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

Refer to NMFS No.:
2007/08174

July 22, 2008

Sean Sheldrake
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 97101-3140

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the U.S. Environmental Protection Agency and Port of Portland Terminal 4 Superfund Phase I of the Removal Action, Willamette River (HUC 17090012), Multnomah County, Oregon

Dear Mr. Sheldrake:

The enclosed document contains a biological opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the proposed authorization of the Superfund Phase 1 Removal Action by the U.S. Environmental Protection Agency (EPA) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq*. (CERCLA or Superfund). In this Opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of seven species of ESA-listed fishes that reside in the Willamette River: Upper Willamette River (UWR) spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Lower Columbia River (LCR) Chinook salmon, LCR steelhead (*O. mykiss*), UWR steelhead, Columbia River (CR) chum salmon (*O. keta*), LCR coho salmon (*O. kisutch*), and green sturgeon (*Acipenser medirostris*).

Further, NMFS concludes that the proposed action will not result in the destruction or adverse modification of critical habitats designated for five of these species. At this time, critical habitat has not been proposed or designated for LCR coho salmon or green sturgeon.

NMFS also concludes that the proposed action is not likely to jeopardize the continued existence of seven species of ESA-listed salmonid fishes that reside in the Columbia River: Upper Columbia River (UCR) Chinook salmon, Snake River (SR) spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR Basin steelhead, UCR steelhead, Middle Columbia River steelhead, and SR sockeye salmon (*O. nerka*). The NMFS concludes that the proposed action will not result in the destruction or adverse modification of critical habitats designated for these species.

As required by section 7 of the ESA, an incidental take statement prepared by NMFS is provided with the Opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize incidental take associated with the proposed action. It also sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal agency and applicant, if any, must comply with to carry out the reasonable and prudent measures. Incidental take from actions by the action agency and applicant that meet these terms and conditions will be exempt from the ESA take prohibition.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. These conservation recommendations are an identical subset of the ESA terms and conditions. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendation, the EPA must explain why the recommendation will not be followed, including the scientific justification for any disagreements over the effects of the action and the recommendation.

If you have questions regarding this consultation, please contact Dr. Nancy Munn in the Willamette Basin Habitat Branch of the Oregon State Habitat Office, at 503-231-6269.

Sincerely,

for Michael Tehan

D. Robert Lohn
Regional Administrator

cc: Rob Neely, NOAA
Alex Cyril, ODEQ
Todd Alsbury, ODFW

Endangered Species Act-Section 7 Consultation
Biological Opinion

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

U.S Environmental Protection Agency and Port of Portland Terminal 4
Superfund Phase I of the Removal Action,
Willamette River (HUC 17090012), Multnomah County, Oregon

Lead Action Agency: U.S. Environmental Protection Agency

Consultation Conducted By: National Marine Fisheries Service
Northwest Region

Date Issued: July 22, 2008

Issued by: for Michael Tehan
D. Robert Lohn
Regional Administrator

NMFS No.: **2007/08174**

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INTRODUCTION

The biological opinion (Opinion) and incidental take statement portions 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.

The essential fish habitat (EFH) consultation 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 docket for this consultation is on file at the Oregon State Habitat Office in Portland, Oregon.

Background and Consultation History

The NMFS received a letter and a biological assessment (BA) on December 27, 2007, from the U.S. Environmental Protection Agency (EPA) requesting formal consultation under the ESA and MSA on the proposed authorization of the Port of Portland's (Port) Terminal 4 Superfund Phase 1 Removal Action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq*. (CERCLA or Superfund). The NMFS received additional information on March 4, 2008, and April 9, 2008. Terminal 4 is along the east bank of the Willamette River in the City of Portland, Oregon (Figure 1), downstream from the St. Johns Bridge and between river miles (RMs) 4 and 5.

The EPA concluded that the proposed action was "likely to adversely affect" Upper Willamette River (UWR) spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Lower Columbia River (LCR) Chinook salmon, LCR steelhead (*O. mykiss*), UWR steelhead, Columbia River (CR) chum salmon (*O. keta*), and LCR coho salmon (*O. kisutch*) (hereafter collectively referred to as "listed salmonids"). The EPA also concluded that the proposed action was "not likely to adversely affect" Upper Columbia River (UCR) Chinook salmon, Snake River (SR) spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR Basin steelhead, UCR steelhead, Middle Columbia River (MCR) steelhead, and SR sockeye salmon (*O. nerka*). The Opinion also addresses effects to critical habitat designated for all of the species listed above with the exception of LCR coho salmon; critical habitat has not been proposed or designated for LCR coho salmon. In the December 27, 2007, letter, the EPA did not provide information on, or make an effect determination for, green sturgeon (*Acipenser medirostris*).

Proposed Action

The proposed action includes permitting of all methods and actions described in the following paragraphs. This is a complex project and the following project description does not include all of the design details used to analyze the effects of the action. The Design Analysis Report (Anchor Environmental, April 9, 2008) prepared for the Port and the Water Quality Monitoring and Compliance Conditions Plan (Parametrix, March 5, 2008) prepared for EPA provide project details that NMFS used to complete this Opinion. Subsequent refinements to these documents are not likely to alter the effects analysis.

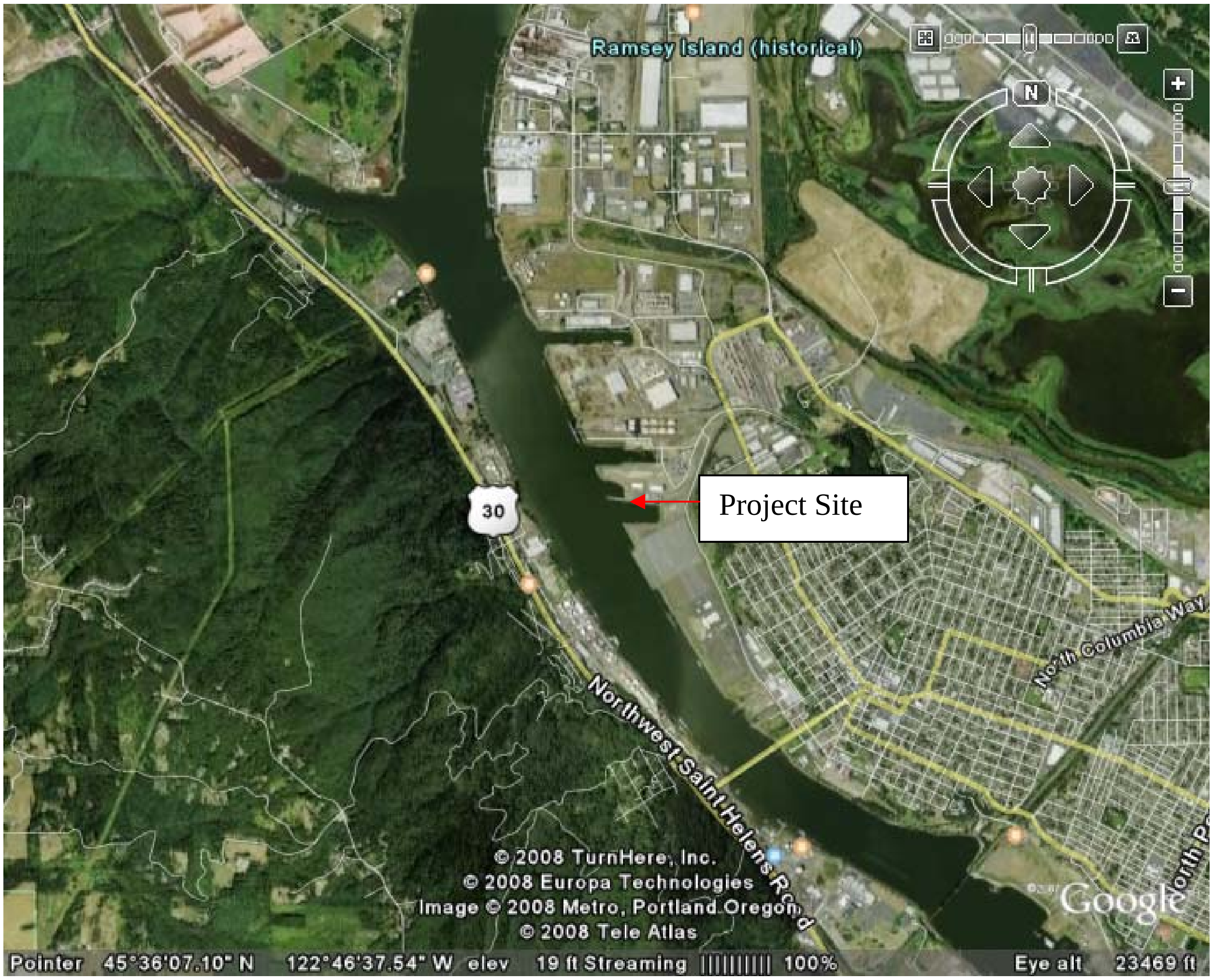
Background. The proposed action is Phase I of a removal action to address contaminated sediments at the Port's Terminal 4 between rivermiles (RMs) 4 and 5 on the Willamette River. The site is within the Portland Harbor Superfund Site, which is on the CERCLA National Priorities List. In 2006, EPA evaluated and selected a Non-Time Critical Removal Action for Terminal 4. This selection was detailed in the EPA Action Memorandum issued on May 11, 2006, and included a combination of monitored natural recovery, capping, and dredging with placement of contaminated sediments in a confined disposal facility (CDF) to be built on site. Since December 2006, the Port and EPA teams have been working through technical questions and issues associated with the design. Some of these issues are linked to the overall harbor-wide remedial investigation/feasibility (RI/FS) process, and therefore, EPA has agreed to revise the schedule for implementation of some portions of the Terminal 4 removal action.

At this time, EPA is requiring the Port to implement an abatement action during the 2008 in-water work window to reduce risks at Terminal 4. As a consequence, the removal action will be implemented in two phases. Phase I (the proposed action) is an abatement action planned for 2008. Phase II may include building the CDF, and will commence when the project is realigned with the harbor-wide RI/FS process. EPA will scope the Phase II action when the Phase I action is complete and the extent and type of contaminants remaining in Slip 3 and the Willamette River are defined. EPA is also waiting for the RI/FS process so the determination can be made whether a CDF is needed for placement of harbor-wide sediments. Therefore, consultation for Phase II will be conducted at a later date.

Phase I of the removal action will occur between July and October 31, 2008. EPA expects in-water work to last 4 weeks, and the entire project will last 6 weeks. Phase I includes:

1. Dredging and off-site disposal of sediments exhibiting the highest chemical concentrations, including sediments from Berth 411 and the area north of Berth 414.
2. Construction of a nearshore cap to isolate petroleum-based sediments from aquatic receptors and control a potential ongoing source to nearby areas. This is at the head of Slip 3.
3. Stabilization of a portion of the bank within Wheeler Bay to minimize contaminant migration to the river.
4. Dredging and off-site disposal of contaminated sediments from Berth 410.

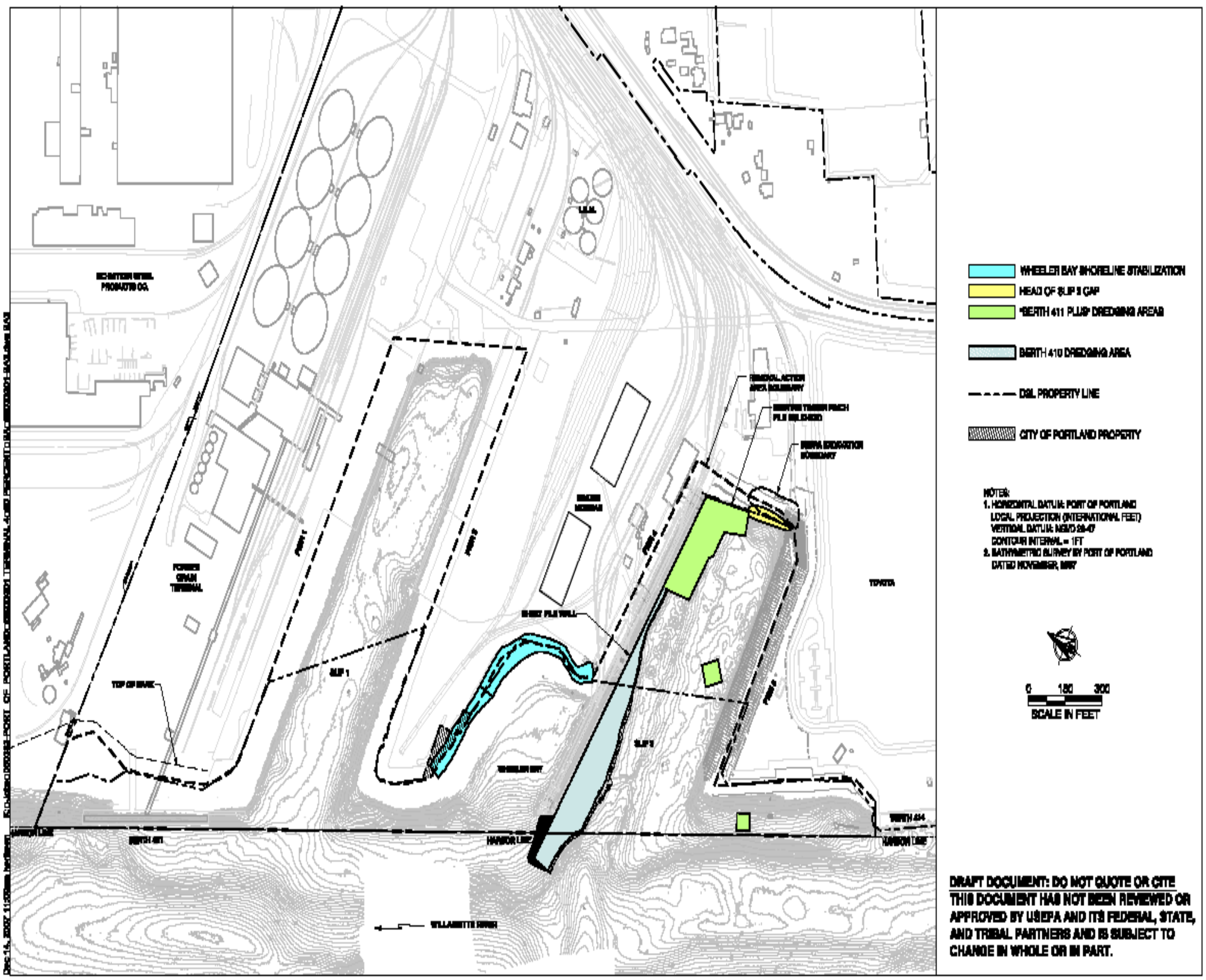
Figure 1. The Port of Portland's Terminal 4 site at RM 5 in the Willamette River.



