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:
2002/01959

November 6, 2003

Captain M.S. Boothe
Chief, Marine Safety Division
Thirteenth Coast Guard District
Room 3506
915 Second Avenue
Seattle, Washington 98174

Mr. Chris Field
Manager, Emergency Response Unit
Environmental Protection Agency Region 10
1200 Sixth Avenue (ECL-116)
Seattle, Washington 98101

Re: Endangered Species Act Section 7 Programmatic Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Oil Spill Response Activities Conducted Under the Northwest Area Contingency Plan (NWACP)

Dear Captain Boothe and Mr. Field:

This letter responds to the U.S. Coast Guard's (USCG) November 12, 2002, request to initiate formal, programmatic Endangered Species Act (ESA) consultation and programmatic Magnuson-Stevens Fishery Conservation and Management Act (MSA) essential fish habitat (EFH) consultation with the National Marine Fisheries Service (NOAA Fisheries) on the Oil Spill Response Activities Conducted Under the Northwest Area Contingency Plan (NWACP). Attached you will find NOAA Fisheries' Biological Opinion (Opinion) in accordance with Section 7 of the ESA, as amended (16 USC 1531 *et seq.*). Also included is an EFH consultation pursuant to Section 305(b) of the MSA and implementing regulations (50 CFR Part 600).

As stated in the Biological Assessment (BA), the USCG and Environmental Protection Agency (EPA) have determined that the proposed action is likely to adversely affect listed species under NOAA Fisheries' jurisdiction. Furthermore, the EFH consultation concludes that EFH would be adversely affected by the proposed action. The ESA-listed salmon and steelhead species considered within this Opinion include southern Oregon/northern California Coasts coho salmon (*Oncorhynchus kisutch*), Oregon Coast coho salmon (*O. kisutch*), Snake River Fall-run chinook salmon (*O. tshawytscha*), Snake River spring/summer-run chinook salmon (*O. tshawytscha*), lower Columbia River chinook salmon (*O. tshawytscha*), upper Willamette River chinook salmon (*O. tshawytscha*), upper Columbia River spring-run chinook salmon (*O.*

tshawytscha), Hood Canal summer-run chum salmon (*O. keta*), Columbia River chum salmon (*O. keta*), Snake River sockeye salmon (*O. nerka*), upper Columbia River steelhead (*O. mykiss*), Snake River Basin steelhead (*O. mykiss*), lower Columbia River steelhead (*O. mykiss*), upper Willamette River steelhead (*O. mykiss*), and middle Columbia River steelhead (*O. mykiss*) and Puget Sound chinook salmon (*O. tshawytscha*) and Lake Ozette sockeye salmon (*O. nerka*). Listed marine mammals considered in this Opinion include blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), humpback whales (*Megaptera novaeangliae*), northern right whales (*Eubalaena glacialis*), sei whales (*B. borealis*), sperm whales (*Physeter macrocephalus*), and the Steller sea lion (*Eumetopias jubatus*).

With respect to the above-listed species, NOAA Fisheries has determined that the proposed action is not likely to jeopardize the continued existence of the listed species or destroy or adversely modify designated critical habitats. As required by Section 7 of the ESA, NOAA Fisheries has included reasonable and prudent measures with nondiscretionary terms and conditions that NOAA Fisheries believes are necessary to minimize the potential for incidental take associated with this action. NOAA Fisheries has determined that EFH may be adversely affected, but has concluded that the reasonable and prudent measures and the terms and conditions of the Incidental Take Statement will sufficiently address adverse effects to EFH.

The USCG and EPA also concluded in their BA that most response activities under the NWACP will have no effect on listed sea turtles that may be found in the action area. Listed sea turtles include green turtles (*Chelonia mydas*), leatherbacks (*Dermochelys coriacea*), loggerheads (*Caretta caretta*), and olive ridleys (*Lepidochelys olivacea*). The primary reasoning behind this determination includes the probable low encounter rate between response vessels, equipment, and activities, and sea turtles. Stranding records and sighting data confirm that sea turtles are rarely found off the coasts of Washington and Oregon, and the chances that they are found in inland waters is close to zero. The BA concludes that the use of dispersants and *in-situ* burning may affect but are not likely to adversely affect sea turtles. Although the rate at which sea turtles are likely to encounter an *in-situ* burn is low, the USCG states that surveys are conducted by responders to ensure that sea turtles are not in the area of a burn prior to igniting the oil. Little is known regarding the effects of dispersants on sea turtles; however, NOAA Fisheries concurs with the conclusions reached in the BA, that any effects to sea turtles from their exposure to dispersants is likely to be short-lived and of low risk. Furthermore, prior to applying dispersants to an oil slick, responders will survey the area for sea turtles. Based on all of the above, NOAA Fisheries concurs with the conclusions stated in the BA, that the collective action is not likely to adversely affect listed sea turtles.

A key point of discussion among the USCG, EPA and NOAA Fisheries during this consultation was the role that the 2001 Interagency Memorandum of Agreement (MOA)[1] would play in spill response consultations subsequent to the issuance of this Opinion. In the MOA, NOAA Fisheries (and U.S. Fish and Wildlife Service) determined that oil spill response activities qualify as an emergency action[2]. As such, the emergency continues to exist until the removal operations are completed and the case is closed in accordance with 40 CFR 300.320(b).

To obviate the need to conduct emergency consultations during every oil spill that occurs in the Northwest, the USCG and the EPA initiated formal consultation with NOAA Fisheries to step-down the national MOA and programmatically assess the effects of most response activities on ESA-listed species in Oregon, Washington, and Idaho. After assessing the effects of the proposed action on these species and critical habitat, NOAA Fisheries determined that most response activities in the northwestern United States can be covered under a programmatic incidental take statement[3]. For a subset of response actions for which effects on listed species were less predictable or for which NOAA Fisheries had particular concern, a "tiered consultation" approach was deemed appropriate. Tiered consultation will help to determine if the proposed response method is within the range of effects analyzed in the Opinion, and may defer to independent emergency consultation after response work (as per the MOA) has been completed. With the issuance of this Opinion there are two pathways for the USCG and EPA to obtain incidental take authorization for ESA listed species: (1) Programmatic application of the Opinion and tiered consultation if necessary; or (2) for response actions not evaluated in the Opinion, individual after-the-fact consultation in accordance with the MOA. Within this letter, NOAA Fisheries has provided regional contacts for tiered consultation, and will update this contact list as needed.

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[1] Inter-agency Memorandum of Agreement Regarding Oil Spill Planning and Response Activities Under the Federal Water Pollution Control Act's National Oil and Hazardous Substances Pollution Contingency Plan and the Endangered Species Act, signed by USCG, EPA, US Fish and Wildlife Service, NOAA Fisheries, National Ocean Service, and Office of Environmental Policy and Compliance, 2001.

[2] Federal regulations implementing the ESA state that "where emergency circumstances mandate the need to consult in an expedited manner, consultation may be conducted informally through alternative procedures that the Director [of NOAA Fisheries] determines to be consistent with the requirements of 7(a) - (d) of the ESA. This provision applies to situations involving acts of God, disasters, casualties, national defense or security emergencies, *etc.*" (50 CFR 402.05).

[3] Site specific circumstances may require spill responses that have not been analyzed within this Opinion or are not included within the proposed action. Nothing within this Opinion limits the application of these spill response actions that allow immediate action to protect public health and safety. In these circumstances, to achieve coverage under section 7, the application of the MOA would occur with individual section 7(a)(2) consultation with NOAA Fisheries after the response is finished.

NOAA Fisheries contacts-Tiered Consultation		
Washington		
North Puget Sound	Thomas Sibley	206.526.4446
Central Puget Sound	Matthew Longenbaugh	360.753.7761
Eastern WA	Dale Bambrick	509.962.8911 x221
Lower Columbia & Southwest WA	Dan Guy	360.534.9342
Oregon	Nancy Munn	503.231.6269
Idaho	Dale Brege	208.983.3859 x222

E-mail addresses: firstname.lastname@NOAA.gov

This concludes section 7 consultation on the proposed action. The USCG and EPA must reinitiate ESA consultation if: (1) New information reveals effects of the action that may affect listed species in a way not previously considered; (2) the action is modified in a manner that causes an effect to the listed species that was not previously considered; or (3) a new species is listed or new critical habitat designated that may be affected by the action (50 CFR 402.16).

NOAA Fisheries appreciates the substantial and collaborative efforts the USCG, EPA, and NOAA Hazardous Materials Staff have committed to this consultation and we look forward to continuing our productive relationship. If you have any questions with this Opinion, please contact Russ.Strach@NOAA.gov or (503.231.6266) . If additional site specific section 7 ESA or EFH consultation are needed, please contact the appropriate Northwest Region NOAA Fisheries representative in Oregon, Washington, or Idaho.

Sincerely,

For Michael R Crouse

D. Robert Lohn
Regional Administrator

cc: Lieutenant Commander Michael Devany, NOAA Haz Mat
Preston Sleager, Department of the Interior

Endangered Species Act - Section 7 Consultation
Programmatic Biological Opinion

&

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

Oil Spill Response Activities Conducted Under the
Northwest Area Contingency Plan

Agency:	United States Coast Guard Environmental Protection Agency
Consultation Conducted By:	National Marine Fisheries Service, Northwest Region
Date Issued:	November 6, 2003
Issued by:	For Michael R Crouse _____ D. Robert Lohn Regional Administrator
Refer to:	**2002/01959**

TABLE OF CONTENTS

1. INTRODUCTION . . . 1
    1.1. Background and Consultation History . . . 1
        1.1.1. Federal Requirements Under the Endangered Species Act . . . 3
        1.1.2. Consultation History . . . 7
    1.2 Description of the Proposed Action . . . 7
        1.2.1 Action Area . . . 10
        1.2.2 Introduction to Oil Spill Response Methods . . . 11
            1.2.2.1 Oil Spill Response Plans . . . 12
            1.2.2.2 Organizational Structure During Oil Spill Response . . . 12
            1.2.2.3 Decision-Making Process During Oil Spill Response . . . 15
            1.2.2.4 Tiered Consultation . . . 16
            1.2.2.5 Natural Recovery . . . 17
        1.2.3 Oil Spill Response in Open Water . . . 18
            1.2.3.1 Booming . . . 18
            1.2.3.2 Skimmers . . . 20
            1.2.3.3 Removal of Floating Oil -Sorbents . . . 23
            1.2.3.4 In-Situ Burning . . . 23
            1.2.3.5 Chemical Dispersion of Floating Oil . . . 25
            1.2.3.6 Barriers/Berms and Underflow Dams . . . 29
            1.2.3.7 Vegetation (Kelp) Cutting . . . 29
        1.2.4 Oil Response in Shoreline Environments . . . 30
            1.2.4.1 Introduction and Background to Habitat Classifications . . . 30
            1.2.4.2 Shoreline Type Consolidations . . . 31
            1.2.4.3 Response Methods Used in Shoreline Environments . . . 32
        1.2.5 Motorized Transportation /Support Actions during Spill Response in Open Water and Shoreline Environments . . . 52
            1.2.5.1 Boats and Other Watercraft . . . 52
            1.2.5.2 Planes . . . 52
            1.2.5.3 Helicopters . . . 53
            1.2.5.4 All Terrain Vehicles . . . 53

2. ENDANGERED SPECIES ACT . . . 54
    2.1 Biological Opinion . . . 54
        2.1.1 Biological Information and Critical Habitat . . . 55
        2.1.2 Evaluating the Proposed Action . . . 58
        2.1.3 Biological Requirements . . . 58
            2.1.3.1 Marine Mammals . . . 58
            2.1.3.2 Salmonids . . . 77
        2.1.4 Environmental Baseline . . . 107
            2.1.4.1 Marine Mammals . . . 108

2.1.4.2 Salmonids 111
2.1.5 Effects of the Proposed Action 123
2.1.5.1 Approach to Effects Analysis for Salmonids 127
2.1.5.2 Habitat Requirements for Salmonids 128
2.1.5.3 Booming 130
2.1.5.4 Skimmers 135
2.1.5.5 Removal of Floating Oil - Sorbents 137
2.1.5.6 In-situ Burning 138
2.1.5.7 Chemical Dispersants 148
2.1.5.8 Barriers/Berms and Underflow Dams 160
2.1.5.9 Vegetation Cutting 163
2.1.5.10 Removal of Surface Oil 166
2.1.5.11 Oiled Debris Removal 168
2.1.5.12 Trenching 170
2.1.5.13 Removal of Oiled Sediment 172
2.1.5.14 Flushing with Ambient Water 174
2.1.5.15 Warm-Water, Moderate-Pressure Washing 178
2.1.5.16 Vegetation Cutting 181
2.1.5.17 Motorized Transport - Aircraft 183
2.1.5.18 Motorized Transport - Boats 184
2.1.5.19 Motorized Transport – ATVs and Heavy Equipment 187
2.1.5.20 Support – Foot traffic 188
2.1.5.21 Summary of Effects to Listed Species 188
2.1.5.22 Summary of Effects to Habitat and Designated Critical Habitat 189
2.1.6. Cumulative Effects 189
2.1.7 Conclusion 190
2.1.8 Conservation Recommendations 191
2.1.9 Reinitiation of Consultation 191
2.2 Incidental Take Statement 191
2.2.1 Amount or Extent of the Take 192
2.2.2 Reasonable and Prudent Measures 193
2.2.3 Terms and Conditions 195

3. MAGNUSON-STEVENS ACT 210
3.1 Background 210
3.2 Identification of EFH 211
3.3 Proposed Action 213
3.4 Effects of the Proposed Action 213
3.5 Conclusion 213
3.6 EFH Conservation Recommendations 213
3.7 Statutory Response Requirement 214

3.8 Supplemental Consultation 214

4. LITERATURE CITED 215

Appendix A 246

Appendix B 248

TABLES

Table 1-1 Response methods for oiled shorelines 33
Table 1-2 Codes for Response Methods presented in Table 1-1. 34
Table 2-1 References for additional background on listing status, critical habitat, protective regulations, and biological information for listed salmonids addressed in this Opinion 78
Table 2-2 Residue produced during the Newfoundland Offshore Burn Experiment 142
Table 2-3 Analysis for heavy metals, cyanide and chlorinated hydrocarbons 149
Table 2-4 Ranges of 96-hour constant and spike EC50s and LC50s for 7 species of juvenile fish and invertebrates 150
Table 2-5 Saltwater-dispersed oil consensus concentrations (ppm) and exposure periods (hours) of concern relative to marine zooplankton and early life stages of fishes and invertebrates, adult crustaceans and adult fishes 152
Table 2-6 Spill Response Scenarios Requiring Tiered Consultation 197
Table 3-1 Species with designated EFH in the waters of Idaho, Oregon and Washington 212

1. INTRODUCTION

1.1. Background and Consultation History

Oil spills can and do occur in both marine and freshwater habitats important to threatened and endangered species. Identifying sensitive resources and developing protection strategies is important in planning for an oil spill. Between 1977 and 1990, the United States Coast Guard (USCG) tracked approximately 105,000 oil spills in coastal and navigable waters, including the Great Lakes and inland regions. Ninety-five percent of these spills were less than 1,000 gallons, and 74% were less than 50 gallons (Michel *et al*. 1994).

Oil is transported and stored over water, rail, highway, and pipeline. While the amounts of oil spilled through marine transportation can be high, the potential amounts from rail and highway transportation is relatively small. It is difficult to obtain data on the rail and highway transportation of oil; however, locations where transportation spills could affect coastal resources (*e.g.*, bridges and waterfront rail yards) are readily identified. The potential spill amounts from pipelines is highly variable and depends on the pipeline diameter, flow rate, spacing between shut-off valves, and the type of leak detection system in place. Oil production wells are also sources of oil spills, and can be both onshore and offshore.

Contingency planning is one way to assess the risk of an oil spill. Accordingly, storage and transfer facilities and vessels transporting oil are required to plan for a worst-case discharge (defined in 33 CFR Part 150, §154.1029 and §155.1020, respectively). The facility plans are submitted to the USCG for the transportation-related portion of the facility and to the United States Environmental Protection Agency (EPA) for the non-transportation portions.

The Federal Water Pollution Control Act (FWPCA) (33 U.S. Code 1251-1376) was originally enacted in 1972, amended in 1977 and renamed the "Clean Water Act.." (CWA). It was reauthorized in 1991. The Clean Water Act strives to restore and maintain the chemical, physical, and biological integrity of the nation's water by setting up a system of water quality standards, discharge limitations, and permits.

Section 1321 of the CWA addresses the development of a National Planning and Response System, which, in conjunction with the National Contingency Plan (described below), addresses responses to worst-case discharges of oil or hazardous substances, and mitigation or prevention of a substantial threat of discharge from a vessel, offshore facility, or onshore facility. Area Committees (both national and regional) are responsible for working with the response community to plan for joint response efforts, including oil spill containment, mechanical recovery, use of dispersants, *in-situ* burning, shoreline cleanup, protection of sensitive areas, and protection, rescue, and rehabilitation of fish and wildlife.

The National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the National Contingency Plan (NCP), is the Federal government's blueprint for responding to both oil spills and hazardous substance releases. The first NCP was developed and published in 1968 and provided the first comprehensive system of accident reporting, spill containment, and cleanup, and established a response headquarters, a national reaction team, and regional reaction teams (precursors to the current National Response Team and Regional Response Teams). Over the years, additional revisions have been made to the NCP to keep pace with the enactment of legislation. The latest revisions to the NCP were finalized in 1994 to reflect the oil spill provisions of the Oil Pollution Act of 1990 (OPA 90). The NCP assigns duties to Federal agencies to protect the public health and welfare, including fish, wildlife, natural resources and the public. The NCP also designates the Federal On Scene Coordinator (FOSC) as the person responsible for coordinating an oil spill response.

The Northwest Area Contingency Plan (NWACP), developed by the Northwest Area Committee, serves as the primary guidance document for responders in Washington, Oregon, and Idaho for oil spills and hazardous materials spills. The effective date of the latest NWACP was on November 1, 1998 and constitutes the summation of policies and procedures for two USCG Captain of the Port (COTP) Zones (Puget Sound and Portland), EPA Inland Region 10 (excluding Alaska), and the States of Oregon, Idaho and Washington. It is consistent with the NCP and as been adopted as the Region 10 Contingency Plan.

Under the NWACP, the USCG has the authority to respond to all oil and hazardous substance spills in the coastal zone, the EPA has authority to respond in the inland zone, and Washington, Oregon, and Idaho respond within their respective state boundaries. The boundaries between the Coast Guard and EPA areas of responsibility are outlined in the NWACP (Table 1-1 in the NWACP). According to the NWACP, "the boundary for undesignated waters shall be the nearer of 100 yards from the junction with, or the first bridge crossing, any river discharging into a salt-waterbody. All waterway that mark the boundary between two states (*e.g.*, the Columbia and Snake Rivers) are the joint, shared responsibility of both states. Spills affecting, or with the potential to affect, shared water must be reported to both states and both states will normally participate in the unified response."

In Washington, the Department of Ecology is designated as the state's lead agency, while in Oregon, the Department of Environmental Quality is the lead state agency. Idaho uses a collaborative system in responding to spill incidents which involves mainly coordination with local response organizations. The state's Division of Environmental Quality plays a key role in facilitating, and the Bureau of Hazardous Materials is responsible for ensuring that emergency response is timely and effective.

In addition to the NWACP, 24 Geographic Response Plans (GRPs) exist for the waters of Washington and Oregon – they are considered part of the NWACP but are distributed and revised separately. The GRPs represent the collective input of natural resource trustee agencies

and spill response organizations regarding environmental protection strategies for a given area. They contain maps and descriptions of sensitive natural resources, identify strategies to protect those resources, and set priorities for various spill scenarios. In general, the GRPs for the Northwest provide guidance on exclusion and deflection booming strategies. Because few of the GRPs contain the most current information on areas where and times of the year when listed species and/or designated critical habitat may be present, as part of this consultation with NOAA Fisheries, the action agencies have put together supplemental tables and maps containing this information. This information will be used in conjunction with an appropriate GRP during oil spill response and is described in more detail in the Description of the Proposed Action (Section 1.2).

The NWACP also contains the "Northwest Area Shoreline Countermeasures Manual and Matrices" (NWSCM), which describes Northwest area-specific habitat and the response strategies that should be recommended or conditionally recommended, should an oil spill occur in an area. Developed by the Northwest Area Committee in February 1995, the NWSCM continues to be revised. In addition, the NWACP contains a "Dispersant Use Policy," which guides all dispersant use activities and establishes standards and guidelines for appropriate applications. Lastly, the NWACP includes an "In-situ Burning Policy," which defines the conditions under which burning may occur on a pre-approved or a case-by-case basis, or where it is not allowed.

1.1.1. Federal Requirements Under the Endangered Species Act

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.; ESA), provides the primary legal framework for the conservation and recovery of species in danger of or threatened with extinction. One of the primary purposes of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and to provide a program for the conservation of such endangered species and threatened species ..." (16 U.S.C. § 1531(b)).

Section 7(a)(2) of the ESA requires that each Federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of[4] any endangered species or threatened species or result in the destruction or adverse

[4]The term "jeopardize the continued existence of" means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of that species" (50 CFR § 404.02)

modification of critical habitat[5] of such species. When the action of a Federal agency may affect a listed species or its critical habitat, that agency is required to consult with either the NOAA Fisheries or the United States Fish and Wildlife Service (USFWS), depending upn the listed species or critical habitat that may be affected. Section 7(b) of the ESA requires NOAA Fisheries and USFWS (collectively the Services) summarize consultations in biological opinions that detail how actions may affect threatened or endangered species and designated critical habitat and conclude whether an action is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Section 7 regulations recognize that an emergency may require expedited consultation, therefor for past oil spills that occurred in the Northwest and that may have affected listed species, the USCG and the EPA ("action agencies") have conducted emergency consultations during the oil spill response. The emergency consultation is initiated informally, with the action agency contacting the Service(s) (USFWS and/or NOAA-Fisheries) as soon as possible for advice on measures that would minimize effects of the response action on listed species or critical habitat[6]. If the initial review indicates that the action may result in jeopardy to a listed species or adverse modification to critical habitat, and no means of reducing or avoiding the effect are apparent, the action agency is advised and the Services' conclusions documented. After the response action is over, and it has been determined that the action(s) has adversely affected listed species or critical habitat, the action agency then initiates formal consultation (*in* Chapter 8, Final ESA Section 7 Handbook, March 1998).

In 2001, the USCG, EPA, Department of Interior's Office of Environmental Compliance and USFWS, and NOAA Fisheries, and NOAA's National Ocean Service signed an agreement entitled: "Inter-agency Memorandum of Agreement (MOA) Regarding Oil Spill Planning and Response Activities Under the FWPCA's National Oil and Hazardous Substances Pollution Contingency Plan and the Endangered Species Act." The purpose of the MOA is to increase cooperation and understanding among agencies involved in ESA compliance at every stage in oil spill planning and response. The MOA outlines procedures to streamline the ESA compliance process before, during, and after an incident. A guidebook has been developed to familiarize oil spill responders and the Services representatives with, among other things, the processes through which cooperation and/or consultation should occur.

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[5]The term "destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical (50 CFR §402.02).

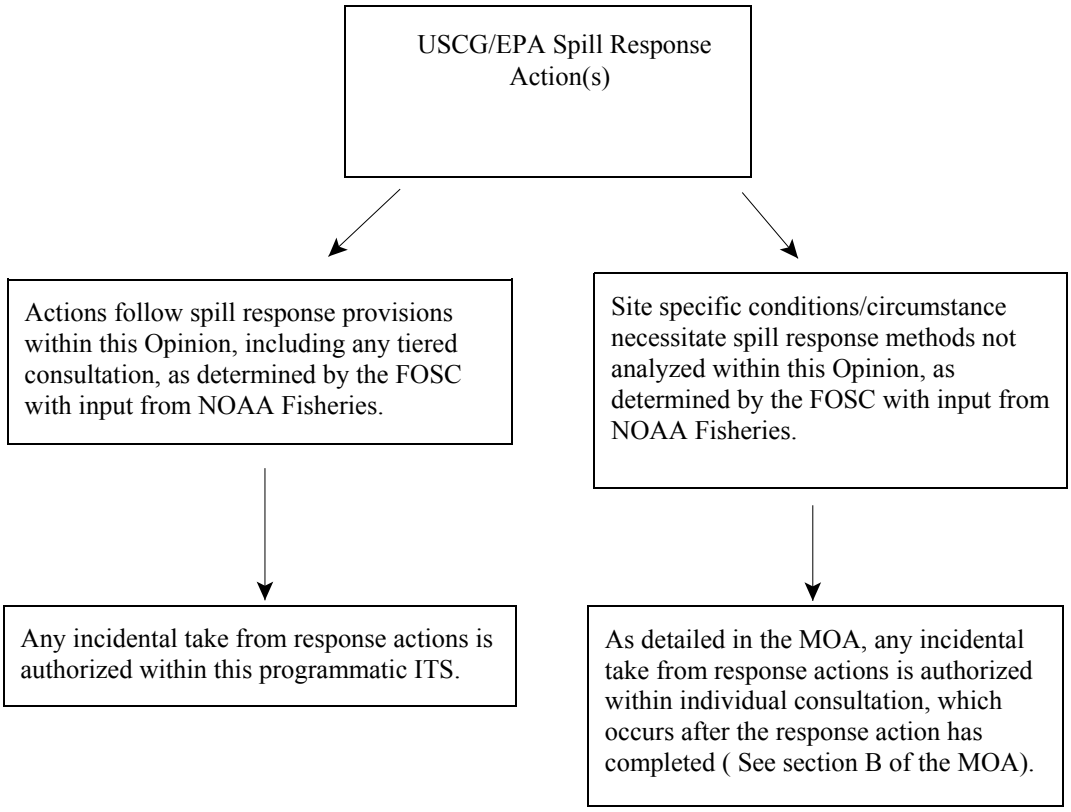
[6] Federal regulations implementing the ESA state that "where emergency circumstances mandate the need to consult in an expedited manner, consultation may be conducted informally through alternative procedures that the Director [of NOAA Fisheries] determines to be consistent with the requirements of 7(a) - (d) of the ESA. This provision applies to situations involving acts of God, disasters, casualties, national defense or security emergencies, *etc.*" (50 CFR 402.05).

According to the MOA, both NOAA Fisheries and USFWS determined that oil spill response activities qualify as an emergency action. As such, the emergency continues to exist until the removal operations are completed and the case is closed in accordance with 40 CFR 300.320(b). The FOSC will continue to conduct emergency consultations, if needed, until the emergency is over and the case is closed. Formal or informal consultation is initiated after the emergency is over, at which time the USFWS and/or NOAA Fisheries evaluates the nature of the emergency actions, the justification for the expedited consultation, and the impacts to listed species and their habitats (page 4 of MOA).

To obviate the need to conduct emergency consultations during every oil spill that occurs in the Northwest, the USCG and the EPA initiated formal consultation with NOAA Fisheries to step-down the MOA and programmatically assess the effects of typical response activities likely to occur on ESA-listed species in Oregon, Washington, and Idaho. After assessing the direct and indirect effects of the proposed action on these species and critical habitat, NOAA Fisheries determined that most response activities in the northwestern United States can be covered under an incidental take statement (ITS). However, for a number of response actions for which effects on listed species were less predictable or for which NOAA Fisheries had particular concern, a "tiered consultation" approach was deemed appropriate. Tiered consultation will help to determine if the proposed recovery method is within the range of effects analyzed within the biological opinion, and may defer to independent emergency consultation after recovery work, as called for in the MOA. Actions for which tiered consultation will be necessary are described in Section 1.2.2.

A key point of discussion among the USCG, EPA and NOAA Fisheries as this document was developed was the role that the MOA would continue to play within spill response action consultations subsequent to the issuance of this programmatic opinion. To aid the understanding of the implementation of this Biological Opinion (Opinion) and the MOA in relation to section 7(a)(2) of the ESA for spill response actions, the below schematic was developed. Essentially, site specific circumstances may require spill responses that have not been analyzed within this Opinion or are not included within the proposed action. Nothing within this Opinion limits the application of these spill response actions that allow immediate action to protect public health and safety. In these circumstances, the application of the MOA would occur with individual section 7(a)(2) consultation with NOAA Fisheries after the response is finished. With the issuance of this Opinion there are two pathways for the USCG and EPA to achieve coverage of incidental take of listed species, one programmatic, the other, as outlined in the MOA, individual after the fact consultation.

Figure 1. Spill Response Actions and Section 7(a)(2) Coverage.



This Opinion fulfills the USCG/EPA and NOAA Fisheries' obligations under section 7 of the ESA through consultation on: The Northwest Area Contingency Plan, including the Dispersant Use Policy, the Decanting Policy, the In-situ Burning Policy, the NWSCM and the GRPs.

This Opinion does not cover listed species take liability for the oil spill itself. The Damage Assessment and Restoration Program (DARP), established by NOAA in 1990, is responsible for restoring coastal and marine resources that have been injured by the release of oil and other hazardous substances and to obtain compensation for the public's lost use and enjoyment of these resources.[7] This consultation does not cover restoration actions by DARP.

This Opinion is based on information contained in the biological assessment and Essential Fish Habitat (EFH) assessment provided by the USCG (USCG 2002) and the best available scientific and commercial data (published and unpublished).

[7]More information on DARP can be found at: http://www.darp.noaa.gov/about.htm

1.1.2. Consultation History

From August through November 2002, as part of an informal consultation, the USCG, the EPA, Hazardous Materials Response Division of NOAA, and NOAA Fisheries held periodic meetings to discuss contents of a draft biological assessment, including description of the proposed action and the effects analyses.

On September 23, 2002, the USCG submitted a species request list to NOAA Fisheries.

On November 12, 2002, the USCG submitted a request to initiate formal, programmatic ESA consultation and programmatic Magnuson-Stevens Fishery Conservation and Management Act (MSA) EFH consultation on the proposed action.

On June 13, 2003, a draft version of this Opinion, including reasonable and prudent measures and terms and conditions, were transmitted to the USCG and EPA. NOAA Fisheries received comments and revisions to the draft from each agency, and as appropriate, adjusted this Opinion accordingly.

1.2 Description of the Proposed Action

Response actions undertaken by the USCG and the EPA to limit or prevent oil discharges and/or their effects have the potential to adversely affect listed species and modify critical habitat. To fully meet the goals of both the NCP and the ESA, the USCG and EPA have initiated a programmatic consultation with NOAA Fisheries on most of their oil spill response strategies. This programmatic consultation will address policies and actions described in the current NWACP (including the Decanting Policy), the Shoreline Countermeasures Manual, the Dispersant Use Policy manual, and the In-situ Burn Policy manual. Because the 24 GRPs are considered part of the NWACP, they are also included in this programmatic consultation, as well as supplemental tables and maps describing the presence of listed species and/or critical habitat, which was included as a result of this ESA consultation. As each GRP is revised, these supplemental species "windows" will be incorporated. The following few paragraphs describe the species "windows" that have been developed and are included as part of this proposed action.

I. Rationale

The Northwest Area Committee (NWC) recognized that organisms and habitats are vulnerable not only to contamination by oil, but also to activities associated with containment and cleanup of spilled oil. As a result, the NWC has taken steps to account for these vulnerabilities in its response planning. As described previously, GRPs have been developed by the NWC, for regions that are considered the most likely to experience an oil spill (*e.g.*, Puget Sound is comprised of several GRPs). They describe in detail response techniques that are expected to be most effective in the specific aquatic and terrestrial environments (*e.g.*, shoreline type), and to have the least environmental impact on the resources, that have been identified in a given GRP. However, the NWC recognized that identifying and minimizing impacts to listed species and

designated critical habitat, specifically, was of the highest priority both within the areas covered by GRPs and throughout Washington, Oregon and Idaho (*i.e.* areas being developed or not currently covered by a GRP). As a result, the development of listed species "windows" was undertaken as a component of the consultation package and is included as a part of the proposed action.

II. Design

The windows provide spatial and temporal information on aggregations of listed species considered in this programmatic consultation. Windows were created for each species, or distinct population segment, for which the best available scientific information indicated that consistent or predictable aggregations of the species occur on at least an annual basis. Available information for listed cetaceans and turtles did not indicate that any breeding, feeding or other aggregations occur within the action area. However, available information did indicate that aggregations occur for listed salmon and steelhead, and for the eastern stock of Steller sea lion. Information relative to seasonal aggregations of listed salmon and steelhead (migration, spawning and rearing) was obtained from status reviews[8], the StreamNet database (http://www.streamnet.org) and expert opinion. State guidance documents from Washington and Oregon that provide recommendations for timing of in-stream construction were also used as a reference to compare timing information found in other sources. Information on seasonal aggregations (*i.e.*, rookeries) of the eastern stock of Steller sea lion was obtained from Federal Register notices (58 FR 45269), Pitcher and Calkins (1981), NMFS (1992) and expert opinion.

Geographic Information System (GIS) data used in developing maps were acquired from the StreamNet website (salmon and steelhead distribution by life stage), Washington Department of Ecology (GRP layers for Washington State), Oregon Department of Environmental Quality (GRP layers for Oregon State), NMFS Northwest Regional Office website (http://www.nwr.noaa.gov/1habcon/habweb/listnwr.htm; salmon and steelhead ESU maps), NOAA Hazardous Material (HAZMAT) Response and Assessment Division (various geographic, demographic and biological layers) and Washington Utilities and Transportation Commission (Olympic Pipeline layers). Location information for Steller sea lion rookeries off the coasts of Oregon and California, including the mandated seaward buffer zone of 3,000 feet (0.9 kilometer [km]) from the baseline of each rookery designated as critical habitat, was obtained from the Code of Federal Regulations (50 CFR 226.202) and then digitized.

III. Level 1

Windows information is presented in a series of maps and tables at three levels of detail. The first level consists of a table that includes each listed species in the action area and the month(s) during which potentially sensitive life stages or activities that comprise an aggregation. This table allows an individual to "look up" aggregation information by species or month, but no

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[8]Chinook (Myers *et al.* 1998, Waples *et al.* 1991a); chum (Johnson *et al.* 1997); coho (Weitkamp *et al.* 1995); sockeye (Gustafson *et al.* 1997, Waples *et al.* 1991b); and steelhead (Busby *et al.* 1996)

spatial information is included. Level 1 allows an initial determination to be made as to whether the potential exists for a response activity to affect listed species aggregations.

IV. Level 2

The second level of detail includes temporal and spatial information. It consists of one table similar to that described in the first level of detail (Level 1) and a second table that lists the watersheds, rivers and streams in which an aggregation of one or more species is known to occur. Three, four and five tables of the latter description characterize, by region, aggregations of listed species throughout Idaho, Oregon and Washington, respectively. In addition, GIS maps were created to illustrate this spatial distribution, by region, or in greater detail, as necessary. In addition to distribution, they also show waterbodies, place names and major roads to aid in orientation. Level 2 maps and tables provide a broad view of distribution and timing of listed species throughout the three states in the action area.

V. Level 3

The third level of detail consists of maps and tables identical to those described under Level 2, except that Level 3 information is provided at the GRP-level of detail. Tables and maps were developed for each of the 24 GRPs that are currently in use. In addition, windows tables and maps were also developed for GRPs that are currently in development, so that they can be incorporated immediately after those GRPs are finalized. Geographic boundaries for windows maps are the same as those for each GRP; GRP base layers were obtained and used for windows maps, where available. For GRPs that have not yet been digitized, map boundaries were created using boundaries obtained from nautical charts. Therefore, each GRP will consist of a windows table and a map for each species/Evolutionary Significant Unit (ESU), usually several maps will be required to achieve the desired level of detail.

VI. Summary

Species windows have been developed in recognition of the importance of protecting listed species from unintended impacts associated with oil spill response activities. Windows consist of tables and maps that illustrate, at several levels of detail, the temporal and spatial distribution of aggregations of listed species. Windows designed at the GRP level will be incorporated in GRPs in forthcoming updates. Windows designed at the regional/state levels will be used in cases when a response is required in areas outside of those for which GRPs have been developed.

VII. Spill Size Covered Under This Consultation

Based on historical spill data and on the potential for the magnitude of an oil spill in offshore and coastal waters, this programmatic consultation will cover an oil spill of up to 250,000 gallons offshore, and up to 10,000 gallons inland of the coastal zone. Response actions triggered by a

spill larger than these are not part of the Federal action and would require a separate section 7 consultation.

To give some perspective of the nature of spills that can and have occurred in the Pacific Northwest, Appendix A contains information from three recent notable spills in the area as well as a compilation of historical spill data from the state of Washington.

VIII. Responses Not Covered Under This Consultation

This consultation does not cover the following spill response actions, some of which are included in the NWACP (chapter 900, section 9640):

1. *In-situ* burning on shorelines.
2. Chemical oil stabilization with elastomizers.
3. Chemical protection of beaches.
4. Chemical cleaning of beaches.
5. Nutrient enhancement.
6. Microbial addition.
7. Dispersants using agents other than COREXIT 9500 and COREXIT 9527.

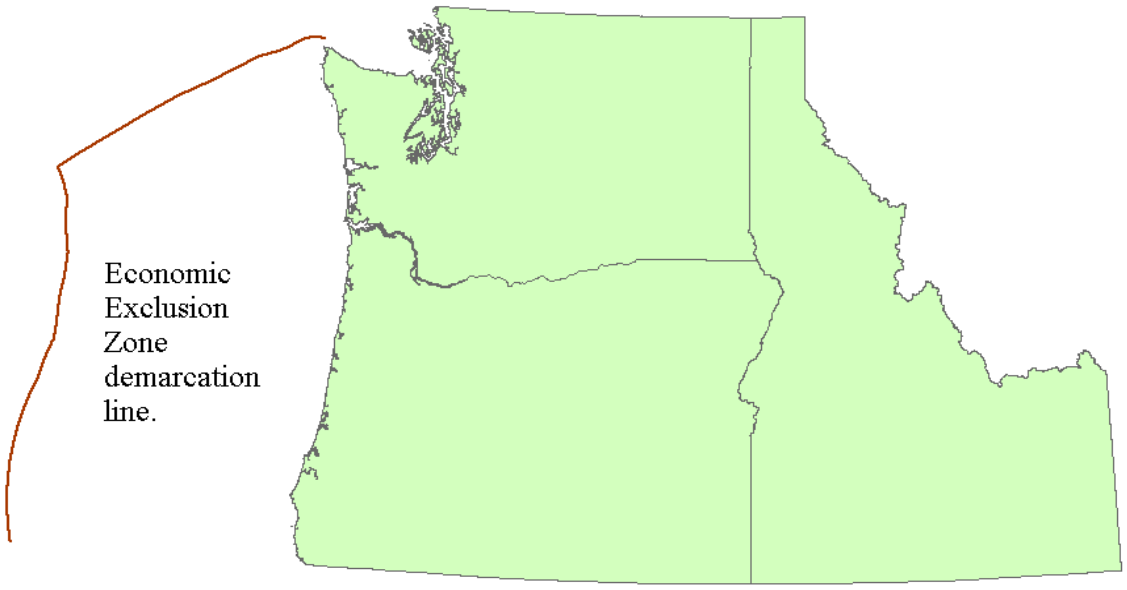
These response actions are not part of the proposed action and would require a separate section 7 consultation along with a separate ITS.

1.2.1 Action Area

The 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(d)). The NWACP covers the USCG COTP Zones[9] Puget Sound and Portland, the states of Washington, Oregon, and Idaho, and the EPA's Inland Region 10, excluding Alaska. Specifically, the geographic area includes the waters under state (0 to 3 nautical miles [nm]) and Federal (3 to 200 nm) management jurisdiction off the coasts of Washington and Oregon, as well as the Snake River and Columbia River (and their tributaries) in the inland waters of Washington, Oregon, and Idaho. These zones, as well as specific geographic boundaries, are provided in the NWACP (Chapter 1000, Section 1400) and at the following website: http://www.rrt10nwac.com/. Generally, the USCG has jurisdiction over the "coastal zone" and the EPA has jurisdiction inland of the coastal zone. Both the coastal zone and the inland zone are defined in the National Contingency Plan (40 CFR 300.5). Figure 2 below illustrates the Economic Exclusion Zone (EEZ) within the action area 200nm off shore of Washington and Oregon. The action area is inclusive of all ocean, near coastal and inland waters (as appropriate) inside of the EEZ off the coast of Washington and Oregon.

[9] The COTP Zones are delineated in 33 CFR, Chapter 1, Part 3 - specifically Section 3.65-10 (Puget Sound) through 3.65-15 (Portland).

Figure 2. Action Area with the Economic Exclusion Zone delineated.



S pill s that may originate outside of the action area (*i.e.* oceanic waters outside of 200nm, spills within the EEZ off the California coast, or in Canadian waters) and drift into the action area will be covered by this Opinion provided that spill response (in the action area) is consistent with the ITS. For those spills that occur in the action area and subsequently drift outside of the action area to California, the USCG and the NOAA Fisheries Southwest region will follow the provisions of the MOA, and this ITS will not apply to those response actions.

1.2.2 Introduction to Oil Spill Response Methods

There are three objectives of oil spill response: (1) Protect human life; (2) prevent, where possible, or minimize the impacts associated with spilled oil; and (3) enhance recovery. To accomplish these objectives, three tactics may be employed. The first tactic is protection – exclude oil from sensitive habitats or reduce the amount that enters the habitat. The second tactic is recovery - remove floating oil from the surface of the water. The third tactic is cleanup – remove stranded oil from shoreline habitats using physical, chemical and/or enhanced biological means. In most spill response situations, protection and recovery of oil are the immediate goals, although all three can be done simultaneously.

1.2.2.1 Oil Spill Response Plans

Under FWPCA Section 311 and Oil Pollution Act (OPA) 90 Section 4201, the owner or operator of a tank vessel or facility participating in removal efforts is required to submit a response plan to the COTP. These response plans shall:

1. Be consistent with the requirements of the NCP and Area Contingency Plans;

2. Identify the qualified individual having full authority to implement removal actions, and require immediate communications between that individual and the appropriate Unified Command official and the persons providing personnel and equipment pursuant to this clause;

3. Identify and ensure by contract the availability of private personnel and equipment necessary to remove to the maximum extent practicable a worse-case discharge (including a discharge resulting from fire or explosion), and to mitigate or prevent a substantial threat of such a discharge;

4. Describe the training, equipment testing, periodic unannounced drills, and response actions of persons on the vessel or at the facility, to be carried out under the plan to ensure the safety of the vessel or facility and to mitigate or prevent the discharge or the substantial threat of a discharge.

5. Facility owners or operators shall ensure that their response plans are in accordance with the Area Contingency Plan (ACP) in effect 6 months prior to initial plan submission or the annual plan review. Facility owners or operators may at their option, conform to an ACP which is less than 6 months old at the time of plan submission.

1.2.2.2 Organizational Structure During Oil Spill Response

The Incident Command System (ICS) provides a modern organizational structure for responding to oil spills and hazardous substance emergencies, as well as other incidents (*e.g.* search and rescue). The ICS enables integrated communication and planning by establishing a manageable span of control. The USCG Management Handbook (USCG COMDTPUB P3120.17) was designed to assist personnel in the use of the ICS during response operations - it is not a policy document but rather is guidance for response personnel.

