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

January 5, 2009

MEMORANDUM FOR: File

FROM: D. Robert Lohn, Regional Administrator for

SUBJECT: Endangered Species Act Section 7 Consultation Biological Opinion, Unlisted Species Analysis, Section 10(a)(2)(B) Findings and Magnuson-Stevens Fisheries Conservation and Management Act Essential Fish Habitat Consultation For Issuance of an Incidental Take Permit to the City of Portland for the Bull Run Water Supply Habitat Conservation Plan in the Sandy River Basin, Oregon (HUC: 17080001) (NMFS Tracking No.: 2008/03771)

The attached document contains a biological opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species act (ESA) on the effects of the proposed issuance of an Incidental Take Permit under section 10(a)(1)(B) of the ESA for the operation and maintenance of the City of Portland's Bull Run water supply system based on the City's Habitat Conservation Plan (HCP) and the Implementing Agreement (IA). Issuance of this permit is supported by the HCP, that has undergone public and NMFS review. In this Opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of threatened Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Columbia River (CR) chum salmon (*O. keta*), LCR coho salmon (*O. kisutch*), and LCR steelhead (*O. mykiss*). Further, NMFS concludes that the proposed action will not result in the destruction or adverse modification of designated critical habitat for these four species.

Within the Unlisted Species Analysis, NMFS analyzed the effects of permit issuance for one candidate species, eulachon (*Thaleichthys pacificus*). This is necessary as the City requests assurances (*i.e.*, No Surprises) that they will receive a section 10(a)(1)(B) incidental take permit for currently unlisted species that are adequately addressed in the HCP, when and if they are listed under the ESA. Therefore, NMFS concludes that the extent of incidental take is not expected to appreciably reduce the likelihood of survival and recovery of eulachon. Implementing the HCP will likely contribute to conservation of the ESA-listed salmonids and the unlisted eulachon.

This document also contains a finding that the HCP meets statutory and regulatory requirements for issuance of an Incidental Take Permit under section 10(a)(2)(B) of the ESA, and a consultation on the effects of the HCP on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act. In the EFH consultation, NMFS concludes that the proposed action will adversely affect designated EFH for Chinook and coho salmon, but that conservation measures included as part of the proposed action are sufficient to avoid, minimize or offset those adverse effects. Therefore, NMFS has no additional EFH conservation recommendations to make at this time.

If you have questions regarding this Opinion or the Plan, please contact Dr. Nancy Munn at (503) 231-6269 or nancy.munn@noaa.gov.

Endangered Species Act Section 7 Consultation Biological Opinion, Unlisted Species Analysis, Section 10 Findings

and

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

For Issuance of an Incidental Take Permit to the City of Portland for the Bull Run Water Supply Habitat Conservation Plan, Sandy River Basin, Oregon

Lead Action Agency:	National Marine Fisheries Service Northwest Region
Consultation Conducted By:	National Marine Fisheries Service Northwest Region Oregon State Habitat Office
Date Issued:	January 5, 2009
Issued by:	for D. Robert Lohn Regional Administrator
NMFS No.:	**2008/03771**

TABLE OF CONTENTS

1.0 INTRODUCTION

The biological opinion (Opinion) and incidental take statement portions (Section 2.0) of this consultation were prepared by the National Marine Fisheries Service (NMFS) in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq*.), and implementing regulations at 50 CFR 402. With respect to critical habitat, the following analysis relied only on the statutory provisions of the ESA, and not on the regulatory definition of "destruction or adverse modification" at 50 CFR 402.02.

This document also contains an Unlisted Species Analysis (incorporated into the Opinion, and ESA Section 10(a)(2)(B) Findings (Section 3.0) required under section 10(a)(2)(B) of the ESA for the issuance of an Incidental Take Permit (ITP) to the City of Portland (City) based upon their Habitat Conservation Plan (HCP) and Implementing Agreement (IA). The project site is in the Sandy River basin, Oregon, within the range of threatened Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Columbia River (CR) chum salmon (*O. keta*), LCR coho salmon (*O. kisutch*), and LCR steelhead (*Oncorhynchus mykiss*) (Table 1). The Sandy River basin is within the range of eulachon (*Thaleichthys pacificus*), an ESA candidate species.

The essential fish habitat (EFH) consultation (Section 4.0) was prepared in accordance with Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq*.) and implementing regulations at 50 CFR 600. The Sandy River basin is EFH for Chinook and coho salmon.

The docket for this consultation is on file at the Oregon State Habitat Office in Portland, Oregon.

1.1 Background and Consultation History

From 1998 through 2007, NMFS provided technical and policy assistance to the City in the development of a conservation plan for listed and unlisted species. The proposed Bull Run Water Supply HCP integrates the City's need to continue to maintain and operate the Bull Run water supply system with the habitat needs of fish and wildlife in the Bull Run watershed. NMFS also worked with the City to develop an implementation agreement.

The NMFS prepared a draft environmental impact statement (DEIS) to analyze the environmental effects of permit issuance under the National Environmental Policy Act (NEPA) of 1969, as amended. Both the draft HCP and DEIS were released for a 60-day public comment period (73 FR 19822) that closed May 27, 2008.

During the public comment period on the draft HCP and DEIS, NMFS received a total of 14 comment letters. NMFS and the City addressed all of the comments and suggestions in writing, and responded to most with clarification or elaboration. Initiation of consultation is considered to have begun on the day that the City Council voted to approve the final HCP (October 1, 2008).

Table 1. Federal Register notices for final rules that list candidate, threatened and endangered species, designate critical habitats, or apply protective regulations to listed species considered in this consultation. Listing status: 'T' means listed as threatened under the ESA; 'C' means it is a candidate for listing under the ESA.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Lower Columbia River spring-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Chum salmon *(O. keta*)			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon (*O. kisutch*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	Not applicable	6/28/05; 70 FR 37160
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Eulachon (*Thaleichthys pacificus*)	C 3/12/08; 73 FR 13185	Not applicable	Not applicable

1.2 Description of the Proposed Action

NMFS proposes to issue a 50-year ITP for incidental take of four ESA-listed fish species and one unlisted fish species under ESA section 10(a)(1)(B). The City has prepared a multiple species HCP to comply with the ESA and to address water supply activities and habitat conservation activities described below. The 50-year plan will cover the City's activities to monitor and maintain the Bull Run water supply system, part of the Sandy River basin. The HCP is a set of habitat conservation measures and stewardship activities designed to avoid, minimize, mitigate, and monitor the effects of the City's water supply activities and efforts to improve aquatic habitat in the Bull Run River and Sandy River basin. Approval of the HCP by NMFS is required to issue an ITP.

The Bull Run watershed has been used by the City for water supply since 1895. The City's water system provides water to residents and businesses within the city limits of Portland as well as to a number of surrounding communities. Approximately 800,000 Oregonians receive all or part of their water supply from the Bull Run River.

The City has a statutory water right to the full flow of the Bull Run River. When the Portland General Electric (PGE) Little Sandy hydroelectric project is removed, the City will be the only entity diverting water from the Bull Run River and its tributaries. The management activities associated with the Bull Run River HCP and ITP include those activities described in the HCP, as summarized below.

The City seeks ITP coverage for City-implemented or City-authorized activities associated with the lands and facilities to the extent that they affect covered species. Proposed activities include the operation, maintenance and repair of the water system, implementation of habitat conservation, research and monitoring measures, and incidental land management activities.

Operation, Maintenance and Repair of the Water System. The City proposes to continue to complete the following activities to operate, maintain, and repair the Bull Run water supply system:

- Store water in system reservoirs and regulation of reservoir surface elevations.
- Divert water for water supply.
- Alter flow downstream from the water supply dams and diversions.
- Release water from reservoirs into the Bull Run River.
- Adjust water intake depth to regulate temperature, turbidity, and color.
- Seasonally close gates at the Dam 1 spillway to store additional water.
- Remove debris (including logs) from reservoirs.
- Operate boats and barges on reservoirs.
- Deliver and store fuel and lubricants for water supply system vehicles and equipment.
- Deliver and store chlorine gas for water supply disinfection.
- Drain water supply conduits. Maintain landscape within and around facilities.

Habitat Conservation and Research and Monitoring Measures. The City also proposes to complete habitat conservation measures, with the following objectives, as described in Chapter 7 of the HCP, the research and monitoring measures described in Chapter 9 of the HCP, and any additional habitat conservation and monitoring measures implemented as part of the adaptive management:

- Provide instream flows in the lower Bull Run River to improve existing conditions for the four salmonid fish species (Measures F-1, F-2, F-3).
- Provide water temperature conditions in the lower Bull Run River that are equivalent to natural pre-water system conditions and in compliance with the Sandy River basin total maximum daily load (TMDL) and water quality management plan (Measures T-1, T2).
- Improve instream habitat conditions in the lower Bull Run River (Measures H-1 spawning gravel placement, P1 Walker Creek fish passage).
- Protect riparian forest conditions on City land along the lower Bull Run River (Measure H-2 riparian land protection).
- Ensure access for fish into lower Bull Run River tributaries (Measure R-1 reservoir operations).
- Avoid or minimize periodic temporary disturbance of habitat that might otherwise result from routine operation, maintenance, repair of water supply facilities, incidental land management, or from implementation of the HCP habitat conservation measures (Measure R-2 cutthroat trout rescue, R-3 reed canarygrass removal, O&M-1, O&M-2, E-1 Eulachon timing restrictions).
- Protect instream flows in the Little Sandy River (Measure F-4).
- Protect and improve instream and riparian habitat conditions at targeted locations in the Sandy River basin, particularly locations affected by covered activities or locations where benefits would offset impacts that are expected to continue to occur in the Bull Run River (Measures H-3 Little Sandy large wood placement, H-4 Sandy log jams, H-5 Gordon large wood placement, H-6 and H-7 Trout large wood placement, H-8 Sandy River reestablishment of the river mouth; H-9 Sandy channel reconstruction, H-10 turtle survey

and relocation, H-11, H-12 and H-14 Sandy River riparian easement and improvement, H-13 Gordon Creek riparian easement and improvement, H-15 Cedar Creek riparian easement and improvement, H-16 Alder Creek riparian easement and improvement, F-5 Cedar Creek purchase water rights, P-2 and P-3 Alder Creek fish passage, P-4 Cedar Creek fish passage, H-17 Cedar Creek large wood placement, H-18 Sandy River riparian easement and improvement, H-19, H-20 and H-21 Salmon River riparian easement and improvement, H-22 Boulder Creek riparian easement and improvement, H-27 Zigzag Creek channel design, H-28 Zigzag riparian easement and protection).

- Provide habitat improvements offsite to specifically benefit spring Chinook salmon spawning because of the constraints limiting spawning in the lower Bull Run River.
- Provide habitat benefits offsite to specifically benefit fall Chinook salmon.
- Avoid or minimize periodic temporary disturbance of habitat that might otherwise result from implementation of habitat conservation measures.
- Choose locations and project types for offsite conservation measures based on the best available science about habitat conditions, role in productivity of fish and the habitat factors limiting productivity.
- Focus on private lands where incentives and requirements for habitat protection by the landowner are otherwise limited (Measures H-23 and H-24 Salmon Creek Miller Quarry acquisition and restoration, Measure H-26 Boulder Creek large wood placement).
- Prioritize projects that provide the most benefit per dollar paid by the City's ratepayers.
- Assist the Sandy River Basin Partners with implementation of the Sandy River Basin Restoration Strategy (Measures H-25 Salmon River salmon carcass placement, H-29 Zigzag Creek salmon carcass placement, H-30 Habitat Fund).

