water supply should be used for false-weirs and steeppass ladders to avoid potential rejection of the trapping mechanism associated with the transmission of pump/motor sounds.

7.7 Lift/*Hopper* Guidelines
A lift in this context includes a full-sized *hopper* that is capable of collecting/lifting all fish trapped in a holding pool at one time, then either routing fish to the *forebay*, or loading onto a truck for transport.

Criteria and guidelines for the design of lift/*hopper* systems include the following:

7.7.1 Maximum *hopper* and transport truck loading density should be 0.15 ft^3 per pound of fish at a design maximum fish loading. The reason for this guideline is to avoid having so many fish in a *hopper* during lifting operations that there is in little remaining volume for water.

7.7.2 *Hopper freeboard* during lifting, from *hopper* water surface to top of *hopper* bucket, should be greater than the water depth within the *hopper*, to reduce risk of fish jumping out during lifting operations.

7.7.3 When a trap design includes a *hopper* sump (into which the *hopper* is lowered during trapping), side clearances between the *hopper* and sump sidewalls should not exceed 1 inch, thereby minimizing fish access below the *hopper*. Flexible side seals shall be used to assure that fish do not pass below the *hopper*.

7.7.4 Truck transport tanks shall be compatible with the *hopper* design to assure minimized handling stress. If an existing truck or fleet will be used, *hopper* shall be designed to be compatible with existing equipment. If transport tank's opening is larger than the tube or *hopper* opening, a cap or other device shall be designed to prevent fish from jumping at the opening.

7.7.5 Fail-safe measures shall be provided to prevent entry of fish into the holding pool area to be occupied by the *hopper* before the *hopper* is lowered into position.

7.7.6 Design should allow *hopper* water surface control to be transferred to the truck transport tank, so that water and fish do not plunge abruptly from the *hopper* into the fish transport tank during loading.

7.7.7 The fish egress opening from the *hopper* into the transport tank shall have a minimum horizontal cross-sectional area of 3 ft^2, and shall have a smooth transition that minimizes fish injury potential.

7.7.8 The *hopper* interior shall be smooth, and be designed to safeguard fish.

7.8 *Fish Lock*
7.8.1 Description: A *fish lock* allows trapped fish in the trapping system holding pool to be elevated without a *hopper* or *hopper* sump.

7.8.2 For clarification, the following steps are presented describing routing of fish from the lock to the *forebay* or transport vehicle:

- Fish are crowded into the lock.
- The closure gate is shut.
- In-flow into the lock is introduced through floor *diffuser*s below the floor *brail*.
- As the water level rises within the lock, it will ultimately reach a control *weir* equilibrium elevation. The floor *brail* should be raised only after lock water surface elevation is at equilibrium, and should not be used to lift fish out of the water.
- Overflow passes over a control *weir* and through a short, descending slope separator (screen), allowing excess flow to be drained off and adult fish to routed either directly into the anesthetic tank, or into a wetted chute for routing to separate sorting/holding pools, or loading into a transport vehicle.

7.8.3 The lock inflow chamber (below the lowest floor *brail* level) shall be of sufficient depth and volume (see Section 5.6.7) to limit turbulence into the fish holding zone, immediately before lock inflow is introduced. The inflow sump should be designed so that flow upwells uniformly through add-in floor *diffuser*s (see Sections 5.4.2, 5.4.3, 5.4.4, 5.4.5), thereby limiting unstable hydraulic conditions within the lock that may agitate fish.

7.8.3 Depth over the *egress weir* should be at least 6 inches, to facilitate fish egress from the lock for transport or anesthesia/handling.

7.8.4 Floor *brail* should be composed of sufficiently sized screen material (based on life stage and species present), to preclude injury or mortality of non-target species. Side gap openings shall not exceed one inch with seals included to cover all gaps. The floor *brail* panel should be kept in its lowest position until flow passes over the *flow egress weir*.

7.8.5 The floor *brail* hoist should be designed for manual operation to allow movement of the *brail* at 2 feet/minute (upward and downward) that will minimize stress of fish crowded between the floor *brail* and lock *flow egress weir*. Automated operation is allowed only when the water depth above the *brail* is 4 feet or more.

7.9 Single Holding Pool Trap Design Guidelines and Criteria

Single pool traps are often used in tandem with intermittent *exclusion barriers* (see Section 7) for brood-stock collection from small streams. These trapping systems are used to collect, sort, and load adult fish. The following are single holding pool trap design guidelines and criteria:

7.9.1 The trap holding pool volume shall be designed according to Section 5.6.7 to achieve relatively stable interior hydraulic conditions and minimize jumping of trapped fish.

7.9.2 Intakes shall conform with Sections 5.4.7 and 5.4.8.

7.9.3 Sidewall *freeboard* should be a minimum 4 feet above trap pool water surface at high design streamflow.

7.9.4 The trap holding pool interior surfaces shall be smooth to reduce the potential for fish injury.

7.9.5 A description of the proposed means of removing fish from the trapping pool and loading onto a transport truck shall be submitted to NOAA Fisheries for approval.

Section 8. Fish Passage Criteria and Guidelines for Culverts and other Road Crossings

8.1 **Description, Purpose and Rationale:** This section provides criteria and guidelines for the design of stream crossings to aid upstream and downstream movement of anadromous salmonids. Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

For the purpose of fish passage, the distinction between bridge, culvert, and low water crossing is not as important as the effect the structure has on the form and function of the stream. To this end, these criteria conceptually apply to bridges and low water crossings, as well as culverts. In addition to providing fish passage, any road crossing design should include consideration of maintaining ecological function of the stream - passing woody debris, flood flows and sediment, and other species that may be present at the site. The objective of these criteria and guidelines is to provide the basis for road crossing fish passage designs for all life stages of anadromous salmonids present at the site and requiring passage. The design team should be in close contact with all biologists familiar with the site to assess potential impacts on spawning, life stages requiring passage and to assess bed stability.

8.2 **Preferred alternatives for new or replacement culverts** - All the alternatives listed below have the potential to pass fish, but some will perform better than others at a particular site. Based on the biological significance and ecological risk of a particular site, NOAA Fisheries may require a specific design alternative to be developed, if feasible, to allow normative physical processes within the stream-floodplain corridor by (1) promoting natural sediment transport patterns for the reach, (2) providing unaltered fluvial debris movement, (3) restoring or maintaining functional longitudinal continuity and connectivity of the stream-floodplain system.

The following alternatives and structure types are listed in general order of NOAA Fisheries preference:

8.2.1 Road abandonment or road realignment to avoid crossing the stream.

8.2.2 Bridge - spanning the stream to allow for long-term dynamic channel stability, retention of existing spawning areas, maintain food (benthic invertebrate) production and to minimize risk of failure.

8.2.3 Streambed simulation strategies - bottomless arch, embedded culvert design. Note: If a road crossing is proposed in a segment of stream channel that includes a salmonid spawning area, only full span bridges or streambed simulations are acceptable (see Sections 8.3 and 8.4).

8.2.4 Hydraulic design method, associated with more traditional culvert design approaches - limited to low stream gradients (0 to 1%) for fish passage (see Section 8.5).

8.2.5 Culvert designed with a external *fishway* (including roughened channels)- for steeper slopes (see Section 5).

8.2.6 Baffled culvert - to be used only when other alternatives are infeasible. Many baffle designs are untested for anadromous salmonid passage, and *baffles* always reduce the hydraulic capacity of culverts. NOAA Fisheries will only approve baffled culverts on a site by site basis if compelling evidence of successful passage is provided.

8.3 Active Channel Design Method: This provides is a simplified design methodology that is intended to provide a culvert of sufficient size and embedment to allow the natural movement of *bedload* and the formation of a stable bed inside the culvert. Determination of the high and low fish passage design flows, water velocity, and water depth is not required for this method, since the stream hydraulic characteristics within the culvert are intended to mimic the stream conditions upstream and downstream of the crossing. This design method is usually not suitable for stream channels that are greater than 1% in natural slope or for culvert lengths greater than 100 feet. Structures for this design method are typically round, oval, or squashed pipes made of metal or reinforced concrete.

8.3.1 Culvert Width - The minimum culvert bed width shall be equal to or greater than bankfull channel width, and of sufficient vertical clearance to allow ease of maintenance activities.

8.3.2 Culvert Slope - The culvert shall be placed level (0% slope).

8.3.3 Embedment - The bottom of the culvert should be buried into the streambed not less than 20% of the culvert height at the outlet and not more than 40% of the culvert height at the inlet. The slope of the bed shall replicate the natural upstream and downstream stream gradient in the vicinity of the road crossing.

8.3.4 Fill materials should be comprised of material of similar size and shape to natural *bedload* and shall be able to remain in place for all flows.

8.3.5 Water depth and velocity in the culvert shall replicate the natural stream depth and water velocity upstream and downstream of the road crossing.

8.4 Streambed Simulation Design Method: This method is a design process that is intended to mimic the natural upstream and downstream processes within a culvert or under a bridge. Fish passage, sediment transport, and flood and debris conveyance within the culvert are intended to function as they would in a natural channel. Determination of the high and low fish passage design flows, design water velocity, and design water depth is not required for this option since the stream hydraulic characteristics within the culvert or beneath the bridge are designed to mimic the stream conditions upstream and downstream of the road crossing. The structures for this design method are typically open-bottomed arches or boxes but could have buried floors in some cases, or a variety of bridges that span the stream channel. This method utilizes streambed materials that are similar to the adjacent stream channel. Streambed simulation requires a greater level of information on hydrology and geomorphology (topography of the stream channel) and a higher level of engineering expertise than the Active Channel Design method (see section 8.3). In general, streambed simulation should provide sufficient channel complexity to provide passage conditions similar to that which exists in the natural stream, including sufficient depth, velocity and resting areas.

8.4.1 Channel width - The minimum culvert width shall be greater than the *bankfull* channel width. There are many cases where greater widths will be required, based on the objective of providing a stable structure that will allow ecological function to continue.

8.4.2 Channel Vertical clearance - In no case should the minimum culvert vertical clearance be less than six feet.

8.4.3 Channel slope - The slope of the reconstructed streambed within the culvert should approximate the average slope of the adjacent stream from approximately 500 feet upstream and 500 feet downstream of the site in which it is being placed. The maximum slope should not exceed 6%.

8.4.4 Embedment - If a culvert is used, the bottom of the culvert should be buried into the streambed not less than 20% and not more than 50% of the culvert height. For bottomless culverts the footings or foundation shall be designed for the largest anticipated scour depth. Demonstration of ability to retain *bedload* in the design configuration is required.