The ICS divides an emergency response into five manageable functions: Command, Operations, Planning, Logistics, and Finance. A Unified Command is an essential component of the ICS and a management process for responding to a discharge/release of oil or hazardous substances. It forms the framework for an effective and efficient response management structure that brings together the functions of the federal government, state and local governments, and the responsible party. It integrates all responders into a coordinated ICS. Thus, the Unified

Command represents an evolution in response management by emphasizing cooperation among participants at all levels as the best means to achieving cleanup.

The Unified Command provides a management structure to facilitate cooperative participation by representatives from the Federal government, state and local governments, and the responsible party. The USCG or EPA FOSC retains the ultimate decision-making authority. The Unified Command recognizes that the most effective responses involve all parties working together to bring their respective expertise to the response. An ICS led by a Unified Command maintains a cooperative environment, promoting overall efficiency in the emergency response. Unified Command allows all parties with jurisdictional or functional responsibility for the incident to work together to develop a common set of incident objectives and strategies, share information, maximize the utilization of available resources, and enhance the efficiency of the individual response organizations.

The Planning Section is responsible for the collection, evaluation, dissemination and use of information about the progress of the incident and status of resources. This section tracks and assigns available personnel on site to the ICS organizational positions, as appropriate. In addition, this section collects, processes, and displays information about the status of the incident. The Planning Section also supervises the preparation of the Incident Action Plan (IAP) for the next operational period. The Planning Section provides input and recommendations for the IAP from appropriate technical specialists on resources-at-risk priorities, protection strategies and cleanup recommendations, and special operational plans, as needed (*e.g.* disposal, sampling, alternative response measures).

The Situation Unit is part of the Planning Section and is responsible for the collection and evaluation of information about the current and possible future status of the spill and the spill response operations. This includes the compilation of information regarding the type and amount of oil spilled, the amount of oil recovered, the oil's current location and predicted trajectory, the location and quantity of response resources, operational weather/tide/current information, and impacts on natural resources. The Situation Unit helps in the creation of maps to depict the current and possible situation for reports, IAP and ICS briefings.

Resource trustee representatives (*e.g.* NOAA Fisheries and USFWS) provide information about sensitive resources and appropriate response techniques through the Planning Function, specifically in the Environmental Unit. Trustee representatives participate and assist in activities affecting lands and resources under their jurisdiction. For example, trustee representatives may recommend changes in protection priorities or response activities that could prevent or minimize adverse effects to natural resources.

The Environmental Unit leader is responsible for environmental matters associated with the response, including strategic assessment, permitting, modeling, surveillance, and environmental monitoring. The Environmental Unit prepares environmental data for the Situation Unit. Technical Specialists frequently assigned to the Environmental Unit include the Scientific Support Coordinator and the Sampling, Response Technologies, Trajectory Analysis, Weather

Forecast, Resources at Risk, Shoreline Cleanup Assessment, Historical/Cultural Resources, and Disposal Technical Specialists. Relevant duties of the Environmental Unit leader include:

1. Participate in planning section meetings.

2. Identify sensitive areas and recommend response priorities.

3. Determine the extent, fate, and effects of contamination.

4. Acquire, distribute, and provide analysis of weather forecasts.

5. Monitor the environmental consequences of cleanup actions.

6. Develop shoreline cleanup and assessment plans.

7. Identify the need for, and prepare, any special advisories or orders.

8. Identify the need for, and obtain, permits, consultations, and other authorizations.

9. Evaluate the opportunities to use various response technologies.

10. Develop disposal plans.

11. Develop plan for collecting, transporting, and analyzing samples.

The Resources at Risk (RAR) Technical Specialist is responsible for identifying resources thought to be at risk from exposure to spilled oil by analyzing known and anticipated oil movement and the location of natural, cultural, and economic resources. The RAR Technical Specialist considers the relative importance of the resources and the relative risk to develop a priority list for protection. For larger spills, or in states like Washington, where there is an abundance of expertise, the RAR Technical Specialist may be another NOAA HAZMAT person or a state biologist. Duties of the RAR Specialist include:

1. Participate in planning meetings, as required.

2. Determine resource needs.

3. Obtain current and forecasted status information from Situation Unit.

4. Identify natural resources at risk.

5. Develop a prioritized list of the resources at risk for use by the Planning Section.

6. Provide status reports to appropriate requesters.

The Scientific Support Coordinator (SSC), in accordance with the National Contingency Plan, will provide the FOSC, with scientific advice regarding the best course of action during a spill response. The SSC will obtain consensus from the Federal natural resource trustee agencies (*e.g.* NOAA Fisheries and USFWS) and provide spill trajectory analysis data, information on the resources at risk, weather information, tidal, and current information, *etc.* The SSC will be the point of contact for the Scientific Support Team NOAA's Hazardous Material Response and Assessment Division. Relevant duties of the SSC include:

1. Represent the FOSC in planning meetings.

2. Determine resource needs.

3. Provide current and forecast incident status information for the Situation Unit by way of overflight maps and trajectory analysis.

4. Provide weather, tidal and current information.

5. Obtain consensus from the Federal natural resource trustees regarding response options and report to the OSC.

6. Develop a prioritized list of the resources at risk.

7. Provide status reports to appropriate requesters.

If requested, the SSC can act as an RAR specialist and develop the prioritized list. For a given spill, only one prioritized list will be generated by the Environmental Unit, after consultation with the appropriate trustees.

1.2.2.3 Decision-Making Process During Oil Spill Response

The environmental consequences of a spill and the response (or lack of response) will depend on the specific spill conditions, such as the type and amount of oil, weather conditions, and effectiveness of the response methods. During emergency response operations, responders must sort out any available information regarding the nature of the spill, the current and forecasted environmental conditions, and select and deploy equipment as soon and as effectively as possible. Information may be highly uncertain and fragmented at best. Because the goal of oil spill response is to minimize the overall impacts on natural and economic resources, some resources will be of greater concern than others, and response options offering different degrees of resource protection will be selected accordingly.

Decisions regarding the choice to use specific cleanup method(s) must balance two factors. One is the potential environmental impact associated with natural recovery, which incorporates an evaluation of the spilled and/or weathered oil toxicity and the organisms or habitat that may be

exposed to oil. The second factor involves the potential environmental impacts associated with a response method or suite of methods, and considers the potential impact(s), benefits and effectiveness associated with each of the various cleanup techniques.

Endangered and threatened species are given special consideration in determining the resources-at-risk priority and will always be listed as high priority resource if the potential for them to be impacted by either the oil or response activities exists. The next step is to identify the protection priorities. The ability to actually protect the resource and the length of time before the oil will impact the resource will be taken into consideration in setting the protection priorities. The protection of an endangered species may be lower if there is no viable technique to protect them, or if another resource of value will be impacted in a much shorter time period. Input on protection priorities comes from both the Environmental Unit (see description above) and operations.

1.2.2.4 Tiered Consultation

For particular response scenarios (described below), the USCG/EPA will conduct "tiered consultation" with NOAA Fisheries. Given one or more of these scenarios, the USCG/EPA will, if possible, document in writing the proposed response method and site-specific conditions, and supply these documents to NOAA Fisheries for tiered consultation review as soon as practicable, prior to conducting the proposed response method. In-person meetings or phone calls may be used to expedite tiered consultation response; NOAA Fisheries may request supplemental information be provided in these circumstances. In cases where a NOAA SSC is onsite, they may provide technical support to the FOSC to facilitate tiered consultation. In some cases, there will not be enough time to for written communication to occur prior to implementation of actions identified as needing tiered consultation, thus the USCG/EPA will document in writing the substance and subsequent agreements of the tiered consultation after personal communication is used.

Tiered consultation will help to determine if the proposed recovery method is within the range of effects analyzed within this Opinion, and may defer to independent consultation, as specified in the MOA and shown in the schematic in section 1.1.1. after spill response is finished. In cases where emergency conditions do not allow for tiered consultation to occur prior to implementing one of the measures below, the USCG/EPA and NOAA Fisheries will determine whether the effects of the action fit within this Opinion, or whether independent consultation is warranted. The purpose of tiered consultation is to determine methods that further minimize effects from spill response based on site-specific conditions and species use. State biologists, local government or response staff and others, may assist with data request and methods to minimize impacts.

The following spill response scenarios will require tiered consultation:

1. Booming – within rivers and streams with out-migrating/rearing salmon and steelhead, when booms leave less than 18 inches of clearance underneath, including tidal cycles/river stages, within 50 feet of shoreline for more than 24 consecutive hours.

2. In-Situ Burning – prior to use of *in-situ* burning.

3. Chemical Dispersants – when, during monitoring, large (>5 whales or >10 Steller sea lions) feeding aggregations of listed marine mammals are sighted in the area (within 1 mile of proposed application site) in which chemical dispersants are being considered.

4. Berms and Barriers – within rivers and streams with out-migrating/rearing salmon and steelhead, prior to berm and barrier construction.

5. Oiled Debris Removal – Prior to removal of large wood that is a structural component of streams/nearshore habitat.

6. Oiled Sediment Removal, Reworking, and Removal with Replacement – prior to work in lower intertidal and sub-tidal zones.

7. Flushing with Warm or Hot Water – prior to warm and hot water, moderate-pressure washing in waters that host migrating or rearing salmon/steelhead and/or critical habitat that may be adversely modified by an influx of warm or hot water.

8. Steller Sea Lions -- prior to oil spill response work within 500 feet from or on Steller sea lion rookeries or major haulouts when animals are present, or near (within 500 feet) rookeries during the breeding season (May 1 through August 31). Initial emergency work is allowed for all spill response methods covered in this Opinion except vegetation cutting, manual removal of oil, and oiled debris removal.

1.2.2.5 Natural Recovery

There may be an oil spill at a time, or in a place, or under particularly adverse environmental conditions, where there are no effective response methods that meet the objectives of oil spill response. Depending on the circumstances of a given situation—the type of oil spilled, the environment in which it was spilled and the degree of oiling—allowing natural recovery may represent the most effective and least environmentally harmful response to a spill. In such situations, the oil will spread, submerge, evaporate, and disperse, depending on the properties of the oil, and the environmental conditions surrounding the spill (*i.e.* currents, wind, wave energy). There are two reasons why this option may be the best choice: (1) Response to the spill may pose too great of a risk to humans due to location of the spill, environmental conditions, *etc.*; and/or (2) the environmental consequences of response may be greater than allowing natural recovery.

Natural recovery may be used in any habitat; however, this response may be preferred when one or both of the following conditions exist. First, natural recovery may be preferred in habitats that contain a level of wave energy high enough to promote oil removal and degradation at a rate that is at least equal to the rate of removal that could be achieved through another response method. Second, natural recovery may be preferred when other response activities are expected to cause more harm than allowing natural processes to remove oil from the affected area. The choice to allow natural recovery is followed by monitoring for natural oil removal and biological recovery.

While this Opinion focuses on the effects of response methods employed by the USCG and the EPA during an oil spill, it is important to keep in mind that without a response, the environmental consequences of oil impacting sensitive species or habitats may be far greater. Immediately and/or over time, oil may adversely impact ESA-listed species and their critical habitat. Having the chance to respond to an oil spill, to prevent oil from impacting such species and critical habitat, or clean up oil that has already reached an environment will reduce the adverse effects of the oil. In most cases, any short-term adverse impacts to a species or critical habitat through a response will far outweigh the long-term effects of oil on a population or habitat.

The response methods that may be used in the event of an oil spill are described in this section. Responses are designed for specific use in one of two general environments: (1) Open water; and (2) shorelines. Consequently, the response descriptions are divided by headings named for the environment in which they are used (*i.e.*, open water or shoreline habitat). In the interest of keeping the focus of this Opinion/EFH consultation on the response actions and the effects of those actions on listed species, most of the description of the open water and shoreline habitats can be found in Appendix B.

1.2.3 Oil Spill Response in Open Water

"Open water" includes: (1) Marine and brackish open water environments, which includes offshore waters, nearshore waters, bays and estuaries; and (2) fresh water open environments, which includes large lakes, large rivers, small lakes and ponds, and small rivers and streams. A description of these habitats as well as their sensitivity to oil and importance to salmonids is included in Appendix B.

1.2.3.1 Booming

The objective of booming is to control the spread of spilled oil and to protect ecologically sensitive habitats. There are four basic booming strategies: (1) Containment, where boom is used to contain and concentrate the oil until it can be removed; (2) deflection, where boom is used re-direct floating oil away from sensitive areas; (3) diversion, where boom is used to re-direct floating oil toward recovery sites that have slower flow, better access for equipment and personnel, and a means of removing the oil; and (4) exclusion, where boom is used to keep oil out of a sensitive area. In addition, booming strategies can be used in combination with each other. Boom may also be used to enhance recovery of oil by skimmers (described in subsection

1.2.3.2) or to collect and concentrate a sufficient thickness of oil on the water's surface to allow *in-situ* burning (described in subsection 1.2.3.4). During a response, boom is typically in place for days to a week, depending on the spill. During that time, boom may be moved and repositioned to maximize its effectiveness at containing, excluding, diverting or deflecting oil.

Boom is a continuous, flexible floating barrier that is placed on the surface of the water to control the transport of oil and to protect sensitive habitats. Containment boom is the primary tool used for shoreline protection and oil collection and diversion. Oil spill containment boom generally has five operating components - flotation chamber, freeboard, skirt, tension member and ballast. The overall height of the boom is divided between the freeboard, the portion above the surface of the water, and the skirt, the portion below the water surface. Boom heights range from approximately 6 to 90+ inches, to address different types of waterbodies and environmental conditions. For example, in rivers and canals, responders will typically use a 6- to 18-inch boom, while in the ocean, a 90-inch boom will often be used. Flotation attached to the freeboard and ballast attached to the skirt (*e.g.*, chain, weights) enable the boom to float upright in the water. In other words, the plane created by the boom is perpendicular to that of the surface of the water. Boom is typically made up of several 50 foot sections; the sections, and the joints between sections, provide flexibility both in boom length and shape.

Depending on the specific booming strategy employed, boom is towed through the water, anchored in place, or attached to the shoreline or a vessel. Depending on the size of the boom or the environmental conditions, the number and size of anchors may vary. Small anchors (20 to 40 pounds) will not hold in high currents or wind; therefore, 80 to 100 pound anchors may be used, or two or more anchors at a time may be needed to keep a boom in place. Danforth anchors are typically used.

Boom can potentially be used in all open water habitats, depending on environmental conditions, but boom placement may be constrained by water depth and boat accessibility (except in the cases of very small bodies of water, where boom may be deployed by hand). Boom may come in contact with the substrate in shallow water or along shorelines. However, this is undesirable in most cases, as typical floating boom that comes into contact with the substrate is likely to lie flat and lose its ability to contain oil. Boom designed for this specific purpose (*i.e.*, to maintain containment after coming in contact with the substrate), known as "intertidal boom" or "tidal seal boom," may be used for oil containment along shorelines. Like other boom, intertidal boom floats up and down over tidal cycles; however, the skirt is replaced by one or two continuous tubes filled with water, which forms a seal with the substrate. As a result, a vertical plane is maintained by the boom and it continues containing oil as the tide recedes. Traditional boom attached to the shoreline typically comes in contact with substrate along shorelines for only a short distance, usually less than 10 feet, depending on the slope of the shoreline.

In addition to shallow water depths, the effectiveness of booming strategies can be significantly reduced by wind, currents, waves and the presence of large quantities of floating debris. Once deployed, boom is routinely checked and repositioned by response personnel using small boats to maximize its effectiveness in changing environmental conditions.

The selection of the appropriate booming method and technique to install a particular strategy for a shoreline, river, or open water area is conditional on many environmental factors, as well as the type and amount of oil spilled and where it is moving. The GRPs were developed to help first responders avoid confusion during a spill regarding the priorities for placing booms. They also serve as an advantage to responders to have pre-selected booming sites, since less time is needed to make decisions to determine the "best" area to boom. As part of the NWACP, each GRP document serves as "orders" during a spill in the area covered by the appropriate GRP, and contains priority sites requiring protection or exclusion by boom. Such sites could include pupping sites for marine mammals or sensitive habitat such as eelgrass beds.

1.2.3.2 Skimmers

The objective of this response action is to recover floating oil from the water surface using mechanized equipment known as skimmers. Skimmers are placed at the oil/water interface to recover, or skim, oil from the water surface and may be operated independently from shore, mounted on vessels, or completely self-propelled. Recovery operations using this response method often place skimmers where oil naturally accumulates: in pockets, pools or eddies.

Skimmers come in a wide variety of shapes and sizes, and there are numerous types or categories of skimming devices, including weir, centrifugal, submersion plane, and oleophilic. Weir skimmers use gravity to drain oil from the water surface into a submerged holding tank. Once in the holding tank, oil may be pumped away to larger storage facilities. Centrifugal (also vortex) skimmers create a water/oil whirlpool in which the heavier water forces oil to the center of the vortex. Once in the center, oil may be pumped away from the chamber within the skimmer. Submersion plane skimmers use a belt or inclined plane to push oil beneath the water surface and toward a collection well in the hull of the vessel. Oil is scraped from the surface and then flows upward into a collection well, where it is subsequently removed with a pump.

Oleophilic (*i.e.*, having an affinity for oil) skimmers may take on several forms (*e.g.*, disc, drum, belt, rope, brush), but the general principle of oil collection remains the same; oil on the surface of the water adheres to an oleophilic surface. Once oil has adhered to the surface it may be scraped off into containers or pumped directly into large storage tanks. Two types of oleophilic skimmers that are commonly used include "rope" skimmers and "belt" skimmers. Band, or "rope," skimmers use an oleophilic material such as polypropylene. Oil is collected by a floating, continuous rotating band or "rope" drawn through an oil slick or along the water's edge of a contaminated area. These bands are used in either static (stationary) or dynamic (towed) modes. Bands can be torn by solids or skimmed debris. Efficiency of these skimmers is high in calm waters, and poor in choppy waters and waves. "Belt" skimmers use an oleophilic belt mounted on the front of a small vessel. The oleophilic belt pushes the floating oil below the waterline. Oil not adsorbed by the belt is recovered in a holding area behind the belt. Oil carried up the belt is recovered at the top of the system by a squeeze belt or scraper blade. It is then pumped into a storage container. These skimmers cannot operate in shallow waters or tight areas.

In shallow water, hoses attached to vacuum pumps may be used instead of other skimming devices described earlier in this section. Flat head nozzles, sometimes known as "duckbills" are often attached to the suction end of the hose to maximize the contact between the oil and vacuum, thereby minimizing the amount of water that is removed from the environment. Duckbills (very much like an attachment to a vacuum cleaner) are typically 18 inches or less in width and less than 2 inches in height. Consequently, duckbills are relatively small and designed for maximizing the amount of oil removed from the water surface relative to the volume of water removed. Vacuum hoses may also be attached to small, portable skimmer heads to recover oil that has been collected.

To minimize the amount of water collected incidental to skimming oil, booming may be used in conjunction with skimming to concentrate the floating oil in a wedge at the back of the boom, which provides a thick layer of oil to the skimmer head. Oil is herded to a collection point along a containment boom close enough to shore yet in water of sufficient depth for the skimmer to function. Adequate storage for recovered oil/water mixtures, as well as suitable transfer capability, must be available.

This response method can be used in all water environments (weather and visibility permitting) for most oils. The presence of large waves, strong currents, debris, seaweed, kelp, as well as viscous oils, will reduce skimmer efficiency.

I. Decanting

Efforts are made to minimize the amount of water collected during skimming (as discussed above). However, the collection of water, in addition to oil, may be a reality in some circumstances. Limited storage capacity for oil and water collected through skimming restricts the oil removal efficiency of skimmers. Decanting is a procedure that can help maximize the use of storage space. When decanting is not used, storage limitations may necessitate that the removal of floating oil, either by skimming or vacuuming, is ceased until more storage is available. Furthermore, more oil collected in a shorter period of time reduces the chances that the oil will emulsify, making it much harder to recover.

Decanting is the process of draining off recovered water from portable tanks, internal tanks, collection wells or other storage containers to increase the available storage capacity for recovered oil. The tanks are allowed to sit for a sufficient period of time to permit oil to float to the top of the tanks. Water is then drained from the bottom of the tank (stopping in time to retain most of the oil). The water removed from the bottom of the tank is discharged back into the environment, usually in front of the skimmer or back into a boomed area. When decanting is conducted properly, minimal oil is discharged back into the environment. The decanting process is monitored visually to ensure prompt detection of oil discharges in decanted water and that water quality standards set forth in the CWA are not violated.

The NWACP Decanting Policy addresses "incidental discharges" associated with oil spill response activities. Incidental discharge is the release of oil and/or oily water within the

response area in or proximate to the area in which oil recovery activities are taking place during and attendant to oil spill response activities. Incidental discharges include, but are not limited to, the decanting of oily water, oil and oily water returns associated with runoff from vessels and equipment operating in an oiled environment, and the wash down of vessels, facilities and equipment used in the response. Incidental discharges, as addressed by this policy, do not require additional permits and do not constitute a prohibited discharge [see 33 CFR 153.301, 40 CFR 300, RCW 90.56.320(1), WAC 173-201A-110, ORS 468b.305 (2)(b)].

Decanting may be allowed because of storage limitations; however, it may not be permitted in all cases. In these cases, the NWACP does advise the FOSC to consider and authorize the use of decanting on a case-by-case basis, after an evaluation of the environmental tradeoffs of allowing oil to remain in the environment (because of storage limitations) or discharging decanted water. The response contractor or responsible party will seek approval from the FOSC and/or State Office of Species Conservation(OSC) (SOSC) prior to decanting by presenting the Unified Command (discussed earlier in Organizational Structure of Oil Spill Response) with a brief description of the area for which decanting approval is sought, the decanting process proposed, the prevailing conditions (wind, weather, *etc.*) and protective measures proposed to be implemented. The FOSC and/or SOSC will review such requests promptly and render a decision as quickly as possible. The FOSC authorization is required in all cases and in addition SOSC authorization is required for decanting activities in state waters.

Several criteria to minimize impacts of decanting and incidental discharge associated with responses to oil spills are included in the NWACP. The following criteria are to be considered by the FOSC and/or the SOSC in determining whether to approve decanting, unless circumstances dictate otherwise:

(1) All decanting should be done in a designated "response area" within a collection area, vessel collection well, recovery belt, weir area, or directly in front of a recovery system.

(2) Vessels employing sweep booms with recovery pumps in the apex of the boom should decant forward of the recovery pump.

(3) All vessels, motor vehicles and other equipment not equipped with an oil/water separator should allow retention time for oil held in internal or portable tanks before decanting commences.

(4) When deemed necessary by the FOSC and/or the SOSC, a containment boom will be deployed around the collection area to minimize loss of decanted oil or entrainment.

(5) Visual monitoring of the decanting area shall be maintained so that discharge of oil in the decanted water is detected promptly.

(6) Decanting in areas where vacuum trucks, portable tanks or other collection systems are used for shore cleanup will be subject to the same rules as vessels.

(7) The FOSC and/or SOSC will review and provide directions and authorizations as appropriate to requests to wash down vessels, facilities and equipment to facilitate response activities.

1.2.3.3 Removal of Floating Oil -Sorbents

The objective of this response is to remove floating oil by allowing the oil to adhere to pads or rolls made of oleophilic material that is generally opaque and white in color. The dimensions of sorbent pads are typically 2 foot by 2 foot. Sorbent rolls are generally wider than 2 foot and may be 100 feet long. The use of sorbents to remove floating oil is different from the use of skimmers in two ways: (1) The use of sorbents is a passive oil collection technique that requires no mechanized equipment, whereas skimmers are active vessels for oil collection; and (2) sorbents are left temporarily in place in the affected environment to adsorb oil in a specific locale, whereas skimmers may transit to collect oil in a broader area.

Sorbents are most likely to be used to remove floating oil in nearshore environments that contain shallow water. They are often used as a secondary method of oil removal following gross oil removal, such as skimming. Sorbents may be used for all types of oil; lighter oils absorb into the material and heavier oils adsorb onto the surface of sorbent material, requiring sorbents with greater surface area.

1.2.3.4 In-Situ Burning

I. Objective and Procedure

The objective of *in-situ* burning is to remove oil from the water surface or habitat by burning it in place, or *in-situ*. Oil floating on the water surface is collected into slicks a minimum of 2 to 3 millimeters (mm) thick and ignited. In open water environments, oil for *in-situ* burning is likely to be collected by two boats towing a fire-resistant boom in a U-formation. The open end of the U is maneuvered through the oil slick and a "boomful" of oil is collected. The boom is towed away from the main slick and the oil is ignited. During the burning, the pooled boom slowly advances ahead of the current to ensure that the oil is concentrated at the back end of the boom and maintains maximum thickness. After the oil is burned, the process may be repeated for as long as *in-situ* burning is feasible. In a slow-moving river (<1 knot), a fire-resistant boom may be anchored across the river to collect the oil. When the oil layer is thick enough, the oil is ignited. In both situations, it is possible to stop the burn by releasing one end of the boom, or by towing it faster so that the oil is no longer contained and, as a result, the thickness of oil necessary to sustain a boom is not maintained.

Although in-situ burning may be used in any open water environment, the environment dictates the specific procedure employed in a given burn. For example, in offshore and nearshore marine environments, bays and estuaries, large lakes and large rivers, a boom may be towed at 1 knot or less during the burning process to maintain the proper oil concentration or thickness. In rivers and small streams, oil carried by currents may be collected and concentrated in stationary boom

attached to the shoreline or other permanent structures (*e.g.*, pilings). In small lakes and ponds the body of water may be too small or shallow to tow a boom and there may not be any consistent current. Wind or mechanically generated currents (known as herding) may be used to collect and concentrate oil along the shoreline or in a stationary boom attached to the shoreline.

Once an oil slick is sufficiently thick, such that it will provide enough insulation to sustain the heat that will produce vapors, an external igniter is used to heat the oil. During combustion, the oil vapors ignite and burn, rather than the liquid itself. When enough oil burns that it stops providing insulation from the cool water below (about 1 to 2 mm thick), the vapors are no longer produced, and the fire goes out.

It is possible for as much as 95% of the oil contained within a boom to be burned, depending on the thickness of the initial layer of oil and the potential for igniting the oil. Thicker layers of oil will more readily ignite and sustain a burn, and such thickness increases with weathering and viscosity of oils. Burning drastically reduces the requirement for waste storage and disposal. Weathered and emulsified oils that contain more than 50% water are extremely difficult to ignite. Therefore, it is important to make the decision to burn within 24 to 48 hours of the spill.

The NWACP requires that trade-offs between the effects of the emissions produced from *in-situ* burning, such as polyaromatic hydrocarbons (PAHs), and the contamination that may result from floating oil or oil that washes ashore, are carefully weighed in making the decision to conduct an *in-situ* burn. The decision to burn involves three basic factors, as outlined in the NWACP. First, if the oil has ignited due to a collision or other means, allowing continued burning may be unavoidable or beneficial. Second, the decision to burn must consider whether this response method will offer a greater level of efficiency in removing oil on water and/or reducing oil impacts to sensitive resources. Natural resource managers are consulted to help determine that *in-situ* burning will cause less overall harm to marine resources (*e.g.* effects of heat or burn residue) than the harm to those resources anticipated if *in-situ* burning does not occur (*e.g.* oiling of shoreline, wildlife). Third, the decision must evaluate whether it is practicable, feasible and safe to burn, given the spill and the conditions involved.

II. In-situ Burn Policy

The *in-situ* burn policy applies to all marine waters as well as inland areas covered by the NWACP. The purpose of the policy is to define conditions under which burning may occur on a pre-approved or case-by-case basis and define conditions under which burning will not be allowed. Under this policy, "pre-approval areas" are defined as those areas which are more than 3 miles distant from a "population," defined as more than 100 people per square mile. All other areas are considered on a case-by-case basis. Decisions to burn or not to burn oil in areas considered case-by-case are made on the basis of the potential for humans to be exposed to the smoke plume, and pollutants associated with it. Exposure to small particles (PM-10) is generally limited to 150 micrograms per cubic meter; however, a cap on exposure to PM-10 has been set in the NWACP at 150 micrograms per cubic meter averaged over a 24 hour period. Smoke plume modeling is performed to predict which areas might be adversely affected. In addition, *in-situ*

burn responses require down-wind air monitoring for PM-10. Aerial surveys are also conducted prior to initiating a burn to minimize the chance that concentrations of marine mammals, sea turtles, and birds are in the operational area and may be affected by the response.

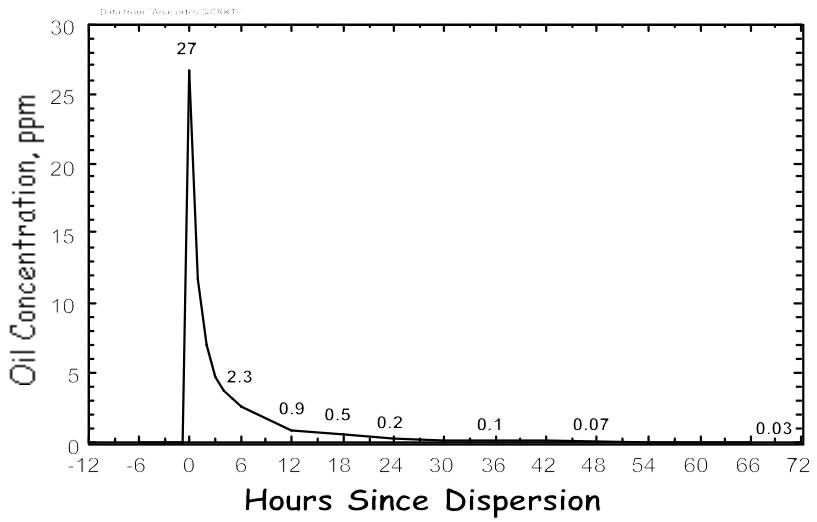
1.2.3.5 Chemical Dispersion of Floating Oil

The objective of this response action is to reduce the impact of oil to sensitive shoreline habitats and animals that use the water surface by chemically dispersing oil into the water column. Dispersants are chemicals that reduce the oil / water interfacial tension, thereby decreasing the energy needed for the slick to break into small droplets and mix into the water column. Specially formulated products containing surface-active agents (surfactants) are sprayed from aircraft or boats onto the slick. On average, the concentration of dispersants sprayed are 2 to 5% by volume of the oil. Agitation from wind / waves is required to achieve dispersion. Depending on the level of energy, very small droplets of oil (10 to 100 microns in diameter) are mixed in the upper meter of the water column creating a sub-surface plume. This plume of dispersed oil droplets rapidly (*i.e.* within hours) mixes and expands in three dimensions (horizontal spreading and vertical mixing) down to as much as 10 meters below the surface (Lewis *et al.* 1998, Lunel 1995, Lunel and Davies 1996, NRC 1989). As a result of this mixing, oil concentrations decrease rapidly from the initial peak concentrations, for example from 10 or 100 parts per million (ppm) down to 1 ppm or less, in hours to a day.

1.2.3.5.1 Fate

Figure 1-1 shows the mean concentrations of oil in a dispersed oil plume starting 2 to 3 miles east of northern Whidbey Island 6 hours following a 500 barrel (bbl) spill of Alaska North Slope Crude oil near Anacortes, Washington on April 11, 1998 (after Mearns *et al.* 2001a). The mean oil concentration peak at dispersion was about 27 ppm. Six, 12, 24 and 48 hours later the mean concentration declined to 2.3, 0.9, 0.2 and 0.07 ppm, respectively, as the plume expanded. At a dispersant concentration equal to 5% of the oil (1:20), mean dispersant concentrations will be 1/20th of those shown for the oil.

Figure 1-1. Simulation of trend in mean oil concentrations (ppm total oil) in subsurface plume of Alaska North Slope oil dispersed 6 hours after a 500 bbls spill near Anacortes, Washington, under tidal current conditions prevailing April 11-13, 1998. After Mearns *et al.*2001. At a dispersant/oil ratio of 1:20, mean free dispersant concentrations in the water would be 1/20th of the oil concentrations given above (*i.e.*, peak dispersant concentration 1.4 ppm).



This example is one of many model runs done to determine dispersed oil concentrations and the rates at which they decrease following treatment. Several field studies have been conducted on dispersion of oil and actual measurements of dispersed oil concentrations (Cormack and Nichols 1977, McAuliffe *et al.* 1980, McAuliffe *et al.* 1981, Lichtenthaler and Daling 1985, Brandvick *et al.* 1995, Walker and Lunel 1995, Coelho *et al.* 1995). Measurements taken during field studies are important because they provide information about the "behavior" of dispersed oil (*e.g.*, size of the plume, concentration of oil in the water column) over time and in relation to variable conditions, such as type and amount of spilled oil, the environment and the dispersant used. Some field studies indicate that the maximum concentration of oil in the top 1 meter of the water column, after highly effective dispersion (80 to 95%) may range from about 20 ppm to over 100 ppm (McAuliffe *et al.* 1981) in the first 30 minutes following application of the dispersant; typical concentrations over this period range between 20 ppm and 50 ppm (Coelho *et al.* 2002, McAuliffe *et al.* 1980, Lichtenthaler and Daling 1985, Coelho *et al.* 1995, Brandvick *et al.* 1995, Walker and Lunel 1995), for approximately 500 barrels of oil. (Dispersed oil concentrations depend on the volume of oil available for dispersion and the efficiency with which it is dispersed. Concentrations of dispersed oil for studies in which 100 to 150 barrels of oil were dispersed yielded maximum concentrations of approximately 2 to 8 ppm.) Dispersed oil concentrations were generally between 1 and 4 ppm one hour after application of the dispersant in all of the studies. These data indicate that the models are conservative (*i.e.* they overestimate the concentrations of dispersed oil that actually occurs in the field).

1.2.3.5.2 Effectiveness

Applications of dispersants are rarely 100% effective, so some oil will likely remain floating on the surface. Dispersing oil will also change the trajectory of the oil plume from onshore to along-shore, as dispersed oil is no longer transported by the wind. Therefore, oil dispersion may help protect sensitive shoreline environments, as wind is usually the dominant environmental factor that brings floating oil ashore to strand. Because of the relatively short window of opportunity (generally the first 24 hours) in which oil may be dispersed, the decision to use, and the implementation of, this response is time critical.

1.2.3.5.3 Monitoring

Knowing the concentration of oil in the water column after dispersion allows wildlife managers and spill responders to evaluate the potential risks involved with dispersion.

1.2.3.5.4 NWACP Dispersant Use Policy

After the potential impact of the floating oil has been determined to be greater than the potential impact of dispersed oil, this response can be used in marine open waterbodies with sufficient depth and volume for mixing and dilution of dispersed oil.

In accordance with the NCP, the FOSC may authorize the use of dispersants in pre-approved areas. Prior to deploying dispersants, a dispersant use checklist included in the NWACP is filled out to verify that the pre-approval criteria have been met. The FOSC also notifies the EPA and appropriate state and Federal natural resource trustees of when and where dispersants will be deployed. Trustees may request assistance in observing the dispersant operations and/or conducting visual surveys to ensure that listed species are not at risk. In those areas where dispersant use is approved on a case-by-case basis, the NCP requires the FOSC to obtain permission from the Regional Response Team (RRT). The FOSC will submit the completed dispersant use checklist from the NWACP to the RRT. After reviewing the checklist information, the RRT will decide whether to approve or deny permission to use dispersants. In approving dispersant use, the affected state and EPA members of the RRT must concur. The RRT members with natural resource trustee responsibilities, such as the Department of Interior and Department of Commerce, must be consulted. Dispersant operations will be monitored for effectiveness by the FOSC using SMART (Special Monitoring for Advanced Response Technologies)[10]. Tier 1 (visual monitoring) protocols will always be conducted; Tier 2 and 3 (fluorometric monitoring) protocols will be conducted wherever feasible.

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[10]Readers interested in learning more about SMART protocols can visit the following webiste: http://response.restoration.noaa.gov/oilaids/SMART/SMART.html.

I. Washington

Based on an Environmental Impact Statement (EIS) prepared by Washington Department of Ecology (WADOE) in 1993, dispersants may be used in Washington State waters when the following conditions are met: (1) Water is greater than 60 feet in depth; (2) the area in which dispersants are to be used is at least 3 miles from sensitive resources and shoreline; (3) there is a significant likelihood that floating oil will impact sensitive resources; (4) the potential dispersant use area is larger than 200 sqare km; and (5) the risk to fish in the water column ranks low relative to the risk to wildlife and/or sensitive habitat(s).

The EIS identified geographical areas in Washington state waters and temporal windows when all five of these conditions were met ("pre-approved areas"). In areas where criteria 1 through 4 were met, but the relative risks of fish to wildlife/sensitive habitats (*i.e.*, the risks to the water column posed by dispersed oil as compared to the risk posed by floating on the surface or to shoreline habitats) could not be predicted, dispersant use is allowed on a case-by-case basis. In such situations, the RRT approves or disapproves dispersant use after consultation with resource trustees.

The State of Washington prohibits the use of dispersants in Puget Sound waters east of Port Angeles any time of the year except in Haro Strait (see below). Chemical dispersion is generally pre-approved for use in outer continental shelf and shelf edge offshore waters summer through winter months (June to February) because these areas meet specified criteria (WADOE 1993). These offshore waters may be approved for use of chemical dispersants on a case-by-case basis in the spring (March to May).

Inner shelf and continental slope offshore waters may be approved for dispersant use on a case-by-case basis throughout the year. In addition, the following three areas may be approved for dispersant use on a case-by-case basis only in the specified months: (1) the outer Strait of Juan De Fuca between September to November; and (2) Haro Strait between March to May and September to November. As determined in the Washington State EIS (WADOE 1993) the use of dispersants in Puget Sound waters is prohibited east of Port Angeles any time of the year (except Haro Strait March to May and September to November).

II. Oregon

The State of Oregon did not conduct an EIS study, but adopted the Washington State dispersant use criteria described above. Therefore, because no formal environmental analysis of trade-offs has been done, the use of dispersants in Oregon state waters meeting criteria 1 to 4 is on a case-by-case basis; there are no pre-approved areas for dispersant use in Oregon.

III. Idaho and Inland Waters

Dispersants have not been approved for use in any fresh or brackish open water areas any time of the year (includes the states of Idaho, Oregon, and Washington).

1.2.3.6 Barriers/Berms and Underflow Dams

The objective of this response action is to prevent entry of oil into a sensitive area or to divert oil to a collection area. A physical barrier is placed across an area of moving water to prevent moving oil from passing. Oil may be removed using sorbent material, placed in the water where oil is trapped by the barrier, skimmers or vacuums. Barriers can consist of earthen berms, filter fences, boards or other solid barriers. Because of the time and labor required to construct berms, they are likely to be in place for 1 to 5 weeks, depending on the specific event, if the decision is made to implement this response. This response is more likely to be implemented in shallow and small waterbodies, rather than deep waterbodies.

Earthen berms are fortified with sandbags or geotextile fabric (fabric or synthetic material that enhances water movement and retards soil movement), to minimize the amount of siltation that may be caused as a result of the structure. Silt fences and settling ponds (or a series of them) are used to contain any suspended sediments that may be mobilized in the water while the berm is being constructed in place or being removed. In-stream barriers may be removed using manual or mechanical means, or both, depending on the accessibility of the site, the size of the structure and stream, and the sensitivity of the area to the use of heavy machinery.

If it is necessary for water to pass because of water flow volume or downstream needs, underflow dams (for low flow rates) can be used. Underflow dams contain oil with a solid barrier (*e.g.* boards, earthen berms) at the water level, while a submerged pipe (*e.g.*, PVC or opening along the bottom of the barrier) allows some water to flow beneath and past the barrier. This response action is used in small rivers and streams, or at the entrances to shallow sloughs when the flow of oil threatens sensitive habitats.

1.2.3.7 Vegetation (Kelp) Cutting

The objective of this response method is the removal of large quantities of oil trapped in the canopy of kelp beds. Vegetation cutting is used to prevent the risk of oiling of sensitive wildlife using the kelp habitat or the remobilization of trapped oil to other adjacent sensitive environments. Thick layers of oil can become trapped in the dense surface canopy of kelp, adhering to kelp fronds or collecting under the kelp canopy, increasing the persistence of oil within the environment. While the mucous coating on kelp prevents oil from directly adhering to fronds, the increase of oil persistence within the canopy increases the risk of exposure to organisms concentrated in the habitat, particularly during storms, which could re-expose and release trapped oil into the environment. This response action may be used in nearshore marine areas along the coasts and northern Puget Sound.

To recover the trapped oil, responders may choose to cut kelp and remove it for disposal. The upper 1 to 2 feet of the kelp canopy is cut away by hand (*e.g.* for bull kelp *Nereocystis leutkeana* or a mechanical kelp harvester (*e.g.* for giant kelp *Macrocystis pyrifera*). The oiled kelp cuttings are removed for disposal. Any remaining oil pooled around the holdfasts and stipes can then be

flushed out for recovery. Trapped tar balls in the kelp are freed and can be manually collected or flushed to a collection site.

1.2.4 Oil Response in Shoreline Environments

1.2.4.1 Introduction and Background to Habitat Classifications

The OPA 90 and similar state legislation established oil spill contingency planning requirements that necessitate information on the location of sensitive resources to be used as the basis for establishing protection priorities. Environmental Sensitivity Index (ESI) maps have served as an integral component of oil spill contingency planning and response since 1979, when the first maps were quickly prepared in response to anticipating the arrival of oil slicks from a well blowout in the Gulf of Mexico. In the Pacific Northwest, a total of 161 maps have been prepared: 55 maps have been prepared for the Oregon/Washington outer coast (published in 1989), 26 maps have been prepared for Oregon/Washington and the Columbia River (published in 1989) and 36 and 44 maps have been prepared for the Strait of Juan De Fuca/Northern Puget Sound (published in 1984) and Central/Southern Puget Sound (published in 1985), respectively, in Washington State.

The ESI maps are comprised of three general types of information: (1) Shoreline Classification - ranked according to a scale relating to sensitivity, natural persistence of oil, and ease of cleanup; (2) Biological Resources - including oil-sensitive animals and rare plants and habitats, which are used by oil-sensitive species or are themselves sensitive to oil spills; and (3) Human-Use Resources - specific areas that have added sensitivity and value because of their use, such as beaches, parks and marine sanctuaries, water intakes, and archaeological sites. Appendix B contains a detailed description of how shorelines and biological resources are classified, concentrating on those habitats and resources that are relevant to this Biological Opinion/EFH consultation.

Shoreline types labeled with ESI numbers are mapped in NOAA Sensitivity of Coastal Environments and Wildlife to Spilled Oil Atlases for Washington (Strait of Juan De Fuca/ Northern Puget Sound); Washington (Central/Southern Puget Sound); Oregon/Washington (Outer Coast). Shoreline types labeled with Columbia River Environmental Sensitivity Index (CR-ESI) numbers are mapped in NOAA Sensitivity of Riverine Environments and Wildlife to Spilled Oil – Columbia River Atlas. This information on shoreline types has also been captured in the GRPs developed for these areas. For areas where the shoreline types have not been mapped, shoreline types will be identified at the time of the spill using criteria from the *NOAA Environmental Sensitivity Index Guidelines (Version 3.0), March 2002* (NOAA 2002).