<u>Dredging</u>. The highest-risk surface sediments (*i.e.*, surface sediments with probable effects concentration (PEC) exceedance ratios greater than 10) within the removal action area are located at the head of Slip 3 and along Berth 411, and within an area north of Berth 414 (Figure 2). The Port proposes to remove these contaminated sediments. The Port also proposes to dredge Berth 410 because dredging is necessary to maintain navigable water depths for deep draft cargo vessels. The majority of the proposed dredging footprint is within the EPA-identified removal action area. Sediment accumulation at Terminal 4 is sufficient to require dredging approximately every 2 years or less.

The Port proposes to dredge Berth 411 plus ("Berth 411 Plus") two additional areas (indicated in green on Figure 2) with high concentrations of chemicals of concern (COCs), and dispose of them at an EPA-approved upland landfill. Sediments in the dredging area will be removed down to dredge elevations established using existing and proposed cores located within the footprints. Elevations will be set to remove materials above a PEC exceedance ratio of 10 within the footprints. The current expected depth of removal is between 1 and 3 feet of sediment. The EPA expects dredge cuts to extend out to the boundary of the dredge prism with temporary side slopes of 3:1 (H:V) to 2:1. No dredging is proposed below -46 feet National Geodatic Vertical Datum (NGVD) within 50 feet of the sheetpile wall, because geotechnical analyses concluded that dredging below -46 feet NGVD within 50 feet of the sheetpile wall will compromise its stability. If newly-exposed surface concentrations are predicted to be higher than 20 times PEC, the Port may place a 6-inch sand layer over the area. The Port expects to remove approximately 7,400- to 8,400 cubic yards (cy) for this dredging, covering an area of 50,110 square feet. Existing and finished elevations for the three dredging areas are provided in Table 1.

Figure 2. Areas of Removal Action activities at Terminal 4.



ANCHOR

Figure 3
Summary of the Proposed Phase I Removal Action
Phase I of the Removal Action - Biological Assessment
Portland, Oregon

Table 1. Existing and finished dredging elevations at Terminal 4.

Elevation (NGVD)	Berth 411 Area Plus (50,110 square feet, 7,400 to 8,400 cy removed)			Berth 410
	Head of Slip 3	Adjacent to Pier 5	North of Berth 414	
Existing	-43 to -45 feet	-38 to -39 feet	-16 to -25 feet	-34 to -58 feet
Finished	-45 to -50 feet	-40 to -42 feet	-18 to -28 feet	-42 feet
Volume Removed	5,200 to 10,000 cubic yards			9,000 cubic yards
Area Affected	75,000 square feet			

Berth 410 is used to load soda ash for export. This berth requires dredging approximately every 2 years to ensure continued use by deep draft cargo vessels. Approximately 4,000 cubic yards of sediments was removed in 2005. The berth requires dredging now to remove the navigational impediments. This area generally does not coincide with the area with the highest concentrations of contaminants. The existing surface concentrations are generally less than 1 times the PEC for metals, except for one location where the metals are 4.3 times the PEC; the surface concentrations for polynuclear aromatic hydrocarbons (PAHs) range from 1.8 to 2.8 times the PEC. The Port predicts that the final (post-dredging) surface chemical concentrations should be less than or equal to the existing surface concentrations, except in the east end of the dredging area near Berth 411 that may have sediments with high concentrations of PAHs exposed after dredging.

A clamshell bucket suspended from a crane mounted on a barge will be used to dredge the sediment. No in-water rehandling will be conducted. The depth of the bucket will be monitored by markings on the cable holding the bucket, and the dredge will be equipped with a positioning computer system designed to monitor the amount of material moved from each location. The sediments will be placed in a flat-deck barge with watertight sideboards or in a bin-barge with one or multiple cells. The barge will be equipped to hold dredged material and water, and the material will be transported by barge or a combination of barge and truck/train to an EPA-approved landfill for disposal. The contractor will arrange and coordinate the offloading site, which is expected to be on the Columbia River, upstream of the confluence with the Willamette River. At the offloading site, the barge will either be offloaded and treated to reduce water in the sediment prior to placement into trucks or railcars, or will be offloaded directly into trucks or railcars for transportation to an approved landfill. Depending on the water content of the sediments, an additive may be added to the dredged material to absorb excess water that would be disposed of with the dredged material. Alternatively, excess water may be released into a municipal sanitary sewer system, and the trucks or rail cars may be lined with plastic sheeting to ensure that no release of water or sediments will occur during transportation.

The Port will perform post-dredge surveys to confirm the estimated amount of sediments removed from target areas, and to ensure that target depths are achieved.

Construction of Nearshore Cap. The head of Slip 3 is the site of a historical petroleum seep, and the Port has taken remedial action to minimize this source. However, petroleum-contaminated sediments remain in the water below 3 feet NGVD. The Port proposes to stabilize these sediments with a rock cap. The Port will construct a wedge against the outer edge of the existing wood bulkhead. The wedge will be a 12-inch layer containing 70 cy of fine to medium grain sand overlain by approximately 220 cy of riprap. This wedge will cover approximately 1,500 square feet.

After the bulkhead is stabilized, the Port will work upslope (behind) the bulkhead. The Port will remove the existing riprap and filter blanket to expose the existing sand and organoclay unit. Sandy gravel mixed with organoclay will be placed against the existing sand fill/organoclay unit and on the slope down toward the timber bulkhead. The sandy gravel mix will be isolated with a layer of filter material, and then a layer of armor material placed on top. Approximately 435 cy of material, including 100 cy of filter material, 85 cy of sandy gravel and 250 cy of rock will be placed over the currently armored area of 6,100 square feet. The placement will start at lower elevations, working to higher elevations.

Cap material will be placed mechanically either from the upland or from a barge using a clamshell bucket. The clamshell will be used for areas below the existing timber bulkhead. For each lift, the bucket will be cracked above the water surface while moving side to side to spread the material, and with sufficient control to meet the design thickness. Following placement of the cap, the Port will take a bathymetric survey of capped aquatic areas. Excavated riprap material that is contaminated (approximately 200 cy) will either be loaded directly to a barge, or contained on-site in a stockpile and then loaded to a truck or barge for transport to an appropriate landfill.

Due to the physical configuration of Slip 3 (deep water perpendicular to the river) and potential vessel traffic in the dredging area, the Port considers operational controls (as opposed to silt curtains, etc.) the most effective measures for control of turbidity during capping.

Wheeler Bay Shoreline Stabilization. The Port proposes to stabilize the shoreline of Wheeler Bay through redgrading the surface, planting and placement of features to help with stabilization, and placing of armor material in areas where the potential for erosion is high due to steepness or proximity to erosion-generating forces.

Wheeler Bay is a potential contaminant source to the nearshore sediments because of contaminants (PAHs, metals, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD)) and the potential for erosion. This Phase I action only addresses contaminated sediment in Wheeler Bay above +10 feet NGVD, partially due to a lower likelihood of recontamination. Contaminated sediment below this elevation will be addressed in Phase II of the removal action.

The bank excavation during regrading will be limited to the area 40 feet from the center of the existing rail alignment or a maximum distance of 25 feet from the top of the bank. Regrading of the contaminated sediment/soil will occur between elevations +30 feet NGVD to +10 feet NGVD and will occur in the dry. Grading and excavation will occur over 43,300 square feet, approximately half of which will need to be cleared and grubbed to removed concrete or other debris.

Once graded, 4,300 cy of material will be placed; there will be 2,000 cy of gravelly sand between elevations +30 and +10 feet NGVD and a final surface treatment of either rock armor (1,000 cubic yards over 13,300 square feet) or coir erosion control blanket (30,000 square feet) between elevations +15 to +20 feet NGVD. The armor material will stabilize steep slopes and areas subject to erosion generated by river flow and vessel-induced waves. Approximately half of the 13,300 square feet to be covered by armor currently has some form of rock.

The Port will install live willow stakes in a band approximately 5 feet wide along the shoreline between elevations +15 to +20 feet NGVD, covering approximately 10,800 square feet. The Port will install a 2-foot layer of high-quality, natural, imported topsoil or a manufactured topsoil mix in areas where willow live stakes will be planted. The Port will place 4 to 6 inches of mulch on top of the topsoil, and install a temporary below-ground irrigation system and keep it available until the willows are established. The Port will also hydroseed in a jute mat in a band between elevations +20 to +30 feet NGVD, covering approximately 13,000 square feet.

The Port will install large wood along the shoreline of Wheeler Bay between elevations of +10 to +15 feet NGVD, within a 19,500 square foot area.

The Port will use trackhoes and bulldozers to clear, grub and regrade the shoreline area. This will be done in the dry. Excess material will be stockpiled and taken to an appropriate landfill for disposal. Construction equipment will not enter the water, and erosion control measures will be implemented.

Habitat Improvements. The Port will plan, carry out, and manage compensatory mitigation activities using performance standards and criteria described in 40 CFR Part 230 to compensate for the degradation or loss of 0.33 acres of shallow-water habitat and other aquatic resources that will be adversely affected by the proposed removal action. Among other things, the compensatory mitigation plan will be based on: (1) Measurable, enforceable, ecological performance standards, including a mitigation ratio of 1.5:one to offset resource losses due to the time lag between permitted impacts and completion of the compensatory mitigation actions; (2) regular monitoring to ensure completion; (3) assurances of long-term protection of compensation sites; (4) financial assurances; and (5) identification of the parties responsible for specific project tasks. The Port will submit this Plan to NMFS for approval or disapproval within 2 years of the start of operations, and complete all actions necessary to mitigate the adverse effects of operations within 5 years of plan approval.

The Port will also place sand and gravel over the riprap surface of the Wheeler Bay bank stabilization and cap to create a more natural habitat. The Port recognizes that the long-term viability of sand placement over a riprap surface depends on site-specific conditions such as wave action, the shape of the shoreline, nearby river activities, and river dynamics. The Port will place the sand at this location because the Wheeler Bay conditions may be conducive to sand staying in place. The Port will monitor the area as a pilot project to determine whether the site-specific conditions are conducive to maintaining a sand habitat layer over the riprap. If monitoring demonstrates that a sandy surface can be maintained long-term, this may be considered by NMFS and EPA when determining the appropriate mitigation project for the Wheeler Bay bank stabilization and cap.

Construction Sequencing. Most of the work at the head of Slip 3 and all of the Wheeler Bay work will occur from land. Within Slip 3, the placement of armor in the water at the bulkhead will occur from a barge. The dredging work will occur from the water independent of the capping and shoreline stabilization work.

The EPA expects the Slip 3 cap work to require 2 weeks to complete, and will occur simultaneously with the dredging. The EPA also expects the dredging to require 3 to 4 weeks, assuming the contractor can work 12 hours per day, 6 days per week. The Wheeler Bay shoreline stabilization work will begin after the Slip 3 work is complete, and will take about 4 weeks to complete. The EPA expects the entire project to take 6 weeks to complete.

Monitoring. The Port will monitor to evaluate short-term impacts of construction and the effectiveness of the conservation measures.

1. The Port will monitor water quality during dredging, capping and offloading, as described in the Water Quality Monitoring and Compliance Conditions Plan (Parametrix 2008).
2. The Port will conduct bathymetric and/or land-based surveys after dredging and capping to confirm specified elevations are achieved.
3. The Port will monitor the loading and unloading areas. The Port will prepare a dredged and stockpiled material handling plan that will include best management practices (BMPs) that will be implemented to minimize the potential for off-site tracking of contaminated sediment. Monitoring activities will verify the effectiveness of the BMPs.
4. The Port will conduct long-term monitoring at the head of Slip 3 to verify the physical integrity of the cap and to ensure the cap functions as designed.
5. The Port will monitor Wheeler Bay by conducting inspections to evaluate the physical integrity of the stabilized area, to check for erosion, and to monitor the establishment of vegetation and the stability and presence of large wood as designed.

Conservation Measures. The Port proposes to incorporate the following to minimize the effects of the proposed action. These measures are a subset of measures proposed in the biological assessment.

1. All work will occur during the summer in-water work window of July 1 through October 31 of 2008.
2. The Port will use a dredge sequence strategy to minimize sediment with higher contamination levels from dispersing into adjacent areas. Dredging will begin at the head of Slip 3 and work towards the mouth. Slopes will be dredged beginning with the highest elevation and working toward the lowest elevation. Slopes will not be oversteepened.
3. The potential for scour will be limited by controlling contractor vessel draft and movements.
4. During transport and handling of sediment, adequate containment measures will be used to minimize spillage.
5. The Port will require the contractor to conduct a surface debris survey prior to dredging.
6. The Port will use a geographical information system (GPS) system to ensure material removal from the correct locations.

7. The dredge bucket will be swung directly to the haul barge after it breaks the surface, using the minimal swing distance. The contractor will not pause the bucket as it breaks the surface of the water.
8. The Port will not allow bottom or beach stockpiling of dredged material.
9. The Port will not overfill the bucket, and will not take multiple bites with the clamshell bucket.
10. The Port will not allow the barge to be filled beyond 85 percent capacity.
11. The Port will not allow material to leak from the bins or overtop the walls of the barge.
12. During offloading, the Port will use metal spill aprons, upland spill control curbing and collection systems, and other spill control measures. If a bucket is used, the Port will use a dribble apron. The Port will not allow material to re-enter the river at the off-loading facility.
13. The Port will not create or discharge any water.
14. The Port will place cap materials in a controlled and accurate manner, slowly releasing the material from a clamshell bucket, starting at lower elevations and working toward higher elevations.
15. Multiple means will be used to verify adequate coverage during and following cap placement.
16. Cap materials will be imported, clean granular material.
17. Surface booms, oil-absorbent pads, and similar materials will be on site for any sheens that may occur on the surface of the water during construction.
18. No construction equipment will enter the water during the shoreline stabilization activities in Wheeler Bay, and erosion control measures will be in place.
19. The Port will install a passive fish deterrent system prior to dredging that is intended to discourage juvenile salmonids from entering Slip 3 during dredging and construction. The system will consist of a leader net that is intended to guide fish migrating downstream away from the mouth of Slip 3.