The City relied on the work of the Sandy River Basin Partners to identify appropriate aquatic and riparian habitat conservation opportunities in the Sandy River basin. Technical team members used the Ecosystem Diagnosis and Treatment (EDT) model to assess the habitat factors that limit the productivity of fish populations.

In addition to funding the measures described above, the City will provide money to create a $9 million Habitat Fund. A $5 million portion of the Habitat Fund will be available in four increments prior to HCP year 20 and will be dedicated to partnership projects. The remaining $4 million will be dedicated to adaptive management.

The HCP also includes measures to avoid or minimize impacts to northern spotted owls (*Strix occidentalis caurina)*, bald eagles (*Haliaeetus leucocephalus*), and fishers (*Martes pennanti*).

Incidental Land Management Activities. Other land management activities proposed by the City in the Sandy River basin are incidental to the operation of the water supply system (Section 8.7 of the HCP). These include the management of City-owned riparian lands in the Bull Run watershed, the maintenance and repair of roads, bridges, culverts, parking lots, easements, and rights-of-way on non-Federal lands in the Bull Run watershed, and the operation and maintenance of the Sandy River Station maintenance facility.

The City owns approximately 3,800 acres of land in the Bull Run Watershed Management Unit, which includes land around and downstream from Reservoir 2. The City owns 1,200 acres of

additional land along the lower Bull Run River and/or near the confluence of the Bull Run and Sandy rivers, including at Dodge Park and the adjacent Sandy River Station maintenance facility. This land fronts approximately 5.6 stream miles of the Bull Run and Sandy rivers.

Maintenance activities are likely to include the removal of trees that pose a hazard to power lines, and stump treatment of herbicides on hardwood trees in the BPA transmission line easement. Road maintenance activities include the mechanical removal of brush along primary roadways, and conduit maintenance involves inspections, minor repair and painting where the conduit pipes are exposed, as well as removal of brush that hinders inspection and removal of trees that pose a hazard to the conduits or to staff.

The Sandy River Station is an approximately 5.5-acre maintenance facility adjacent to the mainstem Sandy River. Facilities include an office, a repair ship, fuel pumps/tanks, indoor storage, parking and outdoor equipment, vehicle, and materials storage.

Monitoring, Research, and Adaptive Management Programs. The City will provide an annual report (or at a frequency mutually agreed to by the City and NMFS) for the life of the HCP that describes the progress toward implementing the HCP conservation measures. The City also proposes to convene formal progress meetings approximately every 5 years to discuss progress and any new information affecting successful implementation of the HCP. Although adaptive management will be discussed at these meetings and minor adaptive management decisions might be made, major adaptive management decisions will be made at years 20, 30 and 35.

The City has proposed both compliance monitoring and effectiveness monitoring. The compliance monitoring will address the Bull Run conservation measures, compliance locations for flow and temperature, and for offsite conservation measures. The effectiveness monitoring will address fish passage improvements, carcass placements, riparian improvements, water rights purchases, and offsite measures. For each conservation measure, the City has developed a measurable habitat objective and has defined the way it will be measured.

As part of the HCP, the City has also committed to a four-part research program. In the Bull Run watershed, the City will study the placement of spawning gravel, the degree of Chinook spawning gravel scour, the concentrations of total dissolved gases, and the abundance of spawning Chinook salmon adults. For the Sandy River basin, the City will collaborate with the Oregon Department of Fish and Wildlife, Mount Hood National Forest, Bureau of Land Management, and ODEQ to measure the number of juvenile salmonid outmigrants from the Sandy River basin.

The City proposes to incorporate adaptive management into the HCP through the Sandy River Basin Restoration Strategy, the HCP implementation committee, and an adaptive management response framework, as presented in Chapter 9 of the HCP. The framework includes adaptive responses for individual measures, and decision milestones for addressing the effectiveness of the HCP as a whole.

1.3 Description of the Action Area

The action area for this consultation includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The proposed Federal action is the issuance of an ITP under section 10 of the ESA. The City seeks coverage in the ITP for all incidental take resulting from its proposed actions within the hydrologic boundary of the Sandy River basin (Figure 2-1 of the HCP), including operation and maintenance of the following facilities:

- Bull Run Dam 1 and Dam 2, and associated structures.
- Reservoir 1 and 2, and associated structures.
- Diversion dams, weirs and pools.
- Headworks facility.
- Water supply conduits, bridges, and trestles (except mainstem Sandy River crossings)
- Water quality monitoring stations and flow gauges.
- Sandy River Station maintenance facility.
- City-owned or maintained roads and other road surfaces and easements on non-Federal lands.
- Easements owned or maintained by others on City-owned land.

The Bull Run River watershed encompasses 88,962 acres, with 78,899 acres under Federal ownership, and 4,426 acres owned by the City. The Bull Run watershed is in the foothills of the Cascade Mountains, northwest of Mount Hood and to the east of the City. The Bull Run River is a major tributary of the Sandy River; the Sandy River flows into the Columbia River. The Bull Run River is approximately 25 miles long, and most of the watershed is within the Mount Hood National Forest. The City owns most of the riparian land along the lower 6 miles of the Bull Run River.

The action area also includes all locations where actions will take place to minimize or mitigate the effects of the City's operation and maintenance activities. Habitat conservation measures are proposed for the Bull Run River and reservoir, Little Sandy River, the middle Sandy River, the upper Sandy River, the Salmon River and the Zigzag River.

1.4 Changed Circumstances

The HCP covers the City's continued operation and maintenance of the Bull Run water supply system and habitat enhancement activities in the Sandy River basin under ordinary and changed circumstances during the term of this HCP. "Changed circumstances" means a change or changes in the circumstances affecting a covered species, or the HCP area, which can reasonably be anticipated by the City and NMFS, and which has been planned for in the HCP. Changed circumstances are different than unforeseen circumstances because they can be anticipated, and can include natural events such as long-term changes in hydrology, changes in water temperature in the Bull Run River, and a significant change in the status of habitat within the Sandy River basin. The ITP will authorize the incidental take of covered species under ordinary circumstances as well as these changed circumstances, so long as the City is operating in compliance with the HCP, the ITP, and the IA. If additional mitigation measures or costs

beyond those provided in the HCP are deemed necessary to respond to any changed circumstances, NMFS will not require any such measures or costs of the City without the City's prior consent.

These changed circumstances are described below and in Chapter 10 of the HCP (City of Portland 2008). The general habitat conservation measures (Chapter 7 of the HCP) that these measures would supplement are described in section 1.2 above.

Climate Change/Long-term Changes in the Hydrology of the Bull Run River. The lower Bull Run River stream flow conservation measures of the HCP are based on the needs of the covered fish species, the anticipated water supply demands of the City, and a 60-year record of flows in the Bull Run River. The HCP addresses extreme seasonal low flows as determined from the hydrologic record, particularly during the critical spring and critical fall seasons. Currently available data show a reduction in the Bull Run reservoir inflows over the last 60 years (Chapter 2 of the HCP). The City will apply three statistical tests to the Bull Run reservoir inflow data (both past data and data that will be collected in the future) to determine whether there has been a significant change: trend analysis, comparison of means and/or median flow values, and frequency of critical flow year occurrence (Appendix H of the HCP). The City will consider three options if a long-term change in reservoir inflows occurs, with two of the options requiring the City to revise the HCP measures (refer to Chapter 10 of the HCP). The first option is continued implementation of flow measures with no modification of the HCP. The second option is revised instream flow measures with minor modification of the HCP, and the third option is a major amendment to the HCP. If amendments to the HCP measures are needed, the City will continue to operate the water supply system to provide favorable flows for salmon and steelhead to the maximum extent practical while any necessary amendments to the HCP are being negotiated and analyzed.

Climate Change/Changes in Water Temperature of the Bull Run River. Water temperature is a key management concern in the lower Bull Run River. Detailed modeling analyses have demonstrated that even under natural pre-water-system conditions, temperatures in the lower Bull Run River would often exceed the state numeric criteria for salmonid rearing and spawning. The natural temperatures are elevated in the summer months because of the river's east-west orientation, the bedrock morphology, and low summer flows. The flow measures in the HCP were designed to manage temperatures in the lower Bull Run River to meet the state standard and to favor native salmonids to the maximum extent practicable. It is possible that climatic conditions will change and the Bull Run reservoir inflow temperatures will increase to the extent that the City cannot meet the Little Sandy River reference standard (the standard is described in measure T-2, Chapter 7 of the HCP, and is expressed as a 7-day moving average of the daily maximum temperature, with a special focus on the time period between August 16 and October 15 when elevated water temperatures are the greatest concern). If that occurs, the City, NMFS and the Oregon Department of Water Quality (ODEQ) will negotiate a resolution, with the potential to revise flow or the temperature measures of the HCP.

Significant Change in the Status of Habitat within the Sandy River Basin. Many of the measures described in Chapter 7 of the HCP address the improvement of salmonid habitat conditions in the Sandy River basin (7.2.4 and 7.5). A significant decrease in the quantity or

quality of fish habitat within the basin could alter the overall status of one or more covered species. The City defines a significant change in the status of habitat as the loss through destruction or degradation of more than 50% of the ability of a sixth-field or larger stream1 within the basin to support covered fish species, expected to last for 10 years or longer. A change at this scale could result from a volcanic eruption, widescale flooding, or unexpected outcomes following the removal of the Little Sandy dam. The City used the EDT model to predict the biological outcome of the implementation of the HCP habitat measures, based on the current status of the species and the habitat baseline. If habitat is degraded more than 50% as determined through monitoring and EDT model results, then predicted response of the covered species are no longer valid, and the City will undertake a review and possible modification of the HCP measures. A consequence may be that this would constitute an unforeseen circumstance, but a more likely consequence is that the EDT model will be revised and new or different HCP measures implemented to achieve the desired species response.

2.0 ENDANGERED SPECIES ACT BIOLOGICAL OPINION

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

The objective of this Opinion is to determine whether the approval and implementation of the HCP is likely to jeopardize the continued existence of listed species. The species analyzed in this Opinion are the ESA-listed LCR steelhead, LCR Chinook salmon, LCR coho salmon, and CR chum salmon, and the unlisted candidate species eulachon. The Opinion was completed pursuant to the ESA and its implementing regulations (50 CFR 402) and constitutes formal consultation on the HCP for all covered species.

2.1 Evaluating the Proposed Action

To complete the jeopardy analysis presented in this Opinion, NMFS reviewed the status of each listed species of Pacific salmon and steelhead considered in this consultation, the environmental baseline in the action area, and analyzed the effects of the action, together with all cumulative effects (50 CFR 402.14(g)). From this analysis, NMFS determined whether effects of the action were expected, directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of the affected listed species.

For the critical habitat adverse modification analysis, NMFS considered the status of the entire designated critical habitat considered in this consultation, the environmental baseline in the

1 Based on USGS Hydrologic Units (HUCs) which is a hierarchical subdivision of land area of the United States based on hydrology. This unit defines the scale of this analysis.

action area, the likely effects of the action on the function and conservation role of the affected critical habitat, and cumulative effects. NMFS used this assessment to determine whether, with implementation of the proposed action, critical habitat would remain functional, or retain the current ability for the primary constituent elements (PCEs) to become functionally established, to serve the intended conservation role for the species (Hogarth 2005).

2.1.1 Status of the Species and Critical Habitat

This section defines the biological requirements of each listed and unlisted species affected by the proposed action, and the status of each designated critical habitat relative to those requirements.