Shoreline types are ranked on a scale of 1 to 10, and this ranking is used on most ESI maps. Each ESI map has a legend that defines the shoreline ranking scale, describes the nature and distribution of each shoreline type in the area, predicts the behavior of oil on that shoreline type, and makes general cleanup recommendations. For the purposes of this programmatic consultation, the shoreline types are updated from existing ESI atlases for the following areas:

the Strait of Juan de Fuca and Northern Puget Sound, Central and Southern Puget Sound, Oregon and Washington, and the Columbia River. Specifically, the Columbia River has six shoreline types: unvegetated steep banks and cliffs (ESI-3), sand/gravel beaches (ESI-5), rip rap (ESI-6C), flats (ESI-7), vegetated banks (ESI-9B), and marsh/swamp (ESI-10).

1.2.4.2 Shoreline Type Consolidations

To facilitate the Programmatic Section 7 Consultation on the NWACP, some of the ESI shoreline types used in NWSCM, February 1998 (Chapter 9000, Section 9640 of NWACP) were consolidated in USCG (2002). Criteria for consolidation included the following: similar behavior of oil on shoreline, similarity of response techniques recommended between shoreline types, and similar utilization of shoreline types by ESA/EFH-listed species.

The 15 ESI/CR-ESI shoreline types were consolidated and will be used in this analysis from this point forward, both for the description of the response methods and in the Effects Analysis section.

(A) <u>Exposed Rocky Shorelines Consolidated</u>
- (1) ESI-1 — Exposed rocky cliff face and vertical sea walls or piers
- (2) ESI-2 — Exposed wave-cut platforms

(B) <u>Sand Beaches Consolidated</u>
- (1) ESI-3 [CR-ESI-1] — Fine- to medium-grained sand beaches
- (2) ESI-4 — Coarse-grained sand beaches
- (3) (ESI-5 [CR-ESI-2] — Mixed sand and gravel beaches

(C) <u>Gravel Beaches Consolidated</u>
- (1) ESI-6A — Gravel beaches – pebbles to cobbles
- (2) ESI-6B — Gravel beaches – cobbles to boulders
- (3) ESI-6C [CR-ESI-3] — Rip-rap

(D) <u>Tidal-Flats Consolidated</u>
- (1) ESI-7 [CR-ESI-4] — Exposed tidal flats
- (2) ESI-9A — Sheltered tidal flats of sand and mud

(E) <u>Sheltered Rocky Shore and Solid Man-made Structure</u>
- (1) ESI-8A — Sheltered vertical rocky shores and sheltered solid man-made structures

(F) <u>Sheltered Rubble Slope</u>
- (1) ESI-8B — Sheltered rubble slope

(G) <u>Sheltered Vegetated Low Bank</u>
- (1) ESI-9B [CR-ESI-5] — Sheltered vegetated low bank

(H) Marshes – Saltwater and Freshwater

(1) ESI-10 [CR-ESI-10] Salt/brackish water marsh and fresh water marsh and herbaceous/woody vegetation

1.2.4.3 Response Methods Used in Shoreline Environments

The response actions used in the shoreline environment are comprised of a variety of methods, each of which are further subdivided into two or more variations (Table 1-1). While the effects of each response, and each variation thereof, may be discussed separately, they have been consolidated in a similar process that followed in the consolidation of shoreline types. For the purposes of this analysis, it makes sense, both in terms of continuity and brevity, to consolidate response methods that are similar in terms of: (1) The habitats in which they are used (*e.g.*, sand beaches, rocky shorelines); (2) the types of effects that may potentially result from them (*e.g.*, increases in water temperature, turbidity); and (3) the overall activities associated with each (*e.g.*, boat activity, use of machinery). Where a variation of a response is expected to result in different or magnified effects to listed species, the analysis of effects is expanded to address such differences.

The shoreline responses listed below are, in general, consistent with the shoreline countermeasures matrices located and discussed in the NWSCM (found in NWAC [chapter 9000, section 9640]). However, in some cases discrepancies between NWSCM and USCG (2002) exist. The NWSCM (and NWACP) is a working document. In other words, practices have evolved to reflect new response technologies and experiences related to the successes or shortcomings of response methods. While the NWSCM represented practices in 1995, the information in USCG (2002) represents current practices.

The Biological Assessment provided a "Shoreline Countermeasures Matrix" modified from matrices provided in the NWSCM. The modified matrix is a composite of three matrices in the NWSCM for heavy (*e.g.* heavy crude oils, intermediate fuel oils, Bunker C and weathered medium crudes), medium (*e.g.* most crude oils and some heavily weathered light crudes) and light (*e.g.* diesel, No. 2 fuel oils, light crudes) oils. A fourth matrix for very light oils exists in the NWSCM, but it was not included because it is very seldom feasible to clean up very light oils (*e.g.* jet fuels, gasoline) on shorelines (USCG 2002). In each description of response, a description of the type of oil for which the particular response would be appropriate, will be provided, where possible.

Table 1-1 shows the various response methods that may be used in a particular habitat, as well as their likelihood of use (*i.e.* recommended or conditionally recommended). Table 1-2 includes a list of codes for response methods. In some shoreline habitats, no response technique has been categorized as recommended. In these circumstances, the term "none" is used. Note that the use of the term "none" is not intended to mean that the recommended response is no response. A response is "Recommended" when it may be the preferred response method that best achieves the goal of minimizing destruction or injury to the environment. A response may be

"Conditionally Recommended" when it is viable and possibly useful but may result in limited adverse effects to the environment.

Table 1-1 Response methods for oiled shorelines.

ESI Consolidated	Recommended Response	Conditionally Recommended Response
(A) Exposed rocky shorelines consolidated	none	r/so (mr, ps, vr) od fl (fl/lp, fl/ep) fl/wm (fl/ht) vc
(B) Sand beaches consolidated	r/so (ps) od	r/so (mr, vr) tr s/r (s/rw, s/rp) fl (fd, fl/lp)
(C) Gravel beaches consolidated	r/so (ps) od fl (fd)	r/so (mr, vr) tr s/r (s/rw, s/rp) fl (fl/lp, fl/ep) fl/wm (fl/ht) vc
(D) Tidal-flats consolidated	none	r/so (ps) od
(E) Sheltered rocky shore and solid man-made structure	r/so (mr, ps) od	r/so (vr) fl (fd, fl/lp, fl/ep) fl/wm (fl/ht) vc
(F) Sheltered rubble slope	r/so (mr, ps) od	r/so (vr) s/r (s/rp) fl (fd, fl/lp, fl/ep) vc
(G) Sheltered vegetated low bank	r/so (ps)	r/so (mr, vr) od tr s/r fl (fd, fl/lp) vc
(H) Marshes – saltwater and freshwater	r/so (ps)	r/so (mr, vr) od fl (fd, fl/lp) vc

Table 1-2 Codes for Response Methods presented in Table 1-1.

Code	Description	Variations of the response
r/so	removal of surface oil	**mr** = manual removal of oil (hand tools)
		ps = passive sorbents
		vr = vacuum removal
od	oiled debris removal	
tr	trenching/recovery wells	
s/r	oiled sediment removal	**s/rw** = oiled sediment reworking
		s/rp = oiled sediment removal with replacement
fl	flushing with ambient water	**fd** = flooding
		fl/lp = flushing with low pressure
		fl/ep = flushing with elevated pressure
fl/wm	flushing with warm water	**fl/ht** = flushing with hot water
vc	vegetation cutting	

1.2.4.3.1 Removal of Surface Oil

The objective of this response method to remove oil stranded on the shoreline with a minimum of sediment. Collected oil is placed in bags or containers and removed from the shoreline. No mechanized machinery is used, with the possible exception of All Terrain Vehicles (ATVs) that may be used to transport containers of collected oil to a staging area for retrieval. The ATVs are generally used on sand beaches, and restricted to transiting outside of the oiled areas along the upper part of the beach. The techniques used in the removal of surface oil can be used on most shoreline types, but they are most effective on sand or gravel beaches. It is most appropriate for light to moderate oiling conditions by medium to heavy oils. Light oils such as gasoline and diesel rapidly evaporate and spread out to very thin layers and are not easily picked up. Generally, removal of surface oil is not recommended on soft mud substrates (*e.g.* mud flats) where mixing of oil deeper in the sediment might occur, unless this activity can take place from a boat when the substrate is underwater. For similar reasons, removal of surface oil is typically only used along the edges of sheltered vegetated low riverbanks and marshes and must be closely monitored.

Three variations of this response exist: (1) Manual removal of oil; (2) passive collection of oil (sorbents); and (3) vacuum removal of oil. A brief description of each variation follows.

Manual Removal of Oil Using Hand Tools

The objective of this variation of the removal of surface oil is to remove oil by using tools such as hands, rakes, shovels, and other manual means. This response variation is most appropriate for light to moderate oiling conditions. Collected oil is placed in bags or containers and removed from the shoreline.

Habitats Used: Manual removal of oil using hand tools is recommended for use on: (1) Sheltered rocky shore and solid man-made structure and (2) sheltered rubble slope. This variation is conditionally recommended for use on: (1) rocky shorelines, (2) sandy beaches, (3) gravel beaches, (4) sheltered vegetated low bank, and (5) marshes. Manual removal is not recommended for use on tidal flats, where the threat of mixing oil deeper into sediments as a result of foot traffic is typically greater than the benefits gained through use of this variation.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Manual removal of oil may be used on all shoreline types with the exception of tidal flats; it is not recommended for this shoreline type because of the likelihood of mixing oil deeper into the sediments.

- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) or remobilization is expected; minimize burial and/or remobilization by conducting cleanup between tidal cycles (between high tides).

- Minimize the amount of sediment removed with the oil.

- Minimize foot traffic through oiled areas on non-solid substrates (sand, gravel, dirt, *etc.*) to reduce the likelihood that oil will be worked into the sediment.
- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to hazardous waste site.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pad and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

Passive Collection of Oil (Sorbents)

This variation of the removal of surface oil allows for oil adsorption onto oleophilic material placed in the intertidal zone or along the riverbank. Oil adheres to the outside of the material or "sorbs" into the material by capillary action. There are three basic types of sorbent materials: mineral based, natural organic, and synthetic organic. Currently, only synthetic organic sorbents are being used in the field in the forms of boom, pads, and mops. Sorbent material is placed on the surface of the shoreline substrate, allowing it to adsorb oil as it is released by tidal or wave action.

Sorbents most typically used for medium to heavy oils are snares (similar to cheerleader pompoms), made of oleophilic material. The oil must be of a viscosity and thickness to be released by the substrate and absorbed by the sorbent. Snares are attached at 18-inch intervals along a rope that can be tied, anchored or staked along the intertidal shoreline. As the snares are moved about by tidal or wave action, they also help remobilize oil by rubbing across rock surfaces. Snare lines are monitored on a regular basis for their effectiveness at picking up oil and so responders can collect and replace oiled sorbents with new material. This method is often used as a secondary treatment method after gross oil removal, and along sensitive shorelines where access is restricted. Passive collection with sorbents can also be used in conjunction with other techniques (*e.g.,* flushing and booming) to collect floating oil for recovery.

Habitats Used: This variation of the response is recommended for use on: (1) Sand beaches, (2) gravel beaches, (3) sheltered rocky shores and solid man-made structures, (4) sheltered rubble slopes, (5) sheltered vegetated low banks, and (6) marshes. Passive sorbents are conditionally recommended for use on: (1) Exposed rocky shorelines and (2) tidal flats.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Continually monitor and collect passive sorbent material deployed in the intertidal zone to prevent it from entering the environment as nondegradable, oily debris.

- Minimize foot traffic through oiled areas on non-solid substrates (sand, gravel, dirt, *etc.*) to reduce the likelihood that oil will be worked into the sediment.

- Monitor passive absorbents placed in the middle or lower intertidal zone for potential entrapment of small crustaceans; coordinate with Environmental Unit* for corrective actions if entrapment is observed.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping and breeding, fish spawning, *etc.*).*

- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to hazardous waste sites.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pads and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

Vacuum Removal of Oil

The objective of this variation of the removal of surface oil is to remove free oil that has pooled on the substrate. It involves the use of a vacuum unit with a suction head to recover free oil. Equipment can range in size from small portable units that fill individual 55 gallon drums to large "supersuckers" that are truck-mounted and have the capacity to lift large rocks. Supersuckers are primarily used when circumstances (*e.g.*, the length or number of hoses used) necessitate that the suction capacity is great. In other words, suction is reduced with increasing hose length and with a number of the hoses used. In these situations, additional suction capacity may be necessary to make up for these losses. This system can also be used with water spray systems to flush the oil towards the suction head. This response variation is used when free, liquid oil is stranded on the shoreline (usually along the high-tide line) or is trapped in vegetation that is readily accessible.

There are two vacuum systems that are currently in use. The first system is classified as a vacuum device, but it requires a high-velocity air stream at 150 miles per hour (mph), to draw oil, water, and debris into the unit's collection chamber. Due to the 6 to 12 inch diameter of the inlet hose, it rarely becomes clogged by debris. The inlet nozzle should be placed slightly above (never below) the fluid's surface. The distance at which it is held above the fluid is critical to limit the amount of water intake. This system is suitable for picking up weathered oil, tar balls, and mousse from water or shorelines, and to vacuum oil from skimming vessels, boomed areas, or debris-laden sites. The primary advantage is its ability to pick up oil of any viscosity and, where necessary, lift fluid more than 30 feet. The system can pick up and decant simultaneously. The main disadvantages are that it usually picks up a high water/oil ratio, and can be difficult to repair in the field.

The second system, barge-mounted vacuum trucks, use high-suction pumps and a cylindrical chamber capable of sustaining very low internal pressure (*i.e.* -12 pounds per square inch [psi]). A vacuum is created in the chamber, and a 3 to 4 inch diameter hose is usually placed slightly below the surface of a floating oil slick, allowing a mixture of water and oil to enter the

collection chamber. The position of the open end of the vacuum hose is critical: if it is placed too far down in the oil slick, recovered fluid will be mostly water; if not deep enough, air will be sucked into the system, and much of the vacuum will be lost. The primary advantages of the vacuum truck system are: it can recover fluid of nearly any viscosity; it has a rapid pickup rate of thick oil layers; and it can recover a wide variety of small debris. Primary disadvantages include: limited lift (*i.e.* no more than 20 to 30 feet) and the length of time required to re-establish a vacuum if air enters the hose. Similar to the other vacuum, this system also picks up a high water/oil ratio.

Habitats Used: This variation of the response is conditionally recommended on all shoreline habitat types except for tidal flats.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Vacuum removal of oil may be used on any shoreline type where liquid oil has pooled with the exception of tidal flats.
- Closely monitor vacuum operations in wetlands; site specific restrictions* may be required to minimize impact to marsh plant root system which could lead to erosion.
- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) is expected.
- Minimize foot traffic through oiled areas on non-solid substrates (sand, gravel, dirt, *etc.*) to reduce the likelihood that oil will be worked into the sediment.
- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.
- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping and breeding, fish spawning, *etc.*).*

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.4.3.2 Oiled Debris Removal

The objective of this response is the removal of oiled debris (organic and man-made) from the shoreline. Debris (*e.g.*, seaweed, trash and logs) is removed when it becomes heavily contaminated and when it is either a potential source of chronic oil release, an aesthetic problem, or a source of contamination for organisms on the shoreline. If time and resources permit, unoiled, man-made debris (*e.g.*, trash, mooring lines) may be removed or placed above the high tide line prior to oil reaching a shoreline (based on oil spill trajectory) to minimize the amount of

oiled debris generated by the spill. Depending on the type of shoreline, this response may be recommended or conditionally recommended for all oil types.

Habitats Used: This response is recommended for use on: (1) Sand beaches, (2) gravel beaches, (3) sheltered rocky shore and solid man-made structures, and (4) sheltered rubble slope. Oiled debris removal is conditionally recommended for use on: (1) Exposed rocky shorelines, (2) tidal flats, (3) sheltered vegetated low banks, and (4) marshes.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Removal of oily debris may be used on all shoreline types; removal of oily debris from shorelines with soft mud substrates (mudflats, marshes) is usually restricted to debris stranded at the high tide line, where it can be recovered without grinding oil into the substrate.

- Minimize foot traffic through oiled areas on non-solid substrates (sand, gravel, dirt, *etc.*) to reduce the likelihood that oil will be worked into the sediment.

- Minimize quantity of oiled vegetative debris removed by concentrating on that which is moderately to heavily oiled; leave lightly oiled and clean stranded seaweed and wood debris in place to provide habitat for small invertebrates and help stabilize shoreline.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.
- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping and breeding, fish spawning, *etc.*).*

- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to a hazardous waste site.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pads and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.4.3.3 Trenching/Recovery Wells

The objective of this action is to remove subsurface oil from permeable substrates. Trenches or wells are dug down to the depth of the oil (or water table) to intercept oil migrating through the substrate. The oil collected in the trench or well is then recovered by vacuum pump or skimmer,

and disposed of off site. The oil must be liquid enough to flow at ambient temperatures. Water flooding or flushing the substrate can be used to speed up oil migration into the trench or well. If the trench or well is not deep enough to reach the water table, the bottom must be lined with plastic to prevent oil penetration deeper into the sediment. Trenches are not dug in the lower portions of the beach, where attached plants and organisms may be abundant. This response is used for all oil types (heavy, medium, light, and very light oil).

Responders use a variety of tools to dig trenches and wells, including shovels, buckets, or, if access to the site is available, a backhoe. The sizes of the trenches or wells can vary, but are usually 1 to 2 feet deep and 2 to 3 feet wide, and, for trenches - 5 to 6 feet long. The soil removed is deposited far from the shoreline. If it is contaminated with oil, it is disposed offsite. If it is uncontaminated, it is used to fill up the trench or recovery well after the oil has been removed.

Habitats Used: Trenching and recovery wells are conditionally recommended for use on: (1) Sand beaches, (2) gravel beaches (pebble- to cobble-size substrate), and (3) vegetated low banks.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Trenching and recovery wells may be used on sand and gravel shorelines with grain sizes ranging from fine sand to pebble size gravel.
- Line the bottom of trenches which do not reach the water table (dry) with plastic to prevent the collected oil from penetrating deeper into the substrate.
- Restrict trenches from the lower intertidal zone where attached algae and organisms are abundant.
- Collapse or fill in trenches/well when response action is completed; ensure sides and bottom of trenches are clean before collapsing.
- Minimize foot traffic through oiled areas on non-solid substrates (sand, gravel, dirt, *etc.*) to reduce the likelihood that oil will be worked into the sediment.
- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.
- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*
- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to hazardous waste site.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pad and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.4.3.4 Removal of Oiled Sediment

The objective of this response method is to remove oiled surface sediments. Oiled sediment is removed by either manual use of hand tools or mechanical use of various kinds of motorized equipment. Oiled sediment removal is restricted to the supratidal and upper intertidal areas to minimize disturbance of biological communities in the lower intertidal and subtidal. After removal, oiled sediments are transported and disposed of off site. New sediments are not typically transported to replace those that were removed; however, a variation of this response that includes sediment replacement (described below) is used for beaches with low natural replenishment rates or high rates of erosion. This method of cleanup is most effective when there is a limited amount of oiled sediment that must be removed. Close monitoring is required to ensure that the quantity of sediment removed, siltation and the likelihood of erosion are minimized in all cases. Such operations are generally restricted in fish spawning areas. Sensitive areas that are adjacent, and may be potentially affected by released oil sheens, must also be protected.

Depending on the type of shoreline, this response may be used on light, medium and heavy oils.

Habitats Used: Oiled sediment removal is conditionally recommended for use on: (1) Sand beaches, (2) gravel beaches, (3) sheltered rubble slope, and (4) sheltered vegetated low banks.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Oiled sediment removal (without replacement) is used primarily on sand beaches not subject to high rates of erosion; small quantities of oiled sediment removal may be permitted on gravel beaches (pebble to cobble size gravel or riprap) and sheltered vegetated stream banks.

- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) or remobilization is expected; minimize burial and/or remobilization by conducting cleanup between tidal cycles.

- Restrict sediment removal to supra and upper intertidal zones (or above waterline on stream banks) to minimize disturbance of biological communities in lower intertidal and subtidal zones.

- Take appropriate actions to protect nearby sensitive environments* (salmon spawning streams, nursery areas) from the effects of increased oil runoff/sheening or siltation by the proper deployment of booms, siltation curtains, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Minimize the amount of oiled sediment removed by closely monitoring mechanical equipment operations.

- Coordinate the locations of any temporary oiled sediment staging or storage sites near the shoreline with the Environmental Unit.*

- Minimize vehicle traffic through oiled areas to reduce the likelihood that oil will be worked into the sediment and contamination carried off site by cleanup equipment.

- Restrict foot or vehicular traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to hazardous waste site.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pads and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

Oiled Sediment Reworking

Oiled sediment reworking is included as a variation of "Removal of oiled sediment" because the potential effects of these actions are similar (*i.e.* sediment is destabilized or removed). The objective of this response variation is to re-work oiled sediments to break up oil deposits, increase surface area, and mix oxygen into deep subsurface oil layers. This activity exposes the oil to natural removal processes and enhances the rate of oil degradation. Oiled sediment is not removed from the beach. Instead, beach sediments are roto-tilled or otherwise mechanically mixed with the use of heavy equipment. The oiled sediments in the upper beach area may also be relocated to the mid-tidal portion of the beach. Relocation enhances natural cleanup during reworking by wave activity. This procedure is also known as surf washing or berm relocation. Sediment reworking is typically used on sand or gravel beaches where high erosion rates or low natural sediment replenishment rates are issues of concern. Sediment reworking may also be used where remoteness or other logistical limitations make sediment removal unfeasible.

Depending on the shoreline type, this response type is generally used on all types of oil.

Habitats Used: Reworking of oiled sediment is conditionally recommended for use on: (1) Sand beaches, and (2) gravel beaches.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Oiled sediment reworking is used primarily on sand or sand and gravel beaches, especially those prone to erosion.
- Berm relocation or surf washing may be used on sand, sand and gravel, or gravel (pebble to cobble) beaches exposed to at least moderate wave energy.
- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) is expected.
- Restrict rototilling to mid- and upper-intertidal zones to minimize disturbance of biological communities in lower intertidal and subtidal zones.
- Restrict berm relocation/surf washing in vicinity of sensitive environments* (salmon spawning streams, nursery areas) to prevent adverse effects from increased oil runoff/sheening or siltation.
- Restrict foot or vehicular traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.
- Shoreline access to specific areas* may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations* (marine mammal pupping, breeding, fish spawning, *etc.*).
- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (bird nesting, marine mammal pupping, breeding, fish spawning, *etc.*).*

*Operations Section will be advised by Planning Section (Environmental Unit).

Oiled Sediment Removal with Replacement

The objective of this response variation is to remove oiled sediment and replace it with cleaned or new material. Oiled sediments are excavated using heavy equipment on the beach at low tide. After removal of the oiled sediment, new clean sediment of similar composition is brought in for replacement. The oiled sediment may also be cleaned and then replaced on the beach. The

sediments are loaded into a container for washing. Cleansing methods include a hot water wash or physical agitation with a cleaning solution. After the cleansing process, the rinsed materials are returned to the original area. Cleaning equipment must be placed close to beaches to reduce transportation problems. It is generally used on beaches with sediment that is sand- to boulder-sized, including rip-rap, although the beaches must be exposed to wave activity so the replaced sediments can be re-worked into a natural distribution.

Depending on the shoreline type, this response method is used for light, medium, and heavy oils and is not used for very light oils.

Habitats Used: Oiled sediment removal with replacement is conditionally recommended for use on: (1) Sand beaches, (2) gravel beaches, and (3) sheltered rubble slope.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Oiled sediment removal (with replacement) is used primarily on sand, sand and gravel, gravel, and vegetated stream bank shorelines subjected to high rates of erosion.

- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) or remobilization is expected; minimize burial and/or remobilization by conducting cleanup between tidal cycles.

- Restrict sediment removal and replacement to supra and upper intertidal zones (or above waterline on stream banks) to minimize disturbance of biological communities in lower intertidal and subtidal zones.

- Take appropriate actions to protect nearby sensitive environments* (salmon spawning streams, nursery areas) from the effects of increased oil runoff/sheening or siltation by the proper deployment of booms, siltation curtains, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Minimize the amount of oiled sediment removed by closely monitoring mechanical equipment operations.

- Coordinate the locations of any temporary oiled sediment staging or storage sites near the shoreline with the Environmental Unit.*

- Minimize vehicle traffic through oiled areas to reduce the likelihood that oil will be worked into the sediment and contamination carried off site by cleanup equipment.

- Restrict foot or vehicular traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to hazardous waste site.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pads and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.4.3.5 Flushing with Ambient Water

The objective of this response action is to remobilize oil stranded on surface substrate, as well as oil from crevices and rock interstices, to the water's edge for collection. Water is pumped from hoses onto an oiled beach, beginning above the highest level where the oil is stranded and slowly working down to the water level. The flow of water refloats or remobilizes oil stranded on the surface sediments and flushes it down to water's edge. The remobilized oil is contained by boom and recovered for disposal. Increased water pressure may be needed to assist in the remobilization as the oil weathers and begins to harden on the substrate. Because of the potential for higher pressures to cause siltation and physical disruption of the softer substrates, flushing with higher pressures is restricted to rock or hard man-made substrates.

Intake and outflow hoses may range from 2 to 4 inches in diameter and, depending on the pump used, pump between 200 and 400 gallons of water per minute. Intake hoses are fitted with screens to minimize the extraction of debris, flora and fauna. Screen holes generally range from 0.25 to 1 inch in diameter, depending on the environment from which the water is being pumped. Intake hoses are propped off bottom using rebar in about 3 feet of water to further minimize the amount of sediment and debris, and the number of organisms, taken into the hose and pump.

Depending on the shoreline type, ambient water flushing and its variants are recommended or conditionally recommended for light, medium and heavy oils and not used for very light oils.

Three variations of this response are described below: flooding (deluge), flushing with ambient water/low pressure, and flushing with ambient water/elevated pressure.

Flooding (Deluge)

The objective of this response variation is to mobilize stranded oil from rock crevices and interstices. It is used on heavily oiled shorelines when the oil is still fluid and loosely adhering to the substrate and where oil has penetrated into cobble or boulder beaches. Ambient water is pumped through a header pipe at low pressure above and inshore from the fouled area of

shoreline. The pipe is meant to create a sheet of water that simulates tidal washing over the affected area. Removing stranded oil may be particularly important when a more sensitive habitat is nearby and in danger of becoming fouled with oil after the intertidal zone is washed over the next tidal cycle, remobilizing oil. The effects of flooding may also be desired when a spring tide has deposited oil above the normal high water mark or when the wave energy of the adjacent water is not great enough to sufficiently wash the affected area over the following tidal cycle. After oil has been loosened from the substrate, it may be collected and removed using a variety of mechanical, manual and passive methods.

Habitats Used: Flooding is recommended for use on gravel beaches only. This response is conditionally recommended for use on: (1) Sand beaches, (2) sheltered rocky shores and man-made structures, (3) sheltered rubble slopes, (4) sheltered vegetated low banks and (5) marshes.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Ambient water flooding (deluge) may be used on all shoreline types with the exception of fine- to coarse-grained sand beaches, which could mobilize contaminated sediment into the environmentally sensitive subtidal zone or cause excessive siltation.

- Ambient water flooding is not generally useful on exposed rocky shorelines or submerged tidal flats because they are already well flooded.

- Closely monitor flooding of shorelines with fine sediments (sand & gravel, sheltered rubble, sheltered vegetative banks, marshes) to minimize excessive siltation or contaminated sediments mobilization into the subtidal zone.

- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) or remobilization is expected; minimize burial and/or remobilization by conducting cleanup between tidal cycles.

- Protect nearby sensitive environments* (salmon spawning streams, submerged aquatic vegetation, nursery areas, *etc.*) from the effects of increased oil runoff by the proper deployment of booms, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Restrict foot or vehicular traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

*Operations Section will be advised by Planning Section (Environmental Unit).

Flushing with Ambient Water, Low-Pressure

The objective of this response variation is to mobilize liquid oil that has adhered to the substrate or man-made structures, pooled on the surface, or become trapped in vegetation to the water's edge for collection. Low-pressure washing (<50 psi) with ambient seawater sprayed through hoses is used to flush oil to the water's edge for pickup. Oil is trapped by booms and picked up with skimmers or sorbents. This variation may also be used in concert with ambient water flooding, which helps move the oil without the potential effects associated with higher water pressures.

Habitats Used: Low-pressure flushing is conditionally recommended for all shoreline habitats except for tidal flats.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Ambient water low pressure flushing may be used on all shoreline types with the exception of sand beaches (fine- to coarse-grained) and mud flats (exposed or sheltered).

- Prevent pushing or mixing oil deeper into the sediment by not directing the stream of water directly into the oil; direct hoses to place stream of water above or behind the surface oil to create a sheet of water to re-mobilize and carry oil down the beach to a containment area for recovery.

- Closely monitor flushing of shorelines with fine sediments (sand & gravel, sheltered rubble, sheltered vegetative banks, marshes) to minimize excessive siltation or contaminated sediments mobilization into the subtidal zone.

- Restrict flushing in marshes from boats or on shore above the high tide line during high tide to minimize mixing oil into the sediments or mechanically damaging the marsh plants.

- Cleanup should commence after the majority of oil has come ashore, unless significant burial (sand beaches) or remobilization is expected; minimize burial and/or remobilization by conducting cleanup between tidal cycles.

- Protect nearby sensitive environments* (salmon spawning streams, submerged aquatic vegetation, nursery areas, *etc.*) from the effects of increased oil runoff by the proper deployment of booms, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas* may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations* (marine mammal pupping, breeding, fish spawning, *etc.*).

*Operations Section will be advised by Planning Section (Environmental Unit).

Flushing with Ambient Water, Elevated-Pressure

The objective of this response variation is to mobilize oil that has adhered to hard substrates or man-made structures to the water's edge for collection. It is similar to low-pressure washing except the water pressure may reach 100+ psi, and it can be used to flush floating oil or loose oil out of tide pools and between crevices on rip-rap. Compared to the lower pressure spray, high-pressure spray will more effectively remove oil that has adhered to rocks. Because the total water volume emitted is typically low, this response method may require the placement of sorbents directly below the treatment area or the use of flooding (deluge) to carry oil to the water's edge for collection.

Habitats Used: High-pressure flushing is conditionally recommended for use on: (1) Exposed rocky shores; (2) gravel beaches, particularly those consisting of cobble- and boulder-size rocks, and rip-rap; (3) sheltered rocky shores and man-made structures; and (4) sheltered rubble slopes.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Ambient water high pressure flushing may be used on rocky (exposed and sheltered) and riprap shorelines.

- Prevent pushing or mixing oil deeper into the riprap by not directing the stream of water directly into the oil; direct hoses to place stream of water above or behind the surface oil to create a sheet of water to re-mobilize and carry oil down to a containment area for recovery.

- If small volumes of high pressure water are used to remobilize weathered oil from rocky surface, include larger volume of low pressure water to help carry remobilized oil into containment area for recovery.

- Cleanup should commence after the majority of oil has come ashore.

- Protect nearby sensitive environments* (salmon spawning streams, submerged aquatic vegetation, nursery areas, *etc.*) from the effects of increased oil runoff by the proper deployment of booms, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas* may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations* (marine mammal pupping, breeding, fish spawning, *etc.*).

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.4.3.6 Warm Water, Moderate-Pressure Washing

The objective of this response method is to mobilize thick and weathered oil that has adhered to rock surfaces, prior to flushing it to the water's edge for collection. Seawater is heated (typically between the ambient temperature and 90ºF) and applied at moderate pressure to mobilize weathered oil that has adhered to rocks. If the warm water is not sufficient to flush the oil down the beach, flooding or additional low- or high-pressure washing may be used to float the oil to the water's edge for pickup. Oil is then trapped by booms and may be picked up with skimmers or sorbents. One variation of the response exists, hot water, moderate-pressure washing (described below).

Depending on the shoreline type, this response type is used for only medium and heavy oils.

Habitats Used: Warm water, moderate-pressure washing is conditionally recommended for use on: (1) Exposed rocky shores, (2) gravel beaches (including rip-rap) and (3) sheltered rocky shores and man-made structures.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Warm water moderate pressure flushing may be used on heavily oiled gravel beaches, riprap and hard, vertical, manmade structures such as seawalls, bulkheads, and docks.

- Restrict use to certain tidal elevations so that the oil/water effluent does not drain across sensitive low-tide habitats (damage can result from exposure to oil, oiled sediments, and hot water).

- If small volumes of warm water are used to remobilize weathered oil from rocky surface, include larger volume of ambient water at low-pressure water to help carry remobilized oil into containment area for recovery.

- Cleanup should commence after the majority of oil has come ashore.

- Protect nearby sensitive environments* (salmon spawning streams, submerged aquatic vegetation, nursery areas, *etc.*) from the effects of increased oil runoff by the proper deployment of booms, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

*Operations Section will be advised by Planning Section (Environmental Unit).

Hot Water, Moderate-Pressure Washing

The objective of this response variation is to dislodge and mobilize trapped and weathered oil from inaccessible locations and surfaces not amenable to mechanical removal, prior to flushing oil to water's edge for collection. Water heaters are mounted offshore on barges or small land-based units. The water is heated to temperatures from 90ºF to 170ºF, which is usually sprayed in small volumes by hand using moderate-pressure wands. Used without water flooding, this procedure requires immediate use of vacuums (vacuum trucks or super suckers) to remove the oil/water runoff. With a deluge system, the oil is flushed to the water's surface for collection with skimmers or sorbents. This response is generally used when the oil has weathered to the point that even warm water at high pressure is ineffective for the removal of adhered oil, which must be removed due to the threat of continued release of oil or for aesthetic reasons.

Depending on the shoreline type, this response method is only used for medium and heavy oils.

Habitats Used: Hot water flushing is conditionally recommended for use on: (1) Exposed rocky shorelines; (2) gravel beaches (specifically rip-rap); and (3) sheltered rocky shores and man-made structures.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Hot water moderate pressure flushing is used only on heavily oiled hard, manmade structures such as seawalls, bulkheads, docks and riprap, primarily for aesthetic purposes.

- Restrict use to certain tidal elevations so that the oil/water effluent does not drain across sensitive low-tide habitats (damage can result from exposure to oil, oiled sediments, and hot water).

- If small volumes of hot water are used to remobilize weathered oil from rocky surface, remobilized oil must be recovered using sorbent material at the base of the structure; or a second stream with ambient water can be used to flush the remobilized oil to the water's edge for recovery.

- Cleanup should commence after the majority of oil has come ashore.

- Protect nearby sensitive environments* (salmon spawning streams, submerged aquatic vegetation, nursery areas, *etc.*) from the effects of increased oil runoff by the proper deployment of booms, sorbents, *etc.*; monitor for effectiveness of protection measures.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.4.3.7 Cutting Vegetation

The objective of this response method is the removal of oiled vegetation attached to the shoreline to prevent the oiling of wildlife or remobilization of trapped oil. This response method is generally used when large quantities of potentially mobile oil is trapped in the vegetation or when the risk of oiled vegetation contaminating wildlife is greater than the value of the vegetation that is to be cut, and there is no less destructive method to remove the oil. Thick layers of oil may adhere to plant leaves or pool on the substrate under a layer of overlapping plant leaves. The upper parts of the oiled plant are cut away using hand tools or "weed eater" type power tools. The oiled plant cuttings are raked up and removed for disposal. Any remaining oil pooled around the roots/stems can then be flushed out for recovery.

Depending on the shoreline type, cutting vegetation is used for light, medium, and heavy oil and is not used on very light oil.

Habitats Used: This response is conditionally recommended for use on: (1) Exposed rocky shorelines, (2) gravel beaches, (3) sheltered rocky shores and man-made structures, (4) sheltered rubble slopes, (5) sheltered vegetated low banks and (6) marshes.

Best Management Practices: The USCG and the EPA generally use the following "best management practices" when carrying out this response action:

- Vegetation cutting may be used on marsh, rock, gravel (boulder/riprap) and vegetated riverbanks.

- Minimize mechanical impacts on vegetation being cut by taking appropriate actions* to ensure continued health and survival of vegetative ecosystem.

- Cleanup should commence after the majority of oil has come ashore.

- Minimize foot traffic through oiled areas on non-solid substrates (sand, gravel, dirt, *etc.*) to reduce the likelihood that oil will be worked into the sediment.

- Restrict foot traffic over sensitive areas* (salmon redds, algal mats, *etc.*) to reduce the potential for mechanical damage.

- Shoreline access to specific areas may be restricted for periods of time to minimize impact of human presence/excessive noise on nearby sensitive biological populations (marine mammal pupping, breeding, fish spawning, *etc.*).*

- Separate and segregate any contaminated wastes generated to optimize waste disposal stream and minimize what has to be sent to hazardous waste site.

- Establish temporary upland collection sites for oiled waste materials for large spill events; collection sites should be lined with asphalt pads and surrounded by berms to prevent secondary contamination from runoff.

*Operations Section will be advised by Planning Section (Environmental Unit).

1.2.5 Motorized Transportation /Support Actions during Spill Response in Open Water and Shoreline Environments

Several of the open water and shoreline response actions described in sections 1.3.3 and 1.3.4, respectively, may require the use of machinery in support of the response, or for transport of personnel. The responses that may use this equipment are noted in their descriptions; however, the use of boats and other watercraft, planes and helicopters, ATVs and personnel warrants further discussion.

1.2.5.1 Boats and Other Watercraft

Boats and other watercraft (*e.g.*, hovercraft, wave runners) may be used in open water and shoreline responses. The use of these resources varies depending on the specific response. However, they may be used as a component of the response itself (*e.g.*, skimmers, platforms for applying dispersants, deploying or collecting boom), or as a mode of transportation to and from remote locations for response personnel (*e.g.*, manual oil removal). As a result, boats and other watercraft may be used in shallow or deep water, nearshore or offshore, fresh water or marine environments, *etc.* The GRPs outline boat and watercraft use restrictions within 200 yards of offshore National Wildlife Refuge sites or other sensitive areas.

1.2.5.2 Planes

Planes may be used in open water and shoreline responses. The use of planes depends on the specific response. However, they may be used as a component of the response itself (*e.g.*, platforms for applying dispersants), or as a part of pre- or post-response monitoring (*e.g.*,

wildlife surveys). As a result, planes may be used over any aquatic or terrestrial environment. However, flight restriction zones have been designated by the GRPs as a precaution against disturbing wildlife species (*e.g.*, marine mammal rookeries, breeding bird colonies). Year-round restrictions may be imposed in some locations; however, restrictions are more likely to be imposed only during times of year in which species have been identified as most sensitive.

Typically, for areas that have been identified as sensitive, restrictions are in place such that flying is prohibited within a 1,500 foot radius and below 1,000 foot in altitude of such areas. However, some areas have more restrictive zones, such as the Olympic Coast National Marine Sanctuary and Olympic National Park. In addition to restrictions associated with wildlife, tribal authorities may also request notification when overflights are likely to affect culturally sensitive areas within reservations.

1.2.5.3 Helicopters

Helicopters may be used in open water and shoreline responses. The use of helicopters depends on the specific response. However, they may be used as a component of the response itself (*e.g.*, platforms for igniting floating oil), or as a part of pre- or post-response monitoring (*e.g.*, wildlife surveys). As a result, helicopters may be used over any aquatic or terrestrial environment. However, flight restriction zones have been designated by the GRPs as a precaution against disturbing wildlife species (*e.g.*, marine mammal rookeries, breeding bird colonies). Year-round restrictions may be imposed in some locations; however, restrictions are more likely to be imposed only during times of year in which species have been identified as most sensitive (*e.g.*, during the breeding season).

Typically, the area within a 1,500 foot radius and below 1,000 foot in altitude is restricted to flying around areas that have been identified as sensitive. However, some areas have more restrictive zones, such as the Olympic Coast National Marine Sanctuary and Olympic National Park. In addition to restrictions associated with wildlife, tribal authorities may also request notification when overflights are likely to affect culturally sensitive areas within reservations.

1.2.5.4 All Terrain Vehicles

ATVs may be used for a variety of purposes, including the transportation of response personnel and for the collection and disposal of oil, oiled sediments or oiled debris in support of response activities in nearshore open water and on shorelines. The use of ATVs is often dependent upon the accessibility of the site (*e.g.*, proximity of roads) to this type of vehicle and the type of shoreline in which they are to be used.

It is possible to use ATVs on any accessible shoreline type in which an ATV can safely be driven; however, some shoreline types (*e.g.*, marshes, vegetated low banks) are more sensitive to the use of motorized equipment (as well as human foot traffic) than other shoreline types, both in the presence and absence of oil. For example, it is recognized that the use of ATVs may adversely affect particular unoiled shoreline habitats that are susceptible to erosion. Some oiled

shoreline types, such as marshes, are particularly vulnerable to the introduction and mixing of oil into subsurface sediments. As a result of these concerns relating to shoreline damage, care is taken to weigh the tradeoffs of ATV use on a particular shoreline type, whether oiled or unoiled. Therefore, in a practical sense, ATV use may be limited to those situations in which it is judged that the benefits of using ATVs outweigh any potential adverse effects of their use.

Generally, ATVs are used on sand beaches, and restricted to transiting outside of the oiled areas along the upper part of the beach. The decision process for use of ATVs near sensitive aggregations of wildlife (*e.g.*, sea lion rookery) is similar to that described for shoreline habitats discussed above.

2. ENDANGERED SPECIES ACT

The Endangered Species Act (16 U.S.C. 1531-1544), amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the habitats on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with NOAA Fisheries (and USFWS), as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitats. This Opinion is the product of an interagency consultation pursuant to section 7(a)(2) of the ESA and implementing regulations found at
50 Code of Federal Regulations (CFR) Part 402.

2.1 Biological Opinion

The purpose of this Opinion is to determine whether oil spill response activities conducted and/or administered by the USCG and the EPA under the NWACP and related documents (Shoreline Countermeasures Manual, Dispersant Use Policy, and In-situ Burn Policy) are likely to jeopardize the continued existence of ESA-listed species or cause the destruction or adverse modification of their designated critical habitat. A Biological Assessment provided by the USCG with a November 12, 2002, request for consultation included the finding that their activities are "likely to adversely affect" the following ESA-listed species:

Marine Mammals	Status
Steller sea lion - eastern population (*Eumetopias jubatus*)	Threatened

Salmonids	Status
Chinook salmon (*Oncorhynchus tshawytscha*)	
Puget Sound ESU	Threatened
Chinook salmon - Lower Columbia River ESU	Threatened
Chinook salmon - Upper Columbia River -	

Spring-run ESU	Endangered
Chinook salmon - Upper Willamette River ESU	Threatened
Chinook salmon - Snake River - Fall-run ESU	Threatened
Chinook salmon - Snake River - Spring/Summer-run ESU	Threatened
Chum salmon (*O. keta*) - Columbia River ESU	Threatened
Chum salmon - Hood Canal - Summer-run ESU	Threatened
Coho salmon (*O. kisutch*) - Southern Oregon/ Northern California Coasts ESU	Threatened
Coho salmon - Oregon Coast ESU	Threatened
Sockeye salmon (*O. nerka*) - Ozette Lake ESU	Threatened
Sockeye salmon - Snake River ESU	Endangered
Steelhead (*O. mykiss*) - Lower Columbia River ESU	Threatened
Steelhead - Middle Columbia River ESU	Threatened
Steelhead - Upper Columbia River ESU	Endangered
Steelhead - Snake River Basin ESU	Threatened
Steelhead - Upper Willamette River ESU	Threatened
Blue whale (*Balaenoptera musculus*)	Endangered
Fin whale (*B. physalus*)	Endangered
Humpback whale (*Megaptera novoaeangliae*)	Endangered
Right whale (*Eubalaena glacialis*)	Endangered
Sei whale (*B. borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered

2.1.1 Biological Information and Critical Habitat

Critical habitat has been designated for the following listed species in the action area: (1) the eastern stock of Steller sea lion and (2) four listed salmonid ESUs present in the action area (see discussion below).