NMFS relied on the foregoing description of the proposed action, including all stated minimization measures, to complete this consultation. To ensure that this consultation remain valid, NMFS requests that the action agency or applicant keep NMFS informed of any changes to the proposed action.

Action Area

‘Action area’ means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The Port’s Terminal 4 is between RMs 4 and 5 along the east bank of the Willamette River. The Port has not chosen a sediment disposal facility, but will likely use one of the several subtitle D landfills upstream from Terminal 4 on the Columbia River. No in-water work or discharge of any material is proposed for the Columbia River. For this consultation, the action area is defined to include Terminal 4, the sediment transport corridor, and the offloading area. Based on a worst-case scenario for dispersal of sediments and associated contaminants, the action area extends from 0.5 miles upstream of Terminal 4, Slip 3, (RM 5.5) downstream to the mouth of the Willamette River, and upstream on the Columbia River to the offloading location, to include an area 0.25 mile upstream from the location.

The listed salmonids described in Table 2 use the action area for adult migration, and juvenile rearing and migration. The action area is designated EFH for Chinook salmon and coho salmon (PFMC 1999), and is an area where environmental effects of the proposed action may adversely affect EFH of those species.

Table 2. Federal Register notices for final rules that list threatened and endangered species, designate critical habitats, or apply protective regulations to listed species considered in this consultation. (Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered.)

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River spring-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Chum salmon *(O. keta*)			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon (*O. kisutch*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	Not applicable	6/28/05; 70 FR 37160
Sockeye salmon (*O. nerka*)			
Snake River	E 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Snake River Basin	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Green sturgeon (*Acipenser medirostris)*			
Southern Distinct Population[1]	T 4/7/06; 71 FR 17757	Not applicable	Not applicable

ENDANGERED SPECIES ACT

The ESA establishes a national program to conserve threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a) (2) of the ESA requires Federal agencies to consult with U.S. Fish and Wildlife Service, 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.

[1] A 4(d) rule allowing for "take" of green sturgeon has not yet been issued.

Biological Opinion

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, the effects of the action, and cumulative effects (50 CFR 402.14(g)). From this analysis, NMFS determined whether effects of the action were likely, in view of existing risks, 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 area of the critical habitat considered in this consultation, the environmental baseline in the action area, the likely effects of the action on the function and conservation role of the affected critical habitat, and cumulative effects. The 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).

Status of the Species and Critical Habitat

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

Status of the Species. The NMFS reviews the condition of the listed species affected by the proposed action using criteria that describe a 'viable salmonid population' (VSP) (McElhany *et al*. 2000). Attributes associated with a VSP include abundance, productivity, spatial structure, and genetic diversity that maintain its capacity to adapt to various environmental conditions and allow it 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 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 a result of dams that 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 (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 2005, NMFS 2006). The 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.

Most of the LCR Chinook salmon are part of the Clackamas fall run population. Based on a recent viability status report (McElhany *et al*. 2007), there are no reliable abundance data for this population, but estimates put the population in the "extirpated or nearly so" persistence category based on the minimum abundance threshold. There is no abundance or productivity evidence supporting the existence of a viable natural-origin population in the Clackamas. This population is at significant risk based on the criteria for diversity, spatial structure, and abundance and productivity, and 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 River and in the Columbia River mainstem and estuary would likely have a significant effect on fall Chinook salmon (McElhany *et al*. 2007).

UWR spring-run Chinook salmon. The UWR spring-run Chinook salmon includes seven populations of native spring-run populations above Willamette Falls and in the Clackamas River. All the populations are in a single stratum since they share a similar life history pattern (spring run) and a single ecozone (McElhany *et al*. 2003, Myers *et al*. 2006).

Numbers of spring Chinook salmon in the Willamette River basin are extremely depressed (McElhany *et al*. 2007). Historically, the spring run of Chinook may have exceeded 300,000 fish (Myers *et al*. 2003). The current abundance of wild fish is less than 10,000 fish, and only two populations (McKenzie and Clackamas) have significant natural production. The UWR Chinook have been adversely affected by the degradation and loss of spawning and rearing habitat (loss of 30 to 40%) associated with hydropower development, and interaction with a large number of natural spawning hatchery fish. Other limiting factors include altered water quality and temperature, lost and degraded floodplain connectivity and lowland stream habitat, and altered streamflow in the tributaries (NMFS 2005, NMFS 2006). The NMFS (2007) identified degraded flooplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, water quality, fish passage, and hatchery impacts as the major factors limiting recovery of this species.

McElhany *et al*. (2007) analyzed the population criteria (diversity, spatial structure, and abundance and productivity) for UWR Chinook salmon and found that the risk of extinction is high. The Clackamas population exhibited the lowest extinction risk. However, five of the seven populations were clearly in the high risk category, and thus the ESU can be characterized as having a high risk of extinction.

Chinook salmon generally spawn and rear in mainstem reaches of large river systems such as the Willamette River and the Clackamas River. Juvenile Chinook salmon that have emerged from spawning sites in the upper Willamette River watershed use the lower mainstem Willamette River and Columbia Slough through Portland for temporary rearing as they migrate to the ocean.

CR chum salmon. The Oregon portion of the CR chum ESU historically contained 8 populations of CR chum salmon (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 populations are considered extirpated or nearly so. All of the Oregon chum salmon 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 2005, NMFS 2006). The 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.

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 rivers 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 Clackamas 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). Spatial structure scores are reduced because of significant habitat degradation in lower basin tributaries such as Johnson and Kellogg creeks, and other urbanized portions of the lower Willamette River, Multnomah Channel and Sauvie Island. This habitat loss has reduced the population's diversity score. Despite this, the Clackamas is the only population in Oregon's portion of the species that is most likely in the viable category, and thus the risk of extinction for coho in Oregon remains high (McElhany *et al.* 2007).

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 populations of winter steelhead and one population of summer steelhead exist in Oregon (McElhany *et al.* 2007). The population most likely present in the action area is the Clackamas River population, which is part of the Cascade winter stratum.

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

The Clackamas population is at low risk for abundance and productivity, although the future impacts of human population growth and climate change add a degree of uncertainty (McElhany *et al.* 2007). Loss of accessibility is limited to higher order streams, primarily due to watershed development in the lower basin. The upper Clackamas River basin contains most of the historically-productive habitat, and most of that habitat is of high quality today. For the species, the overall risk classification for Oregon LCR steelhead is moderate, with the Clackamas population at the lowest risk.

Factors limiting recovery for LCR steelhead are degraded floodplain and stream channel structure and function, reduced access to spawning/rearing habitat, altered streamflow in tributaries, excessive sediment and elevated water temperatures in tributaries, and hatchery impacts (NMFS 2005, NMFS 2006). The 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.

UWR steelhead. This species consists of four populations: the Molalla, North Santiam, South Santiam, and Calapooia. All populations of UWR steelhead migrate through and rear in the action area. These populations are depressed from historical levels, with adverse impacts from the alteration and loss of spawning and rearing habitat associated with hydropower development. Based on recent analyses of the population criteria, McElhany *et al*. (2007) concluded that the species risk of extinction is moderate, with the highest risk category being genetic diversity.

Habitat loss, hatchery steelhead introgression, and harvest are the major contributors to the decline of this species. Willamette Falls (RM 26.5) is a known migration barrier. Winter-run steelhead and spring-run Chinook salmon historically occurred above the falls, whereas summer-run steelhead, fall-run Chinook, and coho salmon did not. Detroit and Big Cliff dams have cut off access to 335 miles of spawning and rearing habitat in the North Santiam River. In general, habitat in this species has become substantially simplified since the 1800s by removal of large wood to increase the river's navigability.

NMFS (2007) identified degraded floodplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, streamflow, fish passage, and predation/competition and disease as the major factors limiting recovery of this species.

UCR spring-run Chinook salmon. Based on redd count data series, spawning escapements for the three populations identified by (Ford *et al.* 2001) for this species (Wenatchee, Entiat, and Methow rivers) have declined an average of 5.6%, 4.8%, and 6.3% per year, respectively, since 1958. Adult returns increased substantially in 2000 and 2001 compared to lows in 1996 to 1999, but the short-term trends analyzed by the biological review team (BRT) for 1996-2001 remained negative (Good *et al.* 2005).

Based on 1980-2000 returns, the average annual growth rate for this species is estimated as 0.85 (a growth rate of less than 1.0 is non-viable) (Good *et al.* 2005). Assuming that population growth rates were to continue at 1980-2000 levels, UCR spring-run Chinook salmon populations are likely to have very high probabilities of decline within 50 years (87 to 100%) (Good *et al.* 2005), and the species is likely to go extinct.

Current abundances for populations in the UCR Chinook species are well below the minimum thresholds defined in the draft viability criteria of the Interior Columbia River Basin Technical Recovery Team (ICTRT). Actually achieving abundance and productivity criteria will require a sustained and significant response by the populations (ICTRT 2006).

The risk estimates reflect strong ongoing concerns regarding abundance and growth rate/productivity (high to very high risk) and somewhat less (but still significant) concerns for spatial structure (moderate risk) and diversity (moderately high risk) (Good *et al.* 2005).

The NMFS identified mortality in the Columbia River hydropower system, tributary riparian degradation and loss of in-river wood, altered tributary floodplain and channel morphology, reduced tributary stream flow and impaired passage, and harvest impacts as the major factors limiting recovery of this species (NMFS 2007).

SR spring/summer run Chinook salmon. The ICTRT identified 32 populations in 5 major population groups (MPGs) (Upper Salmon River, South Fork Salmon River, Middle Fork Salmon River, Grande Ronde/Imnaha, Lower Snake Mainstem Tributaries) for this species. Historical populations above Hells Canyon Dam are extinct (ICTRT 2003).

Although direct estimates of historical annual SR spring/summer run Chinook salmon returns are not available, returns may have declined by as much as 97% between the late 1800s and 2000.

According to Matthews and Waples (1991), total annual SR spring/summer run Chinook salmon production may have exceeded 1.5 million adult fish in the late 1800s. Total (natural plus hatchery origin) returns fell to roughly 100,000 spawners by the late 1960s (Fulton 1968) and were below 10,000 by 1980. Between 1981 and 2000, total returns fluctuated between extremes of 1,800 and 44,000 fish. The 2001 and 2002 total returns increased to over 185,000 and 97,184 adults, respectively. However, over 80% of the 2001 return and over 60% of the 2002 return originated in hatcheries. Despite the recent increases in total returns of SR spring/summer run Chinook salmon returns, current abundance levels for populations in the Snake River Chinook species are well below the minimum thresholds defined in the ICTRT viability criteria (ICTRT 2006). Actually achieving abundance and productivity criteria will require a sustained and significant response by the populations (ICTRT 2006).

The NMFS identified mortality from the mainstem lower Snake River and Columbia River hydropower systems, reduced tributary stream flows, altered tributary channel morphology, excessive sediment in tributaries, degraded tributary water quality, and harvest- and hatchery-related adverse effects as the major factors limiting recovery of this species (NMFS 2007).

SR fall-run Chinook salmon. The BRT found moderate risk to the species for productivity and moderately high risks for abundance, spatial structure, and diversity (Good *et al.* 2005). The paragraphs below summarize information from BRT, the ICTRT, and other sources on the status of SR fall-run Chinook salmon in terms of those four viability components.

The estimated annual return for the period 1938 to 1949 was 72,000 fish, and by the 1950s, numbers had declined to an annual average of 29,000 fish. Numbers of SR fall-run Chinook salmon continued to decline during the 1960s and 1970s as approximately 80% of their historical habitat was eliminated or severely degraded by the construction of the Hells Canyon hydropower complex (1958 to 1967) and the lower Snake River dams (1961 to 1975). Counts of natural-origin adult SR fall-run Chinook salmon at Lower Granite Dam were 1000 fish in 1975, and ranged from 78 to 905 fish (with an average of 489 fish) over the ensuing 25-year period through 2000 (Good *et al.* 2005). Numbers of natural-origin SR fall-run Chinook salmon have increased over the last few years, with estimates at Lower Granite dam of 2,652 fish in 2001 (Good *et al.* 2005), 2,095 fish in 2002, and 3,895 fish in 2003. Despite the recent increases in total returns of SR fall Chinook salmon, current abundance levels for populations in the Snake River Chinook species are well below the minimum thresholds defined in the ICTRT viability criteria (ICTRT 2006).

The NMFS identified mortality in the mainstem lower Snake River and Columbia River hydropower systems, degraded water quality, reduced spawning/rearing habitat due to the lower Snake River hydropower system, and harvest as the major factors limiting recovery of this species (NMFS 2007).

SR Basin steelhead. The SRB steelhead species does not include resident forms of *O. mykiss* (rainbow trout) co-occurring with these steelhead. The ICTRT (2003) identified 23 populations in six MPGs in this species.

Annual return estimates are limited to counts of the aggregate return over Lower Granite Dam, and spawner estimates for the Tucannon, Grande Ronde, and Imnaha rivers. The 2001 return over Lower Granite Dam was substantially higher than the low levels seen in the 1990s, but the recent 5-year mean abundance was approximately 29% of the interim recovery target level. Abundances in surveyed sections of the Grande Ronde, Imnaha and Tucannon rivers improved in 2001. However, recent 5-year abundance and productivity trends (through 2001) were mixed. The majority of long-term population growth rate estimates for the nine available series were below replacement. The majority of short-term population growth rates (through 2001) were marginally above replacement or well below replacement, depending upon the assumption made regarding the effectiveness of hatchery fish in contributing to natural production (Good *et al.* 2005). In spite of the recent increases in SRB steelhead returns, the BRT believed that the species remains at moderate risk for abundance, productivity, and diversity. The BRT was also concerned about the predominance of hatchery-origin fish in this species, the inferred displacement of naturally-produced fish by hatchery-origin fish, and potential impacts on species diversity (Good *et al.* 2005).