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

LCR coho salmon. This ESU includes 25 populations that historically existed in the Columbia River basin from the Hood River downstream (McElhany *et al.* 2007. The boundaries do not extend into the upper Willamette portion of the basin because Willamette Falls is a natural barrier to fall migrating salmonids. In general, wild coho in the Columbia River basin have been in decline for the last 75 years. The number of wild coho returning historically was at least 600,000 fish (Chapman 1986). As recently as 1996, the total return of wild fish may have been as few as 400 fish (Chilcote 1999). Of the 25 historical populations, only the Clackamas and Sandy rivers show direct evidence that coho production is not reproductively dependent on the spawning of stray hatchery fish (McElhany *et al.* 2007). However, in the last 5 years there has been an increase in the abundance of wild coho in the Clackamas and Sandy rivers, plus a reappearance of moderate numbers of wild coho in the Scappoose and Clatskanie river basins after a 10-year period in the 1990s when they were largely absent (McElhany *et al.* 2007).

The NMFS (2007) identified floodplain connectivity and function, degraded channel structure and complexity, degraded riparian areas and large wood recruitment, degraded stream substrate, degraded streamflows, degraded water quality, and harvest and hatchery impacts as the major factors limiting recovery of LCR coho salmon.

The Sandy River population would be the most likely population found in the action area. Based on a recent analysis, this population is most likely in the low risk category for abundance and productivity, although all the other populations are in the high or very high risk category (McElhany *et al.* 2007). Although this coho population is one of the two in the LCR that is known to have persisted through the poor marine survival period of the 1990s, it was at very low levels during this period and may have experienced the effects of a genetic bottleneck. Spatial structure scores are reduced because of significant habitat degradation in tributaries and blocked passage, and urban influences in the lower basin. This habitat loss has reduced the population's

diversity score. Despite this, the Sandy is the second to the Clackamas population in Oregon's portion of the species, and is in the moderate risk of extinction category, and thus the risk of extinction for LCR coho remains high (McElhany *et al.* 2007).

The Sandy River is one of only two rivers in the lower Columbia River region that supports appreciable natural production of coho salmon; the other is the Clackamas River. Historically adult coho returned from October through February, culminating in a peak spawning season that lasted from November through February. With the exception of reaches upstream of Bull Run and the Little Sandy dams, coho distribution has changed little from historical conditions. The majority of suitable coho spawning and rearing habitat in the Sandy River is upstream from Marmot Dam in the mainstem Sandy River, in the Salmon River below Final Falls, and in Still Creek. Lower basin tributaries that may support coho include Cedar, Trout, Beaver, Gordon, and Buck creeks. Coho populations have been affected by dwindling habitat diversity and quantity, obstructions caused by dams, and reduced stability of the stream channel.

LCR steelhead. This species includes all naturally spawning populations of steelhead in streams and tributaries of the Columbia River between, and including, the Cowlitz and Wind rivers in Washington, along with, and including, the Willamette River and Hood River in Oregon. Excluded are steelhead in the upper Willamette River basin above Willamette Falls and steelhead from the Little and Big White Salmon rivers in Washington (NMFS 2004).

Five population of winter steelhead and one population of summer steelhead exist in Oregon's portion of the species (McElhany *et al.* 2007). The population most likely present in the action area is the Sandy River, which is part of the cascade winter stratum.

In general, wild steelhead are depressed in abundance from historical levels but are likely to exist in most of their historical range, and all historical populations probably are extant. However, up until recent years, the presence of naturally spawning hatchery fish in most populations has been high (McElhany *et al.* 2007).

The Sandy River population shows very low abundance, and significant portions of the historical winter steelhead in the Sandy River have been blocked by dam construction in the Bull Run and Little Sandy watersheds since blocked areas were productive habitats McElhany *et al.* 2007). For the species, the overall risk classification for Oregon LCR steelhead is moderate, with the Sandy River population at a high risk of extinction.

Factors limiting recovery for LCR steelhead include 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 (NMFS 2005b, NMFS 2006). NMFS (2007) identified degraded floodplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, stream substrate, streamflow; water quality, fish passage, and predation/competition as the major factors limiting recovery of this species.

Young winter steelhead are present year-round throughout most of the Sandy River mainstem in both the upper and lower portions of the basin. Winter steelhead primarily spawn and rear in

their historic habitat which extends upstream of Marmot Dam in the Salmon River, its tributaries, and in Still Creek. Other waterways in the basin that support winter steelhead include the Bull Run River and Gordon, Trout, and Buck creeks. Decreases in steelhead abundance in the basin can be attributed to loss of habitat diversity and quantity, increased sediment loads, and obstructions from dams. The Technical Recovery Team (TRT) classified the winter run in the Sandy River basin as a "core' population and primary to the recovery of the ESU (McElhany *et al*. 2003, 2004).

LCR Chinook salmon. The range of this species includes all naturally-spawned populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon, east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River. Historical records of Chinook salmon abundance are sparse, but cannery records suggest a peak run of 4.6 million fish in 1883. Although fall-run Chinook salmon are still present throughout much of their historical range, they are still subject to large-scale hatchery production, relatively high harvest, and extensive habitat degradation. The spring-run populations are largely extirpated as the result of dams which block access to their higher elevation habitat. Abundances largely declined during 1998-2000 and trend indicators for most populations are negative, especially if hatchery fish are assumed to have a reproductive success equivalent to that of natural-origin fish. However, 2001 and 2002 abundance estimates increased for most LCR Chinook salmon populations over the previous few years (*as cited in* Good *et al*. 2005). In 2003, 2,873 fall-run Chinook salmon spawned in the main channel of the Columbia River between RM 113 and RM 143.

Factors limiting recovery for LCR Chinook salmon 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 temperature in tributaries, and harvest impacts on fall Chinook (NMFS 2005b, NMFS 2006). NMFS (2007) identified degraded estuarine and nearshore habitat; floodplain connectivity, and function; channel structure and complexity; riparian areas and large wood; stream substrate, streamflow; fish passage; and harvest and hatchery impacts as the major factors limiting the recovery of this species.

The predominant life history type for this species is the fall-run, which consists of an early component that returns to the Columbia River in mid-August and spawns within a few weeks (Kostow 1995). Spring-run Chinook salmon enter freshwater in March and April and spawn in late summer. Adults from this species pass through the action area from February through November, with peak passage occurring from mid-March through May, and from October through early November (Friesen 2005). The majority of juveniles in this species leave as subyearlings, with downstream movement observed as early as December, with most moving during summer and fall.

Fall-run Chinook salmon were native to the lower Willamette River and its, principle tributary, the Clackamas River, and likely other tributaries below Willamette Falls. Most of the LCR Chinook salmon in the action area are part of the Sandy fall-run population. Based on a recent viability status report (McElhany *et al*. 2007), the Sandy population is at high to moderate risk of

extinction. From the perspective of all viability criteria, LCR Chinook in Oregon are at high risk (McElhany *et al*. 2007). Habitat degradation in the basin has reduced the spatial distribution of suitable habitats for fall Chinook. Further habitat changes in the Willamette and Columbia mainstem and estuary would likely have a significant effect on fall Chinook salmon (McElhany *et al*. 2007).

The Sandy River is one of only two rivers of the lower Columbia River that supports appreciable natural production of fall Chinook salmon. Most juvenile fall Chinook salmon typically spend only a brief time in the Sandy River before migrating to the ocean. Typically, adults return to the Sandy River basin in August and spawn from October through December. Fall Chinook were historically found in the basin far upstream in the Salmon, Zigzag, and upper Sandy rivers as well as in the Little Sandy and the Bull Run rivers. Today, runs of fall Chinook occur in the rivers below Marmot, Little Sandy, and Bull Run dams, and spawning occurs primarily in the mainstem Sandy River and its tributaries near Oxbow Park. The Lower Columbia TRT has classified the late run Sandy River brights as both a "core" and a "genetic integrity" population in their recovery planning efforts. These designations means the population was historically abundant and productive, the current populations resembles the historic life histories and genetic types in the Sandy River basin, and it currently offers one of the most likely paths to recovery in the LCR Chinook ESU (McElhany *et al*. 2003). Limiting factors for this population include water temperatures, blocked access to habitat, flow diversions that reduced the availability to spawning and rearing habitat, and quality of habitat (Sandy River Basin Partners 2005).

CR chum salmon. The Oregon portion of the CR chum ESU historically contained 8 populations (McElhany *et al.* 2007), with over a million chum returning in some years to the Columbia River (McElhany 2005). Recently only a few hundred to a few thousand chum have returned each year to the Columbia, mainly to the Washington side of the Columbia River. All of the historical Oregon side populations are considered extirpated or nearly so. All of the Oregon chum populations are in the very high risk category, and the ESU is also at very high risk of extinction (McElhany *et al.* 2007).

The factors limiting recovery for CR chum salmon are altered channel form and stability in tributaries, excessive sediment in tributary spawning gravels, altered stream flow in tributaries and the mainstem Columbia River, loss of some tributary habitat types, and harassment of spawners in the tributaries and mainstem (NMFS 2005b, NMFS 2006). NMFS (2007) identified degraded estuarine and nearshore marine areas; floodplain connectivity and function; channel structure and complexity; riparian areas and large wood recruitment; stream substrate; streamflow; and fish passage as the major factors limiting recovery of this species.

Eulachon. Eulachon (smelt) are endemic to the eastern Pacific Ocean ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon occur only on the coast of northwestern North America, from northern California to southwestern Alaska. In the portion of the species' range that lies south of the U.S./Canada border, most eulachon production originates in the Columbia River basin.

Within the Columbia River basin, the major and most consistent spawning runs occur in the mainstem of the Columbia River (from just upstream of the estuary, river mile (RM) 25 to

immediately downstream of Bonneville Dam at RM 146). Periodic spawning occurs in the Grays, Skamokawa, Elochoman, Kalama, Lewis, Cowlitz, and Sandy rivers (Emmett *et al*. 1991, Musick *et al*. 2000). In the Columbia River and its tributaries, spawning usually begins in January or February (Beacham *et al.* 2005).

Eulachon are anadromous fish that spawn in the lower reaches of rivers in early spring. They typically spend three to five years in saltwater before returning to freshwater to spawn from late winter through mid-spring. Spawning occurs over sand or coarse gravel substrates, eggs are fertilized in the water column, sink, and adhere to the river bottom. Most adults die after spawning, and eggs hatch in 20 to 40 days. The larvae are carried downstream and are dispersed by estuarine and ocean currents shortly after hatching. Runs tend to be erratic, appearing in some years but not others, and appearing only rarely in some river systems (Hinrichsen 1998).

Eulachon are important in the food web as a prey species (Alaska Department of Fish and Game 1994). Newly-hatched and juvenile eulachon are food for a variety of larger marine fish such as salmon and for marine mammals including seals, sea lions and beluga whales. Spawned-out eulachon are eaten by gulls, eagles, bears and sturgeon.

Eulachon spawning runs have declined in the past 20 years, especially since the mid-1990s (Hay and McCarter 2000). The cause of these declines remains uncertain. Eulachon are caught as bycatch during shrimp fishing, but in most areas the total bycatch is small (Beacham *et al*. 2005). Predation by pinnipeds may be substantial, and other risk factors could include global climate change and deterioration of marine and freshwater conditions (73 FR 13185).

In 1999, NMFS received a petition to list the Columbia River populations of eulachon as an endangered or threatened species and to designate critical habitat under the ESA. NMFS determine the petition did not present enough substantial evidence to warrant the listed (64 FR 66601). In 2007, NMFS received a petition from the Cowlitz Indian Tribe to list southern eulachon (populations in Washington, Oregon and California) as a threatened or endangered species under the ESA. After reviewing the information contained in the petition and other information, NMFS determined that the petition presented substantial scientific and commercial information indicating the petitioned action may be warranted and commenced a review of the status of the species and will make a determination whether the petition action is warranted (73 FR 13185). The current status of eulachon is a candidate species.