<u>Steller Sea Lion</u>
The proposed rule for establishment of critical habitat for the Steller sea lion was published on April 1, 1993 (58 FR 17181), and the final rule was published on August 27, 1993 (58 FR 45269). The following areas have designated as critical habitat in the action area. In Oregon: (1) Pyramid Rock at Rogue Reef (42 deg. 26.4'N /124 deg. 28.1'W) and two sites at Orford Reef: (2) Long Brown Rock (42 deg. 47.3'N / 124 deg. 36.2'W); and (3) Seal Rock (42 deg. 47.1'N /124 deg. 35.4'W) (50 CFR 226.202). Critical habitat for Steller sea lions includes an air zone that extends 3,000 feet (0.9 km) above areas historically occupied by sea lions at each major rookery in Oregon, measured vertically from sea level. Critical habitat also includes an aquatic zone that extends 3,000 feet (0.9 km) seaward in state and Federally-managed waters from the baseline or basepoint of each major rookery in Oregon (50 CFR 226.202).

Salmonid ESUs

On April 30, 2002, the United States District Court for the District of Columbia approved a NOAA Fisheries consent decree withdrawing critical habitat designations for 19 salmon and steelhead populations on the West Coast. NOAA Fisheries action was a response to litigation in which the process by which NOAA Fisheries designated critical habitat for listed salmon and steelhead was contested. Under the ESA, Federal agencies (*i.e.*, NOAA Fisheries) are required to consider the economic impacts on affected businesses, communities and individuals when designating critical habitat. NOAA Fisheries is currently in the process of conducting a more thorough analysis. Critical habitat designations are expected to be reissued at the completion of this analysis.

The critical habitat withdrawal includes 13 listed salmonid ESUs found in the action area and under consideration in this Opinion. These include the following salmonid ESUs: chinook salmon (Puget Sound ESU, Lower Columbia River ESU, Upper Willamette River ESU and Upper Columbia River Spring-run ESU); chum salmon (Hood Canal Summer-run ESU and Columbia River ESU); sockeye salmon (Ozette Lake ESU); coho salmon (Oregon Coast ESU); and steelhead (Upper Columbia River ESU, Snake River Basin ESU, Lower Columbia River ESU, Upper Willamette River ESU and Middle Columbia River ESU). This Federal Register notice can be viewed at NOAA Fisheries' website[11].

Although critical habitat designations are expected to be re-issued, this Opinion will only analyze potential effects of the action on the four designated critical habitats.

Critical habitat for four salmonid ESUs occurring in the action area were not withdrawn. These include: Snake River fall chinook, Snake River spring/summer chinook, Snake River sockeye, and northern California/southern Oregon coho salmon.

The final designation of critical habitat for Snake River fall chinook was published on December 28, 1993 (58 FR 68543)[12]. Critical habitat for the this ESU is designated to include river reaches presently or historically accessible (except reaches above impassable natural falls and Dworshak and Hells Canyon Dams) to Snake River fall chinook in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) and including all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake Rivers; the Snake River, all river reaches from the confluence of the Columbia River, upstream to Hells Canyon Dam; the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Major river basins containing spawning

[11] http://www.nwr.noaa.gov/reference/frn/2000/65FR7764.pdf

[12] http://www.nwr.noaa.gov/reference/frn/1993/58FR68543.pdf

and rearing habitat for this ESU comprise approximately 13,679 square miles in Idaho, Oregon, and Washington.

The final designation of critical habitat for Snake River sockeye salmon was published on December 28, 1993 (58 FR 68543). Critical habitat for this ESU is designated to include river reaches presently or historically accessible (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams) to Snake River sockeye salmon in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) and including all Columbia River estuarine areas and river reaches upstream to the confluence of the Columbia and Snake Rivers; all Snake River reaches from the confluence of the Columbia River upstream to the confluence of the Salmon River; all Salmon River reaches from the confluence of the Snake River upstream to Alturas Lake Creek; Stanley, Redfish, Yellow Belly, Pettit, and Alturas Lakes (including their inlet and outlet creeks); Alturas Lake Creek and that portion of Valley Creek between Stanley Lake Creek and the Salmon River. Watersheds containing spawning and rearing habitat for this ESU comprise approximately 510 square miles in Idaho.

The final designation for Snake River spring/summer-run chinook salmon was published on December 28, 1993 (58 FR 68543) and revised on October 25, 1999 (64 FR 57399)[13]. Critical habitat for this ESU is designated to include river reaches presently or historically accessible (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams) to Snake River spring/summer chinook salmon in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) and including all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake Rivers; all Snake River reaches from the confluence of the Columbia River upstream to Hells Canyon Dam. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 22,390 square miles in Idaho, Oregon, and Washington.

The final designation for northern California/southern Oregon coho salmon was published on May 5, 1999 (64 FR 24049)[14]. Critical habitat for this ESU is designated to include all river reaches accessible to listed coho salmon between Cape Blanco and Punta Gorda. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (*i.e.*, natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 18,090 square miles in California and Oregon.

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[13]http://www.nwr.noaa.gov/reference/frn/1999/64FR57399.pdf

[14]http://www.nwr.noaa.gov/reference/frn/1999/64FR24049.pdf

2.1.2 Evaluating the Proposed Action

The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined by 50 CFR 402 (the consultation regulations). NOAA Fisheries must determine whether the action is likely to jeopardize the continued existence of the listed species and/or whether the action is likely to destroy or adversely modify critical habitat. This analysis involves the initial steps of: (1) defining the biological requirements of the listed species; and (2) evaluating the relevance of the environmental baseline to the species' current status.

Subsequently, NOAA Fisheries evaluates whether the action is likely to jeopardize the listed species by determining if the species can be expected to survive with an adequate potential for recovery. In making this determination, NOAA Fisheries must consider changes in the species' reproduction, distribution, or numbers that would be attributable to the agencies' activities. These effects are then analyzed with the status of the species, environmental baseline, and any cumulative impacts to determine jeopardy. This evaluation must take into account measures for survival and recovery specific to the listed species' life stages that occur beyond the action area. If NOAA Fisheries finds that the action is likely to jeopardize, NOAA Fisheries must identify reasonable and prudent alternatives for the action.

NOAA Fisheries also evaluates whether the action, directly or indirectly, is likely to destroy or adversely modify the listed species' critical habitat. NOAA Fisheries must determine whether habitat modifications appreciably diminish the conservation value of critical habitat for both survival and recovery of the listed species. NOAA Fisheries identifies those effects of the action that impair the function of any essential element of critical habitat. NOAA Fisheries then considers whether such impairment appreciably diminishes the habitat's value for the species' survival and recovery. If NOAA Fisheries concludes that the action will adversely modify critical habitat, it must identify any reasonable and prudent alternatives available.

2.1.3 Biological Requirements

Additional background on listing status, biological information, population status and trends, and critical habitat elements for ESA-listed whales, the Steller sea lion, and 17 listed salmon and steelhead ESUs are described below.

2.1.3.1 Marine Mammals

Most large whales are listed as endangered because their populations were depleted by whalers in the nineteenth and twentieth centuries. Currently, ship strikes and incidental take in commercial fishing operations (domestic and international) are most likely the greatest threat to the recovery of large cetaceans. The factors that have caused the decline in Steller sea lion abundance are poorly known; however, concerns have been raised regarding reduced prey availability due to increased commercial fishing in critical foraging areas. Furthermore, vessels such as tankers, freighters, military vessels, commercial fishing vessels, whale watching and recreational boats all create disturbance and underwater noise that is potentially harmful to

marine mammals. The individual and aggregate effects of these sources of noise and disturbance on marine mammals is unknown.

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), NOAA Fisheries was required to produce stock assessment reports (SARs) for all marine mammal stocks that occur in United States waters. These reports include information on the status and trends of marine mammals and assessments of all human-caused mortality and serious injury of the listed marine mammal stocks. Information on blue whales, fin whales, humpback whales, northern right whales, sei whales, sperm whales and the Steller sea lion was obtained from both final and draft SARs and is presented below, along with other relevant information (sources identified therein).

Blue Whale

Physical Description: Blue whales are the largest living mammal species. They may reach lengths of over 30 meters and weigh up to 160 metric tons (Mackintosh 1942). Blue whales are blue-gray in color with a gray and white mottling. Their ventral surface may be light pink in color. They have a relatively small dorsal fin and, like other baleen whales, blue whales have baleen plates instead of teeth. Blue whales belong to a group of baleen whales known as rorquals that possess ventral grooves. During feeding, the grooves hold large quantities of water for filtration. Blue whales are found in all major oceans, including the coastal shelves, continental shelf and the pelagic environment of the North Pacific (Rice 1974, Donovan 1984).

Life History: Blue whales typically reproduce in the winter. Following a 10 to12 month gestation period, nursing lasts 6 to 7 months. Blue whales are sexually mature at about 5 years (Yochem and Leatherwood 1985). Their age distribution is unknown. Little is known about sources of natural mortality (*e.g.*, disease) and survival rates; however, killer whales (*Orcinus orcas*) are known to attack blue whales. The rate of killer whale attacks and their effect on blue whale populations is unknown. It is possible that competition for prey occurs between blue whales and other baleen whales whose range overlaps (Nemoto 1970). However, there is no evidence to suggest that competition occurs. Further, the migratory nature of blue whales is thought to help them avoid competition (Clapham and Brownell 1996).

Food Habits: Blue whales feed primarily on euphausiids. Species that have been identified as blue whale prey in the North Pacific include *Thysanoëssa inermis, Thysanoëssa longipes, Thysanoëssa raschii* and *Nematoscelis megalops* (Kawamura 1980, Yochem and Leatherwood 1985). Some blue whale stomachs have contained a mixture of copepods and amphipods, in addition to euphausiids; however, the consumption of amphipods and copepods is thought to be incidental (Nemoto and Kawamura 1977). In one exception, blue whales off of Baja California have been observed feeding on pelagic red crabs (Rice 1974, 1986a). Prey preferred by blue whales may be less abundant in the western Pacific (Nemoto 1957). Blue whales there have been observed feeding on schooling fish and squid (Mizue 1951, Sleptsov 1955). Observations indicate that the preferred prey of blue whales in the Gulf of California, Mexico, is *Nyctiphanes simplex.* Whales feed on reproductive swarms of the species (Sears 1990; Gendron 1990, 1992).

However, these predation events may be strongly influenced by the El Niño Southern Oscillation (ENSO) (Gendron and Sears 1993).

Distribution: Blue whales may be found in all oceans of the world. They mate and calve in tropical-to-temperate waters during winter months and feed in polar waters during summer months. In the northern hemisphere, blue whales move north to Arctic waters to feed, while in the southern hemisphere, blue whales move south to the Antarctic to feed. Blue whales migrate long distances between equatorial wintering grounds and high latitude feeding areas. In the eastern North Pacific, they feed in California waters in summer/fall (from June to November) and migrate south to areas off Mexico and as far south as the Costa Rica Dome (10°N) in winter and spring. During the summer, they may be found across the Gulf of Alaska, but they seldom enter the eastern Bering Sea. Historical areas of concentration include the eastern Gulf of Alaska, the eastern Aleutians, and the far western Aleutians. Blue whales spend most of their time along the edges of continental shelves and are seldom seen in coastal waters. Blue whales are rarely seen off Oregon, but they are occasionally heard there (*i.e.* using hydrophones) (McDonald *et al*. 1994, Stafford *et al*. 1998, VonSaunder and Barlow 1999).

Management and Listing Status: The International Whaling Commission (IWC) has formally recognized only one management stock for blue whales in the North Pacific (Donovan 1991). However, evidence now indicates that more than one stock exists in the North Pacific (Ohsumi and Wada 1972, Mizroch *et al.* 1984a, Braham 1991, Barlow *et al.* 1995, Gilpatrick *et al*. 1997), perhaps as many as five (Reeves *et al*. 1998a). One population of blue whales occurs in the action area. This population feeds in the waters off California in the summer and fall (June to November) and migrates as far south as the Costa Rica Dome in the winter and spring (Mate *et al*. 1999).

Blue whales were listed as endangered under the ESA in 1972. Blue whales are also afforded protection under the Convention on International Trade in Endangered Species (CITES) and the MMPA. The North Pacific stock is listed as "low risk, conservation dependent" by the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for blue whales.

Population Status and Trends: The size of the feeding stock of blue whales in California was estimated using a combination of line-transect and mark-recapture methods. Based on ship line-transect surveys conducted 1991 to 1996, Barlow (1997) estimated 1,927 (Coefficient of Variation [CV]=0.16) blue whales off California, Oregon and Washington. Two population size estimates were calculated using photographic mark-recapture (Calambokidis and Steiger 1994). The estimates using photographs of the left sides of whales (2,038, CV=0.33) and right sides (1,997, CV=0.42) were quite similar and in agreement with the estimate based on line-transects. The best estimate of blue whale abundance in the North Pacific is the average of the estimates generated from line-transect and mark-recapture methods, weighted by their variances, or 1,940 (CV=0.15) (Carretta *et al*.2001). The mark-recapture estimates are likely to be negatively biased by individual heterogeneity in sighting probabilities (Hammond 1986); however, Calambokidis

and Steiger (1994) minimized such effects by selecting one sample that was taken randomly with respect to distance from the coast. The line-transect estimates may also be negatively biased, as some of the blue whales in this stock were likely to be off of Baja California, and as a result, out of the study area at the time of the survey (Wade and Gerrodette 1993). The minimum population of blue whales in the North Pacific was estimated to be 1,716 (Carretta *et al.* 2001).

Data indicate that blue whales have increased in abundance in coastal California waters between 1980 and 1991 (Barlow 1994) and between 1991 and 1996 (Barlow 1997). Several hypotheses exist to explain the apparent increase in abundance. The blue whale population could have increased over those time periods; however, Carretta *et al.* (2001) were skeptical that the increase observed by Barlow (1994) could be accounted for by population growth alone. It is also likely that blue whales' use of California as a feeding area has also increased. Because they have been protected since 1966, the blue whale population is expected to have grown. However, the possibility of unauthorized takes and mortalities attributed to gillnets and incidental ship strikes adds uncertainty to this hypothesis (Carretta *et al.* 2001).

Threats

Historic Whaling

Approximately 5,761 blue whales were taken from the North Pacific in harvests between 1889 and 1965 (Reeves *et al*. 1998a). Japanese catch data indicate a decline in the blue whale population. After taking 114 blue whales in 1914, Japan's catch declined continuously between 1915 and 1965. In 1926, 239 blue whales were taken off the coast of California. Between the late 1950s and the early 1960s, 70 blue whales per year were taken off the Aleutian Islands (Mizroch *et al.* 1984a).

Despite the IWC's ban on commercial whaling in the North Pacific in 1966, Soviet whaling is thought to have occurred since then. However, no catches have been reported since the ban, indicating that the blue whale catch was under-represented in Soviet catch reports (*in* Forney and Brownell 1996). In the 1980s and 1990s, surveys were conducted in these former whaling grounds, but no blue whales were sighted (Forney and Brownell 1996).

Fisheries

One possible source of mortality or serious injury to blue whales may be a result of fishery interactions; however, reports of this kind do not exist for any of the blue whale stocks. Entangled whales may go unnoticed by fishers, swimming away unseen with a portion of the net. However, fishers have reported that large blue whales tend to swim through their nets without entangling and causing little damage to nets (Barlow *et al.* 1997).

Vessel Traffic and Noise Disturbance

Ship strikes appeared to be responsible for the deaths of blue whales off the coast of California in 1980, 1986, 1987 and 1993. Large scars, possibly the result of ship strikes, have been observed on the dorsal surfaces of several blue whales off the coast of California (*in* Carretta *et al*. 2002). For the California/Mexico stock, Barlow *et al.* (1997) estimated that the average blue whale mortality due to ship strikes was 0.2 whales per year between 1991 and 1995. Off California, from 2000 to 2001, three unidentified whales were injured and one unidentified balaenopterid was killed due to vessel strikes (J. Cordaro, NOAA Fisheries, personal communication, 2002) - they may have been blue whales.

Fin Whale

Physical Description: Fin whales are the second largest member of the family Balaenopteridae, reaching lengths of between 20 and 29 meters at adulthood (Aguilar and Lockyer 1987). Fin whales are dark gray dorsally and white underneath, with a long, slender body and a prominent dorsal fin about two-thirds of the way back on their body (Agler *et al.* 1990, *in* Reeves, *et al*. 1998b). Like other baleen whales, fin whales have fringed baleen plates and ventral grooves, which expand during feeding.

Life History: Fin whales become sexually mature between 6 to 10 years of age, depending on density-dependent factors (Gambell 1985). Reproductive activities for fin whales occur primarily in the winter. Gestation lasts about 12 months and nursing occurs for 6 to11 months (Perry *et al.* 1999). The age distribution of fin whales in the North Pacific is unknown.

Natural sources and rates of mortality are largely unknown, but based on studies of northeast Atlantic fin whales, Aguilar and Lockyer (1987) suggest annual natural mortality rates may range between 0.04 and 0.06. The occurrence of the nematode, *Crassicauda boopis,* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992, *in* Perry *et al*. 1999). Killer whale or shark attacks may result in serious injury or death in very young and sick whales (Perry *et al.* 1999).

Food Habits: In the North Pacific Ocean, fin whales prefer to feed on euphausiids and large copepods (mainly *Calanus cristatus*), followed by schooling fish such as herring, walleye pollock, and capelin (Reeves *et al*. 1998). Sergent (1977) suggested that euphasiids were the basic food of fin whales, but that they took advantage of fish when sufficiently concentrated, particularly in the pre-spawning, spawning, and post-spawning adult stages on the continental shelf and in coastal waters. The local distribution of fin whales during much of the year is probably governed by prey availability. Although there has been considerable discussion of interspecific competition among mysticete whales for prey, there has been no conclusive evidence to demonstrate that it occurs (Clapham and Brownell 1996).

Distribution: Fin whales are distributed widely in the world's oceans. In the northern hemisphere, most migrate seasonally from high Arctic feeding areas in summer to low latitude breeding and calving areas in winter. Other groups may remain year-round in a particular area,

depending on food supply. They have been known to associate with steep contours, either because tidal and current mixing along such gradients drives high biological production, or because changes in depth aid their navigation.

Fin whales were reported as occurring immediately offshore throughout the North Pacific from central Baja California to Japan and as far north as the Chukchi Sea (Rice 1974). From whaling records, fin whales that were marked in the winter 1962 to 1970 off southern California were later taken in commercial whaling operations between central California and the Gulf of Alaska in summer (Mizroch *et al.* 1984a). More recent observation show aggregations of fin whales year-round in southern/central California (Dohl *et al.* 1983, Barlow 1997, Forney *et al*. 1995), year-round in the Gulf of California (Tershey *et al*. 1993) in summer in Oregon (Green *et al*. 1992, McDonald *et al*.1994) and in summer/autumn in the Shelikof Strait/Gulf of Alaska (Brueggeman *et al*. 1990). Acoustic signals from fin whales are detected year-round off northern California, Oregon and Washington, with a concentration of vocal activity between September and February (Moore *et al*. 1998). Fin whales appear very scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993).

Management and Listing Status: The IWC's Scientific Committee recognizes two management stocks in the North Pacific: (1) the east China Sea, and (2) the rest of the North Pacific (Donovan, 1991). Mizroch *et al.* (1984b) suggested five possible stocks within the North Pacific based on histological and tagging experiments: (1) east and west Pacific that intermingle around the Aleutian Islands; (2) east China Sea; (3) British Columbia; (4) southern/central California to the Gulf of Alaska; and (5) Gulf of California (Rice 1974, Tershy *et al*. 1993). However, NOAA Fisheries considers stock structure in the North Pacific to be equivocal, and recognizes three stocks: (1) California/Oregon/Washington; (2) Alaska (northeast Pacific); and (3) Hawaii (Barlow *et al*. 1997, Hill and DeMaster 1999).

In the North Pacific, the IWC began management of commercial whaling for fin whales in 1969; fin whales were fully protected from commercial whaling in 1976 (Allen 1980). Fin whales were listed as endangered under the ESA. They are also protected by CITES and the MMPA. Fin whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for fin whales.

Population Status and Trends: Prior to exploitation by whaling vessels, the North Pacific population consisted of an estimated 42,000 to 45,000 fin whales (Ohsumi and Wada 1974). Between 1914 and 1975, over 26,040 fin whales were harvested throughout the North Pacific (in Perry *et al*. 1999). Catches in the North Pacific and Bering Sea ranged from 1,000 to 1,500 fin whales annually during the 1950s and 1960s. However, not all Soviet catches were reported (cited in Ferrero *et al*. 2000). In the early 1970s, the entire North Pacific population had been reduced to between 13,620 and 18,630 fin whales (Ohsumi and Wada 1974). During the early 1970s, 8,520 to 10,970 fin whales were surveyed in the eastern half of the North Pacific (Braham 1991).

Based on ship surveys in the summer/autumn of 1993 and 1996, there are an estimated

1,851 (CV=0.19) fin whales off California, Oregon, and Washington (Barlow and Taylor 2001). Because some large whales could not be identified in the field and are marked as "unidentified rorqual" or "unidentified large whale," this number may be underestimated. There is some indication that fin whales have increased in abundance in California coastal waters between 1979 to 1980 and 1991 and between 1991 and 1996, but the trends are not significant (*in* Carretta *et al*. 2001).

Threats

Historic Whaling

As early as the mid-seventeenth century, the Japanese were capturing fin, blue, and other large whales using a fairly primitive open-water netting technique (Tonnessen and Johnsen 1982, Cherfas 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. The North Pacific and Antarctic whaling operations soon added this 'modern' equipment to their arsenal. After blue whales were depleted in most areas, the smaller fin whale became the focus of whaling operations and more than 700,000 fin whales were landed in the twentieth century.

Ship Strikes

The average observed annual mortality of fin whales due to ship strikes is 0.4 fin whales per year for the period 1995 to 1999. Four fin whales were struck by ships in 2002.

Humpback Whale

Physical Description: The humpback whale is of medium size relative to other large whales, with females reaching an average length of around 14 meters, while males average 1 meter shorter (Nitta and Naughton 1989) and a weight of about 34 metric tons at maturity (Johnson and Wolman 1984). They are characterized by wing-like pectoral flippers that are from one-fourth to one-third of their total body length and their heads are covered in tubercles.

Species Distribution: The humpback whale, also a member of the family Balaenopteridae, is distributed worldwide in all ocean basins. Most humpback whales winter in shallow, nearshore temperate and tropical waters, whereas in summer, most are in areas of high biological productivity, usually in the higher latitudes (Nitta and Naughton 1989). They probably mate and give birth while in the wintering areas, but reproductive events may take place during migration. Following reproduction and birthing, most humpback whales migrate considerable distances to the higher latitude summering areas, where they feed intensively on locally abundant prey (NMFS 1991a). Humpback whales are often found alone or in groups of two or three, but throughout their breeding and feeding ranges, they may congregate in groups of up to 15 animals. Their distribution in general is over shallow banks and in shelf waters (Leatherwood and Reeves 1983).

Life History: Humpback whales calve between the months of January and March. Age at sexual maturity has been estimated to range from 4 to 9 years in females, but there is no reliability associated with those estimates, since age estimates used in the past have been questioned, as

have the reliability of the data (Clapham and Mayo 1987). The calving interval is also variable: a range of 2 to 3 years has been given; however, there is some evidence of calving by females in consecutive years. Gestation averages around 12 months, and lactation lasts nearly a year. The majority of calves are weaned at 1 year, but the specific timing of separation is still unknown (*in* Perry *et al*. 1999). In the North Pacific, annual reproductive rates have been estimated from information collected in wintering and summering areas: the least biased estimate came from southeastern Alaska, where the calving rate[15] was estimated to be 0.37. Thus, on average, a mature female gives birth only once every 2.7 years (inverse of calving rate) to a calf that survives its first 6 months of life and its first migratory transit (Baker *et al*. 1987).
The information available does not identify natural causes of death among humpback whales or their number and frequency over time, but potential causes of natural mortality are believed to include parasites, disease, predation (by killer whales, false killer whales, and sharks), biotoxins and entrapment in ice.

Food Habits: Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including krill (euphausiids), juvenile salmonids, Arctic cod (*Boreogadus saida*), walleye pollock (*Theragra virens*), pteropods and some copepods (Johnson and Wolman 1984). Fish prey in the North Pacific include herring, anchovy, capelin, pollock, Atka mackerel, eulachon, sand lance, Pacific cod, saffron cod, arctic cod, juvenile salmon and rockfish. Humpback whales use a wide variety of fishing techniques, at times involving more than one individual and resembling a form of cooperative participation. The two most observable techniques are lob-tail feeding and bubble-cloud feeding. Recently, there has also been documentation of bottom-feeding by humpback whales in the Atlantic (*in* Perry *et al*. 1999). Whether humpback whales in the Pacific feed in this manner is currently unknown; however, it is assumed that baleen whales do not dive beyond 300 meters in depth (Nemoto 1963).

Management and Listing Status: The IWC has designated one stock of humpback whales in the North Pacific (Donovan 1991). However, based on aerial, vessel, and photo-identification surveys and on genetic analyses, NOAA Fisheries recognizes four stocks of humpback whales in the North Pacific: (1) Eastern North Pacific; (2) central North Pacific; (3) western North Pacific; and (4) Mexico (Hill and DeMaster 1999). The eastern North Pacific stock of humpbacks spend their winter and spring in coastal central America and Mexico and migrate north along the coast of California to southern British Columbia in the summer and fall. Only this stock is of interest for this consultation.

Significant levels of genetic differences were found between the California and Alaska feeding groups based on analyses of mitochondrial deoxyribonucleic acid (DNA) (Baker *et al*. 1990) and nuclear DNA (Baker *et al*. 1993). The genetic exchange rate between California and Alaska is estimated to be less than one female per generation (Baker 1992). Two breeding areas (Hawaii and Mexico) showed fewer genetic differences than did the two feeding areas (Baker 1992).

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[15]Calving rate - the proportion of individually identified females, assumed to be sexually mature, accompanied by calves in a given year or summed across years and expressed on a per-year basis. The calving rate of an individual female is equal to the inverse of her calving interval (Baker *et al*. 1987).

This is substantiated by the observed movement of individually-identified whales between Hawaii and Mexico (Baker *et al*. 1990). There have been no individual matches between 597 humpbacks photographed in California and 617 humpback whales photographed in Alaska. Only two of the 81 whales photographed in British Columbia have matched with the California catalog (Calambokidis *et al*. 1996), indicating that the United States/Canada border is an approximate geographic boundary between feeding populations.

There has been a prohibition on taking humpbacks since 1966. Humpback whales were listed as endangered under the ESA in 1973. They are also protected by CITES and the MMPA. Critical habitat has not been designated for the species.

Population Status and Trends: The pre-1905 abundance of humpback whales in the North Pacific has been estimated to be 15,000 (Rice 1978), but whaling likely reduced the population to approximately 1,200 individuals by 1966 (Johnson and Wolman 1984).

The current humpback whale population in the entire North Pacific is likely to consist of at least 6,000 individuals (Calambokidis *et al*. 1997). Dohl *et al*. (1983) first estimated the California feeding population to be 338 (CV=0.29) based on aerial surveys conducted August through November 1980 to 1983. More recently, the size of this feeding stock of humpback whales has been estimated by three independent methods. Calambokidis *et al.* (2000) estimated the number of humpback whales off of California to Washington to be 1,024 (CV=0.10) based on mark-recapture estimates that compared 1998 and 1999 photo-identification catalogs. Barlow and Taylor (2001) estimated 1,177 (CV=0.28) humpback whales in California, Oregon and Washington waters based on ship line-transect surveys in summer/autumn of 1993 and 1996. Forney *et al*. (1995) estimated 319 (CV=0.41) humpback whales in California coastal waters based on aerial line-transect surveys in winter/spring of 1991 and 1992 (not corrected for diving whales). Further, Green *et al*. (1992) reported that humpback whales were the second most abundant large whale (after gray whales) in aerial surveys off Oregon and Washington, but they provided no estimate of population size. These estimates of population size are not significantly different from one another. However, the most precise and least biased estimate for this population is likely to be the photographic mark-recapture estimate of 1,024 (CV=0.10) humpback whales along the United States west coast (Calambokidis *et al*.2000).

The population of humpback whales in the North Pacific is thought to have grown after it was afforded protection from whaling in 1966. Estimated at 1,200 in 1966, the humpback whale population was estimated to be between 6,000 and 8,000 in 1992. Mark-recapture population estimates increased steadily between 1988 to 1990 to 1997 to 1998 at about 8% per year (Calambokidis *et al*. 1999), and an even higher estimate for 1998 to 1999 suggests a continued population increase (Calambokidis *et al*. 2000).

Threats

Historic Whaling
Between 1919 and 1929, approximately 7,300 humpback whales were taken along the west coast of North America, and between 1947 and 1987, commercial whalers killed approximately 7,700 humpbacks in the North Pacific. Catches between 1910 and 1965 totaled 2,000 taken off Oregon and Washington, 3,400 taken off California, and 2,800 taken off Baja California, Mexico (*in* Carretta *et al*. 2001).

Fisheries
From July 1990 to October 1997, before the effective date of the Pacific Cetacean Offshore Take Reduction Plan, observers recorded the incidental entanglement of one humpback by the California/Oregon drift gillnet fishery, in 1994, off southern California. This animal was released alive and uninjured. Following the implementation of the Pacific Offshore Cetacean take Reduction Plan (PCTRP), only one humpback was observed entangled, in 1999, off southern California; this animal was also released alive and uninjured. The California salmon troll fishery has also been responsible for snagging one humpback whale in 1997. The animal swam away with the hook and many feet of trailing monofilament. In addition, the deaths of two humpbacks that stranded off southern California have been attributed to entanglement in fishing gear, and a humpback whale was observed off Ventura, California in 1993 with a section of netting wrapped around it and trailing gear. In 1999, a cow-calf pair was observed entangled in a net off Big Sur, California (*in* Carretta *et al*. 2001).

Ship Strikes
Off California, in 2000, one humpback was struck and killed by a vessel, and from 2000 to 2001, three unidentified whales were injured and one unidentified balaenopterid was killed due to vessel strikes (J. Cordaro, NOAA Fisheries, personal communication 2002). In addition, several humpbacks photographed off California have had large gashes in their dorsal surface which appeared to be from ship strikes. Additional mortality from ship strikes most likely goes unreported, particularly if a whale does not strand, or if they do, they may not have obvious signs of trauma. Large vessels may also not be aware that they have struck a whale.

Northern Right Whale
Physical Description: Northern right whales grow up to 56 feet in length and are mostly black with some white patches on their bellies. They have large heads (about one-fourth of their total length) with strongly arched jaws and wide bodies. Their spouts are "V"-shaped and they have no back fin. In addition, they have light-colored, wart-like skin patches on their heads, called callosities.

Life History: In both northern and southern hemispheres, right whales have been observed in the lower latitudes and more coastal waters during winter, and then tend to migrate to higher latitudes during the summer. Calving may occur in winter months when their distribution is more coastal, but the lack of sighting information suggests that calving may occur farther offshore. The right whale gestation period is about 12 months and the calf is born tail first and near the surface. Right whale calves are nursed and weaned in about 1 year when the they are

roughly 28 feet long. Right whales may have a life expectancy of over 60 years, although this figure is not at all certain.

Food Habits: In summer and fall in both hemispheres, the distribution of right whales appears linked to the distribution of their principal zooplankton prey (Winn *et al*.1986). Right whales in the North Pacific are known to prey on a variety of zooplankton species including *Calanus plumchrus, C. cristatus, Euphausia pacifica, Metridia* spp., and copepods of the genus *Neocalanus.* This is similar to the feeding habits of right whales in the Gulf of Maine, which feed on zooplankton (primarily copepods) (see NMFS 1991b, Murison and Gaskin 1989). Right whales may compete with sympatric sei whales and many other predators or consumers of zooplankton in the eastern North Pacific and Bering Sea. Killer whales are suspected as possible predators, but no data from the North Pacific support this speculation (Scarff 1986).

Distribution: Right whales have occurred historically in all the world's oceans from temperate to subarctic latitudes. Historical whaling records (Maury 1852, Townsend 1935, Scarff 1986) indicate the right whale ranged across the North Pacific above 35˚N. They summered in the North Pacific Ocean and southern Bering Sea from April or May to September, with a peak in sightings in coastal waters of Alaska in June and July (Maury 1852, Townsend 1935, Omura 1958, Klumov 1962, Omura *et al*. 1969). Their summer range extended north of the Bering Strait (Omura *et al*. 1969). However, they were particularly abundant in the Gulf of Alaska from 145˚ to 151˚W (Berzin and Rovnin 1966), and apparently concentrated in the Gulf of Alaska, especially south of Kodiak Islands and in the Eastern Aleutian Islands and southern Bering Sea shelf waters (Braham and Rice 1984).

Very little is known of the current size and distribution of right whales in the North Pacific, and very few of these animals have been seen in the past 20 years. Only 43 right whales have been sighted in the eastern North Pacific over that time period, with five of those occurring off California or Mexico and one off the coast of Washington. The last right whale to be sighted off Washington was in 1992, while none have been sighted off of Oregon (Brownell *et al*. 2001). It is likely that right whales were never common off the coast of Oregon and Washington (Scarff 1986, 1991). Aboriginal and commercial whaling records indicate that right whales were not common off the west coast of North America even during the early stages of the fishery (Townsend 1935, Scarff 1986, Mitchell and Reeves 2001). This cannot be said for other areas of the North Pacific, such as the southeastern Bering Sea and Aleutian Islands, where the paucity of contemporary right whale sightings, despite dedicated marine mammal surveys, is more likely attributable to overharvest (Brownell *et al.* 2001). A recent sighting of a female and her calf during a marine mammal survey in the southeastern Bering Sea is noteworthy, as since 1997, scientists have identified six individual eastern North Pacific right whales, all male (Associated Press article, September 20, 2002)[16]. Their migration patterns are unknown, but are believed to include north-south movements between summer and winter feeding areas.

[16]http://www.theolympian.com/home/specialsections/Critters/20020921/6342.shtml

Management and Listing Status: The IWC currently recognizes two species of northern right whales: *Eubalaena glacialis* in the North Atlantic and *E. japonica* in the North Pacific. However, right whales in the North Atlantic, North Pacific, and the southern hemisphere of both oceans are currently listed under the ESA as one species: Right whales (which includes *E. glacialis*, *E. japonica*, and *E. australis*). For the purposes of ESA section 7(a)(2) consultations, NOAA Fisheries recognizes three major populations of right whales: North Pacific, North

Atlantic, and Southern Hemisphere. The available information is not sufficient to identify stocks in the North Pacific, although Scarff (1986) suggested a right whale stock may be associated with the Gulf of Alaska.

Since 1949, the northern right whale has been protected from commercial whaling by the IWC. Right whales are listed as endangered under the ESA. They are also protected by the CITES and the MMPA. NOAA Fisheries designated critical habitat for the North Atlantic population of right whales on June 3, 1994 (59 FR 28793). Critical habitat has not been designated for right whales in the North Pacific Ocean.

Population Status and Trends: The scarcity of right whales is the result of an 800-year history of whaling that continued into the 1960s (Klumov 1962). Of all of the large whales, right whales are believed to have the highest risk of extinction in the foreseeable future.

The population dynamics of right whales are unknown. The recovery plan for this species suggests that its pre-exploitation abundance was higher than 11,000, based on a known harvest of over 11,000 by United States whalers with additional numbers struck and lost (Brownell *et al.* 1986). Current population estimates range from a low of 100 to 200 (Braham and Rice 1984) to a high of 220 to 500 (Berzin and Yablokov 1978 [in Berzin and Vladimirov 1981]), but Hill and DeMaster (1999) argue that is it is not possible to produce a reliable estimate of population size or trends for the right whale in the North Pacific. No population projections are available.

Threats

Before whaling began in the North Pacific Ocean, right whales were considered common or abundant in the North Pacific (Webb 1988). However, they have probably never been common in waters off Oregon and Washington (Scarff 1986, 1991). By 1900, observations of right whales in the North Pacific had become so rare that it was impossible to know their population status or trend. In the Atlantic Ocean, the major known sources of anthropogenic mortality and injury of right whales include entanglement in commercial fishing gear and ship strikes.

<u>Sei Whale</u>

Physical Description: Most sei whales are between 12.2 and 15.2 meters long, with males slightly smaller than females. Sei whales have a relatively slender body with a compressed tail stock that abruptly joins the flukes. The snout is pointed, and the pectoral fins are short. The dorsal fin is sickle shaped and ranges in height from 25 to 61 centimeters. The body is typically a dark steel gray with irregular white markings ventrally. The ventrum has 38 to 56 deeps

grooves, which may have some feeding function. Each side of the upper part of the mouth contains 300 to 380 ashy-black baleen plates, and the fine inner bristles of these plates are whitish.

Life History: Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months and the calving interval is about 3 years. Sei whales become sexually mature at about age 10. The age structure of the sei whale population is unknown, and the estimated total annual mortality for adult females as 0.088 and adult males as 0.103 (Rice 1977). Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas. Endoparasitic helminths are commonly found in sei whales and can result in pathogenic effects when infestations occur in the liver and kidneys (Rice 1977).

Food Habits: Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95% of their diets (Calkins 1986). The balance of their diet consists of squid and schooling fish, including smelt, sand lance, Arctic cod, rockfish, pollock, capelin, and Atka mackerel (Nemoto and Kawamura 1977). Rice (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage of variable prey resources, but may also increase their potential for competition with commercial fisheries.

Distribution: Sei whales are distributed in all of the world's oceans, except the Arctic Ocean, and they are generally found far out at sea and are not commonly associated with coastal habitats. Whaling effort was continuous across 45˚ to 55˚N (Masaki 1977). Two sei whales tagged off California were later killed in waters off Washington and British Columbia (Rice 1974), and similar movements of sei whales have been observed elsewhere in the North Pacific. Sei whales were the fourth most taken whale by California coastal whaling operations in the 1950s and 1960s (Rice 1974), but now they are considered rare there (Dohl *et al.* 1983, Barlow 1997, Forney *et al.* 1995, Mangels and Gerrodette 1994). Only one confirmed sighting of a sei whale and five possible sightings were made in California waters during aerial and vessel surveys from 1991 to 1993 and 1996. There were no sightings of sei whales in aerial surveys off Oregon and Washington (*in* Carretta *et al.* 2001).

Management and Listing Status: The IWC recognizes all sei whales in the North Pacific Ocean as one stock (Donovan 1991), but some evidence exists for multiple populations. Based on the available information (and lack thereof), NOAA Fisheries considers sei whales in the eastern North Pacific (east of 180° longitude) as one stock (Carretta *et al*. 2001).

There has been an IWC prohibition on the take of sei whales since 1976, and commercial whaling in the United States has been prohibited since 1972 under the MMPA. Sei whales were listed as endangered under the ESA in 1973. They are also protected by CITES and are listed as endangered under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for sei whales.

Population Status and Trends: Sei whale abundance prior to commercial whaling in the North Pacific has been estimated at 42,000 sei whales (Tillman 1977). Japanese and Soviet catches of

sei whales in the North Pacific and Bering Sea increased from 260 whales in 1962 to over 4,500 in 1968 and 1969, after which the sei whale population declined rapidly (Mizroch *et al*. 1984c). By 1974, the population of sei whales in the North Pacific had been reduced to between 7,260 and 12,620 animals (Tillman 1977).

Current abundance and trends are not known for the eastern North Pacific stock of sei whales.

Ship Strikes A Sei whale was struck by a ship that arrived in the Port Angeles (WA) harbor, though it is not known where the collision occurred.

Threats

Historic Whaling
Between 1947 and 1987, commercial whalers took approximately 61,500 sei whales in the North Pacific. Of these, 384 were taken by shore-based whaling stations in central California between 1958 and 1965. There has been a prohibition by the IWC on the take of sei whales since 1976.

Sperm Whale
Physical Description: The sperm whale, a member of the family Physeteridae, is the largest of the toothed whales, and is one of the most widely distributed of marine mammals in all oceans of the world, between 60°N and 70°S (Leatherwood and Reeves 1983). The sperm whale is distinguished by its huge boxlike head (up to 40% of its body length), a dark grayish brown body, with a rounded or triangular hump followed by knuckles along its spine. Its blunt snout houses a large reservoir of spermaceti, a high-quality oil.

Life History: Female sperm whales take about 9 years to become sexually mature (Kasuya 1991). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for 2 to 3 years. The calving interval is estimated to be about 4 to 6 years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980). Potential sources of natural mortality in sperm whales include killer whales and papilloma virus (Lambertson *et al.* 1987).

Food Habits: Sperm whales are known for their deep foraging dives (in excess of 3,000 meters). They feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollock, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales in California coastal waters prey primarily on four species of squid (*i.e. Moroteuthis, Gonatopsis, Histioteuthis and Galiteuthis*) (Fiscus *et al.* 1989). Daily food

consumption rates for sperm whales ranges from 2 to 4% of their total body weight (Kawakami 1980).

Distribution: Sperm whales are distributed in all of the world's oceans. They are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Mature female and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45˚N throughout the year. These groups of adult females and immature sperm whales are rarely found at latitudes higher than 50˚N and 50˚S (Reeves and Whitehead 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to move north into the Aleutian Islands, Gulf of Alaska, and the Bering Sea.

Sperm whales are found year-round in California waters (Dohl *et al.* 1993, Barlow *et al.* 1995, Forney *et al.* 1995). They are also seen in Washington and Oregon every season except winter (December to February) (Green *et al.* 1992).

Management and Listing Status: While the IWC recognizes two management regions for sperm whales stocks in the North Pacific (western and eastern stock) (Donovan 1991), the IWC has not reviewed the stock boundary in many years. For stock assessment purposes, within the Pacific United States exclusive economic zone (370.4 km) NOAA Fisheries has divided sperm whales into three discrete non-contiguous areas: (1) Alaska, (2) California/Oregon/Washington, and (3) Hawaii.

There has been a prohibition on the taking of sperm whales in the north Pacific since 1988, although large-scale pelagic whaling stopped earlier, in 1980. Sperm whales were listed as endangered under the ESA in 1973. They are also protected by CITES and the MMPA. Critical habitat has not been designated for sperm whales.