Cooney (2004) reported continuing high returns of natural-origin SRB steelhead (both A- and B-run fish) during 2002 and 2003, compared to those observed during much of the 1990s. In their preliminary report, Fisher and Hinrichsen (2004) estimated that the geometric mean of the natural-origin run was 37,784 fish during 2001 to 2003, a 253% increase over the 1996 to 2000 period (10,694 fish). The slope of the population trend increased 9.3% (from 1.00 to 1.10) when the counts for 2001 to 2003 were added to the 1990 to 2000 data series. These data indicate that, at least in the short term, the natural-origin run has been increasing.

The NMFS identified mortality from the mainstem Columbia River hydropower system, reduced tributary stream flows, altered tributary channel morphology, excessive sediment in tributaries, degraded tributary water quality, and harvest and hatchery related adverse effects as the major factors limiting recovery of this species (NMFS 2005).

UCR steelhead. This species is currently limited to four extant populations in one MPG. The MPG historically included a fourth population in the Crab Creek drainage, which probably is functionally extinct. Two additional MPGs likely existed, but access to the tributaries that supported them is now cut off by Grand Coulee and Chief Joseph dams (ICTRT 2006).

While total abundance within this species has been relatively stable or increasing, it appears to be occurring only because of major hatchery supplementation programs. The major concern for this species is the replacement failure of natural stocks. The BRT members were also strongly concerned about the problems of genetic homogenization due to hatchery supplementation, apparent high harvest rates on steelhead smolts in rainbow trout fisheries, and the degradation of freshwater habitats within the region, especially the effects of livestock grazing, irrigation diversions and hydroelectric dams (Good *et al.* 2005).

The most serious risk identified by Good *et al.* (2005) was growth rate/productivity, estimated to be high to very high. Other VSP factors were also relatively high, ranging from moderate for spatial structure to moderately high for diversity. The years 1999-2001 have seen an increase in the number of naturally-produced fish. However, the recent mean abundance in the major river basins is still only a fraction of interim recovery targets. Furthermore, overall adult returns are still dominated by hatchery fish, and detailed information is lacking regarding productivity of natural populations. The ratio of naturally-produced adults to the number of parental spawners (including hatchery fish) remains low for UCR steelhead. The BRT did not find data to suggest that the extremely low replacement rate of naturally-spawning fish (estimated adult:adult ratio was only 0.25-0.3 at the time of the last status review update) has improved substantially (Good *et al.* 2005).

The UCR steelhead species continues to have problems including genetic homogenization from hatchery supplementation, high harvest rates on steelhead smolts in rainbow trout fisheries, and the degradation of freshwater habitats (Good *et al.* 2005).

The NMFS identified mortality from the mainstem Columbia River hydropower system, reduced tributary stream flows, tributary riparian degradation and loss of in-river wood, altered tributary floodplain and channel morphology, excessive sediment, and degraded tributary water quality as the major factors limiting recovery of this species (NMFS 2007).

MCR steelhead. The MCR steelhead do not include resident forms of *O. mykiss* (rainbow trout) co-occurring with these steelhead. The ICTRT (2003) identified 15 populations in four MPGs (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla River, and Umatilla River, and the Yakima River) and one unaffiliated independent population (Rock Creek) in this species. There are two extinct populations in the Cascades Eastern Slope MPG: the Deschutes River above Pelton Dam, and the White Salmon River.

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

The 5-year average return (geometric mean) of natural MCR steelhead for 1997 to 2001 was up from previous years' basin estimates (Good *et al.* 2005). Despite recent increases in MCR steelhead returns, the BRT believed that the species remains at moderate risk for all four VSP parameters (Good *et al.* 2005).

The NMFS identified mortality in the Columbia River hydropower system, reduced stream flow in tributaries, altered tributary channel morphology, excessive sediment in tributaries, degraded tributary water quality, and harvest and hatchery related adverse effects as the major factors limiting recovery of this species (NMFS 2005).

SR sockeye salmon. Five lakes in Idaho's Stanley Basin historically contained sockeye salmon: Alturas, Pettit, Redfish, Stanley and Yellowbelly (Bjornn *et al*. 1968). Today, they only occur in Redfish Lake. Sockeye counts at the Redfish Lake weir in 1985, 1986, and 1987 were 11, 29, and 16, respectively (Good *et al.* 2005). The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, 345 captive brood program adults that had migrated to the ocean returned to the Stanley Basin.

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

The NMFS identified reduced tributary stream flow, impaired tributary passage and blockages to migration, and mortality from the Columbia River hydropower system as the major factors limiting recovery of this species (NMFS 2005).

General salmon and steelhead usage of the action area. LCR and UWR steelhead and Chinook salmon, and LCR coho salmon adults migrate through the lower Willamette River on their way to and from spawning grounds in tributaries of the Willamette River. Steelhead are not known to spawn in the mainstem of the Willamette River in the vicinity of the City of Portland (City). Chinook salmon may spawn not far upstream from the City boundary, perhaps in the lower end of the Clackamas River or in the Willamette River just below Willamette Falls, where suitable gravel-type substrate for spawning may occur, and perhaps in Johnson Creek. Coho salmon go up the Clackamas River to spawn. Recent observations of coho salmon juveniles in Miller Creek (tributary at RM 3 on the Willamette River) and in Johnson Creek by City biologists suggest that coho spawning may occur in small tributaries in the City. Chum salmon may use the first few miles of the Willamette River for juvenile rearing, but any occurrences would be very rare.

Adult Chinook and steelhead have been documented holding in the lower mainstem Willamette River for a period of time before moving upriver. Adults migrate upstream to spawn during early spring (spring Chinook), early fall (coho), and late fall through winter (steelhead), and spawn in early to mid-fall (Chinook and coho) and spring (steelhead). Adult steelhead have been documented entering the mouth of the Clackamas River with a darkened coloration, indicating that they have been in freshwater for some time.

Fry emerge from the gravel in late spring/early summer, rear in the natal stream for 1 to 3 years, and outmigrate during spring and fall freshets. These juvenile steelhead, Chinook salmon, and coho salmon migrate to the Pacific Ocean via the Willamette River.

From May 2000 through July 2003, the Oregon Department of Fish and Wildlife (ODFW) and the City of Portland conducted a study of salmonids in the lower Willamette River (Friesen *et al*. 2005). Of the more than 5,000 juvenile salmonids collected during the study, over 87% were Chinook salmon, 9% were coho salmon, and 3% were steelhead. ODFW concluded that the Chinook salmon juveniles were largely spring-run stocks that rear in fresh water for a year or more before migrating to the ocean. Chinook salmon juveniles caught exhibited a bimodal distribution in length indicating the presence of both subyearlings and yearlings. Although at lower abundance, coho salmon juveniles also exhibited this bimodal distribution of yearlings and subyearlings.

The study's key finding is that the lower Willamette River is no longer appropriately considered simply a migration corridor. The presence of naturally-spawned Chinook salmon from November through July, as well as significant evidence of fish growth, contradicts a longstanding assumption that spring Chinook salmon primarily reared in their natal streams over the winter and migrated out of the Willamette River during the spring, and that, therefore, Chinook salmon were not present in the lower river outside of the spring migration period. In this study, juvenile Chinook salmon were present in every month sampled from May 2000 through July 2003. Juvenile salmon were captured more frequently during winter and spring than during other seasons. Coho salmon and steelhead were generally present only during winter and spring.

As in the Columbia River, yearling and older juvenile salmon and steelhead in the Willamette River tend to be found in mid-channel areas, whereas subyearling fish tend to be most abundant at nearshore sites (Dawley *et al*. 1986, Dauble *et al*.1989, Friesen *et al*. 2005). Off-channel habitats such as alcoves, lagoons, backwater areas, and secondary channels are more important areas for juvenile refuge and rearing than mid-channel areas (Friesen 2005, Vile *et al.* 2004). Friesen *et al*. 2005 found significantly higher stomach fullness for juvenile Chinook salmon captured in off-channel sites in the lower Willamette River than at sites in the main river channels. Some of the larger juveniles may spend extended periods of time in off-channel habitat.

Mean migration rates of juvenile salmon ranged from 2.7 km/day for steelhead to 8.6 km/day for subyearling Chinook salmon. Residence time in the lower Willamette River ranged from 4.9 days for Chinook to 15.8 days for steelhead. Catch rates of juvenile salmon were significantly higher at sites composed of natural habitat (*e.g.*, beach, alcoves).

During the ODFW study (Friesen 2005), there were a few cases where yearling salmon did exhibit some form of habitat preference (coho salmon preferred beach habitat and rock outcrops and avoided riprap and artificial fill; abundance of all species was low at seawall sites). However, yearling Chinook and steelhead were not strongly associated with the shoreline and did not exhibit obvious preferences for the different habitat types in the lower river. Juvenile salmon tended to move along the east bank of the river.

Green sturgeon. Green sturgeon is a widely-distributed and marine-oriented species found in nearshore waters from Baja California to Canada (NMFS 2007). Their estuarine/marine distribution and the seasonality of estuarine use range-wide are largely unknown. Green sturgeon are anadromous, spawning in the Sacramento, Klamath and Rogue rivers in the spring (NMFS 2007). Spawning occurs in deep pools or holes in large, turbulent river mainstreams. Specific characteristics of spawning habitat are unknown but likely includes large cobbles, but can range from clean sand to bedrock (NMFS 2007).

There are two distinct population segments (DPS) defined for green sturgeon – a northern DPS (NDPS) with spawning populations in the Klamath and Rogue rivers and a southern DPS (SDPS) that spawns in the Sacramento River (NMFS 2007). The SDPS was listed as threatened in 2006. According to the listing final rule (71 FR 17757), the SDPS includes all spawning populations of green sturgeon south of the Eel River in California. The NDPS remains a species of concern. McLain (2006) noted that SDPS green sturgeon were first determined to occur in Oregon and Washington waters in the late 1950s when tagged San Pablo Bay green sturgeon were recovered in the Columbia River estuary (CDFG 2002). Preliminary work by Israel and May (2006) has determined that 80% or greater of green sturgeon in the Columbia River estuary during late-summer and early fall months were SDPS origin.

Green sturgeon congregate in coastal waters and estuaries, including non-natal estuaries, where they are vulnerable to capture in salmon gillnet and white sturgeon (*Acipenser transmontanus*) sport fisheries.

Sturgeon migrations are probably related to feeding and spawning (Beamis and Kynard 1997). They suggested that green sturgeon move into estuaries of non-natal rivers to feed. Green sturgeon captured during the sport season for white sturgeon could suggest they are feeding in the estuary. However, contradictory evidence in the form of empty stomach contents of green sturgeon captured in the Columbia River gillnet fishery suggests that these green sturgeon were not actively foraging in the estuary (Corps (2007).

Information from fisheries-dependent sampling suggests that green sturgeon only occupy large estuaries during the summer and early fall in the northwestern United States. Commercial catches of green sturgeon peak in October in the Columbia River estuary, and records from other estuarine fisheries (*i.e*., Willapa Bay and Grays Harbor, Washington) support the idea that sturgeon are only present in these estuaries from June until October (Moser and Lindley 2007). However, most green sturgeon taken are as by-catch in fisheries for salmonids, *Oncorhynchus* spp. and white sturgeon (Moyle 2002; Adams *et al*., 2002). Consequently, data from fisheries-dependent sampling may be a poor indicator of green sturgeon distribution in estuaries. Green sturgeon enter the Columbia River at the end of spring with their numbers increasing through June (Corps 2007). The greatest numbers are caught in the estuary in July through September. The majority of green sturgeon are caught in the lower reaches of the Columbia (29,132 from RM 1-20 and 8,086 from RM 20-52) based upon harvest information from 1981-2004 (Corps 2007). A few green sturgeon may be found as far upriver as Bonneville Dam, but there are no known spawning populations in the Columbia River and its tributaries (Corps 2007).

Because the presence of green sturgeon within the action area is extremely remote, NMFS has determined that the proposed action is "not likely to adversely affect" green sturgeon and they are not considered further in this Opinion.

Status of Critical Habitat. The NMFS reviews the status of critical habitat affected by the proposed action by examining the condition and trends of PCEs 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 (Tables 3 and 4).

Table 3. (PCEs of critical habitats designated for Pacific salmon and steelhead species considered in the Opinion (except SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon), and corresponding species life history events.

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
Estuarine areas	Forage, free of obstruction, natural cover, salinity, water quality, water quantity	adult sexual maturation, adult "reverse smoltification", adult upstream migration, holding, kelt (steelhead) seaward migration, fry/parr seaward migration, fry/parr smoltification, smolt growth and development, smolt seaward migration
Nearshore marine areas	forage, free of obstruction, natural cover water quantity water quality	adult sexual maturation, smolt/adult transition
Offshore marine areas	forage, water quality	adult growth and development

Table 4. PCEs of critical habitats designated for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon, and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site	**Site Attribute**	
Spawning and juvenile rearing areas	access (sockeye), cover/shelter, food (juvenile rearing), riparian vegetation, space (Chinook), spawning gravel, water quality, water temperature (sockeye), water quantity	adult spawning, embryo incubation, alevin development, fry emergence, fry/parr growth and development, fry/parr smoltification, smolt growth and development
Juvenile migration corridors	cover/shelter, food, riparian vegetation, safe passage space, substrate, water quality, water quantity, water temperature, water velocity	fry/parr seaward migration, smolt growth and development, smolt seaward migration
Areas for growth and development to adulthood	ocean areas – not identified	adult growth and development adult sexual maturation fry/parr smoltification Smolt/adult transition
Adult migration corridors	cover/shelter, riparian vegetation, safe passage, space substrate, water quality water quantity, water temperature, water velocity	adult sexual maturation, adult "reverse smoltification", adult upstream migration, Kelt (steelhead) seaward migration

The action area is within designated critical habitat for the affected species, except LCR coho salmon, for which critical habitat has not been proposed or designated. The PCEs potentially found at the project site are freshwater rearing and freshwater migration. The value of critical habitat for the species is limited by poor water quality, altered hydrology, lack of floodplain connectivity and shallow-water habitat, and lack of complex habitat to provide forage and cover.

The present condition of PCEs within designated areas and the human activities that have affected PCE trends are further described in the environmental baseline section below.

Environmental Baseline

The action area is within the lower Willamette River watershed between RM 5.5 and the confluence with the Columbia River, and upstream on the Columbia River to the off-loading site. The Willamette River watershed covers approximately 11,500 square miles in northwest Oregon, between the Coast and Cascade ranges. The river flows 187 miles from its headwaters to its mouth at the Columbia River. Most of the rainfall occurs in the fall, winter, and spring, with little rainfall during June, July, and August. The lowest river flow occurs during late summer. The 13 U.S. Army Corps of Engineers dams on tributary systems largely regulate flows in the mainstem Willamette River.