8.4.5 Maximum length of road crossing - The maximum allowable length for streambed simulation is 125 feet.

8.4.6 Fill materials should be comprised of material of similar size and shape to natural *bedload* and shall be able to remain in place for all flows.

8.4.7 Water depths and velocities shall closely resemble those that exist in the adjacent stream, as described in 8.4.3, or those listed in 8.5.6. For streambed simulation gradients exceeding 3% in slope, a resting/holding pool should be provided near the midpoint of the length of the culvert. In addition, holding areas should be provided throughout the length of the streambed simulation, reasonably replicating those found in the adjacent stream.

8.5 Hydraulic design method: The Hydraulic design method is a design process that matches the performance of a culvert with the swimming abilities of a target species and age class of fish. This method targets distinct species of fish and therefore does not account for ecosystem requirements of non-target species. There are significant errors associated with estimation of hydrology and fish swimming speeds that are resolved by making conservative assumptions in the design process. Determination of the high and low fish passage design flows, water velocity, and water depth is required for this option. The Hydraulic design method requires hydrologic data analysis, open channel flow hydraulic calculations, and information on the swimming ability and behavior of the target group of fish. This design method can be applied to the design of new and replacement culverts and can be used to evaluate the effectiveness of retrofits of existing culverts.

8.5.1 Culvert Width and Vertical Clearance - The minimum culvert width and vertical clearance (i.e. from culvert invert to culvert ceiling) shall be six feet.

8.5.2 Culvert Slope - The culvert slope should not exceed the average slope of the stream from approximately 500 feet upstream to 500 feet downstream of the site in which it is being placed. If embedment of the culvert is not possible, the maximum slope should not exceed 0.5%.

8.5.3 Embedment - Where physically possible, the bottom of the culvert should be buried into the streambed a minimum of 20% of the height of the culvert below the elevation of the tailwater control point downstream of the culvert. The minimum embedment shall be at least 1 foot.

8.5.4 High Fish Passage Design Flow - The high design flow (see section 4.3) for adult fish passage is used to determine the maximum water velocity within the culvert.

8.5.5 Low Fish Passage Design Flow - The low design flow (see section 4.2) for fish passage is used to determine the minimum depth of water within a culvert.

8.5.6 The maximum average water velocity in the culvert refers to the calculated average of velocity within the barrel of the culvert at the fish passage design high flow. In most instances, upstream juvenile fish passage requirements should be used for design. Use table 8.5.6 to determine the maximum average water velocity allowed.

Table 8.5.6 - Maximum Allowable Average Culvert Velocity

Culvert Length (ft)	Maximum Average Velocity (ft/s)		
	chinook, steelhead, sockeye and coho adults	pink, chum adults	juvenile salmonids
<60	6.0	5.0	1.0
60-100	5.0	4.0	1.0
100-200	4.0	3.0	1.0
200-300	3.0	2.0	1.0
>300	2.0	2.0	1.0

8.5.7 Minimum water depth at the low fish passage design flow should be: twelve inches for adult steelhead, chinook, coho, and sockeye salmon; nine inches for pink and chum salmon; and six inches for all species of juvenile salmon.

8.5.8 Maximum *Hydraulic Drop* - *Hydraulic drop*s between the water surface in the culvert and the water surface in the adjacent channel should be avoided in all cases. This includes the culvert inlet and outlet. Where physical conditions preclude embedment and the streambed is stable (eg, culvert installation on bedrock) the *hydraulic drop* at the outlet of a culvert shall not exceed the limits specified in Table 11.1 if juvenile fish are present and require upstream passage, or 1 foot if juvenile fish are not present or do not require upstream passage.

8.6 Retrofitting Culverts: For future planning and budgeting at the state and local government levels, redesign and replacement of substandard stream crossings will contribute substantially to the recovery of salmon stocks throughout the state. Unfortunately, current practices do little to address the problem: road crossing corrections are usually made by some modest level of incremental, low cost "improvement" rather than re-design and replacement. These usually involve bank or structure stabilization work, but frequently fail to address fish passage. Furthermore, bank stabilization using hard point techniques frequently denigrates the habitat quality and natural features of a stream. Nevertheless, many existing stream crossings can be made better for fish passage by cost-effective means. The extent of the needed fish passage improvement work depends on the severity of fisheries impacts, the remaining life of the structure, and the status of salmonid stocks in a particular stream or watershed. For work at any stream crossing, site constraints need to be taken into consideration when selecting options.

Some typical site constraints are ease of structure maintenance, construction windows, site access, equipment, and material needs and availability. The decision to replace or improve a crossing should fully consider actions that will result in the greatest net benefit for fish passage. If a particular stream crossing causes substantial fish passage problems that hinder the conservation and recovery of salmon in a watershed, complete redesign and replacement is warranted. Consolidation and/or decommissioning of roads can sometimes be the most cost effective option. Consultations with NOAA Fisheries biologists can help in selecting priorities and alternatives.

Where existing culverts are being modified or retrofitted to improve fish passage, the hydraulic requirements specified in Section 8.5 should be the design objective for the improvements. However, it is acknowledged that the conditions that cause an existing culvert to impair fish passage may also limit the remedies for fish passage improvement. Therefore, short of culvert replacement, the Section 8.5 criteria and guidelines should be the goal for improvement but not necessarily the required design threshold. Fish passage through existing non-embedded culverts may be improved through the use of gradient control *weir*s upstream or downstream of the culvert, interior *baffles* or *weir*s, or, in some cases, *fish ladder*s. However, these measures are not a substitute for good fish passage design for new or replacement culverts. The following guidelines should be used:

8.6.1 Hydraulic Controls - Hydraulic controls in the channel upstream and/or downstream of a culvert can be used to provide a continuous low flow path through culvert and stream reach. They can be used to facilitate fish passage by establishing the following desirable conditions: Control depth and water velocity within culvert, concentrate low flows, provide resting pools upstream and downstream of the culvert, and prevent erosion of bed and banks.

8.6.2 An entrance pool should be provided that is at least 1.5 times the stream depth, or a minimum of two feet deep, whichever is deeper.

8.6.3 *Baffles* may provide incremental fish passage improvement in culverts (if the culvert has excess hydraulic capacity) that cannot be made passable by other means. However, *baffles* will increase the potential for clogging and debris accumulation within the culvert and require special design considerations specific to the baffle type. Culverts that are too long or too high in gradient require resting pools, or other forms of velocity refuge spaced at increments along the culvert length. Baffles will only be approved on a site specific basis, and generally only for interim use.

8.6.4 *Fishway*s (see Section 5 and Section 11) may be required for some situations where excessive drops occur at the culvert outlet. *Fishways* require specialized site-specific design for each installation and as such, a NOAA Fisheries fish passage specialist shall be consulted.

8.7 Miscellaneous Criteria and Guidelines for Fish Passage at all types of Road Crossings

8.7.1 Trash racks should not be used near the culvert inlet. Accumulated debris may lead to severely restricted fish passage and potential injuries to fish. Where trash racks cannot be avoided in culvert installations, they shall only be installed above the water surface indicated by bankfull flow. A minimum of 9 inches clear spacing should be provided between trashrack vertical members. If trash racks are used, a long term maintenance plan shall be provided along with the design, to allow for timely clearing of debris

8.7.2 Livestock fences should not be used near the culvert inlet. Accumulated debris may lead to severely restricted fish passage and potential injuries to fish. Where fencing cannot be avoided, it should be removed during adult salmon upstream migration periods. Otherwise, a minimum of 9 inches clear spacing should be provided between pickets, up to the high flow water surface. If fencing is used, a long term maintenance plan shall be provided along with the design, to allow for timely clearing of debris. Cattle fences that rise with increasing flow are highly recommended.

8.7.3 Natural or artificial supplemental lighting should be considered in new or replacement culverts that are over 150 feet in length. Where supplemental lighting is required, the spacing between light sources should not exceed 75 feet.

8.7.4 NOAA Fisheries and State Fish & Wildlife Officials commonly set in-stream work windows in each watershed. Work in the active stream channel shall not be performed outside of the in-stream work windows.

8.7.5 Temporary crossings, placed in salmonid streams for water diversion during construction activities, shall meet all of the guidelines in this document. However, if it can be shown that the location of a temporary crossing in the stream network is not a fish passage concern at the time of the project, then the construction activity only needs to minimize erosion, sediment delivery, and impact to surrounding riparian vegetation.

8.7.6 Culverts shall be installed only in a de-watered site, with a sediment control and flow routing plan acceptable to NOAA Fisheries.

8.7.7 The work area shall be fully restored upon completion of construction with a mix of native, locally adapted, riparian vegetation. Use of species that grow extensive root networks quickly should be emphasized. Sterile, non-native hybrids may be used for erosion control in the short term if planted in conjunction with native species.

8.7.8 Construction disturbance to the riparian area shall be minimized and the activity shall not adversely impact fish migration or spawning.

8.7.9 If salmon are likely to be present, fish clearing or salvage operations shall be conducted by qualified personnel prior to construction. If these fish are listed as threatened or endangered under the Federal or state Endangered Species Act, consult directly with NOAA Fisheries biologists to gain authorization for these activities. Care should be taken to ensure fish are not chased under banks or logs that will be removed or dislocated by construction. Any stranded fish are to be returned to a suitable location in a nearby live stream by a method that does not require handling of the fish.

8.7.10 If pumps are used to temporarily divert a stream (to facilitate construction), an acceptable fish screen (see Section 12) shall be used to prevent entrainment or impingement of small fish. At no time shall construction or construction staging activity disrupt continuous streamflow downstream of the construction site.

8.7.11 Unacceptable wastewater associated with project activities shall be disposed of off-site in a location that will not drain directly into any stream channel.

8.7.12 Structural Design and Flood Capacity: All culvert stream crossings, regardless of the design option used, shall be designed to withstand the 100-year peak flood flow without structural damage to the crossing. The analysis of the structural integrity of the crossing shall take into consideration the debris loading likely to be encountered during flooding. Stream crossings or culverts located in areas where there is significant risk of inlet plugging by flood-borne debris should be designed to pass the 100-year peak flood without exceeding the top of the culvert inlet (headwater-to-diameter ratio is less than one). This is to ensure a low risk of channel degradation, stream diversion, and failure over the life span of the crossing. Hydraulic capacity shall compensate for expected deposition in the culvert bottom.

8.7.13 Other Hydraulic Considerations: Besides the upper and lower flow limit, other hydraulic effects need to be considered, particularly when installing a culvert. Water surface elevations in the stream reach shall exhibit gradual flow transitions, both upstream and downstream of the road crossing.