Population Status and Trends: Barlow and Taylor (2001) estimated 1,407 (CV=0.39) sperm whales along the coasts of California, Oregon and Washington during summer/fall based on ship line transect surveys conducted in 1993 and 1996. A combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific in spring, 1997 resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 (CV=0.60) based on acoustic detections and visual group size estimates (Barlow and Taylor 1998). Green *et al.* (1992) reported that sperm whales were the third most abundant large whale species (after gray and humpback whales) observed in aerial surveys off Oregon and Washington, but they did not estimate abundance. Estimates of abundance have been made for sperm whale stocks in the eastern tropical Pacific (22,700) and Baja California (1,640) by Wade and Gerrodette (1993) and Barlow and Taylor (2001), respectively, but there is no evidence of interchange between these two stocks of sperm whales and the stock off of California/Oregon/Washington (Carretta *et al.* 2001).

Threats

Historic and Current Whaling

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (*in* Hill and DeMaster 1999). However, both Japan (Kasuya 1998) and the Soviet Union (Kasuya 1998) under-reported catches of sperm whales, so a total of at least 436,000 individuals of this species were taken between 1800 and 1987 (Carretta *et al*. 2001). Of this total, about 33,842 sperm whales were taken by Japanese and Soviet vessels in the eastern North Pacific between 1961 and 1976, and 965 were taken in by land-based operations on the west coast of the United States between 1947 and 1971 (Ohsumi 1980). An additional
13 whales were taken by shore whaling stations between 1919 and 1926 (Clapham *et al.* 1997).

In 2000, the Japanese Whaling Association announced that it proposed to kill 10 sperm whales in the Pacific Ocean for research purposes, which was the first time sperm whales have been taken since the international ban on commercial whaling took effect in 1987. Despite protests from the United States government and members of the IWC, the Japanese government plans to conduct this research. The implications of this action for the status and trend of sperm whales is uncertain.

Steller Sea Lion

The Steller sea lion is the only extant species of the genus *Eumetopias*. The closest extant relatives of the Steller sea lion appear to be the other sea lion genera, including *Zalophus*, *Otaria*, *Neophoca*, and *Phocarctos*, and the fur seals of the genera *Callorhinus* and *Arctocephalus*.

Physical Description: Steller sea lions are the largest of the family Otariidae, and show marked sexual dimorphism, males averaging 282 centimeter (cm), 566 kilogram (kg), and females averaging 228 cm and 263 kg. They have a light buff to reddish brown pelage, and the adult males have long coarse hair on their upper body and back and a massive chest and neck (*in* Clapham *et al.* 1997).

Life History: Within their distribution, land sites used by Steller sea lions are referred to as rookeries and haulout sites. Rookeries are used by adult males and females for mating, pupping and nursing during the reproductive season (May through early July). Haulouts are used by all size and sex classes but are generally not sites of reproductive activity. The continued use of particular sites may be due to site fidelity, or the tendency of sea lions to return repeatedly to the same site, often the site of their birth. Despite the wide-ranging movements of juveniles and adults males outside of the breeding season, little mixing between rookeries occurs. Presumably, these haulout sites were chosen and continue to be used because of their substrate and terrain, the protection they offer from terrestrial and marine predators, protection from severe climate or sea surface conditions, and the availability of prey resources. Steller sea lions haul out and breed on a variety of substrates, including sand, gravel, cobble, boulder and bedrock (NMFS 1992).

Steller sea lions have a polygynous reproductive system, where a single male may mate with multiple females. As mating occurs on land (or in the surf or intertidal zones), males are able to defend territories and thereby exert at least partial control over access to adult females and mating privileges. The pupping and mating season is relatively short and synchronous, probably due to the strong seasonality of the sea lions' environment and the need to balance aggregation for reproductive purposes with dispersion to take advantage of distant food resources (Bartholomew 1970).

In the beginning of the season, adult males compete for rookery territories. Soon afterwards, adult females arrive at the rookeries, where pregnant females give birth to a single pup. The sex ratio of pups at birth is approximately 1:1 or biased toward slightly greater production of males (*e.g.*, Pike and Maxwell 1958, Lowry *et al.* 1982, NMFS 1992). Mating occurs about 1 to 2 weeks after pupping (Gentry 1970). The gestation period is probably about 50 to 51 weeks, but implantation of the blastocyst is delayed for 2 to 3 months (Pitcher and Calkins 1981). Due to delayed implantation, the metabolic demands of a developing fetus are not imposed on the female until well into fall and early winter. After parturition (birth), females nurse their pups over a period of months to several years.
There are three main Steller sea lion rookeries in the action area - Rogue Reef and Orford Reef in Oregon and St. George Reef in Crescent City, California[17]. In addition, between 4 to10 pups are consistently born every year at Three Arch Rock, about a half-mile offshore from Oceanside, west of Tillamook R. Brown, Oregon Department of Fish and Wildlife [ODFW], personal communication 2002). Males begin showing up on the rookeries in late April and early May. Females arrive in May, the first viable pups are born in mid-May, and pupping occurs through the first week of July (99% complete). Breeding activity continues throughout this period, the adult males depart, and mothers and pups remain on the rookery through approximately the end of August. Most pups on these rookeries are capable of moving around and swimming by mid-July. By September, most of the rookeries are abandoned, as Steller sea lions have moved to other haulout areas R. Brown, ODFW, personal communication 2002).

Relatively little is known about the life history of sea lions during the juvenile years between weaning and maturity. Pitcher and Calkins (1981) reported that females sampled in the late 1970s reached reproductive maturity between ages 2 and 8, and the average age of first pregnancy was 4.9 ±1.2 years. These results indicate a mean age of first birth of about 6 years. The available literature indicates an overall reproductive (birth) rate on the order of 55 to 70% or greater (Pike and Maxwell 1958, Gentry 1970, Pitcher and Calkins 1981, Pitcher *et al*. in review).

Food Habits: Steller sea lions, like all pinnipeds, are central place foragers. That is, their foraging trips radiate away from a central land base. Data indicate that Steller sea lions feed

[17] NOAA Fisheries has chosen to include this Northern California Steller sea lion rookery as part of the action area because (1) the rookery is just south of the California/Oregon border; (2) the trajectory of an oil spill occurring off the Oregon coast could conceivably reach this rookery; and therefore, (3) any protective measures imposed as part of this section 7 consultation should include this important rookery.

primarily within the closest 10 nautical miles from rookeries and haulouts. They are opportunistic foragers, feeding on demersal, semi-demersal and off-bottom species, using a broad spectrum of foraging styles. They also forage on fish species that are aggregating, such as during spawning season. While the species that sea lions prey upon vary geographically and temporally, dominant prey species include Pacific whiting, walleye pollock, rockfish, Pacific salmon, herring and Pacific cod. Steller sea lions also occasionally feed on harbor seals, spotted seals bearded seals, ringed seals, fur seals and sea otters (Gentry and Johnson 1981, Pitcher and Fay 1982). Near the Oregon rookeries, the most common prey items of Steller sea lions included: Pacific whiting, Pacific lamprey, salmonids, Pacific herring, cephalopods, skate, and smelt species (Riemer *et al*. 2001).

Distribution: Steller sea lions are distributed around the North Pacific rim from the Channel Islands off Southern California to northern Hokkaido, Japan. The species' distribution extends northward into the Bering Sea and along the eastern shore of the Kamchatka Peninsula. The Gulf of Alaska and the Aleutian Islands are considered the geographic center of the sea lions' distribution (Kenyon and Rice 1961). Steller sea lions are not known to migrate, but adult males and juveniles do disperse widely outside of the breeding season.

In the Pacific Northwest, Steller sea lions are found year-round. In Washington, the peak numbers of Steller sea lions occur in late summer, fall, and winter. Although there are no Steller sea lion rookeries in Washington, they do haul out at Split and Willoughby Rocks on the south Washington coast and at Carroll Island, Cape Alava and Tatoosh Island on the north Washington coast. They are often found on jetties, offshore rocks, and coastal islands. In Oregon, at least 10 haul-out sites are used on a regular basis and reproductive activities occur primarily at three sites (Rogue Reef, Orford Reef, and a smaller site at Three Arch Rocks). As mentioned, another important rookery for Steller sea lions occurs just south of the Oregon border, at St. George Reef, off Crescent City, California.

Management and Listing Status: On November 26, 1990, the Steller sea lion was listed as threatened under the ESA. Subsequently, in 1997, the species was split into two separate stocks based on demographic and genetic dissimilarities (Bickham *et al.* 1996, Loughlin 1997); the status of the western stock was changed to endangered; and the status of the eastern stock was left unchanged (threatened) (62 FR 30772).
Loughlin (1997) considered the following information when classifying the stock structure of Steller sea lions based on the phylogeographic approach described by Dizon *et al*. (1992):
(1) Distributional data; (2) population response data, such as substantial differences in population dynamics; (3) phenotypic data; and (4) genotypic data, such as substantial differences in mitochondrial DNA (Bickham *et al*. 1996). Based on this information, the two stocks of Steller sea lion now recognized in United States waters are: (1) An eastern stock, including animals east of Cape Suckling, Alaska (144° W); and (2) a western stock, including animals at and west of Cape Suckling (Loughlin 1997). Over the last three decades, the western stock of Steller sea lion has declined in abundance nearly 80%, while the eastern stock has remained stable or increased slightly. The eastern United States stock is the stock of interest in this Opinion.

As described earlier, critical habitat was designated for Steller sea lions in 1993 to protect rookeries and important haulouts. Critical habitat includes an air zone that extends 3,000 feet (0.9 km) above areas historically occupied by sea lions at each major rookery in Oregon: (1) Pyramid Rock at Rogue Reef and two sites at Orford Reef ; (2) Long Brown Rock; and (3) Seal Rock, measured vertically from sea level. Critical habitat includes an aquatic zone that extends 3,000 feet (0.9 km) seaward in state and Federally-managed waters from the baseline or basepoint of each major rookery in Oregon (50 CFR 226.202).

Population Status and Trends: For the eastern population (east of 144˚W), counts of nonpups (adults and juveniles) have increased overall from just under 15,000 in 1982 to just over 20,000 in 1994 (Hill and DeMaster 1999). The latest minimum population estimate is 31,005. This estimate is based on the addition of the 1998 counts from southeast Alaska (15,173), the 1996 counts from Washington, Oregon, and California (6,555), and the 1994 counts from British Columbia (9,277). This count is not corrected for animals who may have been at sea during the time of the survey, and trend sites indicated that the population has been increasing overall (see below) (Carretta *et al*. 2001).

California

Counts of Steller sea lions in California, particularly in southern and central, have declined from historic counts. Between 1927 and 1947, counts ranged between 5,000 and 7,000 non-pups with no apparent trend. Since then, however, counts have declined by over 50%, ranging between 1,500 and 2,000 non-pups during 1980 to 1998 counts. At Año Nuevo, in central California, pup and non-pup counts have shown a steady decline since 1970 (Carretta *et al*. 2001).

Oregon

Steller sea lion abundance and distribution has been monitored at Rogue Reef and Orford Reef rookeries and at eight other haul-out areas in Oregon from 1976 to 2001. Counts of Steller sea lion juveniles and adults have increased from 1,486 in 1976 to 3,786 in 2000, with an average annual rate of 3.9%. In recent years, between 600 to 800 Steller pups were born at the two primary sea lion rookeries in Oregon (Reimer).

British Columbia

Counts of non-pups in British Columbia increased from 4,711 in 1982 to 9,818 in 1998 and have shown an annual increase of 2.8% from 1971 to 1998 (Carretta *et al*. 2001). The increase in British Columbia likely represents partial recovery from the effects of "control" programs in the earlier part of the century.

Southeast Alaska

Counts of non-pups at trend sites in southeast Alaska have increased from 6,376 in 1979 to 8,693 in 1998, a 28% increase. From 1979 to 1997, the number of pups born on three rookeries increased by an average of 5.9% per year. In 1996, a total of 6,555 Steller sea lions were counted in California (2,042), Oregon (3,990) and Washington (523), including 5,464 non-pups and 1,091 pups (Carretta *et al.* 2001).

Based on recent trends in southeast Alaska and British Columbia, prospects for recovery of the eastern population are encouraging. In Southeast Alaska, counts of non-pups at trend sites increased 28% from 1979 to 1996 from 6,376 to 8,693 (Sease and Loughlin 1999).

Trend counts in Oregon were relatively stable in the 1980s; however, counts in Oregon increased gradually between 1976 (1,486) and 1998 (3,971) (Brown and Reimer 1992, Carretta *et al.* 2001). No trend sites exist in Washington.

Threats

Subsistence and Native Harvest
Steller sea lions may be taken by subsistence hunters in Southeast Alaska and Canada. In Southeast Alaska, the number of sea lions taken annually between 1992 and 1997 (including those struck and lost by hunters) was six, one, five, zero, zero, and zero, respectively. An unknown number of sea lions from the eastern stock are taken by subsistence harvests in Canada; however, the magnitude of the Canadian take is believed to be small (Carretta *et al.* 2001).

Other Mortality
Illegal shooting was thought to be a potentially significant source of sea lion mortality prior to the species' listing as threatened in 1990. At least four sea lions were shot and killed in Southeast Alaska between 1995 and 1999 (Carretta *et al*. 2001).

Steller sea lions are taken in commercial salmon aquaculture operations in Canada. Preliminary figures indicate that a mean annual mortality of 44 sea lions from this stock between 1995 and 1999 (P. Olesiuk, personal communication., as cited in Carretta *et al*. 2001). Takes of sea lions related to salmon aquaculture have increased in recent years, in part, because of an increase in abundance of sea lions in British Columbia. This increase is thought to be a result of a shift in the distribution and abundance of herring, a main prey item for Steller sea lions (P. Olesiuk, personal communication., as cited in Carretta *et al*. 2001).

2.1.3.2 Salmonids

The listing status and history for salmonid species addressed in this Opinion are summarized in Table 2-1. Designated critical habitat for each of the 17 listed salmon and steelhead ESUs considered in this Opinion occurs within the proposed action area. Essential elements of critical habitat for salmonids are: (1) Substrate; (2) water quality; (3) water quantity; (4) water temperature; (5) water velocity; (6) cover/shelter; (7) food; (8) riparian vegetation; (9) space; and (10) safe passage conditions. Based on migratory and other life history timing, it is likely that any life stages of these 17 listed ESUs may be present in the action area during an oil spill. Actions authorized by the USCG and the EPA during an oil spill may affect any or all of these essential habitat features, although the effects of each individual action will vary in timing, duration, and intensity.

Table 2-1 References for additional background on listing status, critical habitat, protective regulations, and biological information for listed salmonids addressed in this Opinion.

Species	Listing Status	Critical Habitat[18]	Protected Regulations	Biological Information/Population Trends
Snake River fall chinook salmon	Threatened 04/22/92 57 FR 14653	12/28/93 58 FR 68543	7/22/92 57 FR 14653 and 7/10/00 65 FR 42422	Waples *et al*. 1991a; Healey 1991; ODFW and Washington Department of Fish and Wildlife (WDFW) 1998
Snake River spring/summer chinook salmon	Threatened 04/22/92 57 FR 14653	12/28/93 58 FR 68543 and 10/25/99 64 FR 57399	04/22/92 57 FR 14653 and 7/10/00 65 FR 42422	Matthews and Waples 1991; Healey 1991; ODFW and WDFW 1998
Puget Sound chinook salmon	Threatened 03/24/99 64 FR 14308	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Meyers *et al*. 1998 WDFW 1993
Lower Columbia River chinook salmon	Threatened 03/24/99 64 FR 14308	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Myers *et al*., 1998; Healey 1991; ODFW and WDFW 1998
Upper Columbia River spring-run chinook salmon	Endangered 03/24/99 64 FR 14308	02/16/00 65 FR 7764	ESA prohibition on take applies	Myers *et al*., 1998; Healey 1991; ODFW and WDFW 1998
Upper Willamette River chinook salmon	Threatened 03/24/99 64 FR 14308	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Myers *et al*., 1998; Healey 1991; ODFW and WDFW 1998
Hood Canal summer-run chum salmon	Threatened 03/25/99 64 FR 14508	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Johnson *et al*. 1997; WDFW 1993
Columbia River chum salmon	Threatened 03/25/99 64 FR 14508	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Johnson *et al* 1997; Salo 1991; ODFW and WDFW 1998

[18]Critical habitat was withdrawn for all but Snake River sockeye, Snake River spring/summer chinook, Snake River fall chinook, and Southern Oregon/Northern California coho.

Species	Listing Status	Critical Habitat[19]	Protected Regulations	Biological Information/Population Trends
Southern Oregon/Northern California coast coho salmon	Threatened 05/06/97 62 FR 24588	05/05/99 64 FR 24049	07/18/97 62 FR 38479	Weitkamp *et al* 1995; NMFS 1997a; Sandercock 1991; Nickelsen *et al*. 1992
Oregon Coast coho salmon	Threatened 08/10/98 63 FR 42587	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Weitkamp *et al* 1995; Nickelsen *et al*. 1992; NMFS 1997b; Sandercock 1991
Snake River sockeye salmon	Endangered 11/20/91 56 FR 58619	12/28/93 58 FR 68543	ESA prohibition on take applies	Waples *et al*. 1991b; Burgner 1991; ODFW and WDFW 1998
Ozette Lake sockeye salmon	Threatened 03/25/99 64 FR 14528	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Gustafson *et al*., 1997; WDF *et al*., 1993
Lower Columbia River steelhead	Threatened 03/19/98 63 FR 13347	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Busby *et al*. 1995,1996; ODFW and WDFW 1998
Middle Columbia River steelhead	Threatened 03/25/99 64 FR 14517	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Busby *et al*. 1995,1996, 1999; ODFW and WDFW 1998
Upper Columbia River steelhead	Endangered 08/18/97 62 FR 43937	02/16/00 65 FR 7764	ESA prohibition on take applies	Busby *et al*. 1995, 1996; ODFW and WDFW 1998
Snake River Basin steelhead	Threatened 08/18/97 62 FR 43937	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Busby *et al*. 1995, 1996; ODFW and WDFW 1998
Upper Willamette River steelhead	Threatened 03/25/99 64 FR 14517	02/16/00 65 FR 7764	07/10/00 65 FR 42422	Busby *et al*. 1995, 1996, 1999 ODFW and WDFW 1998

The following section provides a summary of physical description, life history (including biological requirements), and food habits of the five listed salmonid species (chinook, chum, coho, sockeye and steelhead) within the action area. Following the description for each individual species, the status of the respective ESUs are summarized.

Chinook Salmon

Physical Description: The chinook (also known as "king" salmon) is distinguished from other *Oncorhynchus* species by its large size (adults reach a length of 33 to 36 inches (Scott and

[19]Critical habitat was withdrawn for all but Snake River sockeye, Snake River spring/summer chinook, Snake River fall chinook, and Southern Oregon/Northern California coho.

Crossman 1973), the small black spots covering its entire caudal fin, black pigment along the base of its teeth, and a large number of pyloric caeca (*in* Groot and Margolis 1991). Adults have an iridescent green to blue-green back, top of head, and upper sides, with the lower side silvery. Breeding fish are an overall olive-brown to purple color, with males darker than females. Chinook also have a variable flesh color, ranging from white through various shades of pink to red. Young have 6 to 12 parr marks, each longer and wider than other Pacific salmon (Scott and Crossman 1973).

Life History: Chinook show great variation in age at seaward migration, length of time in freshwater, estuarine, and oceanic residence, ocean distribution and migratory patterns, and age and season of spawning migration (Groot and Margolis 1991). Chinook are divided into two races[20], "stream-type" and "ocean-type," each of which have a range of tactical variations in their life history. "Stream-type" chinook are typical of northern populations and headwater tributaries of southern populations in North America. Steam-type chinook spend one or more years as fry or parr in fresh water before migrating to sea. Once in the ocean, they migrate extensively offshore before returning to their natal river in the spring or summer, several months prior to spawning. Occasionally, stream-type males mature precociously without ever going to sea. "Ocean-type" chinook are typical of populations on the North American coast south of 56°N latitude. Chinook of this type migrate to sea during their first year of life, normally within three months after emergence, spend most of their ocean life in coastal waters, and return to their natal river in the fall, a few days or weeks before spawning (Groot and Margolis 1991).

Spawning adults enter rivers during most of the year and generally spawn in larger rivers or larger tributaries, near riffles. Many rivers have more than one run (spring to winter chinooks), each made up of fish bound for different spawning grounds (Scott and Crossman 1973). The general trend throughout the range is for earlier spawning further north, with the northern populations tending to spawn from July to September, and the southern populations spawning from November to January (Groot and Margolis 1991). Chinook also vary in distance traveled up river, spawning just above the tidal influence, to as far as 600 (Fraser River) to over 1,200 miles (Yukon River) (Scott and Grossman 1973). Chinook will generally spawn in deeper water and on larger gravel than other Pacific salmon, although spawning beds vary considerably, from water depths of a few centimeters to several meters. Despite the variety of conditions, most authors note the importance of subgravel flow ("percolation") in the choice of redd sites by chinook, probably because their large eggs are more sensitive to any reduced oxygen levels and therefore require a more certain rate of irrigation (*in* Groot and Margolis 1991).
Females lay between 2,000 and 17,000 eggs, often in more than one nest, and females may spawn with different males. Once the eggs hatch, alevins spend 2 to 3 weeks in the nest while the yolk is absorbed before emerging through the gravel as fry. Most fry migrate downstream immediately after emergence, probably to distribute themselves among suitable rearing habitats. "Ocean-type" chinook fry migrate seaward either soon after yolk resorption, as fry 60 to160 days after hatching, or as fingerlings in the late summer or fall of their first year. "Stream-type"

[20]"Race" has been used by Merrell 1981 (*in* Groot and Margolis, 1991) to identify subdivisions of a population that are geographically separated to some degree and between which gene flow is reduced.

chinook will remain in freshwater for at least a year. In the larger rivers, chinook fry migrate more at the edges of the river, and when the river is deeper than about 3 meters, they prefer to migrate on the surface (*in* Groot and Margolis 1991). The preferred temperature for fry is between 53.6° to 57.2°F (12° to 14°C), while upper lethal temperature is 77.2°F (25.1°C).

Of the two types, ocean-type chinook salmon predominate in coastal regions, including Puget Sound, and depend on estuaries and coastal areas for juvenile rearing, spending up to half a year in estuarine habitats. Studies have shown juvenile chinook to be present nearly year-round in the nearshore, and are most abundant in intertidal flats and shallow subtidal channels near estuarine and tidal marshes and eelgrass meadows (Starkes 2001).

From limited information derived from fisheries-caught chinook, ocean-type chinook generally do not disperse more than 1,000 kilometers from their natal river and do not wander far from shore. Stream-type chinook, on the other hand, have been found broadly dispersed in the high-seas. Chinook originating from Washington and Oregon rivers are probably distributed mainly in the eastern North Pacific, with the greatest concentration over the continental shelf waters along North America (Healey 1983 *in* Groot and Margolis 1991).

Food Habits: Studies on the food habits of chinook in rivers indicate that they feed opportunistically at the surface, in the water column, and off the bottom. Young chinook feed on small fishes (sand lance, eulachon, herring), terrestrial insects (caddisflies, mites, spiders, aphids, ants), and crustaceans (amphipods, copepods, euphausiids, and cladeocerans, and the larvae of crabs and barnacles). Young in the sea close to shore feed on chironomid larvae and pupae, while adults in the ocean feed primarily on fish (*e.g.* herring, anchovy, whiting, cod, rockfish, sand lance), and to a lesser degree on invertebrates (squid, amphipods, shrimp) (Hart 1973; *in* Scott and Grossman 1973; *in* Groot and Margolis 1991).

<u>Snake River Fall Chinook ESU</u>

Snake River fall chinook were listed as a threatened species on April 22, 1992 (57 FR 14653). Critical habitat was designated on December 28, 1993 (58 FR 68543) and remains effective. The Snake River Basin drains an area of approximately 280,000 km^2 and incorporates a range of vegetative life zones, climatic regions, and geological formations, including the deepest canyon (Hells Canyon) in North America. The location, geology, and climate of the Snake River region create a unique aquatic ecosystem for fall chinook salmon. This ESU includes all natural populations of fall chinook salmon in the mainstem Snake River and all tributaries (includes the following subbasins: Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River), from their confluence with the Columbia River to the Hells Canyon Dam complex. Because genetic analyses indicate that fall chinook salmon in the Snake River are distinct from the spring/summer chinook in the Snake River Basin (Waples *et al.* 1991a), Snake River fall chinook salmon are considered separately from the other one form. They are also considered separately from those assigned to the Upper Columbia River summer and fall ESU because of considerable differences in habitat characteristics and adult ocean distribution and less definitive, but still significant, genetic differences. There is, however, some concern that

recent introgression from Columbia River hatchery strays is causing the Snake River population to lose the qualities that made it distinct for ESA purposes.

Snake River fall chinook salmon remained stable at high levels of abundance through the first part of the twentieth century, but then declined substantially. Although the historical abundance of fall chinook salmon in the Snake River is difficult to estimate, adult returns appear to have declined by three orders of magnitude since the 1940s, and perhaps by another order of magnitude from pristine levels. Irving and Bjornn (1981) estimated that the mean number of fall chinook salmon returning to the Snake River declined from 72,000 during the period 1938 to 1949 to 29,000 during the 1950s. Further declines occurred upon completion of the Hells Canyon Dam complex, which blocked access to primary production areas in the late 1950s (see below).

Fall chinook salmon in this ESU are ocean-type. Adults return to the Snake River at ages 2 through 5, with age 4 most common at spawning (Chapman *et al.* 1991). Spawning, which takes place in late fall, occurs in the mainstem and in the lower parts of major tributaries (Northwest Power Planning Commission [NWPPC] 1989; Bugert *et al.* 1990). Juvenile fall chinook salmon move seaward slowly as subyearlings, typically within several weeks of emergence (Chapman *et al.* 1991). Based on modeling by the Chinook Technical Committee, the Pacific Salmon Commission estimates that a significant proportion of the Snake River fall chinook (about 36%) are taken in Alaska and Canada, indicating a far-ranging ocean distribution. In recent years, only 19% were caught off Washington, Oregon, and California, with the balance (45%) taken in the Columbia River (Simmons 2000).

With dams and hydropower development, the most productive areas of the Snake River Basin are now inaccessible or inundated. The upper reaches of the mainstem Snake River were the primary areas used by fall chinook salmon, with only limited spawning activity reported downstream from river kilometer (Rkm) 439. The construction of Brownlee Dam (1958; Rkm 459), Oxbow Dam (1961; Rkm 439), and Hells Canyon Dam (1967; Rkm 397) eliminated the primary production areas of SR fall chinook salmon. There are now 12 dams on the mainstem Snake River, and they have substantially reduced the distribution and abundance of fall chinook salmon (Irving and Bjornn 1981).

The Snake River has contained hatchery-reared fall chinook salmon since 1981 (Busack 1991). The hatchery contribution to Snake River escapement has been estimated at greater than 47% (Myers *et al* 1998). Artificial propagation is recent, so cumulative genetic changes associated with it may be limited. Wild fish are incorporated into the brood stock each year, which should reduce divergence from the wild population. Release of subyearling fish may also help minimize the differences in mortality patterns between hatchery and wild populations that can lead to genetic change (Waples 1999). (See NMFS [1999a] for further discussion of the Snake River fall chinook salmon supplementation program.)

Some Snake River fall chinook historically migrated over 1,500 km from the ocean. Although the Snake River population is now restricted to habitat in the lower river, genes associated with

the lengthier migration may still reside in the population. Because longer freshwater migrations in chinook salmon tend to be associated with more-extensive oceanic migrations (Healey 1983), maintaining populations occupying habitat that is well inland may be important in continuing diversity in the marine ecosystem as well.

For the Snake River fall chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period[21] ranges from 0.94 to 0.86, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

Snake River Spring/Summer Chinook ESU

Snake River spring/summer chinook were listed as a threatened species on April 22, 1992 (57 FR 14653). Critical habitat was designated on December 28, 1993 (58 FR 68543), revised on October 25, 1999 (64 FR 57399) and remains effective. This ESU includes all natural populations of spring/summer chinook in the mainstem Snake River and any of the following subbasins: Tucannon River, Grande Ronde River, Imnaha River, and Salmon River.

Spring/summer chinook salmon are found in several subbasins of the Snake River (Columbia Basin Fish and Wildlife Authority [CBFWA] 1990). Of these, the Grande Ronde and Salmon Rivers are large, complex systems composed of several smaller tributaries that are further composed of many small streams. In contrast, the Tucannon and Imnaha Rivers are small systems with most salmon production in the main river. In addition to these major subbasins, three small streams (Asotin, Granite, and Sheep Creeks) that enter the Snake River between Lower Granite and Hells Canyon Dams provide small spawning and rearing areas (CBFWA 1990). Although there are some indications that multiple ESUs may exist within the Snake River Basin, the available data do not clearly demonstrate their existence or define their boundaries. Because of compelling genetic and life-history evidence that fall chinook salmon are distinct from other chinook salmon in the Snake River, however, they are considered a separate ESU.

Historically, spring/summer chinook salmon spawned in virtually all accessible and suitable habitat in the Snake River system (Evermann 1895; Fulton 1968). During the late 1800s, the Snake River produced a substantial fraction of all Columbia Basin spring and summer chinook salmon, with total production probably exceeding 1.5 million in some years. By the mid-1900s, the abundance of adult spring and summer chinook salmon had greatly declined. Fulton (1968) estimated that an average of 125,000 adults per year entered the Snake River tributaries from 1950 through 1960. As evidenced by adult counts at dams; however, spring and summer chinook salmon have declined considerably since the 1960s.

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[21] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals presented here and below are based on population trends observed during a base period beginning in 1980. Population trends are projected under the assumption that all conditions will stay the same into the future. For further information, see NMFS (2000).

In the Snake River, spring and summer chinook share key life history traits. Both are stream-type fish, with juveniles that migrate swiftly to sea as yearling smolts. Depending primarily on location within the basin (and not on run type), adults tend to return after either 2 or 3 years in the ocean. Both spawn and rear in small, high-elevation streams (Chapman *et al.* 1991), although where the two forms coexist, spring chinook spawn earlier and at higher elevations than summer chinook.

Even before mainstem dams were built, habitat was lost or severely damaged in small tributaries by construction and operation of irrigation dams and diversions, inundation of spawning areas by impoundments, and siltation and pollution from sewage, farming, logging, and mining (Fulton 1968). Recently, the construction of hydroelectric and water storage dams without adequate provision for adult and juvenile passage in the upper Snake River has kept fish from all spawning areas upstream of Hells Canyon Dam.

There is a long history of human efforts to enhance production of chinook salmon in the Snake River Basin through supplementation and stock transfers. The evidence is mixed as to whether these efforts have altered the genetic makeup of indigenous populations. Straying rates appear to be very low.

For the Snake River spring/summer chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period 1 ranges from 0.96 to 0.80, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to the effectiveness of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

<u>Puget Sound Chinook ESU</u>

Puget Sound chinook were listed as a threatened species on March 24, 1999 (64 FR 14308). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. The Puget Sound chinook ESU includes all naturally-spawned populations of chinook salmon from rivers and streams flowing into Puget Sound, including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. Chinook salmon (and their progeny) from the following hatchery stocks are considered part of the listed ESU: Kendall Creek (spring-run); North Fork Stillaguamish River (summer-run); White River (spring-run); Dungeness River (spring-run); and Elwha River (fall).

Updated abundance information has been obtained for almost all streams in the Puget Sound ESU. Most of the 36 streams with available data continue to exhibit declines. Seven of the 10 streams with positive trends in abundance are considered to be influenced by hatchery fish. Both long and short-term trends for natural chinook salmon runs in North Puget Sound were negative, with few exceptions, while in South Puget Sound, both long and short-term trends in abundance were predominantly positive.

Estimating historic abundance of Puget Sound chinook is difficult. Bledsoe *et al*. (1989) estimated that the total Puget Sound catch in 1908 was approximately 670,000 fish, when ocean

harvest and hatchery production was negligible; however, this estimate as well as any other historical estimates should be viewed with caution. Expanding an estimate of naturally spawning escapement entering Puget Sound (based on run reconstruction and commercial landings within Puget Sound), yielded an average potential run size of 426,000 chinook into Puget Sound (Pacific Salmon Commission [PSC] 1994).

Currently, escapement to rivers in Puget Sound and Hood Canal is monitored by the WDFW and the Northwest Indian tribes. Although estimating Puget Sound chinook escapement is complicated by large numbers of naturally spawning hatchery fish, the populations least affected by hatcheries are in the northern part of the Sound: Nooksack, Skagit, Stillaguamish, and Snohomish River systems. North of Bellingham, Washington, the Nooksack River has spring/summer runs in the North and South Forks; both stocks were rated as "critical" by WDFW because of chronically low spawning escapements. The Skagit River south of Anacortes supports three spring-runs, two summer-runs, and a fall-run. Mean spawning escapement of the summer/fall-run has been almost 7,000 fish and is declining. Of the six stocks identified, two are rated healthy, three depressed, and one is of unknown status. On the Stillaguamish River north of Everett, the most recent mean abundance was just over 1,000 fish, and the combined escapement goal from two runs has been met only two times since 1978. Both runs were rated as "depressed." Of four runs identified in the Snohomish River system, two are rated depressed, one unknown, and one as healthy.

In Hood Canal, summer/fall chinook salmon spawn in the Skokomish, Union, Tahuya, Duckabush, Dosewallips and Hamma Hamma Rivers. Because of transfers of hatchery fish, these spawning populations are considered to be a single stock. Fisheries in the area are managed primarily for hatchery production and secondarily for natural escapement. High harvest rates directed at hatchery stocks have resulted in failure to meet natural escapement goals in most years. The 5 year geometric mean natural spawning escapement has been just over 1,000 with negative short and long-term trends.

On the Olympic Peninsula, the Dungeness and Elwha Rivers have natural chinook salmon runs as well as hatcheries. Both populations have recently exhibited severely declining trends in abundance. The Dungeness River has a spring/summer-run chinook with a 5 year geometric mean natural escapement of only 38 fish. Because of the severely depressed numbers, WDFW maintains a captive broodstock program using offspring from local redds. The Elwha River has a 5 year geometric mean escapement of just over 1,500 fish, but it contains two hatcheries, both lacking adequate adult recovery facilities. Because egg take at the hatcheries is augmented from natural spawners, and hatchery fish are known to spawn in the wild, hatchery and natural spawners are not considered discrete stocks within this system. Only limited accessible spawning habitat remains in the Elwha River Basin, and it is uncertain whether the existing population could persist without hatchery intervention.

Throughout the Puget Sound region, a substantial amount of habitat has been degraded or blocked by dams and other barriers. In general, upper tributaries have been negatively affected by forest practices, and lower tributaries and mainstem rivers have been impacted by agriculture

and/or urbanization. Diking for flood control, draining and filling of freshwater and estuarine wetlands, and sedimentation due to forest practices and urban development are cited as problems throughout this ESU. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in several basins. Increasing percentages of land in the area are replaced with impermeable surfaces, causing a reduction in habitat quality due to point and non-point source pollution.

In the past, harvest impacts on Puget Sound chinook salmon stocks have been high. Ocean exploitation rates on natural stocks averaged 56 to 59%, and total exploitation rates have exceeded 90%. Although total exploitation rates averaged 68 to 83% for the 1982 to 1989 brood years, there is some evidence that they have decreased in the past 3 to 4 years.

Lower Columbia River (LCR) Chinook ESU

The Lower Columbia River chinook were listed as a threatened species on March 24, 1999 (64 FR 14308). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. The LCR is characterized by numerous short and medium-length rivers that drain the coast ranges and the west slope of the Cascade Mountains. The LCR chinook salmon ESU includes all native populations from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. The former location of Celilo Falls (inundated by The Dalles reservoir in 1960) is the eastern boundary for this ESU. Stream-type, spring chinook salmon found in the Klickitat River or the introduced Carson spring-run chinook salmon strain are not included in this ESU. Spring chinook salmon in the Sandy River have been influenced by spring chinook salmon introduced from the Willamette River ESU. However, analyses suggest that considerable genetic resources still reside in the existing population (Myers *et al.* 1998). Recent escapements above Marmot Dam on the Sandy River average 2,800 and have been increasing (ODFW 1998a). Tule fall chinook from the LCR chinook salmon ESU were observed spawning in the Ives Island area during October 1999. The Hardy/Hamilton Creeks/Ives Island complex is along the Washington shoreline approximately 2 miles below Bonneville Dam.

Historical records of chinook salmon abundance are sparse, but cannery records suggest a peak run of 4.6 million fish in 1883. Although fall chinook salmon are still present throughout much of their historical range, most of the fish spawning today are first-generation hatchery strays.

Furthermore, spring-run populations have been severely depleted throughout the ESU and extirpated from several rivers.

Most fall-run fish in the LCR chinook salmon ESU emigrate to the marine environment as subyearlings (Reimers and Loeffel 1967, Howell *et al.* 1985, WDF *et al.* 1993). Returning adults that emigrated as yearling smolts may have originated from the extensive hatchery programs in the ESU. It is also possible that modifications in the river environment have altered the duration of freshwater residence. Coded-wire tag (CWT) recoveries of LCR chinook salmon ESU fish suggest a northerly migration route, but (based on CWT recoveries) the fish contribute more to fisheries off British Columbia and Washington than to the Alaskan fishery. Tule fall

chinook salmon return at adult ages 3 and 4; "bright" fall chinook return at ages 4 and 5, with significant numbers returning at age 6. Tule and bright chinook salmon are distinct in their spawn timing. As in other ESUs, chinook salmon have been affected by the alteration of freshwater habitat (Bottom *et al.* 1984, WDF *et al.* 1993, Kostow 1995). Timber harvesting and associated road building peaked in the 1930s, but effects from the timber industry remain (Kostow 1995). Agriculture is widespread in this ESU and has affected riparian vegetation and stream hydrology. The ESU is also highly affected by urbanization, including river diking and channelization, wetland draining and filling, and pollution (Kostow 1995).

The LCR chinook salmon ESU has been subject to intensive hatchery influence. Hatchery programs to enhance chinook salmon fisheries in the lower Columbia River began in the 1870s, releasing billions of fish over time, the equivalent of the total hatchery releases for all other chinook ESUs combined (Myers *et al.* 1998). Although most of the stocks have come from inside the ESU, more than 200 million fish from outside the ESU have been released since 1930 (Myers *et al.* 1998).

For the LCR chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.98 to 0.88, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b *in* McClure *et al.* 2000).

Upper Columbia River (UCR) Spring-run Chinook ESU

The UCR spring-run chinook were listed as an endangered species on March 24, 1999 (64 FR 14308). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. This ESU includes all naturally spawned populations of chinook salmon in all river reaches accessible to chinook in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River. Chinook salmon (and their progeny) from the following hatchery stocks are considered part of the listed ESU: Chiwawa River; Methow River, Twisp River, Chewuch River, White River, and Nason Creek, all spring-run. The populations are genetically and ecologically separate from the summer- and fall-run populations in the lower parts of many of the same river systems (Myers *et al.* 1998). Although fish in this ESU are genetically similar to spring chinook in adjacent ESUs (*i.e.*, mid-Columbia and Snake), they are distinguished by ecological differences in spawning and rearing habitat preferences. For example, spring-run chinook in UCR tributaries spawn at lower elevations (500 to 1,000 m) than in the Snake and John Day River systems.

The UCR chinook populations were intermixed during the Grand Coulee Fish Maintenance Project (1939 through 1943), resulting in loss of genetic diversity between populations in the ESU. Homogenization remains an important feature of the ESU. Fish abundance has trended downward both recently and over the long term. At least six former populations from this ESU are now extinct, and nearly all extant populations have fewer than 100 wild spawners.

The UCR spring-run chinook are considered stream-type fish, with smolts migrating as yearlings. Most stream-type fish mature at 4 years of age. Few CWTs are recovered in ocean fisheries, suggesting that the fish move quickly out of the north central Pacific and do not migrate along the coast.

Spawning and rearing habitat in the Columbia River and its tributaries upstream of the Yakima River includes dry areas where conditions are less conducive to salmonid survival than in many other parts of the Columbia Basin (Mullan *et al.* 1992). Salmon in this ESU must pass up to nine Federal and private dams, and Chief Joseph Dam prevents access to historical spawning grounds farther upstream. Degradation of remaining spawning and rearing habitat continues to be a major concern associated with urbanization, irrigation projects, and livestock grazing along riparian corridors. Overall harvest rates are low for this ESU, currently less than 10% (ODFW and WDFW 1995).

Spring-run chinook salmon from the Carson National Fish Hatchery (a large composite, nonnative stock) were introduced into, and have been released from, local hatcheries (Leavenworth, Entiat, and Winthrop National Fish Hatcheries [NFH]). Little evidence suggests that these hatchery fish stray into wild areas or hybridize with naturally-spawning populations. In addition to these national production hatcheries, two supplementation hatcheries are operated by the WDFW in this ESU. The Methow Fish Hatchery Complex (operations began in 1992) and the Rock Island Fish Hatchery Complex (operations began in 1989) were both designed to implement supplementation programs for naturally spawning populations on the Methow and Wenatchee Rivers, respectively (Chapman *et al.* 1995).

For the UCR spring-run chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.85 to 0.83, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000a).

Upper Willamette River (UWR) Chinook ESU

Upper Willamette River chinook were listed as a threatened species on March 24, 1999 (64 FR 14308). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. The UWR chinook salmon ESU includes native spring-run populations in the Clackamas River and in the Willamette River and its tributaries, above Willamette Falls, Oregon. In the past, it included sizable numbers of spawning salmon in the Santiam River, the middle fork of the Willamette River, and the McKenzie River, as well as smaller numbers in the Molalla River, Calapooia River, and Albiqua Creek. Although the total number of fish returning to the Willamette has been relatively high (24,000), about 4,000 fish now spawn naturally in the ESU, two-thirds of which originate in hatcheries. The McKenzie River supports the only remaining naturally reproducing population in the ESU (ODFW 1998a).

There are no direct estimates of the size of the chinook salmon runs in the Willamette Basin before the 1940s. McKernan and Mattson (1950) present anecdotal information that the Native American fishery at the Willamette Falls may have yielded 2,000,000 lb (908,000 kg) of salmon

(454,000 fish, each weighing 20 pounds [9.08 kg]). Based on egg collections at salmon hatcheries, Mattson (1948) estimates that the spring chinook salmon run in the 1920s may have been five times the run size of 55,000 fish in 1947, or 275,000 fish. Much of the early information on salmon runs in the upper Willamette River Basin comes from operation reports of state and Federal hatcheries.

Fish in this ESU are distinct from those of adjacent ESUs in life history and marine distribution. The life history of chinook salmon in the UWR ESU includes traits from both ocean and stream-type development strategies. Coded wire tag recoveries indicate that the fish travel to the marine waters off British Columbia and Alaska. More Willamette fish are, however, recovered in Alaskan waters than fish from the Lower Columbia River ESU. The UWR chinook salmon mature in their fourth or fifth years. Historically, 5-year-old fish dominated the spawning migration runs; recently, however, most fish have matured at age 4. The timing of the spawning migration is limited by Willamette Falls. High flows in the spring allow access to the upper Willamette basin, whereas low flows in the summer and autumn prevent later-migrating fish from ascending the falls. The low flows may serve as an isolating mechanism, separating this ESU from others nearby.