Significant changes have occurred in the watershed since the arrival of Europeans in the 1800s. The watershed was mostly forested land before the arrival of white settlers. Now, about half the basin is still forested. One-third of the basin is used for agriculture, and about 5% is urbanized or is in residential use. The river receives direct inputs from treated municipal wastes and industrial effluents. Nonpoint source pollution from agricultural, silvicultural, residential, urban and industrial land uses are also significant, especially during rainfall runoff. The industrial section of the Willamette River, including the action area, has been deepened and narrowed through channelization.

The Willamette River, from its mouth to Willamette Falls, is on the 2006 Oregon Department of Environmental Quality (ODEQ) 303(d) list as water quality limited for temperature (summer), bacteria, biological criteria (fish skeletal deformities), and toxics (mercury in fish tissue, dieldrin, aldrin, polycarbonated biphenyls (PCBs), DDT/ DDE, PAHs, manganese, iron, and pentachlorophenol. Results from ODEQ ambient monitoring data indicate that 68% of the values at RM 7, and 61% of the values at RM 13.2 collected during the summer exceed the temperature standard of 68°F. In the lower Willamette River, average turbidity tends to be highest in fall and winter. Monthly average turbidity ranges from 4-149 nephelometric turbidity units (NTUs). In September, 2006, EPA approved a total maximum daily load (TMDL) for mercury, bacteria, and temperature in the lower Willamette River (http://www.deq.state.or.us/wq/tmdls/willamette.htm).

In 1997, DEQ and the EPA took sediment samples within the Portland Harbor. The results of the study indicated that sediments in the harbor, including within the action area, contain concentrations of metals, PCBs, pesticides, herbicides, dioxins/furans, tributlytin (TBT), and PAHs above NMFS' contaminant guidelines (http://response.restoration.noaa.gov/book_shelf/121_sedi_qual_guide.pdf). Cleanup of the contaminated sediments is presently being addressed under the Federal Superfund process. The initial study area for the listing is between RM 3.5 to RM 9.5, although the final designation is likely to expand beyond this area.

The site characterization report (BBL 2004) evaluated the surface sediment concentrations in the vicinity of Terminal 4 and confirmed the degraded condition of the sediment. The EE/CA concluded that existing surface sediment contaminants have likely affected wildlife (including fish) by direct or indirect exposure due to direct contact, feeding, or bioaccumulation (BBL 2005). Two sediment quality guidelines have been used to characterize the sediments: the threshold effects concentration (TEC) is a low effects guideline that represents concentrations below which toxicity effects are unlikely to be observed in freshwater benthic invertebrates, and the PEC is a higher, probable effects guideline that represents concentrations above which toxicity effects are likely to be observed in freshwater benthos. Slip 3 has PEC exceedances for lead, zinc and PAHs, and Wheeler Bay has PEC exceedances for lead and PAHs.

Sediments within the Berth 411 dredging area were historically contaminated with pencil pitch, ores, diesel and other hydrocarbons. Subsurface samples in this area have PEC exceedances for lead, byrene, benzo(a)anthracene, and benzofluoranthene. Surface sediments exceeded screening levels for PAHs, metals, and some organics. Other studies found screening level exceedances for cadmium, lead, zinc, PCBs, and DDT (AMEC 2006, Hart Crowser 2002).

Physical habitat conditions within the lower Willamette River are also highly degraded. The river's banks have been channelized, off-channel areas removed, tributaries put into pipes, and the river disconnected from its floodplain as the lower valley was urbanized. Silt loading to the lower Willamette River has increased over historical levels due to logging, agriculture, road building, and urban and suburban development within the watershed. Limited opportunity exists for large wood recruitment to the lower Willamette River due to the paucity of mature trees along the shoreline, and the lack of relief along the shoreline to catch and hold the material. The lower Willamette River has been deepened and narrowed through channelization, diking and filling, and much of the shallow-water habitat has been converted to deep-water habitat; 79% of the shallow water through the lower river has been lost through historical channel deepening (Northwest Power and Conservation Council 2004). In addition, much of the historical off-channel habitat has been lost due to diking and filling of connected channels and wetlands. Columbia Slough, a tributary within the action area, is the closest remaining off-channel habitat. Connections between the slough and the river have been cut off, and dikes have been constructed along much of the slough.

Shallow-water habitats are important for juvenile listed salmonids because they provide food resources, such as benthic macroinvertebrates, zooplankton, and emergent insects, and refuge from predators in the main river. Although juvenile outmigrants may occupy the entire river, subyearling listed salmonids tend to migrate close to the water surface and near the shoreline. The reduction in current velocities aids juvenile fish by significantly reducing their energy requirements. Because juveniles are small and have relatively weak swimming abilities, feeding is most effective in areas where current velocities are slow. Most of the proposed dredge prism is greater than 20 feet deep and it unlikely to provide shallow-water feeding habitat.

The Willamette River is tidally-influenced within the action area. Juvenile and adult Chinook salmon, coho salmon, chum salmon, and steelhead use the action area as a migratory corridor and as rearing habitat for juveniles.

Slip 3 is deep-water habitat that is maintained by dredging for deep draft vessels. Wheeler Bay has moderate quality beach habitat that accumulates large wood. The section of the shoreline closest to Slip 3 is quite steep, and has some riprap to help prevent active erosion.

The Columbia River is also within the action area. The Columbia River is 1,210 miles long, and drains a watershed area of about 260,000 square miles. Habitat in the Columbia River has been significantly degraded by the development and operation of the Federal Columbia River Power System dams. The lower Columbia River estuary lost approximately 43% of its tidal marsh (from 16,180 acres historically to 9,200 acres today), and 77% of its historical tidal swamp habitats (from 32,020 acres historically to 6,950 acres today) between 1870 and 1970 (Thomas 1983). One example is the diking and filling of floodplains that were formerly connected to the tidal river. This practice eliminated large expanses of low-energy, off-channel habitat for Pacific salmon and steelhead rearing and migrating during high flows. Similarly, diking of estuarine marshes and forested wetlands within the estuary removed most of these important off-channel habitats.

Within the lower Columbia River, diking, river training devices (*e.g.*, pile dikes, riprap), railroads, and highways have narrowed and confined the river to its present location. Between the Willamette River and the mouth of the Columbia River, those human activities have confined 84,000 acres of floodplain that likely contained large amounts of tidal marsh and swamp. The lower Columbia River's remaining tidal marsh and swamp habitats are in a narrow band along the Columbia River and its tributaries' banks, and around undeveloped islands.

The Columbia River in the action area is on the ODEQ 303(d) list as water quality limited for temperature (summer months), dichloro-diphenyl-trichloroethane, PCBs, and arsenic. The Columbia River is on the Washington State Department of Ecology's 303 (d) list for dissolved oxygen, temperature, total dissolved gas, and fecal coliform. OWEB (2006) identified loss of floodplain, loss of estuarine wetlands, fine sediments from farm and forest roads, high stream temperatures, passage barriers and impaired low-gradient stream complexity as issues.

Effects of the Action

The proposed action will affect the listed salmonids considered in this opinion by causing physical, chemical and biological changes to the environmental baseline, and through direct effects. These effects include interaction with fish migrating through or rearing within the action area during in-water work, effects to benthic and pelagic forage opportunities, short-term negative water quality effects (*i.e*., turbidity and increased exposure to contaminants), long-term positive benefits to sediment and water quality, and long-term negative effects to habitat quality. The greatest risk to rearing or migrating salmon and steelhead is the suspension of contaminated sediments, and the potential for direct harm (because the work area will not be isolated from the river). Dredging will also maintain the existing deep-water habitat, despite its being in a depositional area that has a potential to develop into shallow-water habitat, a rare habitat type in the lower Willamette River. The analysis below will first describe the potential for direct effects to listed salmonids, and then describe the effects of the action to water quality and habitat, and finally describe the potential for effects as a consequence of changes in water quality and habitat. The potential effects in the Willamette River and in the Columbia River will be addressed separately.

Effects on ESA-Listed Species.

The potential for harm to ESA-listed salmonids in the Columbia River is remote because no in-water work is proposed for the Columbia River. Contaminated sediment will be transported up the Columbia River to the transfer site. Conservation measures minimize the risk of spillage of contaminated sediment during transport and at the unloading site. With the measures in place, the greatest risk to listed ESA-salmonids in the Columbia River would be associated with an accidental spill of contaminated sediment during transfer from the barge. Accidental spills do happen, so the risk is real for indirect effects because of contaminant exposure. However, the potential for direct effects to ESA-listed fish in the Columbia River is unlikely.

There is potential for harm during dredging and other in-water activities in the Willamette River during the summer in-water work window of July 1 through October 31. Five species of juvenile ESA-listed salmonids, the more sensitive and vulnerable life stage, are present during this work window (Table 5) although densities of juvenile salmonids are lower in the summer months compared with the winter months, and the summer in-water work window avoids peak smolt out-migration and peak adult migration for both Chinook salmon and steelhead (Friesen 2005).

Table 5. The presence/absence of ESA-listed salmonids in the lower Willamette River during the summer in-water work window (July 1 to October 31). 'Y' indicates the species is present, 'Y-' indicates that while the life stage may be present, peak migration is not at this time', 'N' indicates that the species is not likely to be present.

Species	**Presence During Summer In-water Work Window**	
	Adults	**Juveniles**
LCR	Y	Y-
UWR	Y	Y
CR Chum salmon	Y-	N
LCR Coho salmon	Y	Y-
UWR	N	Y-
LCR	Y-	Y-

If ESA-listed salmonids are present while dredging and in-water work is on-going, migration will be delayed or impaired (Quigley 2003, Hecht *et al*. 2007). Adults are better able to avoid work areas, but juvenile salmon and steelhead are less able to swim around disturbances, so their movements will be delayed. If they are delayed in areas with suitable cover and forage opportunities, then the delay will likely be energetically neutral. If cover and forage are not available as is true for Slip 3, then the delay means greater risk of predation, increased exposure to contaminants, and energetic costs associated with poor food availability and swimming in the current, which increase the risk or injury or mortality. Therefore, harassment of ESA-listed juvenile salmonids is likely to occur over a period of 4 to 6 weeks during dredging and other in-water activities in Slip 3. The Port will deploy mesh panels intended to direct juvenile salmonids moving downstream away from the mouth of Slip 3. However, the effectiveness of this measure is unknown, and at best, the panels will reduce the amount of harassment.

Entrainment of migrating and rearing fish by dredging equipment occurs when fish are trapped during the uptake of sediments and water by dredging machinery, which can cause injury or death. The probability of entrainment is largely dependent upon the likelihood of fish occurring within the dredging prism, fish densities, dredging depth, the entrainment zone, location of dredging within the river, equipment operations, time of year, and the species' life stage. Low densities of ESA-listed salmonids are likely to be present during dredging, although the species composition of the community will change depending on when during the work window the action is implemented. For example, juvenile chum salmon are most likely to be present in October. Fish are likely to be transitory in the entrainment zone, and the depth of dredging (from -16 feet to -50 feet) lowers the likelihood of fish presence, as does the deployment of mesh panels on the upstream edge of Slip 3. However, based on the near shore proximity of dredging operations, previous evidence that that dredging operations in the lower Columbia River will entrain juvenile salmon and steelhead (refer to NMFS biological opinion: 2004/01041), the proposed action is likely to harm some migrating and rearing juvenile salmon and steelhead.

Water Quality Effects on Habitat and Listed Salmonids. The proposed action will reduce water quality during and immediately following in-water activities in Slip 3 and during bankline stabilization work in Wheeler Bay. Dredging results in the suspension and transport of sediments along with any associated contaminants. Further, grading and the movement of heavy equipment along the shoreline could increase the mobilization of contaminants within the soil, particularly in the dissolved form.

The use of the dredge bucket will result in an increase in turbidity that will be localized and should dissipate within a few hours following cessation of the activity. Although there is some evidence that higher turbidity along the river bottom may persist for several days after the cessation of dredging (Parametrix 2006). The Port predicts the dredging will take 3 to 4 weeks, and elevated suspended concentrations are expected to persist during that period.

Berg and Northcote (1985) reported that increases in suspended sediment concentrations as low as 17 milligrams per liter (mg/L) resulted in significant increases in inflammation of the gills leading to respiratory stress when juvenile coho salmon were exposed to suspended sediment pulses for periods as short as 4 hours. Berg and Northcote (1985) also reported that increases in suspended sediment concentrations as low as 30 mg/L resulted in significant behavioral responses, such as changes in territorial behavior of juvenile coho salmon that were exposed to suspended sediment pulses for periods as short as 4 hours. Servizi and Martens (1991) reported less than 5% avoidance in juvenile coho salmon exposed to suspended sediment at a concentration of 2550 mg/L for a 96-hour period. Noggle (1978) reported that increases in suspended sediment concentrations at 1200 mg/L for a 96-hour period killed juvenile coho salmon. Finally, Berg (1982) reported that increases in suspended sediment at a concentration of 53.5 mg/L for a 12-hour period caused physiological stress and changes in behavior in coho salmon.

The Port predicts suspended sediment concentrations of 200 to 800 mg/L adjacent to the dredging, with an 83% decline within 25 meters, and an 88% decline within 100 meters (based on DREDGE, DRET and PLUMES models and data). Therefore, it is likely that sediment plumes generated by the dredging in the Willamette River will exceed suspended sediment concentrations greater than the 17 mg/L effects threshold for injury as described above. However, it is unlikely that migrating or rearing juvenile salmon and steelhead will remain in the sediment plume for a period sufficient to elicit an adverse physiological or behavioral response (4 to 96 hours) that would result in injury, since habitat quality in the action area is very low, and salmon and steelhead residence time in the action area is likely to be short-lived. Therefore, while some juvenile salmon and steelhead may be adversely affected from exposure to project-related sediment plumes, these adverse effects will not create the potential for injury, and therefore do not rise to the level where take will occur.