Within the culvert, abrupt changes in water surface and velocity, hydraulic jumps, turbulence and drawdown at the upstream flow entrance shall be avoided in design. A continuous low flow channel shall be maintained at all time throughout the entire stream reach affected by the road crossing construction. In addition, especially in retrofits, hydraulic controls may be necessary to provide resting pools, concentrate low flows, prevent erosion of stream bed or banks, and allow passage of *bedload* material. Hydraulic control devices shall be installed downstream of the culvert to avoid headcutting. Culverts and other structures should be aligned with the stream, with no abrupt changes in flow direction upstream or downstream of the crossing. This can often be accommodated by changes in road alignment or slight elongation of the culvert. Where elongation would be excessive, this must be weighed against better crossing alignment and/or modified transition sections upstream and downstream of the crossing. In crossings that are unusually long compared to streambed width, natural sinuosity of the stream will be lost and sediment transport problems may occur even if the slopes remain constant. Such problems should be anticipated and mitigated in the project design.

Section 9. Tide Gates

9.1 Description, Purpose, and Rationale

This section provides guidelines and criteria to be utilized in the design of *tide gates* for the purpose of providing passage for juvenile and adult salmonids. This material is applicable for projects that are undergoing consultation with NOAA Fisheries, pursuant to Section 7, Section 10 or 4(d) rule responsibilities for protecting fish under the Endangered Species Act (ESA).

Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

9.2 General Procedural Guidelines

In designing for fish passage at *tide gates*, the ability of the fish to swim past the open *tide gate* and through the connected culvert is an important consideration. Research has shown that swimming ability of fish varies and may depend upon a number of factors relating to the physiology of the fish, including species, size, duration of swimming time required, behavioral aspects, migrational stage, physical condition and others, in addition to water quality parameters such as dissolved oxygen concentrations, water temperature, lighting conditions, and others. For this reason, *tide gate* design criteria must be expressed in general terms.

A functional design should be developed that defines type, location, size, hydraulic capacity, method of operation, and other pertinent juvenile fish screen facility characteristics. In the case of applications and consultations under the ESA, a functional design for juvenile and adult fish passage facilities shall be developed and submitted as part of the application or of the Biological Assessment for the facility. It shall reflect NOAA Fisheries input and design criteria and be acceptable to NOAA Fisheries. Functional design drawings shall show all pertinent hydraulic information, including water surface elevations and flows through various areas of the structures, throughout the tidal cycle or river stage fluctuation. Functional design drawings shall show general structural sizes, cross-sectional shapes, and elevations. Types of materials shall be identified where they will directly affect fish. The final detailed design shall be based on the functional design, unless changes are agreed to by NOAA Fisheries.

To minimize risks to anadromous fish at some locations, NOAA Fisheries may require investigation (by the project sponsors) of important and poorly defined site-specific variables that are deemed critical to development of the screen and bypass design. This investigation may include factors such as fish behavioral response to hydraulic conditions, weather conditions (ice, wind, flooding, etc.), river stage-discharge relationships, seasonal operational variability, potential for sediment and debris problems, resident fish populations, potential for creating predation opportunity, and other information.

9.3 Applicability of Criteria

These criteria should be used only for the replacement or modification of existing *tide gates*. Installation of new *tide gates* at sites where none presently exist should only be done as part of an overall enhancement project or for restoration of baseline conditions. This section is intended to provide general criteria in which *tide gates* may be replaced or modified to improve fish passage and habitat functions. *Tide gate* projects that operate in conjunction with other water control methods, such as pumps or diversions, should also account for other NOAA Fisheries criteria (i.e. fish screens), as appropriate. NOAA Fisheries believes that site specific variability can dramatically alter the design and performance of *tide gates*, and that innovative designs can be utilized to meet the criteria outlined here.

Flood gates are mechanically similar to tide gates and are used where the water levels are not influenced by tides. These criteria are intended to include flood gates for the period of time when the water surface elevation in the regulated water body (upland of the flood gate) is higher than the water surface elevation in the receiving water body (seaward of the flood gate).

9.4 Habitat Functions that are Altered by Tide Gates

Tide gates can disrupt habitat function in the following ways:

- Impair or prevent fish passage for adult and juvenile migrating salmonids,
- Dramatic alteration of estuarine water quality,
- Change surface water hydrology and groundwater levels,
- Impede the movement of woody debris,
- Modify natural flooding processes landward of the *tide gate*,
- Create severe water temperature gradient across the *tide gate*,
- Create severe salinity gradient across the *tide gate*, and
- Modify sediment transport regimes upstream and downstream of the *tide gate*.

The biological and engineering design of modified or replacement *tide gates* shall take the above effects into account to minimize the adverse effects to the extent possible.

9. 5 Criteria

The tide gate-culvert system should be designed to meet the following criteria:

9.5.1 The tide gate-culvert system should provide fish passage during 90% of the fish passage season.

9.5.2 The permit application package shall document how the effects listed in Section 9.4 were addressed in the design.

9.5.2 The tide gate-culvert system shall have the following design properties:

a) Culvert Slope: The culvert slope shall not exceed the average slope of the stream from approximately 500 feet upstream and 500 feet downstream of the site

in which it is being placed.
b) Embedment - The bottom of the tide gate culvert will normally be placed at or above the elevation of the stream bed. The vertical distance from the stream bed to the bottom of the culvert shall be based on fish passage and habitat requirements at low tide levels.
c) Culvert Width - The minimum culvert width for non-embedded culverts shall be 6 feet.
d) Maximum water velocities - In order to achieve fish passage, the maximum average water velocity within the barrel of the culvert shall comply with section 8.5.6.

9.5.3 The designers shall establish the Design Tide Inundation Elevation. This elevation is the maximum design water surface elevation to be allowed upland of the *tide gate* during a rising tide. This value should be selected to create the maximum inundation levels that incorporate both drainage and habitat requirements, and that maximize the fish passage time window. The *tide gate* shall remain open whenever the water surface elevation seaward of the tide gate is lower than the Design Tide Inundation Elevation. The Design Tide Innundation Elevation should facilitate the equalization of water quality parameters, such as conductivity, salinity, pH, dissolved oxygen and temperature on the regulated water body (upstream of the tidegate) and the receiving body (downstream of the tidegate).

9.5.4 The hydraulic design should minimize the difference between the upstream and downstream water levels when the *tide gate* is open. The maximum localized water surface drop at the entrance and exit of the culvert and *tide gate* is 0.5 feet when the *tide gate* is open.

9.5.5 The bottom lip of a top-hinged flap gate shall be open at least 1.5 feet from the invert of the culvert when the *tide gate* is open. Side-hinged *tide gates* shall open a minimum of 70-degrees from the closed position when the *tide gate* is open.

9.6 Other Design Considerations

The following design features should also be included:

9.6.1 The design should provide sufficient sediment transport to minimize dredging requirements.

9.6.2 The flow in the culvert should have a free water surface for at least 90 % of the migration season.

9.6.3 It should be possible to adjust the elevation at which the gate closes if necessary to meet habitat and passage goals.

Section 10. Specialized Guidelines and Criteria for Main-Stem Columbia and Snake River Upstream and Downstream Fish Passage Facilities

10.1 Description, Purpose and Rationale

The following criteria and guidelines are specially adapted to certain Columbia and Snake River upstream and downstream fish passage facilities.

Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design. Since these guidelines and criteria are general in nature, there may be cases in which site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, including species of fish not directly under NOAA Fisheries jurisdiction, site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis.

The guidelines and criteria in this section apply at main-stem hydroelectric projects. When not referenced in this section, criteria elsewhere in this document may apply. This section is intended as a starting point for future fish passage facilities designs, and is based on experience at Corps of Engineers (Corps) main-stem hydroelectric dams on the Lower Columbia and Snake Rivers. Where coordinated and scientifically-sound research indicates that one or more of these criteria can be waived without compromising fish protection, alternative criteria will be considered (see Foreword).

Note that this document is *not* for the purpose of including cumulative design criteria and guidelines for all past fish passage facilities designs at main-stem Corps hydro-projects. (That would be a more extensive document, which the Corps of Engineers is considering developing.) Rather, this section lists specific main-stem fish passage criteria and guidelines, for which NOAA Fisheries believes there is a benefit in adding to this document.

10.2 Main-Stem Upstream Passage Criteria and Guidelines

Each main-stem fish ladder system is designed with a specific number (and location) of primary entrances (typically at each shore, and at the powerhouse/spillway interface), a defined hydraulic capacity, and specific operations of auxiliary water, entrance, and exit facilities. For a number of reasons, ladder entrance operations may evolve - and not be consistent with that envisioned in the design phase. Ladder entrances are perhaps the most important feature of the adult fish ladder system. (If entrances are improperly located, and/or discharge is inadequate, excessive upstream fish passage delay may occur.) While this document primarily focuses on design criteria and guidelines, operations of fish passage facilities are a vital and overlapping link. The criteria and guidelines in this sub-section are intended to reinforce what NOAA Fisheries believes is an unfortunate compromise in ladder entrance operations at some locations, relative to original design criteria and intended operation.

Therefore, the following apply to main-stem ladder entrance design and operations.

10.2.1 Total ladder attraction discharge, combined with whether ladder entrances are at satisfactory locations, determine whether up-stream migrating adult fish are able to pass with minimum delay. Total attraction flow discharged from adult fishway entrances should be either a minimum of 3% of mean annual discharge, or the discharge approved in the original design memorandum phase prior to construction.

10.2.2 Unless specifically stated in the original design, all ladder entrances shall be designed to be opened continuously during fish passage months, and operated in accordance with ladder entrance attraction discharge criteria (see below).

10.2.3 Auxiliary water systems shall be designed with sufficient back-up hydraulic capacity to assure continued operation consistent with design criteria.

10.2.4 Unless approved by NOAA Fisheries on the basis of investigations confirming that closure of one or more entrance gates will not adversely influence upstream passage during passage periods, adult ladder total entrance attraction discharge (gravity ladder plus auxiliary water flow) shall not be reduced from original design levels.

10.2.5 Ladder Entrance Attraction Discharge Criteria: Adjustable weir gate crest elevations at primary entrances shall be submerged at a minimum depth of 8 feet (relative to tailwater water surface elevation), with a head differential of 1.0 to 2.0 feet. These two parameters have evolved to become the standard for determining whether main-stem hydro-project fish ladder entrances are discharging at, or above, the minimum satisfactory ladder attraction flow. However, if this criteria cannot be satisfied at one or more ladder entrances (as is the case at some main-stem hydro-projects), an hydraulic investigation should be initiated to determine whether some entrances are discharging excessive attraction flow, while others fail to satisfy minimum discharge criteria. In these cases, it should be determined whether different ladder entrance combinations of head differential and weir submergence can be implemented to provide the minimum equivalent discharge (e.g., provided by 8' weir submergence and 1' head) at each ladder entrance. For instance, if the weir depth at one entrance is reduced by 25%, but the differential is increased, and is still within criteria listed above, the equivalent discharge can still be provided. Analysis findings should be coordinated with all parties before implementation.