Status of Critical Habitat. The NMFS reviews the status of critical habitat affected by the proposed action by examining the condition and trends of primary constituent elements (PCEs) of critical habitat throughout the designated area. The PCEs consist of the physical and biological elements identified as essential to the conservation of the species in the documents identifying critical habitat (Table 2). The PCEs found in the project area include freshwater spawning, freshwater rearing, and freshwater migration.

Table 2. PCEs of critical habitats designated for ESA-listed salmon and steelhead species considered in the Opinion.

Primary Constituent Elements		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence Fry/parr growth and development
Freshwater migration	Free of artificial obstructions Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration, holding Kelt (steelhead) seaward migration Fry/parr seaward migration

Climate change is likely to have negative implications for the conservation value of designated critical habitats in the Pacific Northwest (CIG 2004, Scheuerell and Williams 2005, Zabel *et al.* 2006, ISAB 2007). Average annual Northwest air temperatures have increased by approximately 1^{o}C since 1900, or about 50% more than the global average warming over the same period (ISAB 2007). The latest climate models project a warming of 0.1 to 0.6^{o}C per decade over the next century. According to the ISAB, these effects may have the following physical impacts within the next forty or so years:

- Warmer air temperatures will result in a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a shift to more rain and less snow, the snowpacks will diminish in those areas that typically accumulate and store water until the spring freshet.
- With a smaller snowpack, these watersheds will see their runoff diminished and exhausted earlier in the season, resulting in lower streamflows in the June through September period.
- River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures will continue to rise, especially during the summer months when lower streamflow and warmer air temperatures will contribute to the warming regional waters.

These changes will not be the same across the entire Columbia River basin. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would be less affected. Low-lying areas that historically have received scant precipitation contribute little to total streamflow and are likely to be more affected. The ISAB

also identified the likely effects of projected climate changes on Columbia basin salmon. These long-term effects may include, but are not limited to, depletion of cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species.

To mitigate for the effects of climate change on listed salmonids, the ISAB (2007) recommends planning now for future climate conditions by implementing protective tributary, mainstem, and estuarine habitat measures; as well as protective hydropower mitigation measures. In particular, the ISAB (2007) suggests increased summer flow augmentation from cool/cold storage reservoirs to reduce water temperatures or to create cool water refugia in mainstem reservoirs and the estuary; the protection and restoration of riparian buffers, wetlands, and floodplains; removal of stream barriers; implementation of fish ladders; and assurance of high summer and autumn flows.

Willamette and Lower Columbia (WLC) River Recovery Domain. Critical habitat was designated in the WLC Recovery Domain for UWR spring-run Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, and CR chum salmon. In addition to the Willamette and Columbia river mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Agriculture, urbanization, and gravel mining on the valley floor and timber harvesting in the Cascade and Coast ranges contribute to increased erosion and sediment loads throughout the basin.

The mainstem Willamette River has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Frogatt 1984). Gregory *et al*. (2002a) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to RM 120) incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the Corps. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of

the meander bends are revetted (Gregory *et al*. 2002c). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al*. 2002b).

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

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

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

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats

(Bottom *et al*. 2005, Fresh *et al*. 2005, NMFS 2005a, NOAA Fisheries 2006). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the lower Willamette and lower Columbia rivers (Bottom *et al*. 2005, Fresh *et al*. 2005, NMFS 2005a, NOAA Fisheries 2006). Since 1878, 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River have been dredged as a navigation channel by the Army Corps of Engineers. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. These ports primarily focus on the transport of timber and agricultural commodities. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in lower Columbia River watersheds in the vicinity of the ports and associated industrial activities.

The most extensive urban development in the lower Columbia River subbasin occurs in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of tidal marsh and tidal swamp habitat that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom *et al*. 2005, Fresh *et al*. 2005, NMFS 2005a, NOAA Fisheries 2006). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood *et al*. (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary's capacity to support juvenile salmon (Bottom *et al*. 2005, Fresh *et al*. 2005, NMFS 2005a, NOAA Fisheries 2006). Diking and filling activities that decrease the tidal prism and eliminate emergent and forested wetlands and floodplain habitats have likely reduced the estuary's salmon-rearing capacity. Moreover, water and sediment in the lower Columbia River and its tributaries have levels of toxic contaminants

that are harmful to fish and wildlife (LCREP 2007). Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns might significantly enhance the estuary's productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats, even in their presently altered state.

2.1.2 Environmental Baseline

The action area is within the Sandy River basin, in Clackamas and Multnomah counties. Originating from glaciers on the eastern slopes of Mount Hood in the Cascade Mountains, the Sandy River travels 56 miles before flowing into the Columbia River near the city of Troutdale at Columbia River Mile (RM) 120.5. The basin's major tributaries, the Zigzag, Salmon, Bull Run, and Little Sandy rivers, drain 508 square miles of land. Nearly 25 river miles are designated as a National Wild and Scenic River and 12 miles are designated as an Oregon Scenic Waterway. The headwaters of the Sandy River form on the slopes of Mount Hood, and the upper one-third of the basin is steep, rugged, and heavily timbered. The middle third of the basin is characterized by a series of alternating terraces and steep, narrow canyons, and the lower basin forms a wide, sandy delta that gives the river its name. The middle and upper portions of the basin are Federally owned and forested, whereas the lower portion is mostly privately owned and situated along the outskirts of the urban growth boundary for the Portland metropolitan area. Development in the basin was limited up until the last century when transportation access across the rugged terrain was made possible available by the construction of U.S. Highway 26.

The first sawmill in the basin was constructed on Cedar Creek in 1858. Extensive logging occurred in the lower basin by the late 1800s, but it was the middle of the 20th century before timber harvesting reached the rugged Federal lands in the upper basin (Sandy River Basin Watershed Council [SRBWC] 1999). By that time, the Bull Run watershed (nearly 25% of the basin) had been declared a Federal reserve through presidential proclamation in 1892. The watershed was protected from harvest, grazing, and settlement by the Bull Run Trespass Act of 1904. Subsequent designations of Federal wilderness areas (Mount Hood and Salmon-Huckleberry), and recent set-asides of late-seral forest under the Northwest Forest Plan and Oregon Resource Conservation Act, have resulted in additional protection for the middle and upper basin (Sandy River Basin Partners 2005).

The lower Sandy River basin supported numerous dairies and row crops through the first three decades of the 20th century, but changes in technology and demographic patterns after World War II resulted in the abandonment (and reversion to forest) of many farms, particularly those on slopes too steep to work with mechanized equipment. This trend continued until the late 20th century, when it was reversed by development pressure. From 1980 to 2000, the combined populations of Troutdale, Sandy, and Gresham increased 162% (Oregon Economic and Community Development Department 2004). Similar trends have been noted for the smaller communities along U.S. Highway 26 in the upper basin. Between 1982 and 1992, 100 acres of

wetlands and 1,800 acres of forest were converted to other uses, primarily residential development (SRBWC 1999).

Timber production has been a predominant commercial activity in the Sandy River basin, having a number of effects on terrestrial and aquatic habitats. Initially, forests were logged in large units and logs were floated down streams to mills, resulting in substantial alteration of riparian and aquatic habitats. Railroads, followed by truck roads, eventually replaced streams as transportation corridors, but large-scale clearcutting and logging of riparian areas continued past the mid-20th century.

The Portland General Electric (PGE) hydropower project in the Sandy River basin was constructed in phases between 1906 and 1913. The project's two dams (Marmot and Little Sandy) have influenced flows in the lower Sandy River and blocked anadromous access to the Little Sandy and Upper Sandy rivers. The Marmot dam was removed in 2007, and PGE plans to remove the Little Sandy dam in 2008.

The City of Portland's Bull Run water system first blocked fish passage to the upper Bull Run River in 1921 through construction of the Headworks Dam, and inundated about 800 acres after the development of two more dams. Water withdrawals from the Bull Run facilities since 1895 have altered flows in the lower Bull Run River and the lower Sandy River.

Sandy River fish have been harvested since the mid-1800s. By the 1870s, harvesting (in conjunction with habitat modification) was having a noticeable effect on salmon and steelhead populations in the basin. Spring Chinook was the first fishery targeted in the basin, with harvest peaking at 43 million pounds in 1875. Over the succeeding decades, the fishery shifted progressively to fall Chinook, steelhead, and coho as each run decreased. The fishery also expanded to include ocean trolling in the early 1900s. By the 1940s, the harvest of all species was substantially depressed.

Mixed-ownership characterizes the mainstem of the Sandy River. Approximately 74% of the basin is owned and managed by the U.S. Forest Service-Mount Hood National Forest (approximately 70%) and Bureau of Land Management (BLM) (approximately 4%). About 3% is owned by the Portland Water Bureau and other local, state, and regional governmental entities. Private lands account for approximately 23% of ownership.

The Bull Run River watershed comprises approximately 28% (88,900 acres) of the Sandy River basin. Much of the watershed is in the Bull Run Watershed Management Unit. Its predecessor, the Bull Run Reserve, was created by presidential proclamation in 1892 to protect Portland's water supply. The Bull Run supply consists of two storage reservoirs (Dams No. 1 and No. 2), together with an outlet structure on Bull Run Lake, a natural waterbody near the headwaters. The water supply is an unfiltered water source with the capacity to serve over 800,000 people in the Portland metropolitan area.

Water quality data for the Sandy River basin have been only sporadically collected; the exceptions are the Bull Run River watershed (where water quality is extensively monitored because it is a municipal water source) and an ambient water quality sampling site at the mouth

of the Sandy River (Troutdale Bridge, monitored by ODEQ bimonthly). The data collected over the years generally indicate that water quality in the Sandy River basin is good, but there has been evidence of elevated stream temperatures, chemical contamination, and increased sediment loading and deposition at some locations. Approximately 63 miles within the Sandy River basin are water quality-limited (Sandy River Basin Partners 2005). Water quality-limited means instream water quality fails to meet established standards for certain parameters for all or a portion of the year.

Seven stream segments were listed on ODEQ's 2002 303(d) list as being impaired due to high water temperature, E. coli, and dissolved oxygen. ODEQ recently finalized a new statewide temperature standard and developed a TMDL to address temperature standard and bacteria standard exceedances (ODEQ 2004). ODEQ has also developed a Water Quality Management Plan, in part to temperature control relative to dams and to establish and protect riparian area vegetation (*i.e.,* shading). The plan also includes measures to meet the defined bacteria allocations.

Riparian conditions on forestlands in the basin are generally maintained in good quality as a result of Forest Practices Act and National Forest lands protections. Stream shading is generally good in the middle and upper reaches of the Sandy River, keeping temperatures down and providing habitat for fish and wildlife. The riparian vegetation in the Bull Run River watershed is afforded much more protection than that in other drainages in the state, owing to the protection of the Bull Run River's water quality for municipal water supply.

Some of the upper Sandy River drainage is in wilderness areas, where riparian zones are also protected. The riparian habitat in some of the lower reaches in the basin has been affected by recreation, residential, agricultural, and municipal activities. Situated within minutes of the Portland metropolitan area, the lower river is used heavily for recreation. Agricultural and residential development activities have altered or disturbed some riparian habitat areas, and have also caused instances of streambank erosion, particularly when careful management practices were not followed.