Human activities have had vast effects on the salmonid populations in the Willamette River drainage. First, the Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat (*i.e.*, stream shoreline) by as much as 75%. In addition, the construction of 37 dams in the basin has blocked access to over 700 km of stream and river spawning habitat. The dams also alter the temperature regime of the Willamette and its tributaries, affecting the timing of development of naturally-spawned eggs and fry. Water quality is also affected by development and other economic activities. Agricultural and urban land uses on the valley floor, as well as timber harvesting in the Cascade and Coast ranges, contribute to increased erosion and sediment load in Willamette River Basin streams and rivers. Finally, since at least the 1920s, the lower Willamette River has suffered municipal and industrial pollution.

Hatchery production in the basin began in the late nineteenth century. Eggs were transported throughout the basin, resulting in current populations that are relatively homogeneous genetically (although still distinct from those of surrounding ESUs). Hatchery production continues in the Willamette River, with an average of 8.4 million smolts and fingerlings released each year into the main river or its tributaries between 1975 and 1994. Hatcheries are currently responsible for most production (90% of escapement) in the basin. The Clackamas River currently accounts for about 20% of the production potential in the Willamette Basin, originating from one hatchery plus natural production areas that are primarily above the North Fork Dam. The interim escapement goal for the area above North Fork Dam is 2,900 fish (ODFW 1998b). However, the system is so heavily influenced by hatchery production that it is difficult to distinguish spawners of natural stock from hatchery origin fish. Approximately 1,000 to 1,500 adults have been counted at the North Fork Dam in recent years.

Harvest on this ESU is high, both in the ocean and in river. The total in river harvest below the falls from 1991 through 1995 averaged 33% and was much higher before then. Ocean harvest was estimated as 16%t for 1982 through 1989. ODFW (1998a) indicates that total (marine and freshwater) harvest rates on UWR spring-run stocks were reduced considerably for the 1991 through 1993 brood years, to an average of 21%.

For the UWR chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 1.01 to 0.63, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

Chum Salmon

Physical Description: Chum salmon, also known as "dog salmon" (probably due to the canine-like fangs on mature males), are the second largest Pacific salmon, next to chinook, weighing up to 20.8 kilograms and up to 108.8 cm in length. Adults are metallic blue on their dorsal surfaces with occasional black speckling but no black spots. Males have tinges of black on the tips of the caudal, anal, and pectoral fins. Spawning males are dark olive above, grey-red with dirty green, vertical bars (blotchings) on the sides. Spawning females are similarly but less distinctly marked and lack the extreme dentition of the males. Young chum have parr marks as slender bars (6 to 14), scarcely extending below the lateral line and with green iridescence on the back and white fins. (Hart 1973; Scott and Crossman 1973; Groot and Margolis 1991).

Life History: Chum salmon have the widest natural geographic and spawning distribution of all the Pacific salmon, and have historically constituted up to 50% of the annual biomass of salmon in the North Pacific Ocean. Chum have been documented spawning from Korea and the main island of Japan (Honshu), east around the North Pacific Ocean rim to Monterey Bay, California. They spawn in streams of various sizes and generally migrate directly to sea soon after emergence. Maturing adults return to their home streams at various ages, usually at 2 and 5 years, and in some cases up to 7 years. In western Washington, chum are broadly distributed, with variations in the timing of spawning within early and late autumn runs. For example, in Puget Sound, runs can begin in early September and continue in some streams as late as March. In the Columbia River, chum salmon are limited to the lower part of the river, with more runs in the Washington side than on the Oregon side (Groot and Margolis 1991).

"Summer-run" chum respond to the high flows caused by spring and summer snow melt, while the autumn-run chum arrive at their natal stream when fall rains occur. Once at the spawning site, which for chum tends to be immediately above turbulent areas or where there is groundwater upwelling, the resident female builds four to six nests in succession, in one place. The transitory males move from one spawning female to the other. Males will compete for females and will use physical force to exclude any rivals. Preferred spawning sites in Washington were found to contain water velocities of between 21.3 and 83.8 cm/second (sec) (mean 50.3 cm/sec) and with a water depth generally between 13.4 to 49.7 cm (distribution was highly skewed, with a mean of 27.1 cm) (*in* Groot and Margolis 1991).

Females generally lay between 3,000 to 4,000 eggs (Groot and Margolis 1991), with autumn runs having a higher fecundity (Hart 1973). Temperature plays a crucial role in the survivability of eggs and alevins, with temperatures at or near freezing levels during spawning and incubation accounting for high mortalities. The intergravel dissolved oxygen also plays a role in the survival of salmonid eggs and alevins, with a lethal level (minimum) of 1.67 mg/l for chum salmon (survival rate decreased rapidly when the concentration of oxygen dropped below 2.0 miligram/liter [mg/l]) (*in* Groot and Margolis, 1991). After spending several weeks within the interstitial spaces of the gravel, alevins emerge and begin to migrate downstream, during nighttime hours, to estuarine waters, where they linger until they transition to waters of higher salinity. This ocean-type migratory behavior of chum requires that survival and growth in juvenile chum depend less on freshwater conditions than on favorable estuarine conditions.

In Washington, chum fry migrate downstream from January through June, with variations within river systems. The time it takes for this migration generally depends on the length of the river, and fry behavior varies as well, with fry in some river systems migrating along the banks, and others moving with the stronger currents in the middle of the stream. Chum salmon are second only to chinook in their dependence upon estuaries, choosing either the upper or lower reaches of the estuary, depending on the relative productivity of each. Chum salmon also form schools, presumably to reduce predators. Chum migration into the ocean appears to correlated with the warming of nearshore waters, and juveniles orient to the shoreline until they are large enough to move offshore. Maturing chum salmon are widely distributed offshore and mature after 2 to 6 years of age, with more than 95% in the three to 5 year age group (*in* Groot and Margolis 1991). Compared to other Pacific salmon, chum spend more of their life history in marine waters.

Food Habits: Young chum feed on insect larvae while migrating downstream to the sea, gaining size as they head toward the estuary. Once in the more saline waters of estuaries and shallow nearshore marine habitats, the fry begin feeding on epibenthic and neritic food resources (generally detritus-based). In the nearshore waters of Puget Sound, juveniles were found feeding on copepods and amphipods. During a tidal cycle, juvenile chum will feed successfully on freshwater, estuarine, and marine organisms. As they move offshore, chum feed on planktonic organisms such as calanoid copepods, hyperiid amphipods, larvaceans, euphausiids, decapod and fish larvae. Once in the ocean, chum also feed on fish and squid larvae, though to a lesser extent (*in* Groot and Margolis 1991).

<u>Hood Canal Summer-run Chum ESU</u>

Hood Canal summer-run chum salmon were listed as a threatened species on March 25, 1999 (64 FR 14508). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. This ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in the Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. Hood Canal summer-run chum spawn from mid-September to mid-October. Run-timing data from as early as 1913 show a temporal difference between spawning periods of summer-run verses fall-run chum, which spawn from November through December or January.

In general, summer-run chum salmon are most abundant in the northern part of the species' range, where they spawn in the river mainstems. However, ecologically, chum salmon in this ESU must return to fresh water and spawn during peak periods of high water temperature, suggesting an adaptation to environmental conditions that allow this life-history strategy to persist in an otherwise inhospitable environment.

A total of 11 streams in Hood Canal have been identified as recently having indigenous summer chum populations: Big Quilcene River, Little Quilcene River, Dosewallips River, Duckabush River, Hamma Hamma River, Lilliwaup Creek, Union River, Tahuya River, Dewatto River, Anderson Creek, and Big Beef Creek (Tynan 1992). Summer chum salmon populations in the eastern Strait of Juan de Fuca have been reported in Chimacum Creek, Snow and Salmon Creeks, and Jimmycomelately Creek (WDF *et al*. 1993; Sele 1995).

Summer-run chum in the region use Hood Canal and the Strait of Juan de Fuca estuarine and marine areas for rearing and seaward migration as juveniles. The fish spend 2 to 4 years in the northeast Pacific Ocean feeding areas prior to migrating southward during the summer months as maturing adults along the coasts of Alaska and British Columbia in returning to their natal streams. Adults may delay migration in extreme terminal marine areas for up to several weeks before entering the streams to spawn. Spawning occurs in the lower reaches of each summer chum stream.

Data on the historical escapement of Hood Canal summer-run chum salmon are sparse. Estimates of escapement from 1968 to the present (1997 at the time of writing) were based on the "area under-the curve" method derived from weekly spawning ground surveys. Survey frequency was low prior to the mid-1970s, and peak live spawner abundance and the full extent of spawning were often not reflected in the curves. Thus, early calculations underestimated abundance of Hood Canal chum (Johnson *et al*. 1997). WDF *et al*. (1993) reported the 5 year geometric mean spawner population of Hood Canal summer-run chum to be 508 fish, with a percentage change per year of -17.7%. Excluding the Union River, spawning escapement of summer chum in Hood Canal was reduced from over 40,000 fish in 1968 to only 173 fish in 1989. In 1991, only seven of 12 streams that had historically contained spawning runs of summer chum still had escapements. In 1995, escapement increased to more than 21,000 fish in northern Hood Canal (primarily rivers on the west side), which was the largest return in more than 20 years. Much of this increase was in the Big Quilcene River, where the USFWS has been conducting an enhancement program starting with the 1992 brood year (estimated hatchery contributions to the river were 32% of the 3-year olds in 1995 and 63% of the 4-year olds in 1996) (*in* Johnson, *et al.* 1997).

Updated spawning escapement information on this ESU (Hood Canal and Strait of Juan de Fuca tributaries) was provided in 1999 by WDFW to the Biological Review Team (BRT) assigned to determine whether the ESU should become listed under the ESA. Spawning escapement to the ESU in 1997 was estimated to be 10,013 fish in 1997, and 5,290 in 1998, although of these totals, 8,734 and 3,959 spawners, respectfully, returned to streams with supplementation

programs. These spawning escapements in 1997 and 1998 represent 46% and 25%, respectively, of the recent high escapement of 21,594 in 1996 (BRT 1999).

Historically, summer-run chum in the Hood Canal have not been the primary target species of fisheries. Most fishermen focused on chinook, coho and fall-run chum, and the summer chum were incidentally taken in fisheries directed at those species. Prior to 1974, Hood Canal was designated a commercial salmon fishing reserve, with the only net fisheries occurring on the Skokomish Reservation. In 1974, commercial fisheries were open in Hood Canal, and incidental harvest rates of summer chum increased rapidly. By the late 1970s, incidental harvest rates had increased to 50 to 80% in most of Hood Canal. In 1991, coho salmon fishing in the main part of the Canal was closed, while fisheries targeting hatchery produced coho continued in Quilcene Bay. Beginning in 1992, fishing practices in this fishery were modified to protect the summer chum. Since then, the tribal and non-tribal harvests of coho during the summer chum migration have been by beach seine, with the requirement that summer chum be released or given to the USFWS for broodstock. Such restrictions have greatly reduced exploitation rates of this ESU. Between 1991 and 1996, harvests removed an average of 2.5% of the run, compared to an average of 71% in the period from 1980 to 1989 (*in* Johnson *et al*. 1997).

In recent years, Canadian fisheries targeting Fraser River sockeye salmon in northern Strait of Juan de Fuca have had variable impacts on Hood Canal summer-run chum. With strong runs of sockeye increasing fishing intensity in this area, the impacts to chum are expected to increase as well (BRT 1999).

General habitat losses with the most impact to chum salmon include: (1) Water withdrawal, conveyance, storage, and flood control (resulting in insufficient flows, stranding, juvenile entrainment and instream temperature increases); (2) logging and agriculture (loss of large woody debris, sedimentation, loss of riparian vegetation, habitat simplification); (3) mining (especially gravel removal, dredging, pollution); and (4) urbanization (stream channelization, increased runoff, pollution, habitat simplification). Any spill dams and other small hydropower facilities that are constructed in the lower reaches of rivers also threaten chum salmon. Habitat factors in Hood Canal primarily affecting summer-run chum have been identified to include gravel aggradation (due to logging in some areas), channel shifting, and diking (Johnson *et al*. 1997).

<u>Columbia River (CR) Chum ESU</u>

Columbia River chum were listed as a threatened species on March 25, 1999 (64 FR 14508). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. Chum salmon of the Columbia River ESU spawn in tributaries and in mainstem areas below Bonneville Dam. Most fish spawn on the Washington side of the Columbia River (Johnson *et al.* 1997). Previously, chum salmon were reported in almost every river in the lower Columbia River Basin, but most runs disappeared by the 1950s (Rich 1942, Marr 1943, Fulton 1970). Currently, WDFW regularly monitors only a few natural populations in the basin, one in Grays River, two in small streams near Bonneville Dam, and the mainstem area next to one of the latter two streams. Recently, spawning has occurred in the

mainstem Columbia River at two spots near Vancouver, Washington and in Duncan Creek below Bonneville Dam.

Chum salmon enter the Columbia River from mid-October through early December and spawn from early November to late December. Recent genetic analysis of fish from Hardy and Hamilton Creeks and from the Grays River indicate that these fish are genetically distinct from other chum salmon populations in Washington. Genetic variability within and between populations in several geographic areas is similar, and populations in Washington show levels of genetic subdivision typical of those seen between summer and fall-run populations in other areas and typical of populations within run types (Salo 1991, WDF *et al.* 1993, Phelps *et al.* 1994, and Johnson *et al.* 1997).

Historically, the Columbia River chum salmon ESU supported a large commercial fishery, landing more than 500,000 fish per year. Commercial catches declined beginning in the mid-1950s. There are now no recreational or directed commercial fisheries for chum salmon in the Columbia River, although chum salmon are taken incidentally in the gill-net fisheries for coho and chinook salmon, and some tributaries have a minor recreational harvest (WDF *et al.* 1993). Hatchery fish have had little influence on the wild component of the CR chum salmon ESU. NOAA Fisheries estimates a median population growth rate (lambda) over the base period, for the ESU as a whole, of 1.04 (Tables B-2a and B-2b in McClure *et al.* 2000). Because census data are peak counts (and because the precision of those counts decreases markedly during the spawning season as water levels and turbidity rise), NOAA Fisheries is unable to estimate the risk of absolute extinction for this ESU.

Coho Salmon

Physical Description: Coho salmon (also known as "silver" salmon) are metallic blue to slightly green on their dorsal surface and have silver sides and irregular black spots on their back and upper lobe of the caudal fin. Maturing males in fresh water are bright red on their sides, bright green on their back and head, and often dark on the belly. Spawning females are less strongly colored. Adults reach lengths up to 38.5 inches (98 cm), and they have less than 85 pyloric caeca (Hart 1973). Young coho are blue-green on the back, with silvery sides, and 8 to 12 narrow parr marks (Scott and Crossman 1973).

Life History: The majority of coho spend about four to six months in incubation, up to 15 months rearing in fresh water, followed by a sixteen-month growing period in sea water. Thus, the majority of coho mature in their third year, although there are variations to this normal pattern. Some of the males mature precociously ("jacks") and return to spawn after only 4 to 6 months at sea, while others may stay in fresh water for two winters and return to spawn in their fourth year (Groot and Margolis 1991).

Adult coho salmon begin their river migration in the early fall as a prelude for spawning in October and November (Hart 1973). They school at the mouths of rivers and often move in when the fall rains increase the river flow (Scott and Crossman 1973) and sometimes breach obstructions that are impassable during low flows (Groot and Margolis 1991). Spawning

generally takes place in large rivers and their headwaters. Compared to other Pacific salmon, coho migrate farther upstream than pink and chum salmon, but usually not as far as sockeye and chinook.

Female coho lay between 2,500 to 5,000 eggs, depending on their size and the region (larger-sized fish lay more eggs, and increased fecundity from California to Alaska). Successive spawnings take place in a series of nests, each slightly upstream of the earlier nest, and the female may spawn with other males if the previously dominant male becomes displaced. Although spawning coho can be found in almost all coastal streams, large rivers, and remote tributaries, females generally select redd sites at the head of a riffle area where there is good circulation of oxygenated water.

Hatching usually takes place in early spring, although the length of time required for eggs to incubate is largely dependent on temperature; the colder the temperature, the slower the developmental rate of the embryo and the longer the time to hatching. Eggs in Alaskan rivers may take over 100 days to hatch, while coho eggs in California may take approximately 50 days to hatch (Groot and Margolis 1991). The time from hatching to emergence is also temperature dependent, and to a lesser extent, on dissolved oxygen concentration and can last anywhere between 21 to 40 days or more. After emergence, fry begin to swim close to the banks, taking advantage of any cover available (overhanging branches, side channels). As they become older, coho fry occupy areas along the open shoreline and progressively move into areas of higher velocity in midstream and on the stream margins.

After a year or more in fresh water, coho smolts migrate downstream, usually beginning in the early springtime, with the bulk of the migration taking place at night, moving up to the surface and swimming or drifting with the current. Typically, coho spend one winter in fresh water, although in some river systems, coho may stay two, three, or even four winters in the river before migrating out to sea. Smolts tend to stay in the nearshore areas close to their home streams for several months before migrating further out into the ocean. Coho in the Pacific Northwest tend to move northward along the coast for about a year, then gradually move southward along the coast.

Food Habits: Young coho in freshwater feed mainly on insects, depending strongly on visual cues for locating and capturing food at the surface or in suspension. Since coho normally prefer to occupy slower moving sections of a stream, this strategy allows the capture of food with a limited expenditure of energy. As they become yearlings, coho may become predatory, supplementing their diet with the fry of their own species or of other salmonids such as pink and chum. When they first enter the salt water, juvenile coho feed mainly on marine invertebrates, but as they grow larger, they eat more fish such as anchovy, surf smelt, and sand lance. Older coho have been caught feeding on herring, euphausiids, crab larvae, squid, sardines, and rockfish (Scott and Crossman 1973; *in* Groot and Margolis1991).

Southern Oregon/Northern California Coasts (SO/NC) Coho ESU

The Southern Oregon/Northern California coho were listed as a threatened species on May 6, 1997 (62 FR 24588). Critical habitat was designated on May 5, 1999 (64 FR 24049) and remains effective. This ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California.

In the 1940s, estimated abundance of SO/NC coho salmon ranged from 150,000 to 400,000 naturally spawning fish. Today, coho populations in this ESU are very depressed and number approximately 10,000 naturally produced adults. Although the Oregon portion of the SO/NC coho ESU has declined drastically, the Rogue River Basin increased substantially from 1974 to 1997. The bulk of current coho salmon production in this ESU consists of stocks from the Rogue River, Klamath River, Trinity River, and Eel River in Oregon. In Oregon south of Cape Blanco, all but one coho salmon stock is considered to be at "high risk of extinction." South of Cape Blanco, all Oregon coho salmon stocks are considered "depressed."

In contrast to the life history patterns of other anadromous salmonids, coho salmon exhibit a relatively simple three-year life cycle. Most SO/NC coho salmon enter rivers between September and February and spawn from November to January (occasionally into early spring). Upstream migration is influenced by river flow, especially for many small California stream systems that have sandbars at their mouths for much of the year except winter. Although coho salmon have been captured several thousand kilometers away from their natal stream, this species usually remains closer to its river of origin than chinook salmon. Coho typically spend two growing seasons in the ocean before returning to spawn as 3 year-olds; precocious males ("jacks") may return after only 6 months at sea.

Threats to naturally-reproducing SO/NC coho salmon throughout its range are numerous and varied. Habitat factors include: Channel morphology changes, substrate changes, loss of in-stream roughness, loss of estuarine habitat, loss of wetlands, loss/degradation of riparian areas, declines in water quality (*e.g.*, elevated water temperatures, reduced dissolved oxygen, altered biological communities, toxics, elevated pH, and altered stream fertility), altered stream flows, fish passage impediments, elimination of habitat, and direct take. The major activities responsible for the decline of coho salmon in Oregon are logging, road building, grazing and mining activities, urbanization, stream channelization, dams, wetland loss, beaver trapping, water withdrawals, and unscreened diversions for irrigation.

Other factors contributing to the decline of SO/NC coho include overutilization for commercial recreational, scientific, or education purposes. Harvest management practiced by the tribes is conservative and has resulted in limited impact on the coho stock in the Klamath and Trinity Rivers; overfishing in non-tribal fisheries is believed to have been a significant factor in the decline of coho salmon. Marked hatchery coho are allowed to be harvested in the Rogue River. All other recreational coho salmon fisheries in the Oregon portion of this ESU are closed. Collection for scientific research and educational programs is believed to have had little or no

impact on coho populations in the ESU. Relative to other effects, disease and predation are not believed to be major factors contributing to the overall decline of coho salmon in this ESU. However, disease and predation may have substantial impacts in local areas.

Oregon Coast (OC) Coho ESU

Oregon Coast coho were listed as a threatened species on August 10, 1998 (63 FR 42587). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. This ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco.

Within the OC coho salmon ESU, hatchery populations from the north Oregon coast form a distinctive subgroup. Adult run and spawn-timing are similar to those along the Washington coast and in the Columbia River, but less variable. While marine conditions off the Oregon and Washington coasts are similar, the Columbia River has greater influence north of its mouth, and the continental shelf becomes broader off the Washington coast. Upwelling off the Oregon coast is much more variable and generally weaker than areas south of Cape Blanco.

Estimated escapement of coho salmon in coastal Oregon was about 1.4 million fish in the early 1900s, with harvest of nearly 400,000 fish. Abundance of wild Oregon coast coho salmon declined during the period from about 1965 to 1975 and has fluctuated at a low level since that time. Production potential (based on stock-recruit models) shows a reduction of nearly 50% in habitat capacity. Recent spawning escapement estimates indicate an average spawning escapement of less than 30,000 adults. Current abundance of coho on the Oregon coast may be less than 5% of that in the early part of this century. The Oregon coast coho salmon ESU is not at immediate danger of extinction but may become endangered in the future if present trends continue. For more information on OC coho salmon life history and factors contributing to the decline of the ESU, see, SO/NC coho salmon, above.

Sockeye Salmon

Physical Description: Sockeye salmon have a brilliant steel-blue to green blue dorsal surface of head and body, with no distinct black spots, bright silver sides and a few dark marks on the dorsal fin. Breeding males have bright red to dirty red-gray on their back and sides, with a bright green to olive head to lower jaw. The lower jaw is white to grey. Spawning females are similar, but the body is a darker grey-red color. In some freshwater populations and in rare anadromous populations, the spawners are dull green to yellow, without prominent red coloring (Scott and Crossman 1973). Young sockeye have short and oval parr marks, usually mostly above the lateral line (Hart 1973).

Life History: After pink and chum salmon, the sockeye is the most abundant Pacific salmon, and although they are primarily anadromous, there are distinct populations called "kokanee," which mature, spawn, and die in freshwater without going to sea. Sockeye exhibit a greater variety of life history patterns than other Pacific salmon, typically making more use of lake rearing habitat in their juvenile stage. Juvenile sockeye generally spend approximately one to 3 years rearing in a lake after emergence from gravel. This is not a universal characteristic, however, as some

populations use stream areas for rearing and may migrate to sea soon after emergence. Anadromous sockeye spend from one to four years in the ocean before returning to the fresh water to spawn in late summer and autumn.

Generally, sockeye spawning areas are adjacent to lake rearing areas, so the behavior of juveniles following emergence is dependent on the location of the spawning area in relation to the lake rearing area to be utilized. Sockeye generally spawn in the late summer and autumn, although timing can vary greatly and may depend a lot on the temperature regime in the gravel where the eggs are incubated. Females select a redd site, dig several depressions (nests) in the gravel substrate and deposit their eggs, which are simultaneously fertilized by an male or group of males. Females deposit between 500 and 1,100 eggs per nest, with between three and seven nests per female (most commonly four and five). Fecundity is lower in kokanee, ranging from 300 to less than 2,000 eggs per female, depending on size of the fish. It appears that the primary criteria determining fecundity within populations are the size of the females and the amount of time spent in the ocean; the larger the female and the more time spent at sea, the greater the number of eggs.

Although there are variations within temperature ranges, sockeye spawning occurs during periods of declining temperatures in late summer or autumn, development takes place during the winter at lowered temperatures, and emergence occurs during rising water temperatures. The period of incubation varies by site and by temperature and can range from 50 days to over 5 months (Hart 1973). In general, sockeye have the longest incubation period of the salmonids, benefitting from the increased protection from predation, freezing, fluctuating flows, and desiccation (Velson 1980 *in* Gustafson1997). Alevins may remain in the gravel for 3 to 5 weeks before emerging as free-swimming fry, generally during the nighttime hours. When rearing in a lake, they generally swim along the shore for the first few weeks, moving out over the deeper water where they concentrate in the top 10 or 20 meters. As mentioned, fry in some sockeye populations may head directly to sea, while others may spend 1 to 2 years rearing in the fresh water.

Migration to the sea is positive (oriented downstream); sockeye swim actively in quiet reaches of the river but become passive and tail first in rapids. Once in the ocean, young sockeye become scattered over the northeast Pacific Ocean, mainly near the surface, and mainly east of 170°E longitude. They tend to move north during the marine summer and south during the winter. During the summer, large older fish begin to mature and begin to move shoreward toward their natal stream (Hart 1973).

Food Habits: The diet of newly emerged fry is determined mainly by habitat and the availability of food. When they first enter the nursery lake, sockeye fry typically work along the shore for a few weeks, gradually moving out over the deeper waters, concentrating in the top 10 or 20 meters, but may be found as deep as 40 meters or more. During this time, the sockeye fry generally eat insects and their larvae (shallow water) and later they eat mainly copepods and amphipods. Upon reaching salt water, young sockeye remain inshore for awhile, feeding on insects and crustaceans such as amphipods, copepods, decapods, barnacle larvae, and young

fishes and larvae such as sand lance, whiting, herring, rockfishes, and hake. Later, sockeye migrate to the high seas and feed on more crustaceans and squid, with young fish occasionally comprising an important part of their diet (Hart 1973).

Snake River Sockeye ESU

Snake River sockeye were listed as an endangered species on November 20, 1991 (56 FR 58619). Critical habitat was designated on December 28, 1993 (58 FR 68543) and remains in effect. This ESU includes populations of sockeye salmon from the Snake River Basin, Idaho (extant populations occur in the Stanley River subbasin).

The only remaining anadromous sockeye in the Snake River system are found in Redfish Lake, on the Salmon River. The nonanadromous form (kokanee) are found in Redfish Lake and elsewhere in the Snake River Basin, but only kokanee in Redfish Lake are included in the ESU. Snake River sockeye were historically abundant in several lake systems of Idaho and Oregon. However, all populations have been extirpated in the past century, except fish returning to Redfish Lake. As mentioned, in general, juvenile sockeye salmon rear in the lake environment for 1, 2, or 3 years before migrating to sea. Adults typically return to the natal lake system to spawn after spending 1, 2, 3, or 4 years in the ocean (Gustafson *et al.* 1997).

In 1910, impassable Sunbeam Dam was constructed 20 miles downstream of Redfish Lake. Although several fish ladders and a diversion tunnel were installed during subsequent decades, it is unclear whether enough fish passed above the dam to sustain the run. The dam was partly removed in 1934, after which Redfish Lake runs partially rebounded. Evidence is mixed as to whether the restored runs constitute anadromous forms that managed to persist during the dam years, nonanadromous forms that became migratory, or fish that strayed in from outside the ESU. NOAA Fisheries proposed an interim recovery level of 2,000 adult Snake River sockeye salmon in Redfish Lake and two other lakes in the Snake Basin (Table 1.3-1 in NMFS 1995). Low numbers of adult Snake River sockeye salmon preclude a Quantitative Analysis Report (QAR-type) quantitative analysis of the status of this ESU. Because only 16 wild and 264 hatchery-produced adult sockeye returned to the Salmon River Basin between 1990 and 2000; however, NOAA Fisheries considers the status of this ESU to be dire under any criteria. Clearly, the risk of extinction is very high.

Ozette Lake Sockeye ESU

Ozette Lake sockeye were listed as a threatened species on March 25, 1999 (64 FR 14528). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. This ESU includes all naturally spawned populations of sockeye salmon in Ozette Lake and streams and tributaries flowing into Ozette Lake, Washington. Because it is difficult to distinguish indigenous from non-indigenous fish co-occurring in this ESU, NOAA Fisheries treats all "naturally spawned" fish as listed, but will take actions to minimize or prevent non-indigenous sockeye salmon from spawning in the wild unless the fish are specifically part of a recovery effort (64 FR 14528).

In Ozette Lake, smolts generally out-migrate from early April through late May, (peak outmigration from late April through mid-May), although smolts can be found outmigrating from November through May. Spawning takes place from mid to late November through early February to early April. High water temperatures in the lake and river and low water flows in the summer may create a thermal block to migration and influence the timing of migration (*in* Gustafson *et al*. 1997).

Numerous sources indicate that Ozette sockeye salmon were very important for subsistence and for use in ceremonies of the Makah and Quinault Indian cultures, respectively (*in* Gustafson, *et al*. 1997). Precise estimates of historical abundance have been poorly documented, although data and reports available prior to 1977 indicate that the overall abundance for the naturally-spawned Ozette Lake sockeye salmon has declined substantially from historical levels.

Historical run-size estimates range from a few thousand sockeye salmon in the 1920s, to a peak recorded harvest in the 1940s. Escapement counts for sockeye in Ozette Lake were 3,241 in 1924 (with a portion of the run missed), 6,343 in 1925, and 2,210 in 1926 (*in* Gustafson *et al*. 1997), which is approximately twice the run sizes from the late 1970s to the present. These early numbers are estimated to be conservative, as Makah tribe sockeye salmon harvests during 1949 to 1951 ranged from 14,500 to 17,700 fish (RMP 2002).

Abundance of sockeye salmon smolts outmigrating from Ozette Lake was estimated to be 7,942 in 1990, 2,752 in 1992, and 9,600 in 1997. Based on these estimates and the number of adult returns 2 years later, ocean survival of broodyears 1975, 1990, and 1991 were 5.6%, 18%, and 27%, respectively (Jacobs *et al*. 1996 *in* Gustafson *et al*. 1997). Current escapements average below 1,000 adults per year. Based on weir counts, in 1992 to 1996, the 5 year average annual escapement was 700 adults. Abundance has decreased by about 3% per year from 1977 to 1995, and about 10% per year from 1986 to 1995 (Gustafson, *et al*. 1997). The most recent 4 year annual mean run size from 1996 to 1999 was 1,598 adults (range 1,133 to 20,076). This mean escapement average compares to a mean escapement of 811 for the four previous years of the cycle (1992 to 1995) (range ≤267 to 2,548) (RMP 2002).

If present conditions continue into the future, Ozette Lake sockeye salmon are likely to become in danger of extinction in the near future. Such conditions include: (1) Siltation of beach spawning habitat; (2) very low abundance compared to harvest in the 1950s; (3) overall downward trend in abundance, coupled with large fluctuations in abundance; and (4) potential genetic effects of ongoing hatchery production and past practices of sockeye salmon being interbred with genetically distinct kokanee. Past forest practices have included intensive logging, wood removal in Ozette Lake tributaries, and associated road building in the watershed and have led to increased sediment load in the tributaries and the lake. This degradation of habitat has continued to contribute to the failure of this ESU to recover, despite the discontinuation of sockeye fisheries harvest since 1982. In addition, harbor seals (*Phoca vitulina*) and river otters (*Lutra canadensis*) migrate up the Ozette River into Ozette Lake and have been documented feeding on adult sockeye salmon on spawning beaches (RMP 2002).

Steelhead

Physical Description: Steelhead have an elongated, somewhat compressed body (20 to 30 inches [508 to 762 mm]) with a rounded snout, terminal mouth, and well-developed teeth on both jaws. Their color varies with habitat, size, and sexual condition. Adults returning from the sea are large and silvery, with a steel-blue back, top of the head and upper sides. Cheeks and opercula are pink, and the body sides are marked with a number of small black spots, mostly restricted above the lateral line or scattered over the whole side. Black spots also cover both lobes of the tail. Spawning steelhead develop a distinct pink to red strip-like coloration that blends along the side, both above and below the lateral line. The young are blue to green on the dorsal surface, silver to white on the sides, and white below. There are 5 to 10 dark marks on the back between the head and dorsal fin and 5 to 10 short, dark, oval parr marks widely spaced on the sides (Scott and Crossman 1973).

Life History: All steelhead are iteroparous, capable of spawning more than once before death. Biologically, steelhead can be divided into two basic reproductive groups, based on the state of sexual maturity at the time of river entry and the duration of spawning migration. The "stream-maturing type," commonly referred to as summer steelhead in the Pacific Northwest, re-enters freshwater when it is not quite sexually mature and spends several months in-stream to mature and spawn. The "ocean-maturing type," commonly called winter steelhead, re-enters fresh water when it is sexually mature and spawns shortly thereafter. In the Pacific Northwest, summer steelhead enter fresh water between May and October, while winter steelhead enter fresh water between November and April. While some river basins have both summer and winter steelhead in their streams, summer steelhead usually spawn further upstream than winter steelhead (*in* Busby *et al*. 1996).

Winter steelhead are the most widespread run type, occurring in essentially all coastal rivers of Washington, Oregon, and California. Summer steelhead are less common, occurring in the Columbia River Basin (A-run, and B-run, discussed further in the individual ESU description), southern Oregon and northern California (*in* Busby *et al*. 1996).

Adult steelhead spawn in gravel in main rivers and tributaries. Spawning behavior is similar to that of other salmonids, with the female digging a redd and successively digging, spawning, and resting as she moves upstream. The redd covers up to 6.5 square yards of bottom. The eggs are covered with several inches to a foot of gravel, and eggs spawned first are usually covered with the most gravel. The number of eggs per female ranges from 200 to 9,000 and is dependent on the size of the female and the strain or stock of fish. Eggs hatch after about 50 days, when water temperature is around 50°F. Although up to 95% of the eggs are fertilized, only about 65 to 85% survive the embryonic stage, primarily suffering losses due to siltification. The fry, or alevins, emerge some time later and remain in the peripheral waters of pools until they become large enough to survive in the current of riffles (Wydoski and Whitney 1979).

Most young remain in fresh water for 2 to 3 years, occupying riffle areas in the summer and pools during the other seasons. They are generally associated with the stream bottom. Migration to the sea depends on such factors as fish size and time of the year. In Washington,

smolts usually migrate seaward during April through June, with a peak during mid-April (Wydoski and Whitney 1979). The growth of steelhead increases dramatically at sea, and migrations may be extensive. While there is little information regarding the migratory habits of steelhead, they are caught far offshore and in the high seas by various fisheries.

Steelhead in the Pacific Northwest generally smolt after 2 years in freshwater, then commonly spend 2 years in the ocean before re-entering the fresh water to spawn. Thus, for coastal steelhead in Washington and Oregon, the modal total age at maturity is 4 years. Columbia River and Snake River inland steelhead tend to spend a year in freshwater before spawning, so spawner age could range from 4 to 7 year olds. As noted, steelhead may spawn more than once, although it is relatively uncommon for populations north of Oregon. In Oregon and California, steelhead may perform two spawning migrations in their lifetime, but it is unusual (*in* Busby *et al*. 1996). Those steelhead that perform multiple spawning migrations move slowly downstream to the sea after spawning, and their spawning, rainbow colors of spring return to a bright silvery hue. Lost fats are restored and adults again visit the feeding regions of their first ocean migration. On rare occasions a fish will return to the stream within a few months, but most repeat spawners spend at least one winter in the sea between spawning migrations.

Food Habits: Juvenile steelhead feed primarily on foods associated with the bottom, such as aquatic insects (*e.g.* mayflies, stoneflies, and beetle larvae), amphipods, aquatic worms, and fish eggs. Occasionally they eat small fish. Their diet varies seasonally with availability. In the ocean, maturing and adult steelhead eat crustaceans such as amphipods as well as squid, herring, sand lances, and eulachons (Hart 1973; Wydoski and Whitney 1979).

<u>Lower Columbia River (LCR) Steelhead ESU</u>
Lower Columbia River steelhead were listed as a threatened species on March 19, 1998 (63 FR 13347). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. This ESU encompasses all steelhead runs in tributaries between the Cowlitz and Wind Rivers on the Washington side of the Columbia River, and the Willamette and Hood Rivers on the Oregon side. The populations of steelhead that make up the LCR ESU are distinguished from adjacent populations by genetic and habitat characteristics. The ESU consists of summer and winter coastal steelhead runs in the tributaries of the Columbia River as it cuts through the Cascades. These populations are genetically distinct from inland populations (east of the Cascades), as well as from steelhead populations in the upper Willamette River Basin and coastal runs north and south of the Columbia River mouth.

Not included in the ESU are runs in the Willamette River above Willamette Falls (Upper Willamette River ESU), runs in the Little and Big White Salmon Rivers (Middle Columbia River ESU) and runs based on four imported hatchery stocks: (1) Early-spawning winter Chambers Creek/lower Columbia River mix; (2) summer Skamania Hatchery stock; (3) winter Eagle Creek NFH stock; and (4) winter Clackamas River ODFW stock (63 FR 13351 and 13352). This area has at least 36 distinct runs (Busby *et al.* 1996), 20 of which were identified in the initial listing petition. In addition, numerous small tributaries have historical reports of fish, but no current abundance data. The major runs in the ESU, for which there are estimates of run size, are the

Cowlitz River winter runs, Toutle River winter runs, Kalama River winter and summer runs, Lewis River winter and summer runs, Washougal River winter and summer runs, Wind River summer runs, Clackamas River winter and summer runs, Sandy River winter and summer runs, and Hood River winter and summer runs.

For the larger runs, current counts have been in the range of one to 2,000 fish (Cowlitz, Kalama, and Sandy Rivers); historical counts, however, put these runs at more than 20,000 fish. In general, all runs in the ESU have declined over the past 20 years, with sharp declines in the last 5 years.

Steelhead in this ESU are thought to use estuarine habitats extensively during out-migration, smoltification, and spawning migrations. The lower reaches of the Columbia River are highly modified by urbanization and dredging for navigation. The upland areas covered by this ESU are extensively logged, affecting water quality in the smaller streams used primarily by summer runs. In addition, all major tributaries used by LCR steelhead have some form of hydraulic barrier that impedes fish passage. Barriers range from impassible structures in the Sandy Basin that block access to extensive, historically occupied, steelhead habitat, to passable but disruptive projects on the Cowlitz and Lewis Rivers. The Biological Review Team (BRT 1997) viewed the overall effect of hydrosystem activities on this ESU as an important determinant of extinction risk.

Many populations of steelhead in the LCR ESU are dominated by hatchery escapement. Roughly 500,000 hatchery-raised steelhead are released into drainages within this ESU each year. As a result, first-generation hatchery fish are thought to make up 50 to 80% of the fish counted on natural spawning grounds. The effect of hatchery fish is not uniform, however. Several runs are mostly hatchery strays (*e.g.*, the winter run in the Cowlitz River [92%] and the Kalama River
[77%] and the summer run in the North Fork Washougal River [50%]), whereas others are almost free of hatchery influence (the summer run in the mainstem Washougal River [0%] and the winter runs in the North Fork Toutle and Wind Rivers [0 -1%]).

Escapement estimates for the steelhead fishery in the LCR ESU are based on in-river and estuary sport-fishing reports; there is a limited ocean fishery on this ESU. Harvest rates range from 20 to 50% on the total run, but for hatchery-wild differentiated stocks, harvest rates on wild fish have dropped to 0% to 4% in recent years (punch card data from WDFW through 1994).

For the LCR steelhead ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.98 to 0.78, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in NOAA Fisheries *et al.* 2000).

<u>Middle Columbia River (MCR) Steelhead ESU</u>
Middle Columbia River steelhead were listed as a threatened species on March 25, 1999 (64 FR 14517). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on

April 30, 2002 as a result of a consent decree. The MCR steelhead ESU occupies the Columbia River Basin from above the Wind River in Washington and the Hood River in Oregon (exclusive) and continues upstream to include the Yakima River, Washington. The region includes some of the driest areas of the Pacific Northwest, generally receiving less than 16 inches of precipitation annually (Jackson 1993). Summer steelhead are widespread throughout the ESU; winter steelhead occur in Mosier, Chenowith, Mill, and Fifteenmile Creeks, Oregon, and in the Klickitat and White Salmon Rivers, Washington. The John Day River probably represents the largest native, natural spawning stock of steelhead in the region.

Estimates of historical (pre-1960s) abundance specific to this ESU are available for the Yakima River, which has an estimated run size of 100,000 (WDF *et al.* 1993). Assuming comparable run sizes for other drainage areas in this ESU, the total historical run size may have exceeded 300,000 steelhead.

Most fish in this ESU smolt at 2 years and spend 1 to 2 years in saltwater before reentering freshwater, where they may remain up to a year before spawning (Howell *et al.* 1985, BPA 1992). All steelhead upstream of The Dalles Dam are summer-run (Schreck *et al.* 1986, Reisenbichler *et al.* 1992, Chapman *et al.* 1994). The Klickitat River, however, produces both summer and winter steelhead, and age-2-ocean steelhead dominate the summer steelhead, whereas most other rivers in the region produce about equal numbers of both age-1-and-2-ocean fish. A nonanadromous form co-occurs with the anadromous form in this ESU; information suggests that the two forms may not be isolated reproductively, except where barriers are involved.

The only substantial habitat blockage now present in this ESU is at Pelton Dam on the Deschutes River, but minor blockages occur throughout the region. Water withdrawals and overgrazing have seriously reduced summer flows in the principal summer steelhead spawning and rearing tributaries of the Deschutes River. This is significant because high summer and low winter temperatures are limiting factors for salmonids in many streams in this region (Bottom *et al.* 1984).

Continued increases in the proportion of stray steelhead in the Deschutes Basin is a major concern. The ODFW and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) estimate that 60 to 80% of the naturally spawning population consists of strays, which greatly outnumber naturally produced fish. Although the reproductive success of stray fish has not been evaluated, their numbers are so high that major genetic and ecological effects on natural populations are possible (Busby *et al.* 1999). The negative effects of any interbreeding between stray and native steelhead will be exacerbated if the stray steelhead originated in geographically distant river basins, especially if the river basins are in different ESUs. The populations of steelhead in the Deschutes Basin include steelhead native to the Deschutes River, hatchery steelhead from the Round Butte Hatchery on the Deschutes River, wild steelhead strays from other rivers in the Columbia Basin, and hatchery steelhead strays from other Columbia Basin streams. Regarding the latter, CTWSRO reports preliminary findings from a tagging study by T. Bjornn and M. Jepson (University of Idaho) and NOAA

Fisheries suggesting that a large fraction of the steelhead passing through Columbia River dams (*e.g.*, John Day and Lower Granite dams) have entered the Deschutes River and then returned to the mainstem Columbia River. A key unresolved question about the large number of strays in the Deschutes basin is how many stray fish remain in the basin and spawn naturally.

For the MCR steelhead ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.88 to 0.75, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

Upper Columbia River (UCR) steelhead ESU

Upper Columbia River steelhead were listed as an endangered species on August 18, 1997 (62 FR 43937). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. The UCR steelhead ESU includes all naturally spawned populations in the Columbia River Basin upstream of the Yakima River, Washington, to the United States-Canada boarder. Rivers in the area primarily drain the east slope of the northern Cascade Mountains and include the Wenatchee, Entiat, Methow, and Okanogan River basins. The climate of the area reaches temperature and precipitation extremes; most precipitation falls as mountain snow (Mullan *et al.* 1992). The river valleys are deeply dissected and maintain low gradients, except for the extreme headwaters (Franklin and Dyrness 1973).