All other ladder design and operational features shall comply with Section 5 .

10.3 Main-stem Juvenile Screen and Bypass Criteria and Guidelines

General - *Turbine intake screens* and *vertical barrier screens* at main-stem Columbia and Snake River hydroelectric dams are an exception to design criteria for *conventional screens* referenced in Section 12. Turbine intake screens are considered *partial* screens, because they do not screen the entire turbine discharge. They are *high-velocity* screens, because approach velocities are much higher than allowed for all conventional screens (as described in Section 12). However, since screens were retrofitted to large Columbia and Snake River turbine intakes, it was necessary to protect fish to the extent possible. The following turbine intake screen and vertical barrier screen design criteria are the product of extensive research and development, which has resulted in systems that safely guide a large percentage of downstream migrating juvenile salmon into bypass systems, then route them safely around the dam. This research, in the context of high-volume turbine intake capacity, has demonstrated that high-velocity intake screen and bypass systems can prevent turbine entrainment, and route fish past main-stem dams with low injury/mortality rates. The extensive research confirming satisfactory performance is the primary basis for deviation from conventional screen criteria.

10.3.1 **Turbine Intake Screens** - Existing intake screens are either 20 ft, or 40 ft, long and are located in the bulkhead slot of each turbine. They are lowered into the intake, then rotated to the correct operating inclination.

The following are design criteria for turbine intake screens:

10.3.1.1 Maximum approach velocity (normal to the screen face) shall be 2.75 ft/s. This is supported by extensive research of high-velocity screens. Above this velocity threshold, injury rates increase more rapidly.

10.3.1.2 Intake screen porosity shall be determined on the basis of physical hydraulic modeling.

10.3.1.3 Stagnation point (point where the component of velocity along the screen face is zero ft/s) shall be at a location where the submerged screen intercepts between 40-43% of turbine intake discharge, and shall be within 5 ft of the leading edge of the screen.

10.3.1.4 Gatewell flow shall be approximately 10% of intercept flow (which is flow above the intake screen stagnation point), and approximately 4% of turbine discharge.

10.3.1.5 Intake screen face shall be stainless steel bar screen, with maximum clearance between bars equal to1.75 mm.

10.3.1.6 Intake screen shall have an approved and proven screen cleaning device, which can be adjusted for desired cleaning frequency.

10.3.2 **Vertical Barrier Screens (VBS)** - These screens pass nearly all flow entering the gatewell from the intake screen and intake ceiling apex zone. Fish pass upward along the VBS, then accumulate in the upper gatewell, near an orifice that is designed to pass them safely into the juvenile bypass system.

The following are criteria and guidelines for design of VBS's:

10.3.2.1 Hydraulic modeling shall be used to assure the greatest possible uniform velocity distribution across the entire VBS. Note that this criterion assumes that operating gate position has a significant influence over VBS velocity flow distribution, and is one of the design issues to be reconciled through use of the physical model.

10.3.2.2 Variable-porosity stacked panels shall be developed using a physical hydraulic model, in order to achieve uniform velocity distribution and minimize turbulence in the upper gatewell.

10.3.2.3 Where gatewell flow is increased by a flow vane at the gatewell entrance, VBS's should be constructed of stainless steel bar screens, with upstream surface bar strands oriented horizontally, and a maximum clearance between bars of 1.75 mm.

10.3.2.4 A screen cleaner and debris removal system shall be features of each VBS with a gatewell flow increaser vane.

10.3.2.5 Average VBS through-screen velocity shall be a maximum of 1.0 fps, unless field testing is conducted to prove sufficiently low fish descaling/injury rates at a specific site.

Section 11. Upstream Juvenile Fish Passage

11.1 **Description, Purpose and Rationale:** Upstream juvenile fish passage is necessary at some passage sites, where inadequate conditions exist downstream for rearing fish. In a ladder that uses only a portion of the river flow for *upstream fish passage*, juvenile passage may require special and separate provisions from those designed to optimize adult passage. However, adult passage should never be compromised to accommodate juvenile passage..

As discussed in Section 5.2 (Upstream Passage Systems, Entrance Design), it is recommended that a 12 to 18 inch *hydraulic drop* from entrance pool to tailwater is used for *fishway entrance* design. Attraction of adult salmonids to a *fishway entrance* is compromised with decreased *headloss* at a *fishway entrance*, unless all of the streamflow is passed through the entrance. *Fishway* attraction (i.e., fishes' ability to locate the *fishway entrance* downstream of the dam) is the critical design parameter for an upstream passage facility. Previously, of many *fishway*s on the Columbia River operated with six-inches of *headloss* (measured from the entrance pool water surface to tailwater surface). After extensive laboratory and field studies, it was conclusively determined that higher velocities, which directly relates to the amount of *headloss* through the entrance, provided better attraction of adult salmonids than did lower velocities. This resulted in making hydraulic adjustments to *fishway entrance*s so that they operated with 12 to 18 inches of *headloss*, instead of six inches. Subsequent radio telemetry studies verified that passage times decreased as a result. Thus, there is a clear basis for designing entrance pool to tailwater differentials between 12 and 18 inches for adult salmonid passage.

Within the Northwest Region of NOAA Fisheries (which includes the states of Washington, Oregon, and Idaho), there are varying requirements for juvenile passage. NOAA Fisheries will consider the appropriate design requirements as applicable. Lower required headloss between pools is not going to provide an obstacle to adult fish, provided that the facility satisfies entrance design requirements of Section 5.2.. Powers has researched juvenile fish passage and reports in Structures for Passing Juvenile Salmon Into Off-Channel Habitat American Fisheries Society Annual Meeting in Portland in 1993:

> Studies (Blake, 1983) have shown that fish are more energetically efficient at leaping as opposed to swimming, at certain speeds (usually greater than 9 fps). Also, entrained air which creates an upwelling current from the air bubbles returning to the surface often provides "standing wave" velocities which can propel fish upwards. Even with these considerations the leaping capabilities of juvenile coho salmon appear exceptional. To investigate this further fish passage tests were conducted. The objective was to determine the percent passage of juvenile coho salmon over a wide range of hydraulic drops (i.e. 6", 9", 12" etc.). The preliminary data for coho fry indicate that fish in the 60 to 70 mm size range can pass 12 inches (8 of 37 passed). But, since the percent passing for the 6" and 9" drop was similar, there are no conclusions on percent of passage at this time.
>
> Given the reported swimming speeds for juvenile coho salmon and the observed leaping capabilities, submerged ports or pipes should be avoided when designing passage facilities for juvenile fish, except for inlet and outlet conditions. Fishways should be designed as pool and weir or roughened channel, with drops not to exceed the criteria listed in Table 11.1. In addition to the hydraulic drop, calm water in the pools and a low velocity just upstream of the weir crest is important. Weirs should be designed as sharp crested, where the head over the weir is two times the breadth.

Table 11.1. Juvenile Upstream Fish Passage Criteria

Juvenile Fish Passage Criteria			
Fish Size (mm)	Hydraulic Drop (weir), ft	Hydraulic Drop (Entrance and exit), ft	Velocity (fps) distances <1 ft
45 to 65	0.7	0.13	1.5 to 2.5
80 to 100	1	0.33	3 to 4.5

Powers also indicated that pool volume criteria described in section 5.6. are critical to ensuring appropriate passage conditions. This pool volume, if exceeded, serves as a turbulent barrier to juvenile fish.

Hydraulic design for juvenile upstream passage should be based on representative flows in which juveniles typically migrate. Recent research (NOAA Fisheries, 2001, in progress) indicates that providing for juvenile salmon passage up to the 10% annual exceedance flow will cover the majority of flows in which juveniles have been observed moving upstream.

In some situations, it may be feasible to operate a ladder entrance with a decreased *headloss* at times when adult salmon are not present, and at 12 to18 inches during the adult salmon upstream migration. The feasibility of doing this often entails making a judgement call on the timing of adult passage when often little or no information is available, and if it is available, it can change from year to year. In other situations, it may be appropriate to provide multiple fishway entrances that operate independently, according to the desired *headloss*. One entrance may operate to attract adult fish and convey the appropriate volume shape of attraction jet and velocities and another entrance may operate at a lower differential and convey flow over a weir.

Section 12. Fish Screen and Bypass Facilities

12.0 **Description, Purpose and Rationale**: This section provides criteria and guidelines to be utilized in the development of designs of downstream migrant fish screen facilities for hydroelectric, irrigation, and other water withdrawal projects. Consistent with the terminology used throughout this document, criteria are specified by the word "shall" and guidelines are specified by the word "should". Criteria are required design features, unless site specific conditions preclude their use and a site-specific written waiver is provided by NOAA Fisheries (also see Foreword). Guidelines are not required, but deviation from a guideline require a written explanation by the project designer. It is suggested that deviation from a guideline be discussed with NOAA Fisheries prior to final design.

In designing an effective fish screen facility, the swimming ability of the fish is a primary consideration. Research has shown that swimming ability of fish varies and may depend upon a number of factors relating to the physiology of the fish, including species, size, duration of swimming time required, behavioral aspects, migrational stage, physical condition and others, in addition to water quality parameters such as dissolved oxygen concentrations, water temperature, lighting conditions, and others. For this reason, screen criteria must be expressed in general terms.

Since these criteria and guidelines are general in nature, there may be cases where site constraints or extenuating biological circumstances dictate that certain criteria or guidelines be waived or modified, without delaying or otherwise adversely impacting fish migration. It is the responsibility of the project sponsor provide compelling evidence in support of any proposed waiver. Particular fishway elements that can not be designed to meet these criteria and guidelines should be discussed with NOAA Fisheries engineering staff as early in the design process as possible to explore potential options. Conversely, where NOAA Fisheries deems there is a need to provide additional protection for fish, more restrictive site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis. To facilitate construction of any fish passage facility, rationale for criteria waivers shall accompany design documents sent to NOAA Fisheries staff for review.

Several categories of screen designs are in use but are still considered as experimental technology by NOAA Fisheries. These include Eicher screens, modular inclined screens, coanda screens, and horizontal screens. Criteria for experimental screens can be developed through discussions with NOAA Fisheries engineers, on a case-by-case basis. The process to evaluate experimental technology is described in Section 17.

12.1 A functional screen design should be developed that defines type, location, size, hydraulic capacity, method of operation, and other pertinent juvenile fish screen facility characteristics. In the case of applications to be submitted to the FERC and for consultations under the ESA, a functional design for juvenile (and adult) fish passage facilities shall be developed and submitted as part of the FERC License Application or of the Biological Assessment for the facility. It shall reflect NOAA Fisheries input and design criteria and be acceptable to NOAA Fisheries.