The concentration of contaminants in the water column will increase along with turbidity, thus increasing the exposure of listed salmonids and prey species. In addition, the concentration of dissolved contaminants will increase due to the disturbance of the substrate and the Wheeler Bay bankline. The sediments within the proposed dredge prism are contaminated with PAHs, cadmium, lead and zinc. These contaminants tend to be associated with the sediment particles, but may have a dissolved fraction as well. Elevated concentrations of both dissolved and particulate contaminants are likely downstream or upstream from dredging, depending on the tidal stage during the dredging, and the increases in turbidity and particulate and dissolved contaminants are likely to remain elevated within the proposed action area for up to 24 hours following dredging. Therefore, turbidity and contaminant concentrations are likely to remain elevated throughout the 3 to 4 weeks of dredging.

PAHs in water tend to adsorb to sediments either in the water column or in bottom sediments. This adsorption generally makes them less bioavailable via direct contact with organisms. However, a portion of these PAHs are likely bioavailable to benthic fish and invertebrates through direct contact and diet. PAHs are bioaccumulated in benthic invertebrates, and are passed to salmonids through the food chain (Meador *et al.* 1995). Fish feeding in the project area are likely to ingest contaminated invertebrates and incidentally ingest elevated levels of PAHs or other contaminants that have adsorbed to particles in the water column. PAHs are metabolized and detoxified in vertebrates such as fish, and therefore are not bioaccumulated (Varanasi *et al.* 1989). However, some intermediate metabolites of PAHs are carcinogenic properties and cause other adverse effects in fish (Johnson 2000). Arkoosh *et al.* (1994) found that exposure to both PAHs and PCBs impaired immunity in juvenile fall Chinook salmon. Impaired immunity has been linked to increased susceptibility to disease and increased predation in the marine environment.

Fish exposed to hydrocarbons in their environment have exhibited fin erosion, liver abnormalities, cataracts, and immune system impairments leading to increased susceptibility to disease (Fabacher *et al.* 1991; Weeks and Warinner 1984, 1986; O'Conner and Huggett 1988). Work by Dr. Jim Meador and his colleagues (2006) has shown that exposure to petroleum PAHs can result in a significant reduction in weight and a reduction in lipid stores in juvenile Chinook salmon, which is likely to increase mortality for juvenile fish as they move through the estuary and into the ocean.

Cadmium, a non-essential metal, is found at relatively high concentration in sediments at Terminal 4. In aquatic ecosystems cadmium can bioaccumulate in mussels, oysters, shrimps, lobsters, and fish. The toxicity of cadmium is generally attributed to the free divalent cation, can enter fish through the chloride cells in the gills (Niyogi *et al.* 2004), and acculumates primarily in the kidney, liver, and gills. The susceptibility to cadmium can vary greatly between aquatic organisms, and the availability of cadmium depends on the hardness of the water. Exposure to low concentrations of led to population decreases in the amphipod *Hyalella azteca*, which can lead to food web consequences for fish species that prey on pelagic species (Mebane 2006). Some data also suggest adverse behavioral changes in fish following long-term exposures to low concentrations of cadmium (Mebane 2006).

Lead can be bioconcentrated from water, but does not bioaccumulate and tends to decrease with increasing trophic levels in freshwater habitats (Wong *et al*. 1978, Eisler 1988). Lead adversely affects algae, invertebrates, and fish (Horne and Dunson 1995, Freda 1991). Fish exposed to high levels of lead exhibit a wide-range of effects including muscular and neurological degeneration and destruction, growth inhibition, mortality, reproductive problems, and paralysis (Eisler 1988, EPA 1976). Lead reduces invertebrate reproduction and algal growth. Lead partitions primarily to sediments, but becomes more bioavailable under low pH, hardness and organic matter content (among other factors). Lead bioaccumulates in algae, macrophytes, and benthic organisms, but the inorganic forms of lead do not biomagnify.

In many types of aquatic plants and animals, growth, survival, and reproduction can all be adversely affected by elevated zinc levels (Eisler 1993). Zinc in aquatic systems tends to be partitioned into sediment and less frequently dissolved as hydrated zinc ions and organic and inorganic complexes (MacDonald 1993). Acute toxicity (lethality) in rainbow trout has been observed for zinc concentrations as low as 53 μg/L (Bailey *et al.* 1999).

The biological assessment (page 79) states that the dredge elutriate testing indicate little or no short-term adverse effects to ESA-listed salmonids are likely from exposure to contaminants during dredging. However, these results are based on a comparison to water quality criteria that NMFS has not evaluated for protectiveness of ESA-listed juvenile salmonids. A technical memorandum prepared by Anchor Environmental, LLC (March 4, 2008) states that the concentrations of all parameters (metals and PAHs) will decline to below CERCLA guidance values by 50 meters from the dredging activity. The information provided above indicates that some ESA-listed salmonids will be exposed to project-related contaminants discharged into the Willamette River at concentrations where adverse effects could occur. Those adverse affects are not likely to kill any ESA-listed salmonids, but are likely to result in behavioral changes (*e.g.*, avoidance, altered feeding, delayed migration), physiological stress, and reduced fitness of juvenile salmonids.

The Port is proposing to install mesh panels as a fish deterrent system on the upstream edge of Slip 3 during dredging. The panels are intended to discourage the movement of juvenile salmonids into Slip 3, but the efficacy of this tool is not known. Some fish may continue moving downstream, but other fish may follow the downstream edge of the panels into Slip 3, and be exposed to areas of higher suspended sediment concentrations and contaminants.

In addition, sediment and soil in the bank regrading area are contaminated with PAHs, DDT, DDE and DDD. Amending the regraded contaminated soil with compost and hydroseeding may not prevent the movement of contaminated soil into the water during storm or wind events. The effectiveness of the hydroseeding to remove the regraded contaminated soil as a source was not evaluated in the biological assessment; the likely outcome is that the pathway to the river is reduced, but not eliminated.

The combined effects of increased suspended sediment and increased concentrations of particulate and dissolved contaminants are not known, but could be additive, synergistic (greater than additive), or antagonistic (less than the sum of their individual effects). Adult and juvenile listed salmonids (UWR and LCR Chinook salmon and steelhead, and LCR coho salmon) may avoid the area when possible, although subyearling Chinook salmon may be less effective at avoiding the area because of their poor swimming ability and greater densities than other species. The combined effects will likely be increased physiological stress, reduced feeding, and change in behavior (*e.g.*, avoidance), which frequently result in impaired growth, reduced lipid stores, and increased likelihood of mortality. However, too few fish will be affected by harassment or harm to produce a measureable effect on any of the affected populations or species.

The long-term effects of this removal action should be beneficial because of the removal of contaminated sediments and the isolation of sources of contamination to the river. However, this is not a final remedy; only the highest-risk sediments are being removed, and the newly exposed sediment surface may have contaminant concentrations greater than concentrations shown to cause adverse effects in fish. With EPA approval, the Port proposes to apply a 6-inch sand cap for exposed sediments with contaminant concentrations greater than 20 times the PEC. Therefore, until a final remedy is implemented, the newly exposed sediments may cause adverse effects to ESA-listed salmonids.

The transport of contaminated sediment in the Columbia River to the offloading site, and the transfer of sediment at the unloading site are unlikely to affect water quality or habitat in the Columbia River. Implementation of best management practices on the barge and at the off-loading site will minimize the risk of spills into the river. If a spill of contaminated sediment occurs, the effects will be short term and minimal because of dilution and the transitory presence of listed salmon in the Columbia River.

Effects to Physical Habitat, Prey Base and Listed Species. The area proposed for in-water work at Terminal 4 is primarily deep-water habitat. In deep-water habitat, the primary mode of feeding for juvenile ESA-listed salmonids is on planktonic or pelagic organisms (*e.g.*, *Daphnia* spp., *Corophium* spp.; Vile *et al*. 2004) rather than benthic. Increased turbidity during dredging will disrupt planktonic feeding of ESA-listed salmonids in the dredgearea, and this effect will last for up to 24 hours following the in-water activities, a period totally 3 to 4 weeks. It is unlikely that numeric changes in the pelagic community will be measurable following dredging because of the flow-induced movements of these animals, and their transient presence in the action area. Thus, pelagic feeding of listed salmonids in the deep-water dredging will be disrupted for a maximum of 4 weeks, but the effects are not likely to be measurable over the long term.

The benthic mode of feeding may also be used by listed salmonids within the action area, particularly in Wheeler Bay. Disruptions to benthic feeding during the summer are not likely, because dredging and construction should be completed in the main channel at that time. However, the placement of riprap will displace beach habitat that could provide benthic feeding opportunities in the winter. This loss is significant because Wheeler Bay is one of the few velocity refuges in the lower Willamette River, and this habitat type is a limiting factor for the listed salmonds that use the Willamette River. The existing contamination, disturbance of the substrate and deposition of fine sediment is from dredging, and the frequent ship activity near the mouth of the bay will likely slow the development of a healthy benthic community at the project site, and the effects to benthic productivity and availability of benthic invertebrates as prey items will last in perpetuity. In the biological assessment, the Port states that the existing habitat is of low quality, and that habitat quality will be maintained. The NMFS disagrees with these statements. The site provides a high-flow velocity refuge, and provides a good quality beach that accumulates a significant amount of wood. The Port will maintain some wood on the site, and the plantings will provide some shade, but the type of plantings proposed (primarily willows) will not contribute to habitat complexity over the long term, and the riprap will displace the more valuable beach habitat and winter feeding opportunities.

To compensate for this loss of habitat, the Port proposes to create or preserve an equivalent area (14,000 square feet) of shallow water habitat in the lower Willamette River or Columbia Slough. The availability of shallow water habitat for juvenile rearing is a limiting factor in the recovery of ESA-listed salmonids, and the new or preserved habitat will provide valuable rearing opportunities in the lower river. The net effect of the negative and positive habitat effects on viability factors for the population is likely to be neutral.

The addition of riprap at the back end of Slip 3 will not degrade habitat in that area in a manner that will adversely affect listed salmonids, because Slip 3 is maintained as deep water habitat, a habitat-type that is not limiting in the lower Willamette River.

No effects to physical habitat and the prey base will occur in the Columbia River.

Effects on Critical Habitat

Designated critical habitat within the action area for the salmonids considered in this Opinion consists of a freshwater rearing site and freshwater migration corridor and their essential physical and biological features as listed below. The effects of the proposed action on these features are summarized as a subset of the habitat-related effects of the action that were discussed more fully above. The water quality effects described will last for a maximum of four weeks during during and immediately following in-water dredging, and some effects may persist for the long-term until the final remedy is implemented. The dredging will cause short-term effects to deep-water benthic and pelagic habitat (disruption and loss of habitat). The bankline stabilization work will permanently replace some of the beach/bank habitat with riprap. The PCEs potentially affected by the proposed action are water quality, forage and space, natural cover, and free passage. The likely effects of the action on these essential features are listed below:

1. <u>Water Quality</u>. Suspended sediment will likely be highest within a few hundred feet of the dredging activities. Water quality may also be degraded by accidental spills from equipment or contaminants releases (Willamette River and Columbia River), or contaminants made more available during dredging (Willamette River only). Elevated concentrations of both dissolved and particulate contaminants are likely downstream or upstream from the terminal, depending on the tidal stage, and the increases in turbidity and particulate and dissolved contaminants are likely to remain elevated within the action area throughout the period of dredging which will be a maximum of 4 weeks. Over the long term, water quality in the action area should be improved because of the removal of the contaminated sediments from the river and the isolation of contaminant sources in Wheeler Bay and at the head of Slip 3.
2. <u>Forage and Space</u>. Increased suspended sediment will temporarily reduce food resources for juvenile listed salmonids in the action area, but impacts to the forage base would only occur for a few weeks during and immediately following dredging. The primary food resource in the deeper parts of the site are pelagic invertebrates, and recolonization from upstream areas will be fairly rapid. Pelagic feeding opportunities for juvenile listed salmonids are not limited at the watershed scale. The action area does provide good-quality benthic feeding habitat, which is limiting at the watershed scale. Some of this habitat that is inundated at higher flows will be permanently replaced with riprap. Also,

the newly-exposed sediment surface in dredged areas in Slip 3 may be a new source of contamination to the river and the benthic community. The longer-term consequence of the proposed action is a permanent loss of shallow-water habitat in Wheeler Bay, the continued potential of the Wheeler Bay bankline as a contaminant source area, and, in Slip 3, depositional areas that could potentially develop into shallow-water habitat will be maintained as deep-water habitat. Shallow-water rearing (resting and feeding) habitat is limiting at the reach scale, and the lack of opportunities for resting and feeding is an energetic cost to juvenile salmonids as they move toward the estuary. The creation or preservation of shallow water habitat will recreate shallow-water rearing opportunities over the long term. In addition, the proposed dredging will be maintaining the current condition of deep-water habitat.

3. Natural Cover. Suspended sediment may provide ESA-listed juvenile salmonids with temporary cover from predators. A likely response from adult salmonids would be avoidance of areas with high turbidity.
4. Free Passage. Suspended sediment and the mesh panel might delay migration of adults and juveniles during and immediately following dredging and capping activities. Adults are likely to avoid the active work area because of their strong swimming ability, but juveniles are less likely to avoid the area, and migration will more likely be delayed or impaired.

Factors limiting the salmonid populations in the lower Willamette River are water temperature, water quality, and channel modification (loss of shallow habitat). While this action will adversely affect water quality and channel modification, the effects to water quality are not to affect the conservation value of the lower Willamette River to listed salmonid populations. The adverse effects to sediment (turbidity and contaminant exposure) will be temporary and localized, and the proposed action will be maintaining the existing deep-water habitat at the site. However, riprap will be placed along approximately 14,000 square feet of beach habitat in Wheeler Bay (Willamette River). This will result in a permanent loss of a shallow water rearing habitat during winter months, a habitat type that is limiting at the reach scale and the watershed scale. The creation or preservation of 14,000 square feet of shallow water habitat will compensate for this loss.

Cumulative Effects

Between 2000 and 2006, the population of Multnomah County increased by 3.2%.[2] The NMFS assumes that future private and state actions will continue within the action area, increasing as population density rises. As the human population in the action area continues to grow, demand for industrial and commercial development is also likely to grow and increase in intensity. The effects of those new activities are likely to further reduce the conservation value of the habitat within the action area. State-led upland clean-up of contaminated areas adjacent to the river is ongoing. The NMFS is not aware of any specific future non-Federal activities within the action area that would cause greater impacts to listed species than presently occur. Industrial activities will continue within the action area, as will the ongoing CERCLA clean-up of contaminated sediments. As part of the CERCLA action and the resulting Natural Resource Damage

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

Assessment, as well as the City of Portland's commitment to restore listed salmon and steelhead, habitat restoration actions will be constructed and provide benefits to rearing and migrating fish.