Anadromous fish historically used about 49 stream miles in the Bull Run River watershed, which includes 10 miles of the Little Sandy River. Approximately 9 miles are now inundated by Bull Run reservoirs. Steelhead had access to all 49 miles of streams. Coho, Chinook (spring and fall) salmon, and coastal cutthroat trout probably had access to approximately 40 out of the 49 miles in the watershed. Anadromous fish currently use about 7.5 stream miles of stream habitat in the Bull Run River watershed. Of this total, approximately 6 miles occurs in the lower Bull Run River downstream of the Headworks, with an additional 1.7 miles in the Little Sandy River. This distance represents about 4.7% of the total stream miles (170 miles) currently used by anadromous fish in the basin. Fall and spring Chinook, coho, and steelhead currently use all of the accessible 7.5 stream miles in the Bull Run River watershed. Anadromous (sea-run) cutthroat trout are assumed to use the lower Sandy River (below Marmot Dam), including the lower Bull Run River, although there have been few recent observations. Resident cutthroat trout are well distributed throughout the watershed.

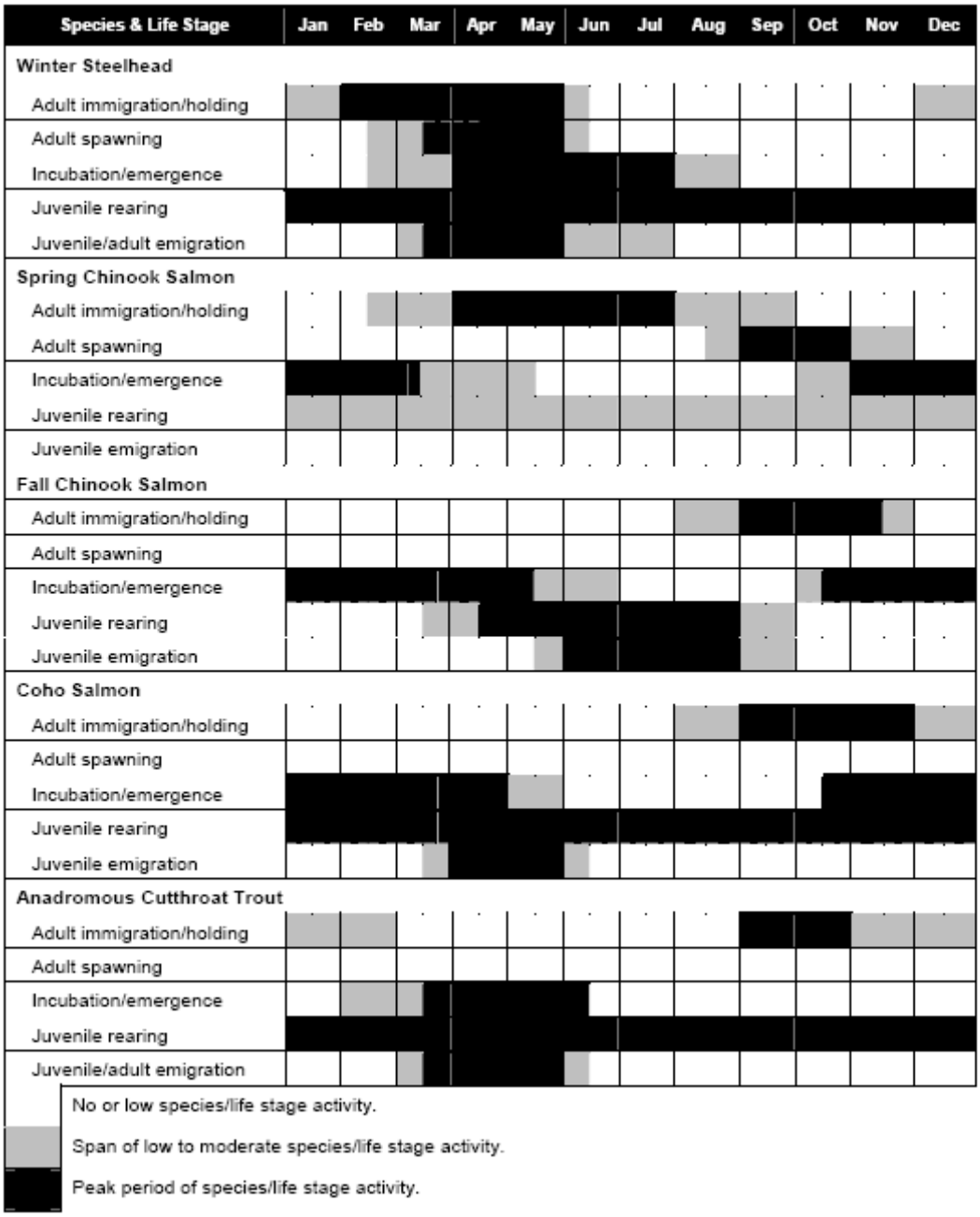
Today, the Bull Run and Little Sandy rivers provide limited migration, spawning, and rearing habitat for anadromous and resident fish species in the Bull Run River watershed downstream from hydroelectric and water diversion projects. Fish passage is blocked at RM 5.8 on the lower Bull Run River and at RM 1.7 on the Little Sandy River. Other tributaries to the lower Bull Run River have limited productivity potential for anadromous fish due to steep gradients or natural waterfalls (City of Portland 2002). Additionally, a culvert barrier in Walker Creek blocks access to about 500 feet of this lower Bull Run River tributary (City of Portland 2002). The timing of fish presence below Marmot Dam is outlined in Figure 1 (Sandy River Basin Partners 2005).

Water temperatures in the lower Bull Run River during summer conditions often exceed the range of temperatures considered suitable for juvenile salmonid fish rearing (R2 Resource Consultants 1998). Three temperature monitoring sites were established during the summer of 1995—in the lower river at RM 5.6 (below Bull Run Dam No. 2 plunge pool), at RM 3.6 (Larson's Bridge), and at RM 1.6 (immediately upstream from the Bull Run Powerhouse)—to characterize longitudinal trends in surface water temperatures. Mean daily water temperature at the upstream site (RM 5.6) ranged between 13.9°C and 19.9°C while averaging 15.6°C during the late summer and early fall monitoring period (July 20 to September 19, 1995).

Spawning gravels are scarce in the lower Bull Run River and probably limit the production of anadromous salmonid fishes in the river (R2 Resource Consultants 1998). High water velocities occurring during peak flow periods reduce gravel quantity. Much of the river is situated in a canyon, and it is confined to a relatively narrow channel by steep bedrock walls. River velocities can become high enough to mobilize and transport gravel and larger bed materials. River discharge and depth also influence the availability of spawning gravels, since the number of gravel patches with sufficient spawning depth decreases directly with stream flow.

In 1996, the USFS concluded that anadromous production in the Sandy River basin is limited by availability of pool habitat, low volume of large wood, poor habitat diversity in some reaches, increased glacial silt and sediment, and warm summer stream temperatures (USFS 1996). Within the lower Bull Run River, anadromous production is affected by access to available habitat, redd stranding, depletion of spawning gravels, and reduction of food resources from fish carcasses. More information on habitat conditions and limiting factors can be found in the Sandy River Basin Characterization Report (Sandy River Basin Partners 2005).

Figure 1. Timing of fish presence in the Little Sandy River below Marmot Dam (from Sandy River Basin Partners 2005),



2.1.3 Analysis of Effects

This section includes an analysis of the direct and indirect effects of the operation and maintenance of the City's Bull Run Water Supply in the Sandy River basin, including the proposed habitat conservation measures, on listed species and their designated critical habitats. These effects are described in detail in Chapter 8 of the HCP, and are categorized as follows:

1. Effects of water supply operations and HCP conservation measures in the lower Bull Run River include effects to streamflow, water temperature, large wood, spawning gravel, access to rearing and spawning habitat, riparian function, and total dissolved gases.
2. Effects of water supply operations and HCP conservation measures in other Sandy River basin watersheds.

The distinction of these categories is the location of the HCP measures being implemented. Each will be discussed in turn.

Effects of water supply operations and HCP conservation measures on covered species in the lower Bull Run River

No effects will occur to chum salmon and eulachon in the lower Bull Run River because they do not currently reside nor were they ever present historically within the Bull Run River.

Effects to Chinook salmon, coho salmon and steelhead that cannot be avoided are associated with the blocked access to the upper Bull Run watershed, low base flows, and reduced availability of wetted habitat area. Habitat effects associated with water supply operations that will be minimized though HCP measures include flow downramping, elevated water temperatures, riparian function and large wood, and supply of spawning gravel. Chinook salmon, coho salmon and steelhead may also be affected water supply activities that result in high flows that scour redds and elevated total dissolved gas levels. The City will study redd scouring and total dissolved gas levels (refer to Chapter 9 of the HCP for research design information) and if the results indicate effects to ESA-listed species, the City will implement minimization and mitigation measures through adaptive management.

With implementation of the HCP, the City will implement conservation measures to increase base flows in the lower Bull Run River and Sandy River. The implementation will also increase the monthly average flows and the seasonal peak flows. Flow measures in the spring and late fall would help improve access to available habitat, avoid redd dewatering, and result in physical improvements in the lower Bull Run River. Flows would be within the range of flows predicted to provide near optimal spawning habitat conditions for fall Chinook salmon, (R2 Resource Consultants 1998). During the primary winter steelhead spawning period (March to May), the City's proposed minimum flows would maintain conditions for spawning and incubation. Flows during the summer and early fall would have moderate positive effects on juvenile steelhead rearing. For coho salmon, the flow measures in spring and late fall will improve access to available habitat, avoid redd dewatering, and result in physical improvements in the lower Bull Run River and elsewhere in the Sandy River basin. The naturally high flows in winter and spring will have minimal effect on coho survival, but support good habitat for juvenile incubation and rearing.

Stream water temperatures would improve (decrease) relative to the current condition, because of the construction of the multi-level intake and implementation of flow measures. Currently, water temperatures in the lower Bull Run River during the summer and early fall periods exceed those preferred by rearing and spawning anadromous fish. Once the intake modifications are

complete, the interim goal is to not exceed 69.8ºF, which is cool enough to allow continued growth and survival. But there would be some temporary sublethal temperature effects including susceptibility to disease, altered migration and run timing, and altered development or maturation stages (McCullough *et al.* 1999).

Implementation of habitat measures will protect riparian habitat. The large trees that fall into the river will affect stream gradients, sort gravels and create small pools that will be beneficial by adding rearing and spawning. Large wood will transport downstream where it would create diverse habitat. Shading from vegetation will help lower water temperatures over time, and will closely approximate natural water temperatures. Placement of spawning gravels will substantially improve the availability of spawning habitat.

Effects of water supply operations and HCP conservation measures on covered species in other Sandy River basin streams

Conservation measures would add large wood to the Sandy River and tributaries, reestablish the mouth of the Sandy River (measure H-8), open up side channels on the mainstem Sandy River and tributaries, reconstruct parts of Sandy River, Salmon River and Zigzag Creek, and acquire riparian easements and improve riparian habitat in the basin. These measures in the middle and lower Sandy River will benefit salmonid rearing and migration habitat by improving riparian zone conditions and increasing large wood volumes. These benefits will occur over the 50-year term of the HCP and will accumulate at varying rates. For example, opening up side channels and removing riprap will be permanent but riparian easements will take 15 years before providing benefits and will take 30 years before reaching full benefit potential (due to natural processes of tree growth and wood recruitment to a river).

The primary limiting factor for winter steelhead in the basin is reduced habitat diversity. HCP conservation measures would improve conditions for winter steelhead on the mainstem Sandy River (measure H-18) and in important tributary streams like the Salmon and Zigzag rivers. For the middle Sandy River, large wood additions, riparian improvements and improved channel diversity would occur in the mainstem Sandy River and Cedar Creek. New habitat would be opened up for winter steelhead in Alder and Cedar creeks.