Estimates of historical (pre-1960s) abundance specific to this ESU are available from fish counts at dams. Counts at Rock Island Dam from 1933 to 1959 averaged 2,600 to 3,700, suggesting a pre-fishery run size exceeding 5,000 adults for tributaries above Rock Island Dam (Chapman *et al.* 1994). However, runs may have already been depressed by lower Columbia River fisheries.

As in other inland ESUs (the Snake and mid-Columbia Basins), steelhead in the UCR ESU remain in freshwater up to a year before spawning. Smolt age is dominated by 2-year-olds. Based on limited data, steelhead from the Wenatchee and Entiat rivers return to freshwater after 1 year in salt water, whereas Methow River steelhead are primarily age-2-ocean (Howell *et al.* 1985). Life history characteristics for UCR steelhead are similar to those of other inland steelhead ESUs; however, some of the oldest smolt ages for steelhead, up to 7 years, are reported from this ESU. The relationship between anadromous and nonanadromous forms in the geographic area is unclear.

The Chief Joseph and Grand Coulee Dam construction caused blockages of substantial habitat, as did that of smaller dams on tributary rivers. Habitat issues for this ESU relate mostly to irrigation diversions and hydroelectric dams, as well as to degraded riparian and instream habitat from urbanization and livestock grazing.

Hatchery fish are widespread and escape to spawn naturally throughout the region. Spawning escapement is dominated by hatchery-produced fish.

For the UCR steelhead ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.94 to 0.66, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

Snake River Basin Steelhead ESU

Snake River Basin steelhead were listed as a threatened species on August 18, 1997 (62 FR 43937), and critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. This ESU includes all naturally spawned populations of steelhead (and their progeny) in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho. Steelhead spawning habitat in the Snake River is distinctive in having large areas of open, low-relief streams at high elevations. In many Snake River tributaries, spawning occurs at a higher elevation (up to 2,000 m) than for steelhead in any other geographic region. Snake River Basin steelhead also migrate farther from the ocean (up to 1,500 km) than most. No estimates of historical (pre-1960s) abundance specific to this ESU are available. Fish in this ESU are summer-run steelhead. They enter freshwater from June to October and spawn during the following March to May. Two groups are identified, based on migration timing, ocean-age, and adult size. "A-run" steelhead, thought to be predominately age-1-ocean, enter freshwater during June through August. "B-run" steelhead, thought to be age-2-ocean, enter freshwater during August through October. B-run steelhead typically are 3 to 4 inches longer at the same age. Both groups usually smolt as 2- or 3-year-olds (Whitt 1954, Hassemer 1992).

Hydrosystem projects create substantial habitat blockages in this ESU; the major ones are the Hells Canyon Dam complex (mainstem Snake River) and Dworshak Dam (North Fork Clearwater River). Minor blockages are common throughout the region. Steelhead spawning areas have been degraded by overgrazing, as well as by historical gold dredging and sedimentation due to poor land management. Habitat in the Snake River Basin is warmer and drier and often more eroded than elsewhere in the Columbia Basin or in coastal areas. Hatchery fish are widespread and stray to spawn naturally throughout the region. In the 1990s, an average of 86% of adult steelhead passing Lower Granite Dam were of hatchery origin. Hatchery contribution to naturally spawning populations varies, however, across the region. Hatchery fish dominate some stocks, but do not contribute to others.

For the Snake River Basin steelhead ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.91 to 0.70, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

Upper Willamette River (UWR) Steelhead ESU

The Upper Willamette River steelhead were listed as a threatened species on March 25, 1999 (64 FR 14517). Critical habitat was designated on February 16, 2000 (65 FR 7764) and withdrawn on April 30, 2002 as a result of a consent decree. The UWR steelhead ESU occupies the Willamette River and tributaries upstream of Willamette Falls, extending to and including the

Calapooia River. These major river basins containing spawning and rearing habitat comprise more than 12,000 km^2 in Oregon. Rivers that contain naturally spawning winter-run steelhead include the Tualatin, Molalla, Santiam, Calapooia, Yamhill, Rickreall, Luckiamute, and Mary's, although the origin and distribution of steelhead in a number of these basins is being debated. Early migrating winter and summer steelhead have been introduced into the upper Willamette Basin, but those components are not part of the ESU. Native winter steelhead within this ESU have been declining since 1971 and have exhibited large fluctuations in abundance.

In general, native steelhead of the upper Willamette Basin are late-migrating winter steelhead, entering freshwater primarily in March and April. This atypical run timing appears to be an adaptation for ascending Willamette Falls, which functions as an isolating mechanism for UWR steelhead. Reproductive isolation resulting from the falls may explain the genetic distinction between steelhead from the upper Willamette Basin and those in the lower river. The UWR late migrating steelhead are ocean-maturing fish. Most return at age 4, with a small proportion returning as 5-year-olds (Busby *et al.* 1996).

Willamette Falls (Rkm 77) is a known migration barrier. Winter steelhead and spring chinook salmon historically occurred above the falls, whereas summer steelhead, fall chinook, and coho salmon did not. Detroit and Big Cliff Dams cut off 540 km of spawning and rearing habitat in the North Santiam River. In general, habitat in this ESU has become substantially simplified since the 1800s by removal of large woody debris to increase the river's navigability.

The main hatchery production of native (late-run) winter steelhead occurs in the North Fork Santiam River, where estimates of hatchery proportion in natural spawning areas range from 14 to 54% (Busby *et al.* 1996). More recent estimates of the percentage of naturally spawning fish attributable to hatcheries in the late 1990s are 24% in the Molalla, 17% in the North Santiam, five to 12% in the South Santiam, and less than 5% in the Calapooia (Chilcote 1997).

For the UWR steelhead ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.94 to 0.87, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure *et al.* 2000).

2.1.4 Environmental Baseline

Regulations implementing section 7 of the ESA (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. The environmental baseline also includes the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions that are contemporaneous with the consultation in progress. The action area is defined in 50 CFR 402.02 to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action."

2.1.4.1 Marine Mammals

The Pacific Northwest Regional Office generally conducts informal consultations for listed marine mammals, since the impacts of any major construction activity are nearly always on or near land, where large whales are not found (*i.e.* actions that are not likely to adversely affect listed whales). Steller sea lions on land haul out and breed in remote areas along the coast, where fewer humans are present to disturb or interact with the species.

Listed marine mammals in the action area face a variety of anthropogenic threats which may result in harassment, harm, injury and/or mortality. Such threats include fisheries, ship strikes, noise, marine pollution, *etc.* Because not all marine mammals strand, many injuries or deaths due to human activity most likely are unaccounted for. Therefore, any estimates of injury or mortality presented here are considered very conservative.

<u>Fisheries</u>

California/Oregon Drift Gillnet Fishery

The California/Oregon thresher shark/swordfish drift gillnet fishery is comprised of between 120-185 permit holders. Effort in this fishery ranges from the United States Mexico border north to waters off the state of Oregon. This fishery has taken and may continue to take listed marine mammal species.
One fin whale was observed taken in the California/Oregon drift gillnet fishery in 1999. Based on data from 1997 to 1999, which takes into account implementation of changes to the fishery through the Pacific Offshore Cetacean Take Reduction Plan (PCTRP), an annual estimate of 1.5 fin whales are taken annually by fisheries off the west coast (Carretta *et al*. 2002). Because of their size, strength, and distribution, it is difficult to assess potential interactions between fin whales and fisheries; for example, fishermen have reported that large blue and fin whales usually swim through their nets without entangling and with very little damage to the net (Barlow *et al*. 1997).

One Steller sea lion mortality was observed in the California/Oregon drift gillnet fisheries in 1992 and 1994, but none were observed for that fishery between 1995 and 1999.

Washington/Oregon/California Groundfish Trawl Fishery

Groundfish trawl vessels harvest a variety of fish species, including Pacific whiting (hake), flatfish, sablefish, lingcod, and rockfish. All observed incidental marine mammal takes have occurred in the mid-water trawl fishery for Pacific whiting. In 1998, approximately 332 vessels used bottom and mid-water trawl gear to harvest Pacific coast groundfish.

One and two Steller sea lion mortalities were observed in the Washington/Oregon/California groundfish trawl fishery in 1994 and 1997, respectively.

Northern Washington Marine Set Gillnet Fishery

In 1996, one Steller sea lion mortality was observed in the northern Washington marine set gillnet fishery.

California/Oregon/Washington Salmon Troll Fishery

Injuries to and mortalities of Steller sea lions are also reported by fishers as a requirement under the MMPA. One injury associated with the California/Oregon/Washington salmon troll fishery was reported in 1990. However, since 1995 reporting has declined and the records are considered incomplete to estimate sea lion mortality.

Other (unknown) Fisheries

The injury or mortality of some large whales due to interactions or entanglements in other fisheries may go unobserved because large whales swim away with a portion of the net or gear, or there are no stranding records. No recent reports indicate listed whales are being killed or seriously injured as a result of other fishing activities in any eastern North Pacific fishery (Carretta *et al*. 2002). However, fishers have reported that large whales tend to swim through their nets without entangling and causing little damage to nets (Barlow *et al.* 1997).

Stranded sea lions can provide information on the extent to which sea lions are injured or killed in commercial fishing operations. However, identification of the responsible fishery or fisheries is not available from the current data. Between 1995 and 1999, four Steller sea lion strandings were associated with commercial fisheries.

<u>Ship Strikes</u>

There have been several reports of ship strikes or other incident occurring as a result of listed species' interactions with vessels and/or vessel traffic.

In 2002, off the Pacific Northwest coast, four fin whales have recently arrived into ports on the bow of vessels; of those three, one has been confirmed to have been hit while alive. Results of examinations on the remaining two whales are pending (B. Norberg, NOAA Fisheries, personal communication, 2002). Additional mortality of fin whales due to ship strikes most likely goes unreported because the whales may not strand, or if they do, they may not have obvious signs of trauma, or the boat owner may be unaware of the strike when it happens. A Sei whale was struck by a ship in 2003, which was discovered when the ship arrived in the Port Angeles (WA) harbor.

Humpback whales have been killed by ship strikes off the western coast of the United States In 1993, at least two humpback whales died as result of being struck by vessels, one humpback was killed in 1995 and one in 2000. Two unidentified whales, which may have been humpbacks, were struck and injured in 1997 and 1999 (Carretta *et al*. 2002).

Humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989, Clapham *et al*. 1993, Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman *et al*. 1980, Watkins *et al.* 1981, Krieger and Wing 1986). Several investigators have suggested that noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still, other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al*. 1993; Wiley *et al*. 1995).

Blue whales may respond to approaching ships in several different ways, depending on the situation. Blue whales do not react as quickly to oncoming ships when they are feeding as they do during non-feeding times. At this time, the data necessary to accurately quantify blue whale mortality attributable to ship strikes do not exist. There are two explanations for the lack of data. First, not all blue whales strand on beaches where they can be found. Second, it can very difficult to determine the origin of scars or trauma on animals that do strand, depending on the state of decomposition and to what extent the carcass has been scavenged.

Scarff (1986) concluded that right whales in the North Pacific are particularly vulnerable to ship strikes because of their habit of feeding at, or near, the water surface.

Other Mortality

Between 1996 and 1999 two Steller sea lions per year, on average, stranded with gunshot wounds in Washington, Oregon and Alaska. In British Columbia, these shooting cases are considered an estimate, as no human-related stranding data are available there. Furthermore, not all wounded sea lions strand or can be evaluated for human interaction by trained personnel.

Anthropogenic Noise

The increasing levels of anthropogenic noise in the marine environment has been suggested as a habitat concern (Reeves *et al.* 1998a). Sound sources may include underwater tests by various military agencies (*e.g.* Navy), oil and gas exploration, including seismic surveys, or general ship traffic, particularly through major ship channels (*e.g.* Strait of Juan de Fuca).

Marine Pollution

Marine pollution from sewage outfalls, dumping at sea, bilge cleaning, discarded trash or fishing gear, *etc.*, could adversely impact the habitat of listed marine mammal species by having a negative effect on their prey, causing entanglement or disrupting the digestives system through ingestion of foreign materials (*e.g.* occlusion of the digestive tract).

2.1.4.2 Salmonids

Declines in the status of salmon and steelhead in state waters are attributed to a variety of factors, including habitat functional quality and amount. Both natural and human-induced activity have contributed to this decline; under formal consultation we focus primarily on human activities.

Natural disturbances are usually relatively short in duration and occur infrequently. While human disturbances may have minimal impacts individually, the number, magnitude, duration, and cumulative impacts since Euro-American settlement combine to form the primary cause of the decline of numerous salmon stocks. Historical and current human-caused disturbances include: Clearing and channelizing rivers, sending logs down streams via splash dams, extensive land clearing, diverting water, livestock grazing in waterways, mining run-off, constructing logging roads and accelerating erosion, removing old growth forests, filling and diking of wetlands and estuaries, armoring shorelines and streambanks, developing hydroelectric dams, creating barriers to fish migration, increasing surface run-off, contaminating water and sediments, introducing non-native plants and animals, changing levels of oxygen and nutrients in waterways and over fishing.

The scale of the action area covered in this programmatic consultation is so large that describing the environmental baseline is a matter of describing the general existing condition of habitat elements in each state (*i.e.* Washington, Oregon, and Idaho).

State of Washington

To provide a general description of habitat conditions in Washington State, this section will summarize the status information reported in *Changing Our Water Ways: Trends in Washington's Water Systems*, published by the Washington State Department of Natural Resources (DNR) in December 2000. The report reviews the trends affecting aquatic resources statewide; highlights of the report follow.

Human activity and development can have significant and damaging impacts on the environment, and Washington's growing population means that there will be increasing pressure on the state's natural resources. Washington's population – 5.8 million in 2000– is expected to increase by nearly 2 million by the year 2020. In 1999, 46,000 more people were added to the state. Adding this many people leads to concerns about how to provide clean and adequate water for fish and wildlife. While each watershed is unique, the issues of concern can be grouped into five broad categories:

- Interrupted flow regime;
- Alterations to aquatic ecosystems;
- Shoreline modifications;
- Effects of shipping and transportation; and
- Pollution.

Interrupted Flow Regime

Currently, there are 1,025 dams obstructing the flow of water in Washington; this number includes any structure than can store 10 or more acre-feet of water. Because dams obstruct the flow of rivers, they change the physical flow of water, resulting in areas that are either drier than normal, or flooded. Changing the depth and flow of rivers also affects the temperature of the water. Dams also alter the flow of materials carried in river water, stopping the flow of debris, nutrients, and sediments. As a result, reservoirs eventually fill with sediments, and inadequate amounts of sediments reach the deltas and estuaries. Dams also change the movement of fish igrating between the streams and oceans. In addition to the many dams blocking fish movement in Washington, an estimated 2,400 human-made barriers, including dikes, culverts and tide gates block passage to an estimated 3,000 miles of freshwater spawning and rearing habitat.

In a more recent report, the WDFW indicates there is a minimum of 2,400-4,000 human-made barriers blocking 3,000 to 4,500 miles of freshwater spawning and rearing habitat for salmon (Washington State Department of Transportation [WSDOT] and WDFW 1999). A recent critique of the Washington State Hydraulic Code estimated that there are approximately 8,800 culvert related barriers blocking over 6,000 miles of habitat. The authors estimated an annual lost opportunity of 10 million adult salmon (Hollowed and Wasserman 2000).

In many river basins, irrigation projects have significantly changed the timing, quantity and quality of flow in the rivers and tributaries. Flood control dikes and highway construction have cut off the rivers from their historic flood plains and wetlands, resulting in habitat destruction, changes in stream temperature and nutrient composition alterations. In the Yakima River Basin, these changes have contributed to the reduction of historically abundant runs of salmon and steelhead. Today, summer chinook, native coho and anadromous sockeye are extinct, and the spring chinook runs have declined from 9,300 in 1986 to 645 in 1997.
Sometimes human impacts and natural events combine to change the flow of a river. The natural course of a river includes its flood plain. In what is known as avulsion, a surface mine pit in a flood plain may suddenly reroute a river during a flood, "capturing" the river. Gravel spawning beds or other habitat in an abandoned channel become unavailable to fish. Gravel from upstream gradually fills the breached mine pit instead of getting washed downstream to replenish gravel bars. The river becomes less stable and less hospitable to salmon. When the east fork of the Lewis River was captured in 1995, it abandoned 1,700 feet of gravel spawning beds, and when captured again in 1996 it abandoned another 3,200 feet.

The availability of water has long been a major issue for all Washington residents, including its aquatic species. Today, decisions about apportioning the flow is a hot topic debated by local, state, and Federal governments, businesses and private landowners. Of Washington's 62 Water Resource Inventory Areas (WRIAs), 16 have both an ESA-listed salmon stock and a water supply problem. There is not enough water to supply the water rights granted to people in those 16 basins and to also support fish and water quality in those streams. In addition, about 450 lakes and streams in Washington are partially or completely closed to further withdrawals.

With approximately 5.8 million people living in Washington, much of the land surface has been covered by impervious surfaces. All this development affects the amount of water that seeps into the ground and washes into streams; it also affects how quickly the water gets to the streams. When land is covered with pavement or buildings, the area available for rainwater and snowmelt to seep into the ground and replenish the groundwater is drastically reduced; in many urban areas it is virtually eliminated. The natural movement of water through the ground to usual discharge points such as springs and streams is altered. Instead, the natural flow is replaced by storm sewers or by more concentrated entrance points of water into the ground.

Changing the timing and amount of water run-off can lead to too much water going directly into streams in the rainy months of winter instead of soaking into the ground. Consequently, there is not enough water in the ground to slowly release into streams in the dry months of summer. Too much water in the winter can cause fish habitat to be scoured by unnaturally swift currents; not enough water in streams in the summer leads to water temperatures too high to support fish. Studies show that when impervious surfaces such as pavement and buildings cover between five to 8% of an urban watershed, the health of streams and the fish in them declines, despite stormwater controls. In the south Puget Sound area, most urban watersheds are 20 to 40% covered with hard surfaces, altering stream flows, water temperatures, and in-stream habitat for everything from insects to fish.

Altered Aquatic Ecosystems

From high mountain streams to coastal shorelines, Washington's varied landscapes provide diverse aquatic habitats. Since the arrival of settlers in the early 1800s, at least 50% and as much as 90% of riparian habitat in Washington has been lost or extensively modified. Wetlands improve water quality by filtering out sediments, nutrients, and toxic chemicals. However, research shows that a watershed can withstand having only 5 to 8% of its land base covered with buildings, roads, and other impervious surfaces before significant changes in wetland functions and stream hydrology begin to occur. Because the value of wetlands and their overall environmental importance have been recognized only recently, Washington has almost two centuries of wetland conversion. A 1989 report by the USFWS estimated that activities such as draining and filling reduced Washington's wetland areas by 33% since statehood, from 1.4 million acres to 938,000 acres.

Estuary losses have occurred primarily through conversions to farms and cities. In the Skagit Valley, for example, a large majority of the estuary mud flats and flood plain was converted to farmland before the first land surveys of 1889. Nearly 75% of the wetland area was lost before statehood. Currently, less than 3 square miles of tidal estuary wetland remain, a 93% loss. When tidal flood plains, estuaries and tide floats are destroyed or significantly disturbed, critical functions are at risk. The vast food source is diminished and silt that is carried along by currents to replenish beaches and nearshore habitat is lost. Replacing estuaries with farms, industry, and cities destroys habitat critically needed by salmon.

Eelgrass, a marine flowering plant, grows low in the intertidal zone and in mud and sand in the shallow subtidal zone. Eelgrass is critical to salmon recovery efforts because it provides fish a place to hide and evade predators. It also provides food and habitat for salmon prey. Because of where it grows, eelgrass is largely inaccessible and hard to survey. As a result, it is unclear how much eelgrass has disappeared from Puget Sound waters over the past 100 years. However, the historical data that scientists do have suggest that eelgrass beds in Bellingham Bay have declined by about 50% over the past 100 years; a figure fairly consistent throughout its range in Washington.

The amount of dissolved oxygen in water is an important measurement of overall water quality. Areas of Puget Sound are experiencing lower levels of dissolved oxygen. In March 2000, the Puget Sound Water Quality Action Team identified 87 areas in Puget Sound that had problems with low dissolved oxygen. Human actions are the main contributor to depleted oxygen. Excessive fertilizers and nitrogen applied to yards and fields, and fecal matter from septic fields and failing septic systems, contribute pathogens and nutrients that can deplete oxygen. Because there is little historical data on dissolved oxygen concentrations in marine waters, it is difficult to compare the health of Washington's marine waters of today to those of the past. However, based in measurements of dissolved oxygen in the southern part of Hood Canal made in the 1950s and 1960s, today's dissolved oxygen concentrations are lower, more frequently.

The introduction of non-native (exotic) species has been known to profoundly affect ecosystems by disrupting food webs and displacing native species. Because of a lack of natural predators or competitors, these introduced species can spread rapidly. In 1998, an expedition looked in Puget Sound for non-native species, and discovered more than 52 invasive species. Non-native species are introduced primarily through shipping, aquaculture, research, and aquaria industries. The following are examples of some of the most tenacious and insidious non-native species that have invaded Washington's waters and aquatic ecosystems:

- Eurasian Water Milfoil (*Myriophyllum spicatum*), an aquatic plant found in lakes and slow-moving streams. It can lower dissolved oxygen and increase pH; displace native aquatic plants and increase water temperature.

- Parrotfeather (*M. aquaticum*) is limited to coastal lakes and streams, the Columbia River, the Chehalis River and private ponds and lakes. The emergent stems shade the water column, eliminating algal growth, which is the basis of the aquatic food web.

- Purple Loosestrife (*Lythrum salicaria*) generally grows in marshes, ponds, streambanks, ditches and lake shores. Because it grows so aggressively, large stands take over an area and eventually replace the native plant species, eliminating the natural food and cover essential to native shoreline and wetland inhabitants.

- Hydrilla (*Hydrilla verticillata*) roots in lake sediments and grows rapidly under very low light conditions. Hydrilla can fill the water column with vegetation, displacing native fish and wildlife.

- Spartina is an exotic species of intertidal cordgrass. If left uncontrolled, Spartina transforms mud flats into dense, raised meadows, cut by narrow, deep channels. The loss of mud flats, eelgrass, and algae directly affect native fish species that depend on these areas for feeding, spawning and rearing.

Shoreline Modification

Washington has more than 3,000 miles of marine shoreline. When these shorelines are changed or eradicated, intertidal and nearshore habitat is affected or lost, causing significant stress on the salmon that rely on these habitats. Modifications of shorelines include bulkheads, docks, piers, or areas that have been filled or dredged. Few statistics exist on the extent of freshwater shoreline modification. One lake that has received some attention is Lake Washington, in Seattle. More than 80% of its shoreline has been armored against erosion and over 3000 residential piers cover approximately 2.5% of the lake's surface. Adverse effects of these shoreline modifications include loss of riparian vegetation, shading of the nearshore aquatic zone, and an increase in attractive refugia for piscivorous birds and fish.

Development of Washington's marine and estuarine shoreline over the past 100 years has created a landscape that is dramatically different from what the first settlers found. About 800 miles of the Puget Sound shoreline have been modified, with 25% of the modifications in the intertidal areas. Up to 52% of the central Puget Sound shoreline and about 35% of the shorelines of Whidbey Island, Hood Canal, and south Puget Sound have been changed or eradicated. To help protect their shoreline property from erosion, many waterfront homeowners construct bulkheads between their land and the beach. Ironically, one consequence of bulkheads is the loss of sand from the beach and beach erosion. The natural process of bluff erosion provides a supply of sand and rocks to the beach. Construction of bulkheads cuts off this supply of beach-building material and prevents the wave's energy from dissipating. A 1998 survey in Puget Sound found that nearly 15% of armored beaches had mostly large rocks and minimal sediment compared to only 1% of unarmored beaches. The loss of sand and pebbles affects small fish that use this habitat for spawning. These small fish form the base of the food chain for larger fish.

The Shoreline Management Act (SMA) was passed in 1971 to protect the state's shorelines from development impacts. However, since passage of the SMA, about 26,000 permits have been issued statewide for substantial shoreline development projects. This number does not include single family homes, which are exempt from the permit process.

Shipping and Transportation

Since the days of early settlement, marine shipping has played a key role in Washington's economy, and ports are the critical hub of this waterborne trade. Early dredging, filling, and other alterations of shallow estuarine areas were devastating to the fish that depended on the habitat as a transition from freshwater to saltwater. Over time, the increased demand for shipping facilities led to more dredging and filling until today an average of 50% of the original

wetland habitat in Puget Sound's major bays has been destroyed. Bays near urban centers such as Tacoma and Seattle have less than 5% of their natural intertidal habitat left.

There are 48 ports in Washington's waters. The total tonnage shipped from those ports has increased 60% over the past five decades, and shipping container traffic is expected to double in the next 20 years. Not only are there more ships, but the ships are being built bigger. To accommodate larger ships, ports expand and shipping channels are dredged deeper. Dredging the bottom of bays and rivers displaces plants and animals living there and can stir up contaminated sediments. Dumping dredged materials elsewhere in the water smothers habitat. In the late 1990s, the Army Corps of Engineers proposed deepening the Columbia River's existing navigation channel to accommodate larger ships. Over the 50 year life of the project, the deeper channel will result in 267 million cubic yards of material which would need to be disposed in the river, in the ocean, or on land. The disposal of dredged material will result in the loss of at least 67 acres of habitat in the river, 200 acres of agricultural land, and 20 acres of wetlands. The dredging project will alter important habitat of at least 13 species of listed salmonids, damage prey species stocks, and alter the food web.

Ports expand to accommodate not only more ships, but larger ships as well. The shipping industry continually builds larger ships to carry larger cargo loads. In response, ports enlarge their facilities and deepen their navigation channels so that larger vessels can dock and unload their goods. The larger vessels carry more ballast water, which when dumped into Washington's waters has the potential of introducing exotic species. Increased shipping activity affects more than just the waterfront–it also results in an increased need for overland transportation. More trucks and rail cars are needed to transfer goods to and from ships and inland destinations. Aquatic ecosystems are at risk of becoming polluted by more petroleum-carrying run-off from increased traffic on roads.

Pollutants

Washington is rich in water resources, but there are unseen risks in many of the state's waterbodies. Of the 1,099 lakes, streams, and estuaries for which there is data, 643 (59%) are so impaired they don't adequately provide for swimming, fishing or habitat. The main causes of water quality problems are related to human activities, such as farming, failing septic systems, increased erosion along streams, and pollutants added to land and water.

The mud and sand in many places beneath Washington's waters are so contaminated they do not meet state and Federal standards. More than 3,000 acres of Puget Sound sediments are so contaminated that Federal laws require they be cleaned up. Of the state's 112 contaminated sites identified by the WADOE, 93 are in saltwater and 19 are in freshwater. Contaminated sediments are detrimental to the health and diversity of aquatic populations.

Declines in Fish

Salmon provide critical links in an entire food web. They transport energy and nutrients between the ocean, estuaries, and freshwater environments, even in death. Recent calculations indicate that only 3% of the marine nutrients once delivered by anadromous salmon to the rivers of Puget Sound, the Washington Coast, and the Columbia River are currently reaching those streams. Researchers surmise this is due to the substantial decline in salmon populations over the past several decades.

The decline in salmon over the past several decades is the result of both natural and human factors. Forestry, agriculture, mining, and urbanization have degraded, simplified, and fragmented habitat. Water diversions for agriculture, flood control, domestic, and hydropower purposes have greatly reduced or eliminated historically accessible habitat. Studies indicate that in most western states, about 80 to 90% of the historic riparian habitat has been eliminated (NMFS 1998).

Conclusion

In its conclusions, *Changing our Water Ways* makes it clear that efforts to resolve resource problems in the past have led to the cumulative effects of dams, agricultural practices, urban development, and industrial activity. Existing policies and programs may not be sufficient to address current environmental challenges. Washington's aquatic habitat has disappeared or is so impaired it no longer supports life the way it used to; populations of many aquatic animals, including listed salmon, are in serious decline. Water quality is poor and riparian structure and function has been significantly altered from historical conditions.

State of Oregon

The analysis presented in this section is based primarily on the *Oregon State of the Environment Report 2000* (Report), published by the Oregon Progress Board in September, 2000 (Risser 2000). The Report provides a comprehensive review of Oregon's environmental baseline in terms of all of its interrelated parts and natural processes. It was developed using a combination of analyses of existing data and best professional scientific judgment. Aquatic ecosystems, marine ecosystems, estuarine ecosystems, freshwater wetlands, and riparian ecosystems were among the resources considered. A set of indicators of ecosystem health was proposed for each resource system and as benchmarks for the State's use in evaluating past decisions and for planning future policies to improve Oregon's environment and economy. The *Report* also included findings regarding the environmental health of Oregon's eight ecoregions and conclusions about future resource management needs. Highlights of the *Report* follow.

Water Supply

Oregon's currently available water supplies are fully or often over-allocated during low flow months of summer and fall. In the Columbia Plateau ecoregion, less than 20% of instream water rights can expect to receive their full allocation 9 months of the year. In the Willamette Valley

and Cascades ecoregions, more than 80% of the instream water rights can expect to receive their full allocation in the winter, but only about 25% in the early fall. Increasing demand for water in Oregon is expected due to a projected 34% increase in human population over the next 25 years in the state. Depletion and storage of natural flows have altered natural hydrological cycles in basins occupied by listed salmonid ESUs. Such phenomena may cause juvenile salmon mortality through migration delay resulting from insufficient flows or habitat blockages; loss of sufficient habitat due to dewatering and blockage; stranding of fish resulting from rapid flow fluctuations; entrainment of juveniles into poorly screened or unscreened diversions; and increased juvenile mortality resulting from increased water temperatures (Spence *et al.* 1996). Reduced flows also negatively affect fish habitats due to increased deposition of fine sediments in spawning gravels, decreased recruitment of new spawning gravels, and encroachment of riparian and exotic vegetation into spawning and rearing areas. Further, some climate models predict 10 to 25% reductions in the amount of late spring-summer-early fall runoff in the coming decades.

Water Quality

Water quality in Oregon was categorized using the Oregon Water Quality Index (OWQI). The OWQI is a large, consistent and reliable data set that covers the state. It is based on a combination of measurements of temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia and nitrate nitrogen, total phosphorus, total solids and fecal coliform. Because water quality is influenced by streamflow, water quality indices are measured during high and low flow periods. Two key water quality factors affecting salmon are water temperature and fine sediment. Summer temperatures above 16°C puts fish at greater risk through effects that range from the individual organism to the aquatic community level. These effects impair salmon productivity from the reach to the stream network scale by reducing the area of usable habitat and reducing the diversity of coldwater fish assemblages. The loss of vegetative shading is the predominant cause of elevated summer water temperature. Smaller streams with naturally lower temperatures that are critical to maintaining downstream water temperatures are most vulnerable to this effect. The same factors that elevate summer water temperature can decrease winter water temperatures and put salmon at additional risk. Widespread channel widening and reduced base flows further exacerbate seasonal water temperature extremes.

Generally, water quality in Oregon is poor for salmon during low flow periods, except in mountainous areas. Instances of excellent or good water quality occur most often in the forested uplands. Poor or very poor water quality occurs most often in the non-forested lowlands where land has been converted to agricultural and urban uses. Most ecoregions include some rivers and streams with excellent water quality and others with very poor water quality. Only the Cascades ecoregion has excellent water quality overall as shown by average OWQI measurements. The Willamette Valley, Columbia Plateau, Northern Basin and Range and southern end of the Eastern Cascade Slope ecoregions have poor water quality indices. The effects of pesticides and fertilizers, especially nitrates, on water supplies and aquatic habitats are a significant concern. Almost all categories of water pollution are growing, as are hazardous waste emissions, air pollution, toxic releases, and waste generation.

Riparian Areas

Oregon contains approximately 114,500 miles of rivers and streams. No statewide measurements exist in the area of riparian vegetation, although some estimates have been made for more localized regions. Using the conservative estimate of a 100-yard riparian corridor on each side of the stream, the total area of riparian habitats for flowing water in Oregon may be 22,900 square miles. That is equal to approximately 15% of the total area of the state. With the exception of fall chinook, which generally spawn and rear in the mainstem, salmon and steelhead spawning and rearing habitat is found in tributaries where riparian areas are a major habitat component. Healthy riparian areas retain the structure and function of natural landscapes as they were before the intensive land use and land conversion that has occurred over the last 150 to 200 years. However, land use activities have reduced the numbers of large trees, the amount of closed-canopy forests, and the proportion of older forests in riparian areas. In western Oregon, riparian plant communities have been altered along almost all streams and rivers.

In the western Cascades, Willamette Valley, Coast Range, and Klamath Mountains, riparian areas on privately-owned land are dominated by younger forests because of timber harvest, whereas riparian areas on public lands have more mature conifers. Old coniferous forests now comprise approximately 20% of the riparian forests in the Cascades, but only 3% in the Coast Range. Older forests historically occurred along most of the McKenzie River, but now account for less than 15% of its riparian forests. Along the mainstem of the upper Willamette River, channel complexity has been reduced by 80% and the total area of riparian forest has been reduced by more than 80% since the 1850s. Downstream portions of the Willamette River have experienced little channel change, but more than 80% of the historical riparian forest has been lost.

Beginning in the early 1800s, riparian areas in eastern and southern Oregon were extensively changed by trapping beaver, logging, mining, livestock grazing, agricultural activities, and associated water diversion projects. Very little of the once extensive riparian vegetation remains to maintain water quality and provide habitats for threatened salmon. Dams have affected flow, sediment, and gravel patterns, which in turn have diminished regeneration and natural succession of riparian vegetation along downstream rivers. Introduced plant species pose a risk to some riparian habitat by dominating local habitats and reducing the diversity of native species. Improper grazing in riparian areas is another significant threat.

Status of Fish Species

Sixty-three species or recognized subspecies of native freshwater fish occur in Oregon. Currently, 14 of those species or subspecies are listed under the ESA as threatened or endangered. An additional 15 species are considered potentially at-risk and are listed as candidate species. Thus, 45% of Oregon's freshwater fish species have declined and are at some risk of extinction. Among the 50 states, Oregon ranks fifth for the greatest number of listed fish species. In response to concern about the health of salmon populations, commercial and sport

harvests have been sharply curtailed, and fishing for coastal coho salmon was eliminated entirely from 1994 to 1998.

Fish Health

Occurrence of tumors, lesions, and deformities in fish is a direct measure of fish health. Systematic data regarding this problem are not available statewide. In the Willamette River, skeletal deformities comprised less than 5% of the sampled population upstream from Corvallis, 20% between Corvallis and Newberg, and 56% of the sampled population in the Newberg pool.

Introduced Species

More than 32 species of freshwater fish have been introduced into Oregon, and are now self-sustaining, making up approximately one-third of Oregon's freshwater fish fauna. Introduced species are frequently predators on native species, compete for food resources, and alter freshwater habitats. In 1998, introduced species were found to comprise 5% of the number of species found in the upper Willamette River, but accounted for 60% of the observed species in the lower river near Portland.

Estuaries

Depending on the species, salmon spend from a few days to 1 or 2 years in an estuary before migrating out to the ocean. Natural variability and extremes in temperature, salinity, tides and river flow make estuarine ecosystems and organisms relatively resilient to disturbance. However, alterations such as filling, dredging, the introduction of nonnative species, and excessive waste disposal have changed Oregon's estuaries, reducing their natural resiliency and functional capacity. The most significant historical changes in Oregon's estuaries are the diking, draining and filling of wetlands and the stabilization, dredging and maintenance of navigation channels. Between 1870 and 1970, approximately 50,000 acres or 68% of the original tidal wetland areas in Oregon estuaries were lost. Nonnative species now comprise a significant portion of Oregon's estuarine flora and fauna. Some, such as the European green crab (*Carcinus maenas*), pose serious threats to native estuarine communities necessary to support healthy salmon populations.

Consumptive use of fresh water in the upper watersheds has reduced freshwater inflow to estuaries by as much as 60 to 80%, thus reducing the natural dilution and flushing of pollutants. Other significant concerns include excessive sediment and runoff pollution from local and watershed source, and general pressures associated with population and tourism growth. Despite these significant historical wetland conversions and continuing degradation by pollutants, the introduction of nuisance species, and navigational improvement, much of the original habitat that existed in the mid-1800s is still relatively intact and under protection of local zoning plans. Hundreds of acres of former estuarine marshes are now being restored.

Conclusion

In summary, the *Report* makes it clear that environmental baseline conditions are most critical in lowlands of major river basins, where most Oregonians live and work. Flow conditions and water quality are poor and riparian structure and function has been significantly degraded from historical conditions. These and other problems reflect the aggregate effects of many small, diffuse, individual decisions and actions.

State of Idaho

A description of baseline conditions currently existing within the state of Idaho where listed salmonids are found (Snake River and Basin area) have been taken from the status reviews for chinook and steelhead (Waples *et al*. 1991a, and Busby *et al*. 1996, respectively).

Geological, topographical, and hydrological features of the Snake River Basin are unique in the Pacific Northwest. The basin extends into five states (Idaho, Oregon, Washington, Wyoming, and Nevada), drains an area of approximately 267,000 km^2, and incorporates a range of vegetative life zones, climatic regions, and geological formations, including the deepest canyon (Hells Canyon) in North America.

One of the most significant habitat problems facing salmonids in Idaho is substantial modification of the migration corridor by hydroelectric power development in the mainstem Snake River. Hydroelectric development has resulted in a major disruption of juvenile and adult migration corridors and affected flow regimes and estuarine habitat.

There have been several substantial habitat blockages in the Snake River basin - the major ones include the Hells Canyon Dam complex on the mainstem Snake River and the Dworshak Dam on the North Fork Clearwater River. Minor blockages from smaller dams, impassable culverts, *etc.*, exist throughout the region. The construction of 12 dams on the mainstem Snake River has substantially reduced the distribution and abundance of Snake River salmonids. Fish passage facilities proved unsuccessful at several projects, and spawning habitats, particularly areas most frequently utilized by fall chinook salmon, were eliminated with the formation of reservoirs.

The construction of Swan Falls Dam in (1901; RKm 734) first obstructed passage of adults and rendered 256 km of mainstem habitat inaccessible to fall chinook salmon. During the early 1900s, the Fish Commission of Oregon placed a weir in the Snake River downstream from Swan Falls Dam near Ontario, Oregon (RKm 599), to collect fall chinook salmon brood stock for hatchery production. Although only a portion of the fall chinook salmon run was intercepted, more than 20 million eggs (a minimum of 4,000 females) were taken in a single year, providing some indication of the distribution and large number of fall chinook salmon migrating into the upper reaches of the Snake River during this period.

The upper reaches of the mainstem Snake River were the primary areas utilized by fall chinook salmon, with only limited spawning activity reported downstream from RKm 439. The construction of Brownlee Dam (1958; RKm 459), Oxbow Dam (1961; RKm 439), and Hells

Canyon Dam (1967; RKm 397) eliminated the primary production areas of Snake River fall chinook salmon. Habitat was further reduced with the construction of four additional dams on the lower Snake River: Ice Harbor Dam (1961; RKm 16), Lower Monumental Dam (1969; RKm 67), Little Goose Dam (1970; RKm 113), and Lower Granite Dam (1975; RKm 173). Apart from the possibility of deep-water spawning in lower areas of the river, the mainstem Snake River from the upper limit of the Lower Granite Dam reservoir to Hells Canyon Dam (approximately 165 km) and the lower reaches of the Imnaha, Grande Ronde, Clearwater, Salmon, and Tucannon Rivers are the only remaining areas available to fall chinook salmon in the Snake River Basin.

High summer and low winter temperatures are also limiting factors for salmonids in many accessible streams in the region. For example, flows below recommended levels occur in the Grande Ronde River, especially in late fall through early spring. Water withdrawals and low flows are severe in several areas of the basin.

Riparian vegetation has been heavily impacted by overgrazing and other agricultural practices, timber harvest, road building, and channelization. Prime salmonid spawning habitat has been degraded by overgrazing in several parts of the Grande Ronde River Basin. Inventories of stream segments in the Grande River Basin revealed that restoration is needed for between 38% (upper basin) and 59% (lower basin) of the river bank. Instream habitat is also affected by these factors, as well as past gold dredging and severe sedimentation due to poor land management practices. Although not as well documented in other basins in this region, similar habitat problems are expected.

Rivers in the southern half of Idaho are also affected by agricultural and urban development. Irrigation return flows, agricultural water withdrawals, vegetation management, and livestock grazing, and urban activities were associated with high nutrient concentrations in the Boise and Snake Rivers. There is also habitat degradation in many areas related to forest and mining practices, with significant factors being lack of pools, high temperatures, low flows, poor overwintering conditions, and high sediment loads.

Conclusion

NOAA Fisheries concludes that not all of the biological requirements of the species within the action area are being met under current conditions, based on the best available information on the status of the affected species; information regarding population status, trends, and genetics; and the environmental baseline within the action area. Significant improvement in habitat conditions over those currently available under the environmental baseline is needed to meet the biological requirements for survival and recovery of these species. Any further degradation of these conditions would have a significant impact due to the amount of risk they presently face under the environmental baseline.

2.1.5 Effects of the Proposed Action

The Endangered Species Act regulations define "effects of the action" as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.2).

This Opinion evaluates the potential effects of oil spill response methods on listed species and critical habitat. However, it is recognized that at times no effective response method will exist to meet the goals of oil spill response: (1) Protect human life and safety; (2) prevent, when possible, or minimize the impacts of spilled oil; and (3) enhance recovery of the natural environment. Depending on the circumstances of a given situation - the type of oil spilled, the environment in which it was spilled and the degree of oiling - allowing natural recovery may represent the most effective and least environmentally harmful response to a spill. Natural recovery may be permitted in any habitat; however, this response may be preferred when one or both of the following conditions exist. First, natural recovery may be preferred in habitats that contain a level of energy high enough to promote oil removal and degradation at a rate that is at least equal to the rate of removal that could be achieved through another response method. Frequently, the high energy in these areas can pose a significant threat to responders. Second, natural recovery may be preferred when other response activities are expected to cause more harm than allowing natural processes to remove oil from the affected area. The choice to allow natural recovery is followed by monitoring for natural oil removal and biological recovery.

This section provides an overview of the potential effects of oil on listed species in the action area: Cetaceans (blue, fin, humpback, right, sei, and sperm whales), Steller sea lions, and salmonids (17 ESUs).

Oil may directly affect listed species through ingestion, inhalation of fumes, physical fouling or effects to prey resources. In addition, oil may indirectly affect these species, the effects of which are not observed until a subsequent time period. The effect of oil on each category of listed species will be discussed in terms of these direct and indirect effects.

<u>Cetaceans</u>
Cetaceans appear to be equipped physiologically to detect and avoid oil. However, many observations have been made of whales entering and surfacing in fouled areas, with no apparent adverse effect to the animals. Whale skin is virtually impenetrable to the volatile compounds

within oil (Geraci and St. Aubin 1990). Unrealistically long exposure times in captive experiments yielded no observable adverse effects (Hansbrough *et al.* 1985). Healing of superficial cuts that were exposed to oil and gasoline was not affected (Geraci and St. Aubin 1990). Furthermore, unlike pinnipeds, cetaceans do not lose heat as a result of the fouling of their skin.