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 will not result in the destruction or adverse modification of designated critical habitat. These conclusions are based on the following considerations.

Juvenile rearing and migration of the ESA-listed species in this Opinion is limited by poor water and sediment quality, and degradation of physical habitat. Adult spawning is limited by poor access to quality spawning areas, and a lack of quality spawning areas. Most populations of the ESA-listed species are at relatively low abundance and are at risk for all VSP categories, including abundance, productivity, diversity and spatial structure (Good *et al*. 2005, McElhany *et al*. 2007). The Willamette River is designated critical habitat for four of the five ESA-listed salmonid species. It is rated as having 'high' conservation value, although present conditions in the action area are degraded due to industrialization and urbanization in the basin that have altered flows, degraded water and sediment quality, reduced the availability of shallow water habitat, and reduced the complexity of the channel.

The proposed action will degrade rearing conditions in the action area for approximately 4 weeks by affecting water quality, forage, space, and safe passage conditions, all of which are limiting factors for the ESA-listed species. However, over the long term (*i.e*., years), the proposed action will maintain or improve existing water and sediment quality at the Port's Terminal 4 in the Willamette River. There will be a permanent loss of approximately 14,000 square feet of beach habitat in Wheeler Bay as the result of riprap placement, but the value of this habitat will be replaced by mitigation work over the long term. No degradation of rearing conditions is likely in the Columbia River, although there may be temporary degradation of water quality if there is a spill of contaminated sediment.

A very small proportion of the total number of each ESA-listed salmonid in the Willamette River will be affected by the short-term effects of the action on rearing and migratory conditions. This is because only a small portion of each species will be migrating past the site during the in-water work window, or will be rearing in the action area during project activities. Those few fish will be exposed to additional stress caused primarily by reduced water quality, increased turbidity, and impaired passage. Any stress and resulting injury experienced by those fish is likely to be last for a few weeks and is limited to the vicinity of Slip 3 and Wheeler Bay. These adverse effects will be experienced by far too few fish to produce an observable effect on the abundance, distribution, diversity or productivity of these listed salmonids at either the population or species scale.

Further, the proposed action will not cause further degradation of freshwater rearing habitat or adverse modification of critical habitat PCEs for LCR steehead and Chinook salmon, UWR steelhead and Chinook salmon, LCR coho salmon, and CR chum salmon. The negative effects will last for a few weeks, are an extension of the existing condition, will be offset be the creation of shallow water habitat, and will not contribute to a reduction in the conservation value of designated critical habitat in the Willamette River for the ESA-listed salmon and steelhead.

The remaining seven species are present in the Columbia River only, and these species rear in the Columbia River as the juveniles move downstream. In the event dredged sediment is spilled during transport, some of these fish will be exposed to degraded water quality. However, any stress experienced by these fish is likely to be brief (days to weeks) and limited to fish near the unloading site. The timing, frequency, intensity, and duration of these adverse effects will be experienced by far too fish to produce an observable effect on the abundance, distribution, diversity or productivity of these seven species at either the population or species scale.

Finally, for the Columbia River, the proposed action will not cause further degradation of freshwater rearing habitat or adverse modification of critical habitat PCEs. The current value of critical habitat along the transport route and the unloading site will be maintained. The negative effects will be short-term or an extension of the existing condition, and will not contribute to a reduction in the conservation value of designated critical habitat in the Columbia River for the ESA-listed salmon and steelhead.

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 ESA-listed species or 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 ESA-listed species or 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).

If the Port fails to provide the compensatory mitigation plan for this removal action to NMFS for approval or disapproval within 2 years of the start of operations under this Opinion, or fails to carry out the plan within 5 years after it is approved, as described in the proposed action and in the reasonable and prudent measures and terms and conditions, NMFS may assume the proposed action has been modified in a manner that has an effect to the ESA-listed species or critical habitat that was not considered in the biological opinion, and may recommend reinitiation of this consultation.

To reinitiate consultation, contact the Oregon State Habitat Office of NMFS and refer to the NMFS Number assigned to this consultation (2007/08174).

Incidental Take Statement

Section 9(a)(1) of the ESA prohibits the taking of listed species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) extend the prohibition to threatened species. Among other things, an action that harasses, wounds, or kills an individual of a listed species or harms a species by altering habitat in a way that significantly impairs its essential behavioral patterns is a taking (50 CFR 222.102). Incidental take refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(o)(2) exempts any taking that meets the terms and conditions of a written incidental take statement from the taking prohibition.

Amount or Extent of Take

Activities necessary to complete the proposed action at Terminal 4 will take place within the active channel of the Willamette River and the Columbia River when individuals of Chinook salmon, coho salmon, chum salmon, sockeye salmon, and steelhead considered in this Opinion are likely to be present. Adverse effects of the proposed action will include the temporary loss of prey items for rearing juveniles in the Willamette River, an increase in turbidity, sediment, and potential exposure to pollutants (PAHs, zinc, cadmium and lead) in the Willamette River and the Columbia River. The habitat that will be adversely affected by these effects is of moderate to poor quality and not limited at the site-specific or watershed scale. The placement of riprap in Wheeler Bay will permanently reduce the quality of shallow-water rearing habitat in the bay, and this habitat is limited at the site-specific and the watershed scales, and will be re-created in the lower Willamette River. These effects are reasonable likely to cause increased physiological stress, reduced feeding, and change in behavior, which frequently result in impaired growth, reduced lipid stores, and increased likelihood of mortality. These effects are likely to harass adults and juveniles by, and harm juveniles by increased predation and reduced resistance to disease, and reduced fitness due to low growth rates (*i.e.*, within an area extending from 500 feet upstream to 1,000 feet downstream of the terminal and the off-loading facility.

The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area for this consultation cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action.

The best available indicators for the extent of take are the areas of the active channel used by ESA-listed salmonids as habitat that will be disturbed by dredging activities, suspended sediment and contaminant plumes, and the bankline activities in Wheeler Bay. These features best integrate the likely take pathways associated with this action, are proportional to the anticipated amount of harm, and are the most practical and feasible indicators to measure. Thus, the predicted extent of take indicators for this consultation are: (1) The disturbance of 75,000 square feet of migration, rearing, and riparian habitat in Wheeler Bay during the summer in-water work window; (2) a 100-meter long plume of increased suspended sediment from dredging activities measured from the edge of the area with in-water activities at 5 NTU over the background level for two consecutive monitoring intervals during the summer window; and (3) an increase in laboratory parameters (PAHs, metals) measured 100 meters from the in-water activities at concentrations greater than the acute criteria for more than three sampling intervals. Dredging-generated suspended sediment is an extent of take indicator due to the relationship between suspended sediment and contaminant concentrations.

In the accompanying Opinion, NMFS determined that this level of incidental take is not likely to result in jeopardy to the species. The increase in turbidity and the aerial extent of dredging are thresholds for reinitiating consultation. Exceeding this indicator for extent of take will trigger the reinitiation provisions of this Opinion.

Reasonable and Prudent Measures

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

Full application of conservation measures included as part of the proposed action, together with use of the reasonable and prudent measures and terms and conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of listed species due to completion of the proposed action.

The EPA shall:

1. Minimize incidental take from project-related activities by applying permit conditions to the proposed action that avoid or minimize adverse effects to water quality and the ecology of aquatic systems.
2. Ensure completion of a monitoring and reporting program to confirm this incidental take statement is meeting its objective of minimizing incidental take from permitted activities.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the EPA and its cooperators, including the applicant, if any, must fully comply with conservation measures described as part of the proposed action and the following terms and conditions that implement the reasonable and prudent measures described above. Partial compliance with these terms and conditions may invalidate this take exemption, result in more take than anticipated, and lead NMFS to a different conclusion regarding whether the proposed action will result in jeopardy or the destruction or adverse modification of critical habitats.

1. To implement reasonable and prudent measure #1, the EPA shall ensure that:

   a. Work Window. To minimize effects to juvenile listed salmonids, the Port limits dredging is limited to the summer in-water work window (July 1 through October 31).
   b. Notice to Contractors. Before beginning work, all contractors working on site are provided with a complete list of reasonable and prudent measures, and terms and conditions intended to minimize the amount and extent of take resulting from general dredging activities, in-water work, and shoreline stabilization activities.
   c. Minimize Impact Area. The Port confines dredging impacts to the minimum area necessary to complete the project.
   d. Dredging.
      i. No fallback or redistribution. All digging passes of the bucket shall be completed without any material being returned to the wetted area. Dumping of partial or full buckets of dredged material back into the river is not allowed. Dredging of holes or sumps below the maximum depth, and redistribution of sediment by dredging, dragging or other means is not allowed.
      ii. Cycling time. Clamshell cycling time shall be slowed, as necessary, to reduce turbidity and reduce sediment drift to adjacent areas.
      iii. A closed-lip or environmental bucket will be used. If the type of material precludes the use of this type of bucket, please notify NMFS.
      iv. Debris. All large anthropogenic debris shall be removed from dredged sediments and transported to an appropriate disposal site.
      v. Post-dredge sampling shall include a full suite of parameters, including metals, SVOC, PCBs, and TOC.
      vi. Materials such as booms and sorbent pads shall be available on-site, and must be used to contain and clean up petroleum products spilled or release as a result of project activities. The booms must be deployed in Slip 3 prior to and during work at the head of Slip 3.
      vii. No release of either sediment or water back into the Willamette River or Columbia River from the transport barge is allowed.
   e. Cap.
      i. All covers or caps over contaminated soil or sediment require demarcation of the base of the cap with a geofabric demarcation barrier.
      ii. Institutional controls are required to protect the integrity of the cap.
      iii. Contaminated soil or sediment shall be capped in place with a minimum of 12 inches of clean cover material over the demarcation fabric. This includes the Wheeler Bay bankline and within Slip 3.
      iv. Cap material shall be from an approved upland source.
   f. Fish Deterrent System. The fish deterrent mesh panels shall be at least 20 feet deep, and shall extend into the Willamette River to the harbor line to greater encourage fish movement past the dock at Berth 410 (as depicted in Figure 15 in

the biological assessment, as opposed to figures in the Design Analysis Report (2008). Filter fabric is the preferred material for the mesh panels. However, the mesh opening shall be no bigger than 0.25 inch.

g. Habitat Measures.

   i. Cable and concrete shall not be used to anchor large wood into the bankline in Wheeler Bay.

   ii. Vegetation Cover in Wheeler Bay. The Port must achieve 80% aerial coverage by established (*i.e*, not newly-planted) vegetation at year 5. Invasive plants species do not count toward the 80% cover.

   iii. Institutional controls (*e.g.*, covenant, easement, or some other long-term measure) must be placed on the Wheeler Bay bankline area to prevent disturbance in the future.

   iv. The Port will submit its proposed compensatory mitigation plan to NMFS for approval or disapproval within 2 years of the start of operations under this Opinion, and complete all actions necessary to carry out the plan within 5 years after the date the plan is approved. As described in 40 CFR 232.3(f)(2), NMFS will consider any time lag between commencement of sediment removal and the start of compensatory mitigation activities that exceeds 2 years to be an additional temporal loss of aquatic resource function when determining whether to the approve or disapprove the proposed mitigation ratio.

h. Monitoring. The size of the dredge prism and sediment/riparian disturbance area shall be monitored (amount and areal extent). In addition, monitoring shall be conducted for turbidity, sheens or other visible contamination in the water or along the bankline, and distressed or dying fish.

   i. Visual monitoring. If any of the above are observed (turbidity plume, sheens, or distressed/dying fish), then the Port must notify EPA immediately to coordinate response decisions, and must evaluate the need to alter activities. Additional quantitative monitoring may be required.

   ii. Quantitative monitoring will be conducted and recorded as described below during dredging, barge unloading and sediment transfer and during cap material placement. Monitoring will occur at one upstream station and three downstream stations, as identified by EPA. Water quality monitoring for laboratory parameters via depth-specific whole water samples will occur at the downstream station having the highest turbidity reading. The monitoring stations may be reversed, depending on the tidal cycle.

   iii. Quantitative monitoring frequency. Monitoring field parameters will be measured at the start of each operation at least once every hour during active in-water work. The first sample of the day will be taken 1 hour after the initiation of the activity. This frequency will continue until four consecutive hourly events indicate no exceedance of any triggers levels, and the sampling frequency will be reduced to every 4 hours. If results exceed the triggers, these same parameters will be measured again within 30 minutes of the determination of the exceedance. In addition, hourly frequency will resume if any visible decline in water quality is observed or if an exceedance has been confirmed. If exceedances continue, then procedures outlined below will be implemented. A properly and regularly calibrated turbidimeter is required. In addition, water samples for analysis of laboratory parameters will be collected once a day in subareas with active dredging and capping operations.

iv. Parameters monitored. The following field parameters shall be monitored: turbidity, dissolved oxygen, pH, and oil/sheen. The following laboratory parameters will be monitored: total suspended solids, anthracene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthese, benzo(a)pyrene, indeno(1,,3-cd)pyrene, dibenzo(a,h)anthracene), benzo(g.h,i)perylene)fluoranthene, pyrene, fluorene, phenanthrene, natphthalene, acenaphthlene, acenaphthene, cadmium, lead, zinc, water velocity.

v. Monitoring depths. Sampling depths for the field and laboratory parameters shall be located at the top, middle and bottom of the water column. For water depths less than 7 feet, two samples will be collected, and for depths less than 2 feet, one sample will be collected.

vi. Representative background point. For field parameters, initial background conditions will be established prior to the start of in-water work, with a minimum of seven independent measurements at least 100 meters upstream of the location of the activity, and over the course of a 2-day period just prior to the initiation of in-water work. For laboratory parameters, depth-specific whole water samples will be taken at one upstream sampling station. The 90^{th} percentile upper confidence limit on the mean will be used to represent initial background conditions.

vii. Compliance point for field parameters. The compliance point of the field parameters (other than turbidity) is 100 m downstream from the center of the activity. The compliance point for turbidity is 100 meters beyond the inner harbor line. Table 4-1 of the water quality monitoring and compliance conditions plan (WQMCCP) outlines triggers for field parameters that require additional controls for the in-water activity. For example, if turbidity at the compliance point is more than 3 NTUs over background (when background <50 NTU) or greater than 10% over background (where background >50 NTUs), the Port will implement additional controls to reduce turbidity. If turbidity is more than 50 NTUs over background, then the Port must cease operations until they can continue without this exceedance.

viii. Compliance point for laboratory parameters. The compliance point is 100 meters downstream of the center of the activity. The WQMCCP, Table 4-1, provides aquatic chronic and acute triggers.

ix. Reporting. Copies of monitoring data shall be made available to NMFS upon request. The Port shall notify NMFS if there are two or more consecutive exceedances of the field or laboratory parameters.

x. The Port shall monitor for injured, sick or dead ESA-listed salmonids during active in-water work. The Port shall conduct this monitoring at least once per day and anytime other parameters are being sampled, to be conducted no sooner than 1 hour after dredge operations have begun.

h. Weather Conditions. If the weather conditions are unsuitable to monitor the dredging operations (*e.g*., heavy fog, excessive winds, rough water), then in-water operations must cease until conditions are suitable for monitoring.

j. Transport. To prevent the blowing of sediment back into the river, the sediments shall be covered during transport on the barge if winds are predicted to be greater than 20 miles per hour during transport. As stated above, no water shall be discharged from the barge.

k. Upland Disposal Site. The upland disposal site shall be large enough to accommodate the quantity of material and water to be placed there to allow adequate settling. No discharge of water (from the upland disposal site) to waterways with ESA-listed salmonids is covered in this Opinion.