Functional design drawings shall show all pertinent hydraulic information, including water surface elevations and flows through various areas of the structures. Functional design drawings shall show general structural sizes, cross-sectional shapes, and elevations. Types of materials shall be identified where they will directly affect fish. The final detailed design shall be based on the functional design, unless changes are agreed to by NOAA Fisheries.

12.2 To minimize risks to anadromous fish at some locations, NOAA Fisheries may require investigation (by the project sponsors) of important and poorly defined site-specific variables that are deemed critical to development of the screen and bypass design. This investigation may include factors such as fish behavioral response to hydraulic conditions, weather conditions (ice, wind, flooding, etc.), river stage-discharge relationships, seasonal operational variability, potential for sediment and debris problems, resident fish populations, potential for creating predation opportunity, and other information. The life stage and size of juvenile salmonids present at a potential screen site usually is not known, and can change from year to year based on flow and temperature conditions. Thus, adequate data to describe the size-time relationship requires substantial sampling efforts over a number of years. For the purpose of designing juvenile fish screens, NOAA Fisheries will assume that fry-sized salmonids and low water temperatures are present at all sites and apply the appropriate criteria listed below, unless adequate biological investigation proves otherwise. The burden-of-proof is the responsibility of the owner of the diversion facility.

12.3 Acceptance criteria for existing screens: If a fish screen was constructed prior the establishment of these criteria, but constructed to NOAA Fisheries criteria established August 21, 1989, or later, approval of these screens will be considered providing that all of the following conditions are met:

1) the entire screen facility is still functioning as designed.
2) the entire screen facility has been maintained and is in good working condition.
3) when the *screen media* wears out, it shall be replaced with *screen media* meeting the current criterion stated in this document. Structural constraints may limit this activity in some instances, and these should be discussed with NOAA Fisheries engineering staff prior to replacing *screen media*.
4) no mortality, injury, entrainment, impingement, migrational delay or other harm to anadromous fish has been noted that is being caused by the facility;
5) no emergent fry are likely to be located in the vicinity of the screen, as agreed to by NOAA Fisheries biologists familiar with the site; and
6) when biological uncertainty exists, access to the diversion site by NOAA Fisheries is permitted by the diverter for verification of numbers 1 through 5.

12.4 **Structure Placement - Streams and Rivers:**

12.4.1 Where physically practical and biologically desirable, the screen shall be constructed at the point of diversion with the screen face generally parallel to river flow. Physical factors that may preclude screen construction at the diversion entrance include excess river gradient, potential for damage by large debris, and potential for heavy sedimentation. For screens constructed at the bankline, the screen face shall be aligned with the adjacent bankline and the bankline shall be shaped to smoothly match the face of the screen structure to prevent eddies in front, upstream, and downstream of the screen. Adverse alterations to riverine habitat shall be minimized.

12.4.2 Where installation of fish screens at the diversion entrance is not desirable or impractical, the screens may be installed in the canal downstream of the entrance at a suitable location. All screens installed downstream from the diversion entrance shall be provided with an effective bypass system approved by NOAA Fisheries, designed to collect and transport fish safely back to the river with minimum delay. The screen location shall be chosen to minimize the effects of the diversion on in-stream flows by placing the bypass outfall as close as biologically and practically feasible to the point of diversion.

12.4.3 All passage facilities shall be designed to function properly through the full range of hydraulic conditions in the river (see Section 4) and in the diversion conveyance, and shall account for debris and sedimentation conditions which may occur.

12.5 Structure Placement - Lakes, Reservoirs and Tidal areas:

12.5.1 Intakes shall be located offshore where feasible to minimize fish contact with the facility. When possible, intakes shall be located in areas with sufficient ambient velocity to minimize sediment accumulation in or around the screen and to facilitate debris removal and fish movement away from the screen face. Intakes in reservoirs should be as deep as practical, to reduce the numbers of juvenile salmonids that encounter the intake.

12.5.2 If a reservoir outlet is used to pass fish from a reservoir, the intake shall be designed to withdraw water from the most appropriate elevation based on providing the best juvenile fish attraction and appropriate water temperature control downstream of the project. The entire range of forebay fluctuation shall be accommodated in design.

12.6 Screen Hydraulics - Rotating Drum Screens, Vertical Screens and Inclined Screens

12.6.1 The *approach velocity* shall not exceed 0.40 feet per second (ft/s) for *active screens*, or 0.20 ft/s for *passive screens*. For screen design, *approach velocity* is calculated by dividing the vertical projection of the effective screen area into the diverted flow amount. This approach velocity will minimize screen contact and/or impingement of juvenile fish.

12.6.2 The *effective screen area* required is calculated by dividing the maximum diverted flow by the allowable *approach velocity*.

12.6.3 For rotating drum screens, the design submergence shall not exceed 85%, nor be less than 65% of drum diameter. Submergence over 85% of the screen diameter increases the possibility of entrainment over the top of the screen (if entirely submerged), and increases the chance for impingement with subsequent entrainment if fish are caught in the narrow wedge of water above the 85% submergence mark. Submerging rotating drum screens less than 65% will reduce the self-cleaning capability of the screen. In many cases, stop logs can be installed downstream of the screens to achieve proper submergence. If stoplogs are used, they should be located at least two drum diameters downstream of the back of the drum.

12.6.4 The screen design shall provide for nearly uniform flow distribution (see section 16) over the screen surface, thereby minimizing approach velocity over the entire screen face. The screen designer shall show how uniform flow distribution is to be achieved. Providing adjustable porosity control on the downstream side of screens, and/or flow training walls may be required. Large facilities may require hydraulic modeling to identify and correct areas of concern. Uniform flow distribution avoids localized areas of high velocity, which have the potential to impinge fish.

12.6.5 Screens longer than six feet shall be angled and shall have sweeping velocity greater than the approach velocity. This angle may be dictated by site specific geometry, hydraulic, and sediment conditions. Optimally, sweeping velocity should be at least 0.8 ft/s and less than 3 ft/s.

12.6.6 Sweeping velocity shall not decrease along the length of the screen.

12.6.7 The plane of an inclined screen shall be oriented at 45° or more relative to the downstream water surface. Horizontally inclined screens are currently under evaluation, and considered as experimental technology (see Section 17).

12.7 *Screen Media*

12.7.1 Circular screen face openings shall not exceed 3/32 inch in diameter. Perforated plate openings shall be punched through in the direction of flow

12.7.2 Slotted screen face openings shall not exceed 1.75 mm (approximately 1/16 inch) in the narrow direction.

12.7.3 Square screen face openings shall not exceed 3/32 inch on a side.

12.7.4 The *screen media* shall be corrosion resistant and sufficiently durable to maintain a smooth uniform surface with long term use.

12.7.5 Other components of the screen facility (such as seals) shall not include gaps greater than the maximum screen opening defined above.

12.8 Civil Works and Structural Features

12.8.1 The face of all screen surfaces shall be placed flush (to the extent possible) with any adjacent screen bay, pier noses, and walls to allow fish unimpeded movement parallel to the screen face and ready access to bypass routes.

12.8.2 Structural features shall be provided to protect the integrity of the fish screens from large debris, and to protect the facility from damage if overtopped by flood flows. A trash rack, log boom, sediment sluice, and other measures may be required.

12.8.3 The civil works shall be designed in a manner that prevents undesirable hydraulic effects (such as eddies and stagnant flow zones) that may delay or injure fish or provide predator habitat or predator access.

12.9 Bypass System

12.9.1 Bypass layout

12.9.1.1 The screen and bypass shall work in tandem to move out-migrating salmonids (including adults) to the bypass outfall with a minimum of injury or delay. The bypass entrance shall be located so that it can easily be located by out-migrants. Screens greater than or equal to six feet in length shall be constructed with the downstream end of the screen terminating at a bypass entrance. Screens less than or equal to six feet long may be constructed perpendicular to flow with a bypass entrance at either or both ends of the screen, or else could be constructed at an angle to flow, with the downstream end terminating at the bypass entrance. Some screen systems do not require a bypass system. For example, an end of pipe screen located in a river, lake or reservoir does not require a bypass system because fish are not removed from their habitat. A second example is a river bank screen with sufficient hydraulic conditions to move fish past the screen face.

12.9.1.2 Multiple bypass entrances may be required if the sweeping velocity will not move fish to the bypass within 60 seconds, assuming fish are transported along the length of the screen face at this velocity.

12.9.1.3 The bypass entrance and all components of the bypass system shall be of sufficient size and hydraulic capacity to minimize the potential for debris blockage.

12.9.1.4 In order to improve bypass collection efficiency for a single bank of vertically-oriented screens, a bypass training wall shall be located at an angle to the screens, with the bypass entrance at the apex and downstream-most point. This will aid fish movement into the bypass by creating hydraulic conditions that conform to observed fish behavior. For single or multiple vee screen configurations, training walls are not required, unless a intermediate bypass is used.

12.9.1.5 In cases where there is insufficient flow available to satisfy hydraulic requirements at the bypass entrance (entrances) for the main screens, a secondary screen may be required. This is a screen located in the main screen bypass which allows the prescribed bypass flow to be used to effectively attract fish into the bypass entrance(s) and then allows for all but a reduced residual bypass flow to be routed back (by pump or gravity) to the diversion canal for the primary use. The residual bypass flow (not passing through the secondary screen) would then convey fish to the bypass outfall location or other destination.

12.9.1.6 Access for inspection and debris removal is required at locations in the bypass system where debris accumulations may occur. If trash racks are used, sufficient hydraulic gradient is required to route juvenile fish from between the trash rack and screens to the bypass.

12.9.1.7 The screen civil works floor shall be designed to allow fish to be routed back to the river safely when the canal is dewatered. This may entail a sumped drain with a small gate and drain pipe, or similar provisions. If this can not be accomplished, an acceptable fish salvage plan shall be developed in consultation with NOAA Fisheries and included in the operation and maintenance plan.

12.9.1.8 To assure that fish move quickly into the bypass system, the rate increase in velocity between any two points in the screen/bypass system should not decrease and should not exceed 0.2 ft/s per foot of travel.

12.9.2 Bypass Entrance

12.9.2.1. Each bypass entrance shall be provided with independent flow-control capability.

12.9.2.2. The minimum bypass entrance flow velocity should be greater than 110% of the maximum true velocity upstream of the bypass entrance. At no point shall flow decelerate along the screen face or in the bypass channel. Bypass flow amounts should be of sufficient quantity to ensure these hydraulic conditions are achieved over the entire range of operations throughout the smolt out migration period.