Substantial habitat benefits will accrue from HCP measures in the upper Sandy River and its tributaries, the middle Sandy River, and the lower Sandy River. The upper Sandy River contains the primary spawning areas for coho salmon, and most anchor habitat reaches for coho salmon are upstream of the former Marmot Dam site. Improvements to habitat diversity, side-channel habitat and riparian zone conditions will improve coho salmon rearing and migratory conditions. Passage improvements in Cedar Creek will provide access for coho salmon in approximately six years.

Habitat conservation measures along the mainstem Sandy River reaches, upstream and downstream of the confluence with the Bull Run River, will improve habitat for chum salmon. The HCP measures that will benefit chum salmon specifically include riparian easements, placement of large wood, and the opening of the historical mouth of the Sandy River and other

side-channel areas. The channel reconnection will improve fish access and reopen approximately one mile of habitat that will provide low velocity rearing habitat.

In addition to the effects described above, implementation of the proposed action will continue the existing condition for access to the upper Bull Run watershed, low base flows, and low weighted usable area in the lower Bull Run River. These are unavoidable effects to Chinook salmon, coho salmon, and steelhead that the City will offset through the implementation of the Sandy River Basin conservation measures. Implementation of the HCP will avoid effects to spawning gravel, flow downramping, and riparian function in the lower Bull Run River. There will be some short-term effects to water temperature; the temperature will be raised at times when fish are present. But in the long term, the natural thermal potential of the lower river will be returned due to the City infrastructure and operational changes for its dams and reservoirs. The removal of large wood from the reservoirs is a small effect on spring Chinook habitat, but the City's riparian zone protection measures will improve large wood accumulations in the future.

Effects on Species

The effects of implementation of the conservation measures in the HCP are described below for the fish species in the Sandy River basin.

Chinook. The abundance of fall Chinook salmon is predicted to increase by 10% in the Sandy River basin, based on the EDT model analysis conducted by the City. Productivity of fall Chinook salmon is predicted to increase by 12% and diversity will increase by 11%. The HCP measures will increase spawner abundance in the Bull Run River, lower Sandy River, and the middle Sandy River, the core of current fall Chinook productivity. Increased adult abundance in multiple watersheds would increase spatial diversity and reduce extinction risk. Fish passage on Alder Creek will add to the spatial structure.

For spring Chinook salmon, the EDT model runs predict a 13% increase in abundance, a 12% increase in productivity and a 6% increase in diversity. The spatial structure of spring Chinook salmon in the basin will improve as actions are focused on increasing spawner abundance in all of the five watersheds historically occupied by spring Chinook salmon. Increased adult abundance in multiple watersheds will reduce the effects of any catastrophic events, which reduces extinction risk.

Steelhead. EDT model runs predict an 11% increase in abundance, a 7% increase in productivity and a 12% increase in diversity. The spatial structure of steelhead in the basin will improve, as actions are focused on increasing spawner abundance in all of the five watersheds that historically supported steelhead. Increased adult abundance in multiple watersheds will reduce the effects of catastrophic events, which reduces extinction risk.

Coho Salmon. EDT model runs predict a 23% increase in abundance, a 4% increase in productivity and a 21% increase in diversity. Spatial structure will improve as actions are focused on increasing spawner abundance in all of the five watersheds that supported coho

salmon production historically. Increased adult abundance in multiple watersheds reduces population exposure to catastrophic events, and thus reduces extinction risk.

Chum Salmon. The City did not model the effects of the HCP measures for chum salmon. The City predicts the EDT results would be similar to the fall Chinook salmon result because both species have similar timing for adult spawning and juvenile habitat preferences. Therefore, the City predicts that population parameters will improve for chum salmon, but less than those predicted for Chinook salmon, since chum salmon use is limited to the lower Sandy River basin.

Eulachon. The effects to eulachon abundance, productivity and diversity are unknown, and the City did not conduct EDT model runs for this species. Improvements at the mouth of the Sandy River may improve conditions for eulachon, but the effects at the population scale are unknown because information on the limiting factors is lacking.

The operation, maintenance and repair of the water supply system will also affect listed salmonids and eulachon. The dams will continue to inundate riverine habitat and block fish access to the upper Bull Run watershed. The diversion of water for water supply and the seasonal closure of gates at Dam 1 to store water results in reduced base flows for fish in the lower Bull Run River and increases the potential for stranding of juvenile fish in the lower Bull Run River. The City developed HCP measures to address and minimize the risk of mortality associated with base flows and stranding. The operation of booms, boats and barges on the reservoirs, and the delivery and storage of fuel and lubricants increases the potential for releases of petroleum products in to the river and reservoirs. The City uses chlorine gas to disinfect the water diverted for water supply. An accidental release of chlorinated water could harass or kill downstream salmonids and their prey base.

Another class of effects not described above is the short-term effects of implementation of conservation measures. Implementation of some of the measures will require work area isolation and fish removal, others will cause localized increases in turbidity, and consequences of accidental releases of petroleum products from machinery and spills that could be toxic to salmonids, eulachon, and their prey base. These effects are more likely to occur to steelhead, coho salmon and Chinook salmon because juveniles of these species rear year-round in the rivers and streams within the action area. In-water timing restrictions will minimize the potential for effects to all species, however incidental take is an expected consequence of the implementation of the HCP measures. Take can be sublethal such as increased exposure to turbidity; the salmonid response to turbidity will vary with sediment concentration, exposure duration, and location relative spawning or rearing habitat (Wilber and Clark 2001). A sublethal response could be reduced feeding by juvenile salmonids (Wilber and Clark 2001), which could result in increased vulnerability to predation and disease. Adult salmonids are generally less vulnerable to turbidity plumes because they are better swimmers and able to avoid these areas at no or little cost to their overall fitness. A sublethal response associated with work area isolation is injury (harm) and increased stress (harass), which can increase vulnerability to predation and reduce the ability to swim and compete for food.

The proposed conservation measures are reasonably certain to result in the injury or death of listed species and eulachon. Mortality rates associated with electrofishing can be as high as 10% (Reynolds and Holliman 2005). Accidental spills of materials toxic to fish (*e.g.*, petroleum products) will kill fish in the immediate vicinity. A number of the measures, such as measures that require channel excavation or removal of blockages, will have equipment within the active channel and/or require fish handling.

The City proposes to use extensive monitoring, adaptive management, and the use of the Habitat Fund to address uncertainty associated with the effectiveness of the implementation on the HCP measures on fish productivity and abundance. While the direct and indirect effects of HCP implementation as described above are reasonably likely to occur, the overall effect of the implementation of the HCP will be the improvement of fish habitat within the Sandy River basin over the 50-year term of the HCP.

Effects on Critical Habitat

Designated critical habitat within the action area for the ESA-listed salmonids and the candidate species eulachon considered in this Opinion consists of freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. The effects of implementation of the HCP on the PCEs for these habitats are described above, but are summarized below.

1. Water quantity. Flow downramping effects in the lower Sandy River will be avoided. Also, the City's commitment to forgo development of Little Sandy River water rights will avoid any effect on free-flowing conditions in the Little Sandy River. The City's flow regime will also reduce the risk of redd scour.
2. Water quality. Even though the City's operations in the Bull Run will not affect water temperatures lower in the Sandy River, some of the City's offsite conservation measures will have small temperature benefits. For the Bull Run River, the City will meet the natural thermal potential of the river once the infrastructure improvements are completed at Dam 1.
3. Substrate. The City will place spawning gravels in the lower Bull Run River which will substantially improve spawning conditions for Chinook salmon, coho salmon, and steelhead.
4. Floodplain connectivity. The existing condition will remain above the dams, but riparian improvements, restoration of side channels and channel work at the mouth of the Sandy River will improve the connectivity to the floodplain in the Sandy River basin.
5. Forage. Improved riparian function, the flow regime, and reconnections to the floodplain will improve the potential for increased forage opportunities.
6. Natural cover. The City will maintain and improve riparian function with a focus on growing large trees.
7. Free passage. Although the proposed action will not provide access to the upper Bull River, improved access in Walker Creek, Alder Creek and Cedar Creek will open up new habitat for winter steelhead and coho salmon.

Factors limiting the salmonid populations in the Sandy River basin include availability of pool habitat, low volume of large wood, poor habitat diversity in some reaches, increased glacial silt

and sediment, and warm summer stream temperatures (USFS 1996). Within the lower Bull Run River, anadromous production is affected by access to available habitat, redd stranding, depletion of spawning gravels, and reduction of food resources from fish carcasses. While the implementation of the proposed HCP will continue the baseline for some conditions (access to the upper Bull Run River) and cause short-term effects to water quality (*e.g.*, increased turbidity), the overall effect of HCP implementation will be beneficial to the PCEs described above. The addition of large wood, spawning gravels, and carcasses will begin to address some of the limiting factors. Access to habitat in Walker Creek, Alder Creek and Cedar Creek will be restored. The offsite measures in the HCP were developed to address factors that limit salmonid production in the Sandy River basin.

2.1.4 Cumulative Effects

Approximately 74% of the Sandy River basin is Federally-owned. The type and rate of land management activities on Federal land is unlikely to change within the 50-year term of the HCP. However, the lower part of the Sandy River basin is within the Portland metropolitan area, and will continue to experience growth in residential, commercial and industrial development. Between 2000 and 2006, the population of Multnomah County increased by 3.2%, and the population of Clackamas County increased by 10.6%.[2] The NMFS expects these increases in population to continue in the lower basin during the term of the HCP.

In 2000, a partnership of public and private organizations convened an effort to coordinate the recovery of anadromous fish species in the Sandy River basin. The formation of this group, the Sandy River Basin Partners, was prompted by the ESA listings and PGE's plans to remove Marmot and the Little Sandy dams. The Sandy River Basin Partners is coordinating and supporting efforts to restore habitat throughout the Sandy River basin.

2.1.5 Conclusion

After reviewing the status of salmonids considered in this Opinion, and their designated critical habitats, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of the listed salmonids and is not likely to destroy or adversely modify designated critical habitat. These conclusions are based on the following considerations:

1. The negative effects (*e.g.*, increased turbidity, handling) associated with implementation of the conservation measures will be short term (days to weeks) during the implementation of each habitat measure over the 50-year HCP, and these measures will ultimately improve habitat conditions such as access/safe passage, gravel supply, forage, space, and water quality over the term of the HCP. The NMFS predicts the environmental baseline of the Sandy River basin will improve as a consequence of the measures implemented under the HCP. Continued monitoring and adaptive management will guide the HCP measures, particularly later in the term of the HCP, to assure the implementation of measures that will most benefit critical habitat quality and availability.

[2] U.S. Census Bureau, State and County Quickfacts, Multnomah County, http://quickfacts.census.gov/qfd/states/41/41051.html

2. Coho populations in the Sandy River basin have been affected by dwindling habitat diversity and quantity, obstructions caused by dams, and reduced stability of the stream channel. HCP measures will increase access to habitat and improve habitat diversity and quantity. EDT model runs predict substantial increases in coho abundance and diversity, and a modest increase in productivity as a consequence of HCP implementation. Increased adult abundance in multiple watersheds reduces population exposure to catastrophic events, and thus reduces extinction risk.

3. Chinook populations in the Sandy River basin are limited by water temperatures, blocked access to habitat, flow diversions that reduced the availability to spawning and rearing habitat, and quality of habitat. HCP measures will improve access to habitat, improve habitat quality, and reduce water temperatures. The flow diversion will remain in the Bull Run River, but the HCP measures will compensate by improving passage in other watersheds, and improving water temperatures and habitat quality. EDT model runs predict the implementation of the HCP will increase the abundance of Chinook in the Sandy River basin, as well as productivity and diversity. The HCP measures will increase spawner abundance in the Bull Run River, lower Sandy River, and the middle Sandy River, the core of current fall Chinook productivity. Increased adult abundance in multiple watersheds would increase spatial diversity and reduce extinction risk.