2. To implement reasonable and prudent measure #2, the EPA shall ensure that:

a. Reporting. The applicant reports all monitoring items, including turbidity measurements, size of the dredged area (amount and aerial extent), depth of sand cap (if needed) and dates of initiation and completion of work, to NMFS within 90 days of the close of any work window that had dredging-related activity within it. Any exceedance of take covered by this Opinion must be reported by the applicant to NMFS immediately. The report will include a discussion of implementation of the terms and conditions in #1, above.

b. The applicant submits monitoring reports to:

National Marine Fisheries Service
Oregon State Habitat Office
Attn: 2007/08174
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232-2778

c. The applicant posts the following notice prominently at the work site:

NOTICE: If a sick, injured or dead specimen of a threatened or endangered species is found in the project area, the finder must notify NMFS through the contact person identified in the transmittal letter for this Opinion, or through the NMFS Office of Law Enforcement at 1-800-853-1964, and follow any instructions. If the proposed action may worsen the fish's condition before NMFS can be contacted, the finder should attempt to move the fish to a suitable location near the capture site while keeping the fish in the water and reducing its stress as much as possible. Do not disturb the fish after it has been moved. If the fish is dead, or dies while being captured or moved, report the following information: (1) NMFS consultation number; (2) the date, time, and location of discovery; (3) a brief description of circumstances and any information that may show the cause of death; and (4) photographs of the fish and where it was found. The NMFS also suggests that the finder coordinate with local biologists to recover any tags or other relevant research information. If the specimen is not needed by local biologists for tag recovery or by NMFS for analysis, the specimen should be returned to the water in which it was found, or otherwise discarded.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The consultation 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 information provided in the BA and 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:

> Degradation of water quality from increased turbidity and contaminant exposure for a period of a few weeks, and loss of riparian and shallow water habitat.

EFH Conservation Recommendations

The NMFS believes that the following conservation measure is necessary to avoid, mitigate, or offset the impact of the proposed action on EFH. This conservation recommendation is an identical subset of the ESA terms and conditions.

1. Dredging and in-water work: Follow terms and conditions 1a – 1k as presented in the ESA portion of this document.
2. Monitoring and reporting: Follow terms and conditions 2a, 2b, and 2c as presented in the ESA portion of this document.

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. Therefore, in your statutory reply to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

Supplemental Consultation

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

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 activities at the Port of Portland Terminal 4 will not jeopardize the affected species. Therefore, the EPA can authorize this action in accordance with its authority under CERCLA. The intended users are the EPA and the Port of Portland.

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.

LITERATURE CITED

Adams, P.B., C.B. Grimes, J.E. Hightower, S.T. Lindley, and M.L. Moser. 2002. Status Review for the North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz CA.

AMEC. 2006. Results of May 2006 Sediment Sampling – Post Toe Slope Removal, Port of Portland Marine Terminal 4, Berths 410 and 411, Portland, Oregon. July 27, 2006.

Anchor Environmental. 2008. Design Analysis Report. Prepared for the Port of Portland, Portland, Oregon. April 9, 2008.

Arkoosh M. R., E. Clemons, M. Myers, E. Casillas. 1994. Suppression of B-cell mediated immunity in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) after exposure to either a polycyclic aromatic hydrocarbon or to polychlorinated biphenyls. Immunopharmacology and Immunotoxicology 16:293–314.

Bailey, H.C., J.R. Elphick, A. Potter and B. Zak. 1999. Zinc toxicity in stormwater runoff from sawmills in British Columbia. Water Research 33:2721-2725.

BBL. 2004. Site Characterization Report, Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Port of Portland, Portland, Oregon. September 17, 2004.

BBL. 2005. Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Public Review Draft. Port of Portland, Portland, Oregon. May 31, 2005.

Beamis, W.E. and B. Kynard. 1997. Sturgeon rivers: An introduction to acipensiform biogeography and life history. *Environmental Biology of Fishes* 48:167-183.

Berg, L., 1982. The effect of exposure to short-term pulses of suspended sediment on the behavior of juvenile salmonids. pages 177 - 196 *in*: G.F. Hartman *et al.*, editors. Proceedings of the Carnation Creek workshop: a ten year review. Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, Canada.

Berg, L. and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Science 42:1410-1417.

Bjornn, T. C., D. R. Craddock, and D. R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, *Oncorhynchus nerka*. Trans. Am. Fish. Soc. 97(4):360-373.

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.

CDFG (California Department of Fish and Game). 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing.

Cooney, T. D. 2004. Updated trend data sets for Interior Columbia basin ESUs. Northwest Fisheries Science Center, Seattle. October 14.

Corps (U.S. Army Corps of Engineers). 2007. Biological assessment for the Julia Butler Hansen Columbian White-tailed deer National Wildlife Refuge Section 536 Habitat Restoration Project.

Dauble D. D., T. L. Page, R. W. Hanf, Jr. 1989. Spatial distribution of juvenile salmonids in the Hanford Reach, Columbia River. Fishery Bulletin 87:775–790.

Dawley, E. M., R. D. Ledgerwood, T. H. Blahm, C. W. Sims, J. T. Durkin, R. A. Kirn, A. E. Rankis, G. E. Monan, and F. J. Ossiander. 1986. Migrational characteristics, biological observations, and relative survival of juvenile salmonids entering the Columbia River estuary, 1966-1983. Final Report to Bonneville Power Administration, 256 p. Available Bonneville Power Administration, P.O. Box 351, Portland, OR 97208.

Eisler, R. 1988. Lead hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish Wildl. Serv. Biol. Rep. 85(1.14).

Eisler, R**.** 1993. *Zinc* hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish Wildl. Serv. Biol. Rep. 10.

Fabacher, D. L., J.M. Besser, C. J. Schmitt, J.C. Harshbarger, P.H. Peterman, and J. A. Lebo. 1991. Contaminated sediments from tributaries of the Great Lakes: chemical characterization and cancer-causing effects in medaka (*Oryzias latipes*). Arch. Environ. Contam. Toxic. 20:17-35.

Ford, M., P. Budy, C. Busack, D. Chapman, T. Cooney, T. Fisher, J. Geiselman, T. Hillman, J. Lukas, C. Peven, C. Toole, E. Weber, and P. Wilson. 2001. Final report of the Upper Columbia River Steelhead and Spring Chinook Salmon Biological Requirements Committee. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. March.

Freda, J. 1991. The effects of aluminum and other metals on amphibians. Environmental Pollution. 71:305–328.

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.

Friesen, T.A., J.S. Vile, and A.L. Pribyl. 2005. Migratory behavior, timing, rearing, and habitat use of juvenile salmonids in the lower Willamette River. Pages 63-137 in T.A. Friesen editor. Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River. Final Report to the City of Portland. ODFW, Clackamas.

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

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.

Hart Crwoser. 2002. Dredge material Characterization Study Marine Terminal 4, Slip 3. Prepared for the Port of Portland. February 19, 2002.

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

Hecht, S. A., D. H. Baldwin, C. A. Mebane, T. Hawkes, S. J. Gross, N. L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-83, 39 p.

Horne, M. T. and W. A. Dunson. 1995. Effects of low pH, metals, and water hardness on larval amphibians. Archives of Environmental Contamination and Toxicology. 29:500-505.

ICTRT (Interior Columbia Technical Recovery Team). 2003. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the interior Columbia River domain. Working draft. July. 180 p.

ICTRT (Interior Columbia Technical Recovery Team). 2006. ICTRT interim gaps report. Required survival rate changes to meet technical recovery team abundance and productivity viability criteria – interior Columbia populations. May 17. 29 p. Available at: http://www.nwfsc.noaa.gov/trt/col_docs/IC_TRT_Memo_Survival_Changes_5-17-06.pdf

Johnson, L. 2000. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. White Paper from National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. 29 p.

Matthews G. M. and R. S. Waples. 1991. Status Review for Snake River Spring and Summer Chinook Salmon. NOAA Technical Memorandum. U.S. Department of Commerce, U.S. Department of Commerce. http://www.nwfsc.noaa.gov/publications/techmemos/tm200/tm200.htm

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.

MacDonald, A. 1993. Development of an approach to the assessment of sediment quality in Florida coastal waters. Florida Department of Environmental Regulation, Tallahassee, FL. By MacDonald Environmental Sciences, Ltd., Ladysmith, British Columbia.

Meador, J. P., J. E. Stein, W. L. Reichert, U. Varanasi. 1995. Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. Reviews of Environmental Contamination and Toxicology, 143:79-165.

Meador, J.P., F.C. Sommers, G.M. Yitalo, and C.A. Sloan. 2006. Altered growth and related physiological responses in juvenile chinook salmon (Oncorhynchus tshawytscha) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). Canadian Journal of Fisheries and Aquatic Sciences 63:2364-2376.

Mebane, C.A. 2006 Cadmium risks to freshwater life: derivation and validation of low-effect criteria values using laboratory and field studies. U.S. Geological Survey, Scientific Investigations Report 2006-5245. Version 1.1, December 2006.

Moser, M. and S. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. *Environmental Biology of Fishes* DOI 10 1007/sl0641-006-9028-1.

Moyle, P.B. 2002. Inland fish of California. 2nd Edition. University of California Press, Berkeley.

Myers, J. M., C. Busack, D. Rawding, A. R. Marshall. 2003. Historical population structure of Willamette and Lower Columbia River Basin Pacific salmonids. WLC-TRT Report, NOAA Fisheries Northwest Fisheries Science Center, Seattle. WA.

Myers, J.M., C. Busack, D. Rawding, A.R. Marshall, D.J. Teel, D.M. Van Doornick, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. NOAA, Seattle.

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). 2005. 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.

Northwest Power and Conservation Council. 2004. Draft Willamette Subbasin Plan. http://www.nwcouncil.org/fw/subbasinplanning/willamette/plan/Intro.pdf

Niyogi, S., P. Couture, G. Pyle, D.G. McDonald, and C.M. Wood. 2004. Acute cadmium biotic ligand model characteristics of laboratory-reared and wild yellow perch (Perca flavescens) relative to rainbow trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Science 61:942-953.

Noggle, C.C. 1978. Behavioral, physiological and lethal effects of suspended sediment on juvenile salmonids. [Thesis] Seattle: University of Washington.

O'Conner, J. M. and R.J. Huggett**.** 1988. Aquatic pollution problems, North Atlantic coast, including Chesapeake Bay. Aquatic Toxicology 11:163-190.

Oregon Watershed Enhancement Board (OWEB). 2006. Oregon plan biennial report 2005-2007. Salem, Oregon.

Parametrix. 2008. Water Quality Monitoring and Compliance Conditions Plan. March 5, 2008.

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

Quigley, Jason Trevor. 2003. Experimental Field Manipulations of Stream Temperatures and Suspended Sediment Concentrations: Behavioural and Physiological Effects to Juvenile Chinook Salmon. M.Sc. Thesis, University of British Columbia.

Servizi, J. A. and D. W. Martens. 1991. Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon (Oncorhynchus kisutch). Canadian Journal of Aquatic Sciences 48:493-497.

USACE, EPA, WDOE, WDNR, ODEQ, IDEQ, NMFS, USFWS. 2006. Northwest Regional Sediment Evaluation Framework. Interim Final. September 2006. http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/DMMO/RSET_Interim_Final.pdf

Thomas, D. W. 1983. Changes in the Columbia river estuary habitat types over the past century. Columbia River estuary data development program. Columbia River estuary study taskforce (CREST). Astoria, Oregon: 51.

Varanasi U, J.E. Stein, M. Nishimoto. 1989. Biotransformation and disposition of PAH in fish. In: Metabolism of polycylic aromatic hydrocarbons in the aquatic environment, Varanasi U (ed.). CRC Press: Boca Raton, FL; 93–149.

Vile, J.S., T.A. Friesen, and M.J. Reesman. 2004. Diets of juvenile salmonids and introduced fishes of the lower Willamette River. Pages 17-62 *in* T.A. Friesen, editor. Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River. Final Report to the City of Portland. ODFW, Clackamas.

Waples, R.S. 1991. Definition of 'Species' Under the Endangered Species Act: Application to Pacific Salmon. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS- F/NWC-194. http://www.nwfsc.noaa.gov/publications/techmemos/tm194/waples.htm

Weeks, B.A. and J. E. Warinner. 1984. Effects of toxic chemicals on macrophage phagocytosis in two estuarine fishes. Mar. Environ. Res. 14:327-35.

Weeks, B.A. and J. E. Warinner. 1986. Functional evaluation of macrophages in fish from a polluted estuary. Vet. Immun. Immunopathol. 12:313-20.

Wong, P. T. S., B. A. Silverberg, Y. K. Chau & P. V. Hodson, 1978. Lead and the aquatic biota. In: The Biogeochemistry of Lead in the Environment, J. O. Nriagu (ed.), Elsevier Science Publ., Amsterdam: 279–342.