12.9.2.3 Ambient lighting conditions are required upstream of the bypass entrance and should extend to the bypass flow control device. Where lighting transitions can not be avoided, they should be gradual, or should occur at a point in the bypass system where fish can not escape the bypass and return to the canal (i.e. when bypass velocity exceeds swimming ability).

12.9.2.4 For diversions greater than 3 cfs, the bypass entrance shall extend from the floor to the canal water surface, and be a minimum of 18 inches wide. For diversions of 3 cfs or less, the bypass entrance shall be a minimum of 12 inches wide.

12.9.2.5 For weirs used in bypass systems, depth over the weir shall be a minimum of one foot throughout the smolt out-migration period.

12.9.3 Bypass Conduit and System Design

12.9.3.1 Bypass pipes and joints shall have smooth surfaces to provide conditions that minimize turbulence, risk of catching debris and the potential for fish injury. Pipe joints may be subject to inspection and approval by NOAA Fisheries prior to implementation of the bypass. Every effort should be made to minimize the length of the bypass pipe.

12.9.3.2 Fish should not be pumped within the bypass system.

12.9.3.3 Fish shall not be allowed to free-fall within a pipe or other enclosed conduit in a bypass system. Downwells shall be designed with a free water surface, and designed for safe and timely fish passage by proper consideration of turbulence, geometry and alignment.

12.9.3.4 In general, bypass flows in any type of conveyance structure should be open channel. If required by site conditions, pressures in the bypass pipe shall be equal to or above atmospheric pressures. Pressurized to non-pressurized (or vice-versa) transitions should be avoided within the pipe. Bypass pipes shall be designed to allow trapped air to escape.

12.9.3.5 Bends should be avoided in the layout of bypass pipes due to the potential for debris clogging and turbulence. The ratio of bypass pipe center-line radius of curvature to pipe diameter (R/D) shall be greater than or equal to 5. Greater R/D may be required for super-critical velocities (see section 12.9.3.9).

12.9.3.6 Bypass pipes or open channels shall be designed to minimize debris clogging and sediment deposition and to facilitate inspection and cleaning as necessary. For bypass pipes longer than 150 feet, access ports should be provided at spacing of less than 100 feet to allow for detection and removal of debris.

12.9.3.7 The bypass pipe diameter or open channel bypass geometry should generally be a function of the bypass flow and slope but shall also comply with velocity and depth criteria in 12.9.3.9 and 12.9.3.10. Generally, a bypass pipe less than 18 inches in diameter is not acceptable. However, if other hydraulic criteria cannot be reasonably satisfied with that size of pipe, the diameter can be reduced with special consideration given to management of debris. In no case can a pipe diameter of less than 10 inches be used. For bypass flows greater than 20 cfs, a 30 inch diameter bypass pipe is recommended. Bypass flows greater than 50 cfs are special cases that need specific consultation with NOAA Fisheries engineers.

12.9.3.8 Design bypass flow should be at least 5% of the total diverted flow amount, unless otherwise approved by NOAA Fisheries.

12.9.3.9 The design bypass pipe velocity should be between 6 and 12 ft/s for the entire operational range. If higher velocities are approved, special attention to pipe and joint smoothness is required. In no instance shall pipe velocity be less than 2 ft/s.

12.9.3.10 The design minimum depth of free surface flow in a bypass pipe should be at least 40% of the bypass pipe diameter, unless otherwise approved by NOAA Fisheries.

12.9.3.11 Closure valves of any type should not be used within the bypass pipe unless specifically approved based on demonstrated fish safety.

12.9.3.12 Sampling facilities installed in the bypass conduit shall not in any way impair operation of the facility during non-sampling operations.

12.9.3.13 There should not be a hydraulic jump within the pipe, unless a weak jump is specifically approved by NOAA Fisheries engineers.

12.9.3.14 Spillways upstream of the screen facility also act as a bypass system. These facilities should also be designed to provide a safe passage route back to the stream, adhering to the bypass design principles described in sections 12.9 and 12.10.

12.10 Bypass Outfall

12.10.1 Bypass outfalls should be located where ambient river velocities are greater than 4.0 ft/s.

12.10.2 Bypass outfalls shall be located to minimize predation by selecting an outfall location free of eddies, reverse flow, or known predator habitat. Predator control systems may be required in areas with high avian predation potential. Bypass outfalls should be located to provide good egress conditions for downstream migrants.

12.10.3 Bypass outfalls shall be located where the receiving water is of sufficient depth (depending on the impact velocity and quantity of bypass flow) to ensure that fish injuries are avoided at all river and bypass flows. The bypass flow shall not impact the river bottom or other physical features at any stage of river flow.

12.10.4 Maximum bypass outfall impact velocity (i.e. the velocity of bypass flow entering the river) including vertical and horizontal velocity components shall be less than 25.0 ft/s.

12.10.5 The bypass outfall discharge into the receiving water shall be designed to avoid attraction of adult fish thereby reducing the potential for jumping injuries and false attraction. The bypass outfall design shall allow for the potential attraction of adult fish, by provision of a safe landing zone if attraction to the outfall flow can potentially occur.

12.11 Debris Management

12.11.1 A reliable, ongoing inspection, preventative maintenance and repair program is necessary to assure facilities are kept free of debris and that *screen media*, seals, drive units, and other components are functioning correctly during the out migration period. A written plan should be completed and submitted for approval with the screen design.

12.11.2 *Active screens* shall be automatically cleaned as frequently as necessary to prevent accumulation of debris. The cleaning system and protocol shall be effective, reliable, and satisfactory to NOAA Fisheries.

12.11.3 A *passive screen* can only be used when all of the following criteria are met:

12.11.3.1 The site is not suitable for an active screen.
12.11.3.2 Uniform flow characteristics can be demonstrated.
12.11.3.3 The debris load is expected to be low.
12.11.3.4 The rate of diversion is less than 3 CFS.
12.11.3.5 Sufficient ambient river velocity exists to carry debris away from the screen face.
12.11.3.6 A maintenance program is approved by NOAA Fisheries and implemented by the water user.
12.11.3.7 The screen is inspected at least daily and debris accumulations are removed, with more frequent inspections as site conditions dictate.
12.11.3.8 Sufficient stream depth exists at the screen site to provide for distance of at least 1 screen radius around the screen.
12.11.3.9 The screen can be easily removed for maintenance, and to protect from flooding.

12.11.4 Intakes shall include a trash rack in the screen facility design which shall be kept free of debris. In certain cases, a satisfactory profile bar screen design can substitute for a trash rack. Based on biological requirements at the screen site, trash rack spacing may be specified that reduces the probability of entraining adult fish.

12.11.5 The head differential to trigger screen cleaning for intermittent type cleaning systems shall be a maximum of 0.1 feet or as agreed to by NOAA Fisheries. A variable timing interval trigger shall also be used for intermittent type cleaning systems as the primary trigger for a cleaning cycle.

12.11.6 The completed screen and bypass facility shall be made available for inspection by NOAA Fisheries, to verify that the screen is being operated consistent with the design criteria.

12.11.7 At some sites, screen and bypass facilities mayl be evaluated for biological effectiveness and to verify that hydraulic design objectives are achieved. At the discretion of NOAA Fisheries, this could entail a complete biological evaluation especially if waivers to screen and bypass criteria are granted, or merely a visual inspection of the operation if screen and bypass criteria is met in total.

12.11.8 Provision shall be made to limit the build-up of sediment, where it could impact screen operations.

12.12 Additional criteria for end of pipe screens (including pump intake screens)

12.12.1 End of Pipe Screen Location: When possible, end of pipe screens shall be placed in locations with sufficient ambient velocity to sweep away debris removed from the screen face.

12.12.2 End of pipe screens shall be submerged to a depth of at least one screen radius below the minimum water surface, with a minimum of one screen radius clearance between screen surfaces and natural or constructed features. For approach velocity calculations, the entire submerged effective area can be used.

12.12.3 A clear escape route should exist for fish that approach the intake volitionally or otherwise. For example, if a pump intake is located off of the river (such as in an intake lagoon), a conventional open channel screen should be placed in the intake channel or at the edge of the river to prevent fish from entering a lagoon.

Section 13. Infiltration Galleries

13.1 **Description, Purpose and Rationale:** This section discusses the application and suitability for the installation *infiltration galleries*. In concept, *infiltration galleries* could provide suitable fish passage conditions at a diversion site. However, if improperly sited, failure can occur that can result in severe adverse habitat impacts and loss of habitat access in addition to the loss of the diversion. This section describes the guidelines and criteria that should be followed in the planning, design, operation, monitoring, and maintenance of *infiltration galleries*.

The intent of these criteria is to build and operate *infiltration galleries* that provide at least the same level of fish protection as conventional screen facilities that meet NOAA Fisheries screen criteria, as presented in Section 12. Accordingly, *infiltration galleries* share some of the design goals as conventional screens. These include: screen media dimensions, approach velocity, bypass, ability to monitor head loss, and the ability to be self-cleaning, maintainability, and owner agreements to maintain and operate the system within criteria. These aspects are discussed in more detail in the following sections.

Since these criteria and guidelines are general in nature, there may be cases where site constraints or extenuating biological circumstances dictate that certain criteria or guidelines be waived or modified, without delaying or otherwise adversely impacting fish migration. It is the responsibility of the project sponsor to provide compelling evidence in support of any proposed waiver. Particular *infiltration gallery* elements that cannot be designed to meet these criteria and guidelines should be discussed with NOAA Fisheries engineering staff as early in the design process as possible to explore potential options. Conversely, where NOAA Fisheries deems there is a need to provide additional protection for fish, more restrictive site-specific criteria may be added. These circumstances will be considered by NOAA Fisheries on a project-by-project basis. To facilitate construction of any fish passage facility, rationale for criteria waivers shall accompany design documents sent to NOAA Fisheries staff for review.

13.2 **Scope:** The term *infiltration gallery*, in this document, refers to a water collection system that is installed in the substrate of a stream, between the stream banks, for the purpose of conveying water to either a pumped or gravity-fed water distribution network. See Figure 13-1. The *infiltration gallery* is intended to be a substitute for a surface-based diversion system that is normally installed above the bed of the stream.

The *infiltration gallery* shall be designed to:

a) provide the same volume, rate, and timing of water supply that the diverter would be entitled to when using a surface-based diversion.

b) withdraw water primarily from the portion of the stream located directly above the *infiltration gallery*, and

c) provide at least the same level of fish protection as conventional screens.