4. Current decreases in steelhead abundance in the Sandy River basin can be attributed to loss of habitat diversity and quantity, increased sediment loads, and obstructions from dams. The HCP measures will improve habitat diversity and quality, and improve access. EDT model runs predict an increase in abundance, productivity and diversity for steelhead in the basin. The spatial structure of steelhead in the basin will improve as actions are focused on increasing spawner abundance in all of the five watersheds that historically supported steelhead. Increased adult abundance in multiple watersheds will reduce the effects of catastrophic events, which reduces extinction risk.

5. Limiting factors for chum salmon include altered channel form and stability in tributaries, excessive sediment in tributary spawning gravels, altered stream flow in tributaries and the mainstem Columbia River, loss of some tributary habitat types, and harassment of spawners in the tributaries and mainstem. Some of the HCP measures address habitat access and quality in the lower Sandy River, including a measure to move the mouth of the Sandy River back to the original channel. The City did not run the EDT for chum salmon, but predicts that population parameters will improve based on the habitat measures that will be implemented at the mouth of the Sandy River. However, improvements in habitat for chum will be less that those predicted for other salmon, since chum salmon use is limited to the lower Sandy River basin.

6. Limiting factors for eulachon remain uncertain. Risk factors include predation by pinnipeds, global climate change, and deterioration of marine and freshwater habitat. HCP measures focused on the first few miles of the Sandy River may provide benefit to eulachon, however the City did not run the EDT model for eulachon, and the effects at the population scale are unknown because too much information on this species is lacking.

2.1.6 Reinitiation of Consultation

Reinitiation of formal consultation is required and shall be requested by the Federal agency or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that has an effect to the listed species or designated critical habitat that was not considered in the biological opinion; or (d) if a new species is listed or critical habitat is designated that may be affected by the identified action (50 CFR 402.16).

To reinitiate consultation, contact the Oregon State Habitat Office of NMFS and refer to the NMFS Number assigned to this consultation (2008/03771).

2.2 Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 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 taking under the ESA, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The Bull Run Water Supply HCP identifies anticipated effects on affected species likely to result from the proposed activities, and the measures that are necessary and appropriate to minimize those impacts. Once the multi-level intake structure is built and operational (approximately 2012), the level of sublethal take associated with elevated temperatures is expected to decline. Other ongoing covered activities with a likelihood of causing injury or death to individual fish include water supply operations, sediment introduced from watershed management activities, fish handling during in-water work area isolation for projects to remove fish passage impediments or restore off-channel areas. For example, the City has committed to a flow measure to protect against large decreases in the river level due to reservoir operations that might otherwise trap (strand) small salmonids, although stranding could still occur. Downstream incubating eggs could be smothered or scoured by careless operations at the dam. The frequency, location and duration of covered activities resulting in levels of impacts severe enough to harm fish is too speculative to allow NMFS to estimate possible numbers of fish taken under this HCP.

2.2.1 Amount or Extent of Take

Actions necessary to complete the proposed HCP will take place in areas beside and within the active stream channel when juvenile and adult individuals of LCR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, and eulachon are likely to be present. Incidental take caused by the adverse effects of the proposed action will include the following: (1) Blocked fish passage to the upper Bull Run watershed; (2) low base flows and wetted channel area associated with continued water diversions; (3) habitat modification due to watershed management, road management, and water supply operations; (4) 170 miles of instream activities where fish are present, such as construction of in-water habitat improvements, road maintenance and improvements, and monitoring activities; and (5) use of equipment in streams during construction. This take will occur over the 50-year term of the HCP, and within the hydrologic boundary of the Sandy River basin (Figure 2-1 of the HCP), including operation and maintenance of Bull Run Dam 1 and Dam 2 and associated structures; Reservoir 1 and 2 and associated structures; diversion dams, weirs and pools; headworks facility; water supply conduits, bridges, and trestles (except mainstem Sandy River crossings); water quality monitoring stations and flow gauges; Sandy River Station maintenance facility; City-owned or maintained roads and other road surfaces and easements on non-Federal land; and easements owned or maintained by others on City-owned land.

Take caused by the habitat-related effects of this action cannot be accurately quantified as a number of fish because the relationship between habitat conditions and the distribution and abundance of those individuals in the action area is imprecise. Passage into the Upper Bull Run watershed will not be restored during the life of the HCP. Aquatic habitats damaged by the City's Bull Run in stream construction will require weeks to years to recover characteristics that are favorable for migration, spawning, and rearing. In such circumstances, NMFS uses the causal link established between the activity and a change in habitat conditions affecting the listed species to describe the extent of take as a numerical level of habitat disturbance.

Here, the best available indicators for the extent of take are the extent of freshwater tributary habitats that will be harmed because those variables are directly proportional to long-term harm attributable to this project, as indicated: (1) Guaranteed minimum flows during normal and critical water years (variable depending on date, see measures F-1 and F-2 of the HCP) and maximum required flows (refer to the same tables); (2) lower Bull Run River water temperatures at or below the appropriate numeric criteria (date dependant) when the Little Sandy River temperature is below the criteria, or at or below the Little Sandy River temperature when the Little Sandy River temperatures are above the numeric criteria (this only applies in years 5 through 50 of the HCP); and (3) effects extend beyond 170 miles downstream of HCP action in the Sandy River basin over the 50-year term of the HCP. In the accompanying biological opinion, NMFS determined that this level of incidental take is not likely to result in jeopardy to the listed species. The minimum and maximum flows, water temperature in the lower Bull Run River, and 170 miles of stream affected by HCP activities are thresholds for reinitiating consultation. Exceeding any of these limits will trigger the reinitiation provisions of this Opinion.

2.2.2 Reasonable and Prudent Measures and Terms and Conditions

All conservation measures described in the final HCP (City of Portland 2008), together with the associated Implementation Agreement and the section 10(a)(1)(B) permit issued with respect to the HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement. Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the ESA to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount and extent of incidental take anticipated under the proposed HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) permit.

3.0 SECTION 10(a)(2)(B) FINDINGS

3.1 Permit Issuance Considerations

Although eulachon are not presently listed as threatened or endangered under the ESA at this time, the permittee elected to address this unlisted species in the HCP and to have it included on the permit with a delayed effective date, *i.e.*, the date of future listing, if any. If eulachon are subsequently listed, the City will be in full ESA compliance for that species and no further action by the City is required. To the extent that take of eulachon would otherwise be prohibited under section 9 of the ESA, its implementing regulations, or pursuant to protective regulations, the City and its designated agents will be exempt those prohibitions, providing such take is incidental to actions described in the Plan and associated documents and as conditioned herein. If measures described in an HCP for the conservation of eulachon are not carried out, and the species is subsequently listed, the City would be found to be out of compliance with the permit with respect to that species and the incidental take of the species would therefore not be authorized.

To issue an ITP under the ESA section 10(a)(1)(b) and 50 CFR section 222.307, NMFS must consider the following:

1. The status of the affected species or stocks. The status of anadromous salmonids and eulachon potentially affected by the HCP has been considered above (section 2.1.1). The environmental baseline for these species and their habitats (section 2.1.2) was also considered.

2. The potential severity of direct, indirect, and cumulative impacts on anadromous salmonids and their habitats as a result of the proposed action. The effects of the implementing the HCP were examined in the Opinion, above (section 2.1).

3. The availability of effective monitoring techniques. Monitoring of the implementation of the HCP and the effectiveness of the HCP measures are a critical feature of this HCP. Monitoring reports will be completed and submitted to NMFS according to the schedule described in Chapter 9 of the HCP. The City has committed to annual reports, with

formal progress meetings approximately every 5 years throughout the entire 50-year term of the HCP.

4. The use of the best available technology for minimizing and mitigating impacts. The measures established in this HCP represent the most recent developments in science and technology in minimizing and mitigating impacts to riparian and aquatic habitats, such as the construction of the multi-level intake structure to reduce water temperatures in the Bull Run River. Further, the adaptive management, decision milestones, and collaborative approach used in the HCP assure new science and technology will continue to be used in the HCP as it is implemented.

5. Public review. The views of the public, scientists, and other interested parties knowledgeable of the species or other matters related to the application were received and reviewed by NMFS. Over the past 8 years, the Applicant has hosted and facilitated tours of the action area, and meetings with Federal, tribal, and state representatives, as well as non-governmental groups, neighbors and stakeholders.

The City first submitted a preliminary working or conceptual draft to NMFS in 2006. This represented more than eight years of work that included a partnership effort involving a dozen or more public and private organizations and detailed technical work. The participants included staff representing NMFS, U.S. Fish and Wildlife Service, U.S. Forest Service (Mount Hood National Forest), Bureau of Land Management, Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Clackamas County, Metro, Multnomah County, Oregon Trout, Northwest Steelheaders, The Nature Conservancy, Western Rivers Conservancy, East Multnomah County Soil and Water Conservation District, PGE as well as the City of Portland Water Bureau. The Partners developed a vision and a basin-wide restoration strategy to guide selection and implementation of projects. The Bull Run HCP is a significant product of this partnership effort.

During the development of the draft HCP, NMFS worked with the City to develop an EIS and Implementing Agreement (IA) to accompany the HCP. To solicit participation of responsible and coordinating Federal, state, and local agencies and of the public in determining the scope of this EIS, a Notice of Intent was published in the Federal Register on March 27, 2006 (71 FR 15168). The notice also announced a 30-day public scoping period during which other agencies, tribes and the public were invited to provide comments and suggestions regarding issues and alternative to be considered.

A total of 14 comment letters were received by NMFS pertaining to the DEIS and HCP: four from government agencies, four from private citizens, three from public organizations, and three from environmental groups. The Response to Comments section of the final EIS (FEIS) contains copies of all the letters and the NMFS responses. Many of the comments and suggestions were incorporated into the final HCP and the FEIS.

The public process had an influence on the final HCP and FEIS. Another factor NMFS considered in making the decision was consistency with the Federal Trust responsibility to Native American Tribes. This Trust responsibility imposes a duty on Federal agencies to protect

Trust assets for Tribes. Through the development and comment phases of drafts of the HCP, the City provided notification to the potentially affected tribal governments. The NMFS conducted a section 106 consultation under the National Historic Preservation Act with the State Historic Preservation Office. A Cultural Resources Management Plan was prepared to protect historical properties and archaeological resources that may be impacted by the HCP conservation measures. Thus, NMFS concluded that the proposed HCP is consistent with this Trust responsibility.

3.2 Permit Issuance Findings

Having considered the above, NMFS makes the following findings under section 10(a)2(b) of the ESA with regard to the adequacy of the HCP meeting the statutory and regulatory requirements for an Incidental Take Permit under section 10(a)(1)(B) of the ESA and 50 CFR section 222.307:

1. The taking of ESA-listed species will be incidental. NMFS anticipates that the proposed action is reasonably likely to result in the incidental take of threatened LCR Chinook salmon, CR chum salmon, LCR steelhead, LCR coho salmon, and the currently unlisted eulachon. Activities that will occur in the HCP area that will result in take will include salvage efforts during in-water activities and through adverse changes in habitat conditions during implementation of HCP measures. The incidental take will occur throughout the term of the HCP, and is not quantifiable because of the uncertainty of location and timing of the activities as well as the distribution and abundance of individuals of each listed species within the action area of the species at the time of implementation.