13.3 **Selection of Appropriate Screen Technology:** Due to their location below the stream bed, *infiltration galleries* are prone to become ineffective due to plugging by sediments. Besides reducing the flow capacity of the facility, plugged galleries also increase risk to small fish due to the creation of velocity hot spots. Since very few existing *infiltration galleries* include effective installed self-cleaning systems, it is a common practice to repair plugged galleries by digging them up and re-building them. This process can create enormous disruption to the river habitat and to the diverters' ability to divert water. Therefore, the designer should select an *infiltration gallery* as the preferred diversion method only after a thorough review of the benefits and risks of using conventional screens indicates that an *infiltration gallery* will create less risk for fish and their habitat.

13.2 **Site Selection** - NOAA Fisheries intends to only permit *infiltration galleries* at stream sites that exhibit sufficient natural fluvial processes to minimize sediment deposition on top of the *infiltration gallery* to the maximum practical extent. The sealing of *infiltration galleries* with transported bedload sediments seems to be a common mode of failure. *Infiltration galleries* should not be installed at sites where natural sedimentation occurs that would plug a gallery.

13.3 **Minimum Depths and Velocities over Infiltration Galleries:**
Infiltration galleries should not be operated when the water depth above the river bed over any part of the *infiltration gallery* is less than 0.5 feet. Use of temporary impoundments such as push-up berms and other dams to raise the water level is not permitted. The minimum stream velocity at low flow should be 2 feet per second.

13.4 **Screen Mesh Opening:** *Infiltration galleries* installed with less than 24 inches of gravel cover should meet juvenile fish screen criteria, as described in Section 12.

13.5 **Flow direction:** *Infiltration galleries* should be designed to withdraw flow primarily from the zone directly above the intake screen.

13.6 **Imported Gravels**: Rock used to backfill over the *infiltration gallery* shall be as designed and approved by the design engineer. The backfill material selection shall also be approved by NOAA Fisheries.

13.7 Induced vertical approach velocity at the stream bed: The maximum vertical interstitial velocity at through the substrate, V_s , shall not exceed 0.05 fps when the substrate is new and after *backwashing* (see Figure 13-1).

V_s is defined according to the following calculations:

$$V_s = Q / [(A_{eff}) (\eta)]$$

Where V_s = Average vertical interstitial velocity through the substrate

Q = *Infiltration gallery* flow rate

$A_{effective} = (W_{effective})(L_{screen})$ = The area, in the plan view, of the stream surface through which the flow is assumed to pass

η = porosity of gravel substrate

13.8 **Determination of Plugged Gallery:** As with conventional screen technology, it is essential to be able to measure the head loss through the *screening media* (See Section 12.11.5). As a minimum, sufficient instrumentation shall be installed to measure the Hydraulic Grade Line (H) values, as shown schematically in Figure 13-1. The gallery *media* shall be backwashed when the head loss measurements indicate that V_s is greater than or equal to 0.10 fps. If *backwashing* does not reduce V_s below 0.10 fps then the gallery shall be shut down and repaired.

13.9 **Backwashing:** All *infiltration galleries* shall be designed to be capable of being backwashed. *Backwashing* may be accomplished using air or water or both. The backwash system shall be designed to thoroughly clean all of the *media* in the Effective Cleaning Section (see Figure 13-1). The Effective Cleaning Zone is the volume of filter medium that the designer has assumed contributes about 90% of the diverted flow rate.

Insert Figure 13-1

13.10 **Limitations/Cessation of Use**

13.10.1 *Infiltration galleries* should not be constructed in areas in where spawning may occur.

13.10.2 Should spawning occur within 10' of a portion of an *infiltration gallery*, then use of those portions of the *Infiltration galleries* within 10' of the redd should be discontinued for 90 days, or as directed by NOAA Fisheries.

13.10.3 Instream excavation to repair *infiltration galleries* is not included in the scope of permitted work beyond 90 days from the date of commencement of initial instream construction, or the end of the approved work period, whichever is earlier, unless performed when there is no flowing water in the creek. This restriction does not apply to repairs that do not disturb the river bed or banks.

13.11 **Qualifications of Infiltration Gallery Designers:** The design of *infiltration galleries* shall be performed by an appropriately qualified engineer or engineering geologist, and the drawings should be signed by the designer and/or stamped with his/her seal. The design of each *infiltration gallery* shall be reviewed and approved by NOAA Fisheries.

13.12 **Operations and Maintenance:** Infiltration galleries shall be operated and maintained in accordance with Section 15.

Section 14. Interim Passage during Construction and/or Modifications

Where construction and/or modifications to man-made impediments (e.g., dams) or upstream passage facilities are planned, upstream passage may be adversely impacted. If possible, these activities should be scheduled for periods when migrating fish are not present, as specified in the in-water work period allowable for construction of facilities in streams. However, this may not always be possible or advisable. In these cases, an interim fish passage plan shall be prepared and submitted to NOAA Fisheries for approval, in advance of work in the field. Criteria listed herein will apply to the interim upstream passage plan. Where this is not possible, project owners shall seek NOAA Fisheries approval of alternate interim fish passage design criteria, and a final interim passage plan.

Section 15. Operations and Maintenance Responsibilities

Passage facilities at impediments must be operated and maintained properly for optimum, or even marginal, success. The preceding criteria are intended for use in the design of passage facilities; however, failure to operate and maintain these facilities to optimize performance in accordance with design will result in compromised fish passage, and ultimate deterioration of the entire facility. Therefore, NOAA Fisheries requires project sponsors to acknowledge and accept long-term responsibility for operations, maintenance, and repair of fish facilities described herein, to ensure protection of fish on a sustained basis. This includes immediate restoration of the passage facility (including repair of damage and sediment/gravel removal) immediately after flooding. Where facilities are inadequately operated or maintained, and mortality of listed fish can be documented, the responsible party is liable to enforcement measures as described in Section 9 of the Endangered Species Act.

An operation and maintenance plan shall be drafted and submitted for approval by NOAA Fisheries. This plan shall include a brief summary of operating criteria posted at the passage facility or made available to the facility operator.

Staff gages shall be installed and maintained at critical areas throughout the facility in order to allow personnel to easily determine if the facility is being operated within the established design criteria.

Section 16. Post-construction evaluations

Post-construction evaluation is important to assure the intended results of the fishway design are accomplished, and to assist in ensuring that mistakes are not repeated elsewhere. There are three parts to this evaluation: 1)Verify the fish passage system is installed in accordance with proper design and construction procedures; 2) measure hydraulic conditions to assure that the facility meets these guidelines, and 3) perform biological assessment to confirm the hydraulic conditions are resulting in successful passage. NOAA Fisheries technical staff may assist in developing a hydraulic or biological evaluation plan to fit site-specific conditions and species, but in any case, evaluation plans are subject to approval by NOAA Fisheries. These evaluations are not intended to cause extensive retrofits of any given project unless the as-built installation does not reasonably conform to the design guidelines, or an obvious fish passage problem continues to exist. Over time, NOAA Fisheries anticipates that the second and third elements of these evaluations will be abbreviated as commonly used designs are evaluated and fine-tuned to assure optimal passage conditions.

Hydraulic evaluations of juvenile fish screens shall include confirmation of uniform approach velocity and the requisite sweeping velocity over the entire screen face. Confirmation of approach and sweeping velocities shall consist of a series of velocity measurements encompassing the entire screen face, divided into a grid with each grid section representing no more than 5% of the total flow through the screen. The approach and sweeping velocity (parallel and perpendicular to the screen face) should be measured at the center point of each grid section, approximately 3 inches from the face of the screen. Uniform approach velocity is achieved when no individual approach velocity measurement exceeds 0.44 ft/s. In addition, velocities at the entrance to the bypass, bypass flow amounts, and total flow should be measured and reported.

Depending on the site and its potential for adverse biological impacts, detailed biological evaluations and/or monitoring will likely be required and are the responsibility of the project sponsor. The need for and scale of biological evaluation will be identified by NOAA Fisheries early in the design process. If a passage facility will be encountered by the majority of the fish migration, and if waivers to the criteria are granted, biological evaluation will likely be required.

Section 17. Experimental Fish Guidance Devices

SUMMARY

NOAA Fisheries believes that conventional fish passage facilities constructed to the criteria and guidelines described above are most appropriate for utilization in the protection of salmon and steelhead at all impediments. However, the process described herein delineates an approach whereby experimental behavioral guidance devices can be evaluated and, if comparable performance is confirmed to the satisfaction of NOAA Fisheries, installed in lieu of conventional passage facilities.

INTRODUCTION

The injury and death of juvenile fish at water diversion intakes have long been identified as a major source of overall fish mortality [Spencer1928, Hatton 1939, Hallock and Woert 1959, Hallock 1987]. Fish diverted into power turbines incur up to 40 percent immediate mortality, while also experiencing injury, disorientation and delay of migration that may increase predation related losses [Bell, 1991]. Fish entrained into agricultural and municipal water diversions experience 100 percent mortality. Diversion mortality is the major cause of decline in some fish populations. For the purposes of this document, diversion losses include turbine, irrigation, municipal, and all other potential fish losses related to the use of water by man.

Positive-exclusion barrier screens that screen the entire diversion flow have long been used to prevent or reduce entrainment of juvenile fish for diversions of up to 6000 cfs. In recent decades, design improvements have been implemented to increase the biological effectiveness of positive-exclusion screen and *bypass system*s by taking advantage of known behavioral responses to hydraulic conditions. Recent evaluations have consistently demonstrated high success rates (typically greater than 98 percent) at moving juvenile salmonids past intakes with a minimum of delay, loss, or injury. (For diversion flows over 6000 cfs, such as at Columbia River main-stem turbine intakes, submerged traveling screens or bar screens are commonly used. These are not considered positive-exclusion screens in the context of this position statement.)

The past few decades have also seen considerable effort in developing "startle" systems to elicit a taxis (response) by fish, with an ultimate goal of reducing entrainment. This paper addresses research performed to avoid losses at intakes and presents a position statement for reviewing and implementing future fish protection measures.

JUVENILES AT INTAKES

Entrainment, impingement, and delay/predation are the primary contributors to the mortality of juvenile migrating salmonids. Entrainment occurs when fish are drawn into the diversion canal or turbine intake. Impingement occurs when a fish is not able to avoid contact with a screen surface, trashrack, or debris at the intake. This can cause bruising, descaling and other injuries.

Impingement, if prolonged, repeated or occurring at high velocities, also causes direct mortality. Predation (which is the leading cause of mortality at some diversion sites) occurs when fish are preyed upon by aquatic or avian animals. Delay at intakes increases predation by stressing or disorienting fish and/or by providing habitat for predators.

A. Positive-Exclusion Screen and *Bypass System*s (PESBS)

Design criteria for PESBS have been developed, tested, and proven to minimize adverse impacts to fish at diversion sites. Screens with small openings and fish-tight seals are positioned at a slight angle to flow. This orientation allows fish to be guided to safety at the downstream end of the screen, while they resist being impinged on the screen face. These screens are very effective at preventing entrainment [Pearce and Lee 1991]. Carefully designed *bypass system*s minimize fish exposure to screens and provide hydraulic conditions that safely return fish to the river, thereby preventing impingement [Rainey 1985]. The PESBS are designed to minimize entrainment, impingement, and delay/predation from the point of diversion through the facility to the bypass outfall.

PESBS have been installed and evaluated at numerous facilities [Abernathy et al 1989, 1990, Rainey, 1990, Johnson, 1988]. A variety of screen types (e.g., fixed-vertical, drum, fixed-inclined) and screen materials (e.g., woven cloth [mesh], perforated plate, profile wire) have proven effective, when used in the context of a satisfactory design for the specific site. Facilities designed to previously referenced criteria consistently resulted in a guidance efficiencies of over 98 percent [Hosey, 1990, Neitzel, 1985, 1986,1990 a,b,c,d, Neitzel, 1991].

The main detriment of PESBS is cost. At diversions of several hundred cubic feet per second and greater, the low velocity requirement and structure complexity can drive the cost of fish passage to over $1 million. At the headworks, the need to clean thescreen, remove trash, control sediment, and provide regular maintenance (e.g., seasonal installation, replacing seals, etc.) also increases costs.

B. Behavioral Devices

Due to the high costs of PESBS, there has been considerable effort since 1960 to develop less expensive behavioral devices as a substitute for positive fish protection [EPRI, 1986]. A behavioral device, as opposed to a conventional screen, requires a volitional taxis on the part of the fish to avoid entrainment. Some devices were investigated with the hope of attracting fish to a desired area while others were designed to repel fish. Most studies focused on soliciting a behavior response, usually noticeable agitation, from the fish.

Investigations of prototype startle-response devices document that fish guidance efficiencies are consistently much lower for these devices than for conventional screens. Experiments show that there may be a large behavioral variation between individual fish of the same size and species to startle responses. Therefore, it cannot be predicted that a fish will always move toward or away from that stimuli. Until shown conclusively in laboratory studies, it should not be assumed that fish can discern where a signal is coming from and what constitutes the clear path to safety.

If juvenile fish respond to a behavioral device, limited size and swimming ability may preclude small fish from avoiding entrainment (even if they have the understanding of where to go and have the desire to get there). Another concern is repeated exposure; fish may no longer react to a signal after an acclimation period. In addition to vagaries in the response of an individual fish, behavior variations due to species, life stage, and water quality conditions can be expected.

Another observation is that past field tests of behavioral devices have been deployed without consideration of how controlled ambient hydraulic conditions (i.e., the use of a training wall to create uniform flow conditions, while minimizing stagnant zones or eddies that can increase exposure to predation) can optimize fish guidance and safe passage away from the intake. Failure to consider that hydraulic conditions can play a big role in guiding fish away from the intake is either the result of the desire to minimize costs or the assumption that behavioral devices can overcome the tendency for poor guidance associated with marginal hydraulic conditions. The provision of satisfactory hydraulic conditions is a key element of PESBS designs.

The primary motivation for selection of behavioral devices relates to cost. However, much of the cost in PESBS is related to construction of physical structures to provide hydraulic conditions that are known to optimize fish guidance. Paradoxically, complementing the behavioral device with hydraulic control structures needed to optimize juvenile passage will compromise much of the cost advantage relative to PESBS.

Skepticism about behavioral devices at this stage of their development is illustrated by the fact that few are currently being used in the field and those that have been installed and evaluated seldom show consistent guidance efficiencies over 60 percent [Vogel, 1988, EPRI, 1986]. The louver system is an example of a behavioral device with a poor record. Entrainment rates were high, even with favorable hydraulic conditions, due to the presence of smaller fish [Vogel, 1988, Cramer, 1973, Bates, 1961]. Due to their poor performance, most of these systems were eventually replaced by PESBS.

EXPERIMENTATION PROCESS

However, there is potential for future development of new passage devices that will safely pass fish at a rate comparable with conventional technology. These new concepts are considered "experimental" until they have been through the process described herein and have been proven in a prototype evaluation validated by NOAA Fisheries. These prototype evaluations should occur over the foreseeable range of adverse hydraulic and water quality conditions (eg. temperature, dissolved oxygen). NOAA Fisheries will not discourage research and development on experimental fish protection devices, but the following elements should be addressed during the process of developing experimental juvenile passage protection concepts:

(1) Consider earlier research. A thorough review of similar methods used in the past should be

performed. Reasons for substandard performances should be clearly identified.

(2) Study plan. A study plan should be developed and presented to NOAA Fisheries for review and concurrence. It is essential that tests occur over a full range of possible hydraulic, biological, and ecological conditions that the device is expected to experience. Failure to receive study plan endorsement from NOAA Fisheries may result in disputable results and conclusions.

(3) Laboratory research. Laboratory experiments under controlled conditions should be developed using species, size, and life stages intended to be protected. For behavioral devices, special attention must be directed at providing favorable hydraulic conditions and demonstrating that the device clearly induces the planned behavioral response. Studies should be repeated with the same test fish to examine any acclimation to the guidance device.

(4) Prototype units. Once laboratory tests show high potential to equal or exceed success rates of conventional passage devices, it is appropriate to further examine the new device as a prototype under real field conditions. Field sites shall be appropriate to (a) demonstrate performance at all expected operational and natural variables, (b) evaluate the species, or an acceptable surrogate, that would be exposed to the device under full operation, and (c) avoid unacceptable risk to depressed or listed stocks at the prototype locations.

(5) Study results. Results of both laboratory tests and field prototype evaluations shall demonstrate a level of performance equal to or exceeding that of conventional fish passage devices before NOAA Fisheries will support permanent installations.

Conclusions

Proven fish passage and protection facilities that have demonstrated high guidance rates at other sites can provide successful passage at most fish passage impediments. Periodically, major initiatives have been advanced to examine the feasibility of experimental passage systems. Results were generally poor or inconclusive, with low guidance efficiencies attributable to the particular device used. Often results were based on a small sample size, or varied with operational conditions. In addition, unforeseen operational and maintenance problems (and safety hazards) were sometimes a byproduct. Nevertheless, some of these passage systems have shown potential for success. To further advance fish protection technology, NOAA Fisheries will not oppose tests that proceed in accordance with the tiered process outlined above. To ensure no further detriment to any fish resource, including delays in implementation of acceptable passage facilities, experimental field testing should occur simultaneous to design and development of conventional passage design for that site. This conventional system should be scheduled for installation in a reasonable time frame, independent of the experimental efforts. In this manner, if the experimental guidance system once again does not prove to be as effective as a PESBS, a proven passage design can be implemented without additional delay and detriment to the resource.

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ATTACHMENT 2

Post-Season Monitoring and Evaluation Form

Post-Season Monitoring and Evaluation Form
Scientific Research Plan
Annual Report

Date: ___________

Plan Name: _____________ **Evaluator's Name:** ____

Contact Name: ___________________ **Contact Email:** __________________________ **Contact Phone #:** __________________
(Contact = person submitting report)

Study Number and Title (if applicable): ____
Provide separate tables for each study.

Part I: This is an example of how to fill out the table. **Replace all red text with the information in the plan.** **Replace all blue text with the actual results of your activities.**

ESU/Species **and population group if specified in your permit**	**Life Stage**	**Origin**	**Take Activity**	**Number of Fish Authorized for Take**	**Actual Number of Listed Fish Taken**	**Authorized Unintentional Mortality**	**Actual Unintentional Mortality**	**Evaluation Location**	**Evaluation Period**
Lower Columbia River (LCR) Chinook	Juvenile	Naturally Produced	Capture, mark, release	100	90	5/100	4/90	Columbia River, Oregon	January – February
LCR Chinook	Adult	Artificially Propagated	Capture, handle, release	10	9	1/10	0/9	Bonneville Dam	June
LCR Chinook	Adult	Naturally Produced	Intentional mortality	20	15	**N/A**	**N/A**	Bonneville Dam	June
Oregon Coast Coho	Juvenile	Naturally Produced	Observe / Harass	500	400	**N/A**	**N/ A**	Nehalem River	October

Instructions:

ESU/Species: Enter the ESU and Species you were permitted to take. Enter by population, if your permit specifies that.

Life Stage: Enter life stage(s) specified in your plan.

Origin: Enter the origins specified in your plan.

Take Activity: Indicate the type of take activity as it is shown in your plan: ACapture, handle release,@[1] ACapture, tag [or mark], release,@ AIntentional mortality,@ or other Take Activities listed in your plan. Intentional mortality (i.e., direct mortality, sacrifice) must be accounted for on a separate line (see above). You must account for all Take Activities in your plan. If you did not take any fish or did not conduct the activities, enter zeros in the Actual Take and Actual Mortality columns.

Number of Fish Authorized for Take: State the number of fish authorized for take under each Take Activity (must be the same as the plan).

Actual Number of Listed Fish Taken: State the actual number of fish taken.

Authorized Unintentional Mortality: State the number of fish authorized for unintentional mortality. Enter it as a number OUT OF the Number of Fish Authorized for Take.

Actual Unintentional Mortality: State the actual number of fish you unintentionally killed. Enter it as a number OUT OF the Actual Number of Listed Fish Taken.

Evaluation Location: State where you conducted the activities. Enter hydrologic unit codes (HUC) if available.

Evaluation Period: State when you conducted the activities.

NOTE: If you conducted activities or took listed fish for which you were not authorized, you must enter them on separate lines of the report and explain exactly what happened (see Part II below).

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[1] Include fish that were not netted but were shocked during activities.

Part II: Briefly Provide the Following Information

1. Measures taken to minimize effects on listed fish and the effectiveness of these measures.

2. The condition of listed fish taken and used for the research.

3. General effects research activities have on fish, including any unforeseen effects.

4. How listed fish were injured or killed and how were they disposed of.

5. How all take estimates were derived.

6. Steps taken to coordinate the research with other researchers.

7. Any problems that were encountered during the activities.

8. Summary of any preliminary findings (provide an attachment if needed).

Submit the report electronically to the appropriate NMFS staff person (listed in the plan). If you do not have an electronic version of your electrofishing logbook, please submit a hard copy to the following address attention the NMFS staff person listed in the plan or send it to the following fax number (please include your permit number on cover page):

Appropriate NMFS staff person
National Marine Fisheries Service
HydroPower Division
FERC and Water Diversions Branch
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232-1274
(503) 231-2318 (FAX)