2. The City will, to the maximum extent practicable, minimize and mitigate the impacts of taking anadromous salmonids and eulachon associated with operation of the water supply system and implementation of the HCP measures. The HCP includes measures to improve water temperature, supply spawning gravels, access to habitat, and improve habitat quality (diversity) and forage. The City will also provide a Habitat Fund to provide local matching funds to enable the implementation of larger scale partnership projects and to provide resources to implement additional habitat projects as part of adaptive management.

3. The City has assured NMFS that the plan will be fully funded and implemented. The suite of mitigation, minimization, and adaptive management measures has assured funding commensurate with the effort and operational costs specific to each element. Signing of the IA by the City assures that the HCP will be implemented. Also, the HCP and IA commit the City to adequately fund implementation of the HCP.

4. Based on the best available scientific information, the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild. Conservation measures were developed in partnership with the Sandy River Basin Partners with the goal of restoring native fish in the Sandy River basin. The ESA's legislative history established the intent of Congress that this issuance criteria be based on a finding of "not likely to jeopardize" under section 7(a)(2) (see 50 CFR section 402.02). This is the

identical standard to section 10(a)(2)(B). The conclusions regarding jeopardy for the listed salmonids and for the unlisted eulachon are found in section 2.4 of the Opinion. In summary, NMFS has considered the status of the species, the environmental baseline, the effects of the proposed action, including any indirect and cumulative effects, to conclude that issuance of the Incidental Take Permit to the City for LCR Chinook salmon, CR chum salmon, LCR steelhead, LCR coho salmon, and the currently unlisted eulachon will not jeopardize the continued existence of any of the species addressed in the HCP.

5. The Bull Run Water Supply HCP has been developed to assure that other measures, as required by NMFS have been met. The HCP and IA incorporate all elements determined by NMFS to be necessary for approval of the HCP and issuance of the permit.

3.3 Conclusion

Based on these findings, NMFS concludes that the City's HCP meets the statutory and regulatory requirements for an Incidental Take Permit under section 10(a)(1)(B) of the ESA and 50 CFR section 222.307.

4.0 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The objective of the EFH consultation is to identify any adverse effects of Federal activities to EFH, and provide conservation recommendations for activities that do adversely affect EFH. The species considered in this EFH consultation are Chinook and coho salmon. The EFH consultation was completed pursuant to the MSA and its implementing regulations (50 CFR 600).

The consultation requirements 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 (PFMC) designated EFH for groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of coho and Chinook salmon (PFMC 1999).

Based on the analysis of effects presented in the ESA portion of this document, NMFS concludes that proposed action will have the following adverse effect on EFH designated for coho and Chinook salmon:

> Short-term (weeks) degradation of water quality from increased turbidity, effects to forage, cover and passage conditions, and long-term positive effects to passage conditions, substrate, habitat quality and availability.

4.1 EFH Conservation Recommendations

The NMFS believes that no additional conservation measures are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH because all conservation measures described in the final HCP (City of Portland 2008), together with the associated Implementation Agreement and the section 10(a)(1)(B) permit issued with respect to the HCP, are hereby incorporated by reference

4.2 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, including 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. Since no conservation measures are recommended, no response from NMFS is required.

4.3 Supplemental Consultation

Reinitiation of EFH consultation must be requested 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)].

5.0 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses

these Data Quality Act (DQA) components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

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

This ESA consultation concludes that the proposed implementation of the City of Portland's Bull Run Water Supply HCP will not jeopardize the affected species. Therefore, NMFS can authorize this action in accordance with its authority under section 10 of the ESA. The intended users are the City of Portland, the U.S. Forest Service and the Sandy River Basin Partners.

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

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

Objectivity:

Information Product Category: Natural Resource Plan.

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

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

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

Review Process: 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.

6.0 REFERENCES

Alaska Department of Fish and Game. 1994. Eulachon: Wildlife Notebook Series. http://www.adfg.state.ad.us/pubs/notebook/fish/eulachon.php

Beacham, T.D., D.E. Hay and K.D. Le. 2005. Population structure and stock identification of eulachon (*Thaleichthys pacificus*), an anadromous smelt, in the Pacific Northwest. Marine Biotechnology 7:363-372.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Baptista, D. A. Jay, K. K. Jones, E. Casillas, M. H. Schiewe. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-68, 246 p.

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Transactions of the American Fisheries Society 115:662-670.

Chilcote, M.W. 1999. Conservation status of lower Columbia River coho salmon. Oregon Department of Fish and Wildlife, Fish Division Information Report 99-3. 41 pages. Oregon Department of Fish and Wildlife, Portland, Oregon.

CIG (Climate Impacts Group). 2004. Overview of climate change impacts in the U.S. Pacific Northwest (July 29, 2004, updated August 17, 2004). Climate Impacts Group, University of Washington, Seattle.

Emmett, R.L., S.A. Hinton, S.L. Stone, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume II: Species life history summaries. ELMR Rep. No. 8 NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD, 329 pp.

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

Friesen, T.A. 2005. Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River. Final Report to the City of Portland. ODFW, Clackamas.

Gregory, S., R. Wildman, L. Ashkenas, K. Wildman, and P. Haggerty. 2002a. Fish assemblages. Pages 44-45 *in* D. Hulse, S. Gregory, and J. Baker, editors. Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, Oregon.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, and K. Wildman. 2002b. Historical Willamette River channel change. Pages 18-26 *in* D. Hulse, S. Gregory, and J. Baker, editors. Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, Oregon.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, R. Wildman, P. Minear, S. Jett, and K. Wildman. 2002c. Revetments. Pages 32-33 *in* D. Hulse, S. Gregory, and J. Baker, editors. Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, Oregon.

Gregory, S., L. Ashkenas, P. Haggerty, D. Oetter, K. Wildman, D. Hulse, A. Branscomb, and J. VanSickle. 2002d. Riparian vegetation. Pages 40-43 *in* D. Hulse, S. Gregory, and J. Baker, editors. Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, Oregon.

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

Hay, D. and P.B. McCarter. 2000. Status of Eulachon *Thaleichthys pacificus* in Canada. Fisheries and Oceans Canada, Ottawa, Ontario.

Hinrichsen, R.A. 1998. The ghost run of the Cowlitz. Cowlitz Historical Quarterly. 40(4):5-21.

Hogarth, W.T. 2005. Memorandum from William T. Hogarth, to Regional Administrators, Office of Protected Resources, NMFS, Regarding Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act, 3p. November 7.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Climate Change Report, ISAB 2007-2, Northwest Power and Conservation Council, Portland, Oregon.

Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife Report. 217 p.

LCREP (Lower Columbia River Estuary Partnership). 2007. Lower Columbia River and estuary ecosystem monitoring: Water quality and salmon sampling report. Lower Columbia River Estuary Partnership. Portland, Oregon.

McCullough, D. A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to Chinook salmon. Prepared for the U.S. Environmental Protection Agency (EPA), Region 10, Seattle, WA. Published as EPA 910-R-99-010. July. 291 pp. Available at: http://www.critfc.org/tech/EPAreport.pdf

McElhany, P. 2005. Columbia River chum salmon ESU. *in* T. P. Good, R. S. Waples, and P. Adams, editors. Updated status of federally listed ESUs of west coast salmon and steelhead. NOAA, Seattle, WA.

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

McElhany, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J.M. Myers, D. Rawding, D. Shively, A. Steel, C. Steward, and T. Whitesel. 2003. Interim report on viability criteria for Willamette and Lower Columbia Basin pacific Salmonids. NOAA Northwest Fisheries Science Center, Seattle.

McElhany, P., M. Chilcote, J. Myers, R. Beamesderfer. 2007. Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basin. September 2007. Prepared for the Oregon Department of Fish and Wildlife and the National Marine Fisheries Service.

Musick, J.A., M.M. Harbin, S.A. Berkeley, G.H. Burgess, A.M. Eklund, L. Findley, R.G. Gilmore, J.T. Golden, D.S. Ha, G.R. Huntsman, J.C. McGovern, S.J. Parker, S.G. Poss, E. Sala, T.W. Schmidt, G. R. Sedberry, H. Weeks, and S.G. Wright. 2000. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). Fisheries 25:6-30.

NMFS (National Marine Fisheries Service). 2004. Biological Opinion. Operation of the Federal Columbia River Power System (FCRPS) including 19 Bureau of Reclamation Projects in the Columbia Basin (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE [D. Oregon]). Northwest Region, Seattle, WA. Available at: http://seahorse.nmfs.noaa.gov/pls/pcts-pub/sxn7.pcts_upload.summary_list_biop?p_id=14756

NMFS (National Marine Fisheries Service). 2005a. Draft interim regional recovery plan for portions of three evolutionarily significant units (ESUs) of salmon and steelhead—Lower Columbia River Chinook (*Oncorhynchus tshawytscha*), Columbia River chum (*Oncorhynchus keta*), and Lower Columbia River steelhead (*Oncorhynchus mykiss*)—within the Washington Lower Columbia Management Unit (April 15, 2005). National Marine Fisheries Service (NMFS).

NMFS (National Marine Fisheries Service). 2005b. 2005 Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000-2004. NMFS, Northwest Region, Seattle, WA.

NMFS (National Marine Fisheries Service). 2006. 2005 Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000-2005. NMFS, Northwest Region, Seattle, WA.

NMFS (National Marine Fisheries Service). 2007. 2007 Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000-2006. NMFS, Northwest Region, Seattle, WA. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm.

NOAA Fisheries. 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Protected Resources Division, Portland, Oregon.

NOAA Fisheries. 2006. Columbia River estuary recovery plan module. NMFS, Protected Resources Division, Portland, Oregon.

Oregon Department of Environmental Quality (ODEQ). 2004. Sandy River Basin Total Maximum Daily Load (TMDL). Draft Report.

PFMC (Pacific Fishery Management Council). 2005. Final Environmental Assessment/ Regulatory Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. http://www.pcouncil.org/groundfish/gffmp/gfa11.html

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

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

R2 Resource Consultants. 1998. Spawning gravel survey of the lower Bull Run River, Oregon. Revised draft report prepared for the Portland Bureau of Water Works. May 27, 1998.

Reynolds, J.B. and F.M. Holliman. 2005. Guidelines for assessment and reduction of electrofishing-induced injuries in trout and salmon. School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks.

Sandy River Basin Partners. 2005. Sandy River Basin Characterization Report. July 2005. http://www.sandyriverpartners.org/pdfs/SRBCR7-20-05.pdf

Sandy River Basin Watershed Council (SRBWC). 1999. Phase 1 Watershed Assessment for the Sandy River Basin. June 1999.

Sedell, J.R. and J. L. Frogatt. 1984. Importance of streamside forests to large rivers: The isolation of the Willamette River, Oregon, USA from its floodplain by snagging and streamside forest removal. International Vereinigung für Theoretische und Angewandte Limnologie Verhandlungen 22:1828-1834.

Sherwood, C. R., D. A. Jay, R. B. Harvey, P. Hamilton, and C. A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25:299–357.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448-457.

U.S Forest Service (USFS). 1996. Upper Sandy Watershed Analysis – Mt. Hood National Forest.

Wentz, D.A., Bonn, B.A., Carpenter, K.D., Hinkle, S.R., Janet, M.L., Rinella, F.A., Uhrich, M.A., Waite, I.R., Laenen, A. and Bencala, K.E. 1998, Water quality in the Willamette Basin, Oregon, 1991-95: U.S. Geological Survey Circular 1161 (updated June 25, 1998).

Wilber, D.H. and D.G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21:855-875.

Zabel, R.W., M.D. Scheuerell, M./M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20:190-200.