Inhalation of the volatile compounds in oil does not appear to pose a threat to listed cetaceans (Geraci and St. Aubin 1990). These compounds exist for a relatively brief period. Cetaceans are more likely to encounter weathered oil that contains little of the toxic hydrocarbon fractions. As a result, oil has the potential to cause irritation or inflammation, if inhaled, but the effects of inhalation are expected to be brief (Geraci and St. Aubin 1990). A whale trapped in an oil slick for the first few hours after a spill may be exposed to concentrations of toxic vapors in sufficient concentration to cause harm to the animal (Geraci and St. Aubin 1990).

With the exception of the sperm whale, all of the listed whales species in the action area feed with baleen plates. Baleen has the potential to become fouled after physical contact with oil. The surface "skim" feeding behavior of right whales makes this species most vulnerable to baleen fouling. In contrast, blue, fin, humpback and sei whales typically "gulp" feed at depth. However, it should be noted that each species exhibits variation in its feeding behaviors. Laboratory studies tested the ability of baleen to function after exposure to oils of differing thickness. Heavy oils (*e.g.*, Bunker C) had the most noticeable impact. Baleen exposed to heavy and weathered oils was fouled for periods of at least several days after reintroduction to clean water. Specifically, the rate at which water flowed through the plates was measured. However, after this period of fouling, the normal properties of the baleen returned despite being visually fouled (Geraci and St. Aubin 1990). As a result of these studies and others, Geraci and St. Aubin (1990) concluded that the risks of oil fouling to baleen are lower than once predicted.

There is no evidence that whales feed in oiled areas. However, extrapolations from studies of terrestrial animals indicate that large whales would have to ingest approximately 600 liters (150 gallons) of oil to reach toxic levels (Geraci and St. Aubin 1990). Geraci and St. Aubin (1990) found it unlikely that whales would consume such quantities of oil under typical circumstances; however, they noted that it is difficult to predict the behavior of wild animals that are confronted by the unfamiliar and potentially threatening situation presented by an oil spill.

The indirect effects of oil on listed cetaceans include the effects of oil on prey resources and habitats. Oil may temporarily decrease the biomass of and reproduction and feeding in zooplankton, as these organisms are relatively sensitive to oil. Long-term effects have not been observed in zooplankton (NOAA 1992). Pelagic fish species (as opposed to benthic species) are less likely to come in contact with fouled sediments for long periods. Therefore, they are unlikely to experience acute or chronic effects of oil. Oil spills rarely cause fish kills in open water environments, areas where cetaceans tend to feed. There is no evidence of bioaccumulation of hydrocarbons in fish. Fish larvae and eggs are thought to be more sensitive to oil spills than adults. As a result, recruitment of some species may be depressed, at least temporarily and locally. This information indicates that cetaceans are unlikely to be indirectly

affected by oil in the long term, but they may experience some short-term effects associated with prey abundance.

Steller Sea Lion

There are very few data and observations of Steller sea lions in and near oil. Therefore, the following discussion utilizes available information on the effects of oil on similar species within the pinniped family.

Steller sea lions, like other pinnipeds, have the sensory capabilities (Nachtigall 1986 *in* Geraci and St. Aubin 1990, Renouf *et al.* 1980) to detect and avoid oil in the environment (Geraci and St. Aubin 1990). However, observation of pinnipeds in the wild do not provide conclusive evidence that these animals do avoid oil; while avoidance has been observed in some spills, seals and sea lions have been observed swimming through slicks in others (Geraci and St. Aubin 1990). Steller sea lions that do come in contact with oil may exhibit changes in their behavior. For example, some observations indicate that fouled pups are ignored or abandoned by their mothers, possibly because the oil coating the pup's pelage obscures its identifying scent to the mother (Geraci and St. Aubin 1990), while pinnipeds appeared to unaffected in other observations (Shaughnessey and Chapman 1984).

Mucous membranes are probably the most sensitive tissues in pinnipeds. They line the orifices, oral cavity and respiratory surfaces, and coat the eyes (Geraci and St. Aubin 1990). Seals displayed irritated eyes within minutes of being exposed to oil in captive studies; however, this effect appears to be temporary, as the irritation subsided shortly after immersion in clean water (Smith and Geraci 1975). It is also possible that the insulative properties of fur could be compromised by contact with oil. This is not likely to affect most pinnipeds, including Steller sea lions, as these species are afforded negligible thermal protection by fur (Geraci and St. Aubin 1990). A thick blubber layer provides most of the insulation in pinnipeds, with the exception of fur seals. However, it has been observed that the locomotion of young pinnipeds may be impeded by fouling with heavier oils (Davis and Anderson 1976).

Oil may be ingested during feeding or grooming. Studies on captive pinnipeds indicated that small doses of oil had no apparent effect on the animals' metabolic activities. Toxic doses were estimated using extrapolations of data from terrestrial species. It is unlikely that pinnipeds would ingest this volume of oil (several hundred milliliters for 50 kg pups; several liters for adults) during feeding or grooming activities (Geraci and St. Aubin 1990). Therefore, ingestion of oil does not appear to pose a metabolic threat to Steller sea lions or other pinnipeds. Chronic ingestion of oil is thought to potentially cause subtle effects that may not be detectable in the absence of long-term monitoring studies (Geraci and St. Aubin 1990). These observations have not been made to date.

No studies have been conducted to assess the effects of inhalation of the hydrocarbon vapors in pinnipeds. It is unlikely that petroleum vapors could reach toxic levels in the wild (Geraci and St. Aubin 1990). However, some immersion studies have attributed toxic effects to respiration, in the absence of any ingestion of oil. It has also been suggested that animals stressed by other

factors, such as handling, physical trauma or parasites are more susceptible to the effects of contact with or inhalation of oil (Geraci and St. Aubin 1987, 1990).

The indirect effects of oil on listed Steller sea lions may include long-term effects to the Steller sea lion as a result of the effects of oil on prey resources and habitats. Oil may temporarily decrease the biomass of and reproduction and feeding in zooplankton, as these organisms are relatively sensitive to the effects of oil. Long-term effects have not been observed in zooplankton (NOAA 1992). While zooplankton do not serve as a food source for sea lions, they may be prey for some species of fish upon which sea lions do feed. Pelagic fish species (as opposed to benthic species) are less likely to come in contact with fouled sediments for long periods. Therefore, they are unlikely to experience acute or chronic effects of oil. Oil spills rarely cause fish kills in open water environments where sea lions typically forage. There is no evidence of bioaccumulation of hydrocarbons in fish. Fish larvae and eggs are thought to be more sensitive to oil spills than adults. As a result, recruitment of some species may be depressed, at least temporarily and locally. This information indicates that Steller sea lions are unlikely to be indirectly affected by oil in the long term, but they may experience some short-term effects associated with prey abundance.

Salmonids

Salmonids may be affected by spilled oil during each stage in their life cycle. Adults are probably the least likely to be directly affected by oil and also the least sensitive to its effects. Juveniles / smolts are also relatively insensitive to the toxic effects of oil, but because they reside in nearshore coastal and estuarine habitats they may be more likely to encounter it, as oil may collect and persist in these areas. Salmonid larvae, or alevins, may be the most sensitive to oil. Alevins remain within the gravel of a stream for 1 to several weeks before they become fry and begin to actively feed on drifting material (Spence *et al.* 1996). Salmonid eggs are also susceptible to exposure to oil because they reside in the gravel interstices of a streambed. However, data indicate that eggs are generally less sensitive to hydrocarbons (*e.g.* benzene) than larvae, but more sensitive than adult fish. Heintz *et al.* (2000) studied the effects of oiled gravel (PAHs) on the development and survival of pink salmon (*Oncorhynchus gorbuscha*) eggs in Alaska. The results of the study indicate that delayed growth and reduced survival of pink salmon can result from low (18 parts per billion [ppb]) doses of oil. The findings further indicate that low oil concentrations may have sublethal effects that may compromise reproduction and fitness years after a spill event, an area of study that has been historically deficient in environmental damage assessments.

Floating and emergent plants in the nearshore community that serve as habitat for salmon and their prey may be affected temporarily (a few weeks) by oil contamination. Copepods are an important prey item to salmonids; however, observations of up to 30 days have shown them to be relatively insensitive to oil contamination. Amphipods represent an important prey item to some life stages of salmon. Dauvin and Gentil (1990) reported heavy mortalities of amphipods immediately following a spill in 1979. The authors noted that most of those populations had recovered within 10 years of the spill. However, depending on the period of time, reductions in abundance of important prey species are likely to have significant adverse impacts to salmonids.

Herring, another important prey species for salmonids, from oiled and unoiled sites showed no statistically significant differences viability of larvae or survival rates of eggs (NOAA 1992). Seagrasses and kelp appear to be less vulnerable to the effects of oil. The main impacts of oil are associated with the fauna that use these habitats (NOAA 1992).

The development and survival of salmon eggs and larvae are expected to be at the greatest risk from the toxic effects of oil relative to other life stages. Adults and developing juveniles are probably at the least risk, in part because of their relatively insensitivity to oil and in part because these life stages become less dependent on benthic sediments for protection and feeding. However, juveniles associated with nearshore habitats may be at increased risk because of the tendency of oil to collect and persist in these areas.

2.1.5.1 Approach to Effects Analysis for Salmonids

While the standards for determinations of "no effect," "may affect, not likely to adversely affect," and "may affect, likely to adversely affect" are generally straightforward for non-salmonid species, the complex life history and habitat requirements have necessitated further explanation of the "adverse effect" determination for salmonid consultations. This subsection provides some insight to a salmonid effects analysis that can be applied to this Opinion.

In developing guidelines to facilitate and standardize determinations of "effect" for ESA consultations focusing on anadromous salmonids, NOAA Fisheries has designed a "matrix of pathways and indicators," which summarizes important environmental parameters and levels of condition for each. The matrix is divided into six overall pathways, including: (1) Water quality; (2) habitat access; (3) habitat elements; (4) channel condition and dynamics; (5) flow/hydrology; and (6) watershed conditions. Each of these represents a significant pathway by which a proposed action or subactions can have potential effects on anadromous salmonids and their habitats. The pathways are further broken down into "indicators," which are generally of two types: (1) Metrics that have associated numeric values; and (2) descriptions. The purpose of having both types of indicators is that numeric data are not always readily available for making determinations and a description of overall condition may be the only appropriate method available.

For actions that affect freshwater habitat, NOAA Fisheries usually defines the biological requirements for salmonids in terms of a concept entitled "properly functioning condition," (PFC). A PFC is the "sustained presence of natural habitat-forming processes in a watershed (*e.g.* riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation" (NMFS1999b). Thus, the indicators of PFC vary based on physiographic and geologic features unique to the landscape. For example, aquatic habitats in glacial mountain valleys are controlled by natural processes operating at different scales and rates than habitats on low-elevation coastal rivers. In the PFC framework, baseline environmental conditions are described according to the levels of condition of the indicator, and are shown as columns in the matrix. Three levels of conditions are included: "properly

functioning," "at risk," and "not properly functioning." Therefore, the effects of an action upon each indicator is classified by whether it will restore, maintain, or degrade the indicator, taking into account the environmental baseline conditions and specific geographic and species applications.

Relative to anadromous salmonids, the definition of "adverse effects" include "...short or long-term, direct or indirect management-related, impacts of an individual or cumulative nature such as mortality, reduced growth, or other adverse physiological changes, harassment of fish, physical disturbance of redds, reduced reproductive success, delayed or premature migration, or other adverse behavioral changes to listed anadromous salmonids at any life stage" (*in* NMFS 1996).

The "Environmental Baseline" section for salmonids provided a summary of current environmental conditions in the states of Washington, Oregon and Idaho as well as more specific conditions or threats facing the 17 listed ESUs in the action area. Because this is a programmatic Biological Opinion, the analysis of effects of a particular response method to listed species is complicated by the fact that an oil spill (and subsequent response action) could occur anywhere and at any time in the action area, in habitat that is properly functioning, at risk, or not properly functioning. For example, in a stream system where the condition of the habitat is poor for a particular listed salmonid ESU, any additional threat or environmental perturbation that is added to the system may exacerbate the already compromised status of the ESU. In contrast, that same threat that takes place in a properly functioning habitat may not have an adverse effect on listed species or their habitat.

The season, or time of year, when a spill may occur is also important and must be taken into account during the decision-making process. This is important both in terms of when a particular salmonid species may be found in the watershed, and/or what the condition of the habitat may be at the time of the oil spill. All of this information should be readily available to responders through the Environmental Unit set up within the Incident Command System.

2.1.5.2 Habitat Requirements for Salmonids

Specific habitat requirements for salmonids vary among the species and life history types, and these requirements change with season, life stage, and the presence of other biota in the system. In general, however, there are five classes of features or characteristics that determine the suitability of aquatic habitats for salmonids: (1) Flow regime; (2) water quality; (3) habitat structure; (4) food (energy) source; and (5) biotic interactions. These characteristics are described more fully by Spence *et al.* (1996), but the important points are summarized below.

The flow regime of a river or estuary directly influence the depth and velocity of the water and the total available habitat space for salmonids and their prey. Other functions of a flow regime include the redistribution of sediments, flushing (aeration) of gravel, and dispersing vegetation. Water quality requirements for salmonids include cool temperatures, high dissolved oxygen, natural nutrient concentrations, and low levels of pollutants. Although individual species have

specific temperature ranges that vary by life stage, salmonids prefer cold water, and temperatures above 25°C are lethal to most species. Fluctuations in temperature are required to trigger spawning, support growth, initiate smoltification, and enable other stages of the salmonid life cycle. In addition, salmonids require well oxygenated water (>6mg/l) throughout their life cycles, and any level below saturation can be harmful. Nutrient levels vary among the streams and river systems but must be sufficient to be able to support natural plant and animal assemblages.

The important structural attributes of streams include pools, riffles, substrate, cover (*e.g.* undercut banks, overhanging vegetation), depth, and hydraulic complexity. The presence of large woody debris is important because it enhances channel complexity, creating hydraulic heterogeneity, pools, side channels, back eddies, and other features favored by salmonids and other aquatic organisms. Stream habitat and channel features vary widely from the upper to mid- to lower part of a river system, to estuaries, and the ocean. Salmonids accommodate and exploit the entire range of habitats encountered during their diverse life stages. Consequently, the loss of specific elements of habitat diversity may reduce the diversity shown in the salmonids' life histories, which in turn may influence the ability of these fish to adapt to natural and anthropogenic changes.

Habitat requirements vary by salmonid life stage. For instance, during spawning migrations, adult salmon need high water quality, which includes cool temperature or thermal refugia, dissolved oxygen near 100%, and low turbidity; adequate flows and depths to allow passage over barriers to reach the spawning sites; and sufficient holding and resting sites. Therefore, habitat concerns include: Passage blockage (*e.g.* culverts, dams); impacts to water quality (*e.g.* high temperatures and pollutants); changes in flows (*e.g.* high flows, low flows, diversions); channel modification/simplification; reduced frequency and depth of holding pools; lack of cover; reduced cold-water refugia; and increased predation resulting from habitat modifications.

Spawning areas are selected based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on: (1) Substrate conditions, including gravel size, porosity, permeability, and oxygen levels; (2) substrate stability during high flows; and (3) appropriate water temperatures (<14°C for most species).

Therefore, habitat concerns may include: (1) The availability of spawning gravel of suitable size; (2) siltation of spawning gravels; (3) redd scour caused by high flows; (4) redd de-watering; (5) temperature and water quality problems; and (6) redd disturbance from trampling by humans and/or animals.

Rearing juveniles also require various habitat features, depending on species and size. Microhabitat requirements for holding, feeding, and resting each differ, and these conditions change seasonally. Migration of juveniles to rearing areas requires unobstructed access to these habitats, including ocean, lakes, or other stream reaches, and physical, chemical, and thermal conditions may impede migration. Smolts swim and drift through the streams and rivers and

must reach the estuary or ocean when there are adequate prey and water quality conditions, while simultaneously finding adequate cover to escape predators as they migrate. Habitat concerns for both migrating smolts and rearing juveniles may include: (1) Diminished pool frequency, area, or depth; (2) diminished channel complexity and cover; (3) temperature/water quality problems; (4) blockage of access to habitat; loss of off-channel areas and wetlands; (5) low or high water flows; (6) increased predation due to habitat simplification or loss of cover; (7) nutrient availability; and (8) diminished prey or competition for prey.

Estuaries also provide a protected and nutrient-rich environment for juvenile salmon growth and allow the transition for both juveniles and adults between the fresh and saltwater environments. Adults may also hold and feed in estuaries before beginning their upstream migrations. Habitat concerns within estuaries include: (1) Altered water quality; altered timing and quantity of fresh water in-flow; (2) loss of habitat resulting from diking, dredging, or filling; (3) diminished habitat complexity; (4) loss of channels, eel grass beds, or woody debris; (4) increased predation resulting from habitat simplification; and (5) diminished prey/competition for prey.

In the following subsections, the impact of each response method will be evaluated independently (*i.e.* in the absence of any other response(s) that may accompany it). NOAA Fisheries recognizes specific spill conditions often will dictate the need for different techniques to be used in the same habitat. Therefore, in an actual response, the methods cannot be evaluated in isolation from one another. In addition, this effects analysis is based on assumption that the various response methods are applied properly by trained personnel, who have knowledge of the current "best management practices." The following subsections provide summaries of the effects of each individual response actions on listed species in open water and shoreline habitat.

2.1.5.3 Booming

As described earlier, booming is an oil spill response method that involves the use of continuous, flexible floating barriers that are placed on the surface of the water to control the transport of spilled oil and to protect sensitive habitats. There are four basic strategies used with booming: (1) Containment; (2) deflection; (3) diversion; and (4) exclusion. Boom may be used to contain, deflect, divert or exclude oil from sensitive areas on all open water habitats. Depending on the specific booming strategy employed, boom is towed through the water, anchored in place, or attached to the shoreline or a vessel. Boom may come in contact with the substrate in shallow water or along shorelines. In such environments, traditional boom can be used, or more often "intertidal boom" or "tidal seal boom" may be used, which can float up and down over tidal cycles.

<u>Affected Habitats</u>
Boom is deployed in open water habitats, including the offshore and nearshore marine environments; bays and estuaries; large freshwaterbodies; large rivers; small lakes and ponds; and small rivers and streams. Depending on the open water environment in which booming is used, different strategies may be implemented, as discussed in the description of the action.

Effects to Large Whales

NOAA Fisheries concurs with USCG (2002) that this response action may affect but is not likely to adversely affect listed whales found in the action area. This concurrence is based on the following conclusions. First, given the large offshore area of the Pacific Northwest in which large whales are most often found migrating, milling, or foraging, the likelihood that large whales in the action area will encounter boom during an oil spill is low. Furthermore, to reduce the likelihood of encounter and ensure that no adverse effects will occur, responders monitor for marine mammals during an oil spill and boom deployment. Although there have been documented marine mammal entanglements in fishing gear, booms is only deployed in the top meter of the water column, it is made of solid, continuous construction, and marine mammals are capable of swimming around or under boom without risk of encounter.

Effects to Steller Sea Lions

Boom may be placed in or near Steller sea lion haulouts or rookeries as a precaution to exclude oil from contaminating the land habitat used by the sea lions or as a measure of containment after oil has been flushed from shoreline sediments. As stated in USCG (2002), without mitigation, the use of boom in the coastal marine environment may adversely affect Steller sea lions by impeding movements and disturbing animals on haulouts and rookeries. The use of boom in the nearshore habitat may have an interdependent effect on Stellers by adversely affecting the forage fish of these pinnipeds.

Impedance of Movement: Boom placed in close proximity to, and directly in front of, breeding rookeries and major haulouts when animals are present may impede the movements of Steller sea lions of all age groups when leaving land and returning from foraging trips. While subadults and adults would be most likely to swim around or under (if possible) the boom, young juveniles and pups may lack such capability and may be compromised by the boom.

Physical Disturbance: The placement of boom near the shoreline where aggregations of Steller sea lions are present will involve the use of personnel, equipment and vessels. The presence and noise that will accompany the response has the potential to disturb Steller sea lions, particularly during the breeding and pupping season (May through August), a particularly sensitive time of the year for pinnipeds. Disturbance to Stellers could be significant, depending on the number of people in the area, the type of equipment used, and the duration of the response, all of which depend on the size and extent of the oiled area.

Disturbance of Steller sea lions on rookeries, during the breeding and pupping season (May to August), may have immediate and delayed effects. Immediate effects during the breeding season may be demonstrated by displaced adults, which may increase the likelihood of aggressive interactions between males. Males that are forced to re-establish their territories may be forced to compete with other males, placing them at increased risk of injury. Immediate effects during the pupping season may be evidenced through trampling of pups by bulls, separation of mother and pup, and/or entrapment of pups in deep crevices. Pups that enter the water prior to developing adequate swimming skills may drown or may be vulnerable to predators such as sharks or killer whales. Delayed effects during the breeding and pupping seasons may be seen

by abandonment of pups by mothers (causing starvation), and disruption of the mating process through overall disturbance of established harems. Long-term (*i.e.* indirect) effects may manifest through increased mortality of pups (*e.g.* caused by starvation described above) or a decreased pupping rate (*i.e.* resulting from disruption of the mating population, described above) of a particular population.

Effect on Forage Fish: Boom used in nearshore waters may adversely affect forage fish that serve as a significant part of the prey base for Steller sea lions by impeding their movement and increasing their vulnerability to collected oil. Three major forage fish in the nearshore waters of the Pacific Northwest include Pacific herring (*Clupea harengus*), surf smelt (*Hypomesus pretiosus*) and sand lance (*Ammodytes hexapterus*), all of which lay eggs in shallow, intertidal, vegetated or sand-gravel beach habitats (Cardwell and Koons 1981 *in* Williams and Thom 2001). Effects to forage fish are expected to be localized and temporary; therefore, they are not likely to be manifested in any detectable effects to Steller sea lions.

Effects to Salmonids

In the offshore marine environment and in deep open water environments, salmonids are not likely to be adversely affected by booming operations. Therefore, this analysis of the effects of booming on listed salmonids will be limited to the nearshore marine environment, shallow bays and estuaries, and shallow freshwater environments. These areas warrant further analysis relative to the effects of booming on salmonids because of the limited depth of the water, the likelihood that listed salmonids will encounter boom and the density of salmonids of all life stages in these habitats. The effects of boom on salmonids in these habitats may be *direct* (affecting salmonids and/or modifying critical habitat) and *indirect* (impacts occurring later in time).

Salmonids are most likely to encounter boom in nearshore habitats such as estuarine and marine shorelines, tidally influenced rivers, or in freshwater streams, particularly those that are shallow or narrow. In shallow waters, such as streams and shallow estuarine and marine nearshore areas, even the smallest boom extending only a few inches into the water column, has the potential to obstruct salmonid migrations. Furthermore, boom may extend across an entire narrow body of water, compounding the obstruction effect to migrating salmonids. Because some salmonid species spend a significant portion of their early life in intertidal areas or in the nearshore areas of estuaries, the "intertidal boom" or "tidal seal boom" may have the most adverse effect on salmonids.

Although species and stocks differ in their migratory behavior (*i.e.* timing and speed), all salmonids require unobstructed (either physically or chemically) access to upstream or downstream reaches for migration or dispersal to feeding grounds. Therefore, where they create unnatural hydraulic configurations, artificial obstructions may impede migrations. Shortly following emergence, the fry of many salmonid species occupy shallow habitats along the margins of streams, generally moving into deeper and faster waters as their size increases. In lake environments, fry often use littoral areas for a month or so before moving offshore (Burgner 1991 *in* Spence *et al*. 1996). Several species of juvenile salmonids (*e.g.* chum, and chinook

salmon) swim along the shallows of estuaries and the nearshore areas during their outmigration, restricting their movements to shallow water (between 0.1 and 2.0 meters) until they reach larger sizes that may allow them to exploit deeper channel and open water habitats (*in* Williams and Thom 2001). While juvenile coho, sockeye and steelhead are generally not as estuarine-dependent as chinook or chum, they have been collected in beach seines over intertidal habitats (Starkes 2001).

The obstruction of salmonid movements and/or migration by boom may have several direct effects on salmonids and their habitat, depending on the season, the species, the life stage affected, and the extent of the obstruction of passage.

Disruption of Migration and Movement: In streams, salmon either attempting to swim downstream (*e.g.* fry, smolts) or upstream (as adults) as a part of a migration may be unable to pass. Salmonid fry prefer to migrate or forage close to the shoreline, and studies have shown that salmon fry concentrate in higher densities behind breakwaters in marina basins compared to unaltered nearshore areas (Heiser and Finn 1970, Pentilla and Aguero 1978 *in* Williams and Thom 2001). Heiser and Finn (1970) studied the behavior of small (35 mm to 45 mm) pink and chum salmon fry around bulkheads and breakwaters and found that they were reluctant to leave the shoreline and venture around the obstruction into deeper water. The authors stated that this behavior was most likely attributed to increased risk of predation by coho smolts and cutthroat trout in the deeper water (discussed next). This type of obstruction could result in less successful spawning runs, depending on the extent, timing, and duration of the obstruction. Along the near-shore in marine waters, boom may cause ocean-type chinook and chum salmon to move offshore to go around the boom or to mill where concentrations of oil exist.

Increased Vulnerability to Predation: Young salmonids that are obstructed from swimming downstream and are forced to aggregate upstream of a boom are likely to be more vulnerable to predation than salmonids that are normally distributed in an unobstructed stream. In nearshore estuarine waters, juvenile chinook and chum salmon may be forced to move offshore to go around a boom, increasing their risk of predation. In addition to the study by Heiser and Finn (1970) (discussed above), unpublished papers have also documented shore-connected breakwaters in the lower Columbia River and coastal areas blocking fish movement along shallow water migration corridors and exposing fry to increased predation (*in* Williams and Thom 2001).

Increased Vulnerability to Oil: Booms that are deployed in the nearshore when aggregations of salmonid fry are present may obstruct their movement if the fry are unable to swim under the boom; this obstruction of movement may increase their vulnerability to the collected oil. Combined with currents and wind, boom can cause the oil to entrain, pushing oil deeper into the water columns at shallow depths where salmon may be accumulating. This oil entrainment could exacerbate exposure of salmonids in the nearshore (*e.g.* chum and chinook) to oil. Oil that is contained or deflected in the boom could adversely affect salmonids in the upper few centimeters of the water column. In Puget Sound, chum fry have been observed to reside for

their first few weeks in the top 2 to 3 centimeters of surface waters and extremely close to the shoreline R. Egan, WDFW, personal communication *in* NMFS 2002a).

Impacts to Forage Fish: Boom may also affect salmonids interdependently by impacting the movements of their prey and subjecting prey species to collected oil. In shallow nearshore environments, boom may exclude species such as Pacific herring, sand lance and surf smelt from spawning and rearing areas. Boom that reaches the bottom and is subjected to current or waves may scrape the bottom and crush benthic invertebrates. In addition, collected oil could impact prey species upstream of the boom, particularly those prey lacking the capability to swim (*i.e.* drifting plankton). These interdependent effects are not likely to manifest into detectable effects on salmonids because boom is in place on a localized, short-term basis and salmonids are likely to find prey in nearby areas not impacted by oil. Furthermore, any prey species normally found on the surface of the water are most likely already debilitated or dead due to the effects of the oil.

Disruption of Habitat: Stream flow may also be altered by a boom. This effect could alter pool formation, aeration and the thermal properties of small bodies of water, all essential features of stream habitat for salmonids, including egg development. Boom that reach the bottom and are subjected to current or wave energy may slide along the bottom and cause temporary bottom disturbance, which may increase sediment suspension. Juvenile salmonids may be especially vulnerable to the lethal and sub-lethal effects of suspended sediments (O'Connor *et al*. 1976 *in* Williams and Thom 2001). However, boom is deployed temporarily, often moved according to predictions of oil plume trajectory models, and any effects to the stream formation and water quality are likely to be very temporary and localized.

Pulling or dragging boom through shallow water where eelgrass is present can adversely affect important habitat for salmonids and their prey (*e.g.* spawning herring) by disrupting the root system, and bending/breaking blades.

<u>Beneficial Effects of the Response</u>

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to contain floating oil in relatively small areas or prevent oil from reaching more sensitive shoreline habitats. After floating oil has been contained by boom, it may be more readily collected and removed from the environment. If oil were allowed to remain in the environment (weeks to months in open water habitats or months to years in shoreline habitats), it is likely that the oil would either strand on a shoreline habitat, disperse into the water column, or both, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the adverse effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

Because boom is often deployed by boat(s), the effects of vessels (including anchoring) will be discussed in the Motorized Transport/Support section.

2.1.5.4 Skimmers

As described previously, skimmers are mechanized equipment used to recover floating oil from the water surface. Skimmers are placed at the oil/water interface to recover, or "skim," oil from the water surface and may be operated independently from shore, mounted on vessels, or completely self-propelled. In shallow water environments, where typical skimmers may not work, vacuums are used to remove floating oil from the water surface. The vacuum removes floating oil, minimizing the intake of water, which would likely result in damage to the vacuum pump and inefficiency. Hose heads known as duckbills may be used to minimize the intake of water and maximize the removal of oil. Decanting is often done where storage space is limited, and it is the process of draining off recovered water from portable tanks, internal tanks, collection wells or other storage containers to increase the available storage capacity for recovered oil.

Affected Habitats

This response is used in all open water habitats, although the design of the skimmer often depends on several factors, including the environment in which it is used. These habitats include the offshore and nearshore marine environments; bays and estuaries; large fresh-waterbodies; large rivers; small lakes and ponds; and small rivers and streams.

Effects to Large Whales

NOAA Fisheries concurs with USCG (2002) that this response action may affect but is not likely to adversely affect listed whales. This concurrence is based on the following conclusions. First, given the large offshore area of the Pacific Northwest in which large whales are most often found migrating, milling, or foraging, the likelihood that large whales in the action area will encounter skimmers during an oil spill is low. Any large whales that may be in the area during skimming activity are not likely to be adversely affected by the activity. In fact, the only aspect of the skimming activity that may affect listed whales is the boat and personnel presence during the activity. Since responders minimize any harm and/or harassment of whales during oil spill response, any effect to these species is expected to be insignificant. Furthermore, most large whales in the Pacific Northwest are accustomed to vessels and generally keep a safe distance. In fact, vessel presence during a response may benefit large whales if their presence deters the whales and prevents them from encountering the oil spill.

Effects to Steller sea lions

In open water environments, skimmers are not likely to adversely affect Steller sea lions. Unless a vessel is actively fishing, pinnipeds off the west coast of the United States are accustomed to vessel activity and generally keep a guarded distance. Skimmers may be used on or near Steller sea lion haulouts or rookeries to clean up oil in the nearshore environment. Where Steller sea lions are present, skimming operations, including the use of personnel and vessels, may directly affect Steller sea lions through disturbance.

Disturbance: The effects of disturbance on Steller sea lions are discussed in Section 2.1.5.3, and will not be repeated here.

Effects to Salmonids

The effects of the use of skimmers in offshore waters on salmonids are likely negligible, simply due to the large distribution of these species in oceanic waters and low expected rate of encounter. In the nearshore or shallower waters, the use of skimmers may affect but is not likely to adversely affect salmonids. Because salmonid fry may be found in the top few centimeters of the water in the nearshore, skimming, particularly vacuuming, has the potential to suck in very small fish. However, these fish are likely to be severely compromised or dead due to the effects of the oil; therefore, any effect of the action would not worsen their condition. Similarly, any salmonid prey species found in the surface layer of the water column has the potential to be sucked in by a skimmer (especially the vacuum); however, the prey species are likely to be dead or debilitated by the effects of the oil. The removal of injured and dead, and therefore contaminated, juvenile salmonids and prey organisms will prevent the contaminants from becoming incorporated into the food chain.

Decanting has the potential to adversely modify salmonid critical habitat by degrading water quality. Oil can be re-introduced into the aquatic environment if decanting is not conducted properly. However, with best management practices in place (described in the description of the action and contained in the NWACP), any effects to habitat are likely to be minimized or eliminated.

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove floating oil from the water surface. If oil were allowed to remain in the environment (weeks to months in open water habitats or months to years in shoreline habitats), it is likely that the oil would either strand on a shoreline habitat, disperse into the water column, or both, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the effects associated with its presence. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

Because skimming may require the storage of large quantities of oil on shore, large tanks or vehicles may accompany the response. Used in spawning streams containing listed salmonids, the use of such heavy equipment may adversely modify critical habitat. The effects of vehicles and heavy equipment are summarized in the Motorized Transportation/Support subsection.

2.1.5.5 Removal of Floating Oil - Sorbents

Sorbents passively remove floating oil by allowing it to adhere to pads or rolls made of oleophilic material. The material is generally opaque and white in color, and dimensions of individual sorbent pads are typically 2 foot x 2 foot. Sorbent rolls are generally wider than 2 foot and may be 100 foot long. No mechanized equipment is required, and sorbent materials generally do not remain in the environment for longer than 1 day. Retrieval of sorbent material is mandatory, as well as at least daily monitoring to ensure that sorbents are not adversely affecting wildlife or breaking apart after lengthy deployments. Sorbents are most likely to be used to remove floating oil in nearshore environments that contain shallow water.

Effects to Large Whales
Because sorbents are likely to be used in shallow water environments, large whales are not likely to encounter them. Therefore, this action is not likely to affect large whales.

Effects to Steller Sea Lions
The deployment of sorbents in a nearshore environment where Steller sea lions may be hauled out may adversely affect the animals through physical disturbance. Steller sea lions are not likely to ingest sorbents, nor are they likely to be entangled or entrapped by sorbents or sorbent rolls. Since the area that may contain sorbents is small relative to the vast area available to Steller sea lions for foraging, the use of sorbents is not likely to affect their prey availability.

Physical Disturbance: Because the deployment of sorbents may involve personnel and/or motorized vessels, if this response is performed in or near a Steller sea lion haulout area or breeding area where animals are present, the pinnipeds could be adversely affected by the action. The effects of physical disturbances to Steller sea lions is described extensively in Section 2.1.5.3 and will not be repeated here.

Effects to Salmonids
While there are obvious physical differences between the deployment of a temporary, translucent, long sorbent roll on the water surface and the construction of a permanent non-transparent overwater structure, most studies of the effect of overwater structures on the ability of salmonids (or other fish) to access and utilize the habitat have involved permanent structures such as piers.

In the short term, shading can disrupt the migration and movements of salmonids, particularly the small juvenile fish, who appear to be more behaviorally constrained to the shallow water habitats but are more likely to avoid entering shaded habitats. Although salmon fry are more likely to use natural refuge and darkness (*e.g.* shading from docks, floats and turbidity) as refuge, they tend to migrate along the edges rather than penetrate them (Simenstad *et al*. 1999). No studies are available that support or refute the hypothesis that modification of juvenile salmonid behavior in shoreline habitats due to shading resulted in changes to their survival. Furthermore, there are few studies that confirm that the presence of overwater structures increases predation of salmonids (NMFS 2002b). While sorbents will create a shaded zone beneath them, this zone is

expected to have less contrast than those produced by solid structures such as piers and docks. Therefore, disruption of outmigration by juvenile salmonids is expected to be less than that produced by most overwater structures.

Regarding long-term effects of overwater structures, juvenile fish have exhibited negative growth under piers (indicating that it was too dark to forage), general abundance and diversity of fish species is typically lower under piers, and juvenile chinook have shown preference for pier edges. In addition, overwater structures may limit the productivity of epibenthic invertebrates and may increase the vulnerability of juveniles to predation by causing them to move further offshore or in deeper waters due to the light/dark interface (*in* NMFS 2002b).

Based on the above, the likely direct effect to salmonids by the deployment of sorbents is a temporary impact to the migration and movement of salmonid fry and juveniles. Because sorbents are in the environment for 24 hours maximum, this effect is likely to be temporary and localized, and therefore, impacts to listed salmonids are considered negligible.

Impacts to Prey Species: While improperly deployed or tended sorbent material can smother sensitive organisms that salmonids may rely on for prey, these surface organisms are likely to be debilitated or dead by the effects of the oil in the environment. Therefore, this action is not likely to exacerbate effects to prey species of salmonids.

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove floating oil from the water surface in the nearshore environment. If oil were allowed to remain in the environment (weeks to months in open water habitats or months to years in shoreline habitats), it is likely that the oil would either strand on a shoreline habitat, disperse into the water column, or both, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the effects associated with its presence. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.6 In-situ Burning

As described in Section 1.2.3.4, the objective of *in-situ* burning is to remove oil from the water surface or habitat by burning it in place. Oil floating on the water surface is collected into slicks and ignited. Burn residue is produced, and responders attempt to collect as much of it as possible before it sinks. In addition, *in-situ* burning produces a thick black smoke that is composed of

partially-burned byproducts in particulate and gaseous form. The *in-situ* burn policy, described in Section 1.2.3.4, contains guidance measures that responders shall use in considering whether to conduct an *in-situ* burn as a form of response to an oil spill.

General Effects of *In-situ* Burning

In general, the surface area affected by *in-situ* burning is likely to be very small relative to the total surface area and depth of a given body of water, particularly if the burning takes place in the open ocean or a large lake. This does not preclude adverse ecological impacts, however, particularly if sensitive species are in or near the area to be burned. Organisms that use the surface or uppermost layers of the water column, those that may come in contact with residual material, and possibly some benthic plants and animals, would be the most vulnerable to *in-situ* burning.

Direct Temperature Effects: The surface microlayer (*i.e.* the upper millimeter or less of the water surface) serves as important habitat for many sensitive life stages of marine organisms, including eggs and larval stages of fish (*e.g.* cod, sole, flounder, hake, and anchovy) and invertebrates (*e.g.* crab). It also serves as habitat for reproductive stages of other plants and animals. The surface microlayer also contains dense populations of microalgae and may serve as a substrate for microorganisms.

In open water, because ambient temperature seawater is continually supplied below the oil/water interface as the boom is towed (*i.e.* there would be a continuous exchange of water below the slick), the length of time the burning layer resides over a given water surface may be too brief to induce a high water temperature change below the oil. During static tests of burning (in tanks), which likely represent the worst-case scenario, researchers found that temperature did not increase in the static water layers at depths greater than 4 centimeters below the oil (*in* Shigenaka and Barnea1993).

In an experimental burn in a 1.13 m^2 pan, the temperature immediately below the burning oil increased from 10 to 60°C (Evans *et al*. 1988 *in* Buist *et al*. 1994). During a series of mesoscale experiments, water temperature in the upper 35 millimeters (1.4 inches) of the water column increased by 5 to 40°C, at depths of 70 to 115 millimeters (2.8 to 4.5 inches), temperatures increased by 1 to 4°C, and at a depth of 145 millimeters (5.7 inches), temperatures increased by 2°C or less (Walton *et al*. 1993 *in* Buist *et al*. 1994). Thus, while some heat is transferred from the fire to the water column, the amount transferred is minor underneath 5 inches from the surface of the water, and would likely be of little consequence in burns on the open ocean.

Air Emissions: In-situ burning generates a thick black smoke that is composed of partially-burned by-products in particulate and gaseous (*i.e.* carbon dioxide, carbon monoxide, water vapor, nitrous oxide and PAHs) form. Emission studies from *in-situ* burning show fairly consistent results. About 85 to 95% of the burned oil becomes carbon dioxide and water, 5 to 15% of the oil is not burned efficiently and is converted to particulates (mostly soot), and the rest (1 to 3%) is comprised of nitrogen dioxide, sulfur dioxide, carbon monoxide, PAHs, ketones, aldehydes, and other combustion by-products (Ferek *et al*. 1997).

Particulates are small pieces of solid materials (*e.g.* dust, soot) or liquid material (*e.g.* mist, fog, spray) that remain suspended in the air long enough to be inhaled. The size of the particulate plays a crucial role in the potential effects to human and air-breathing marine species' health, because the size determines how far the particles travel before they settle out of the air and how deeply they can be inhaled into the lungs. Particulates larger than 10 microns in diameter settle 1 foot in less than a minute in still air, so they settle in the environment relatively quickly and generally are not inhaled. Comparatively, particulates that are as small as 0.5 microns in diameter take 5.5 hours to settle one foot. Thus, the smaller particulates (ranging from a fraction of a micron to several microns in diameter) travel farther from the burn site before they settle out of the air.

Scientists divide the particulate mass into "total" particulates, which may include any size measurable, and "PM-10," which is the fraction of particulates smaller than 10 microns in diameter. Particulates at or below 10 microns may be inhaled and may become a burden on a respiratory system. Particulates that are 5 to 10 microns in diameter may be inhaled, but most are only deposited in the upper part of the respiratory tract and can be cleared by mucociliary action, which is efficient and relatively quick. Only particulates that are smaller than 5 microns in diameter may reach the sensitive aveolar portion of the lungs. It is much more difficult and less efficient to clear these particulates. The median size of particulates reaching the aveolar portion of the lungs is 0.5 microns, while the mean size of particulates produced by an *in-situ* burn is also 0.5 microns (Shigenaka and Barnea 1993). Small particulates which can be inhaled deeply into the lungs are considered to pose the greatest risk to humans and nearby air-breathing wildlife.

A major concern with *in-situ* burning is the smoke plume that results, since smoke particles can cause severe health problems (in humans and most likely air-breathing wildlife) if inhaled in high concentrations. As mentioned, those particles which are small enough to be inhaled into the lungs (PM-10) cause the most concern. The PM-10s make up approximately 90% of the mass of particulate emitted from an *in-situ* burn, and the average particle size of the soot is approximately 1 millimeter. Approximately 15%, by weight, of the oil burned is emitted as smoke particles (Ross 1997).

Analysis from the Newfoundland Offshore Burn Experiment (NOBE) crude oil burns conducted in August 1993, showed that the smoke contained high concentrations of submicron, respirable particles. Particulate mass loadings near 100 $\mu g/m^3$ were measured out to distances of 25km. However, because the smoke plume rose quickly to the upper part of the boundary level (300 to 500 meters above sea level), and some smoke penetrated higher as the fire pulsed larger parcels, these high particle concentrations were not measured at sea level. Therefore, human populations near the burn site would most likely not have been affected. At the time of the burn, atmospheric conditions were stable and prevented the smoke from mixing back down to the surface. Thus, the intensity of a fire and the stability of the lower atmosphere will dictate whether (and in what amounts) smoke will intercept the surface, and if a smoke plume remained near the surface and traveled into a populated area, the emissions from the NOBE burns most probably would have been unacceptable due to the high particle concentrations. In general, most

of the oil was consumed and converted to benign products (carbon dioxide and water), and the remaining pollutants were dispersed above sea level. According to Ross *et al*. (1996), "the total amounts of pollutants released by the NOBE burns were comparable to, or better than, those released from a number of common sources of air pollution."

In three mesoscale burns of diesel in Mobile, Alabama in 1994, particulates in air were found to be greater than recommended exposure levels up to 100 meters downwind at ground level, and concentrations were higher than that of crude oil fires (Fingas *et al*. 1996).

Crude oil burns result in PAHs downwind of the fire, but the concentrations of the particulate matter are often a fraction of the concentration in the starting oil. Diesel fuel contains low levels of PAHs with smaller molecular size, but an *in-situ* burn will either cause the creation or concentration of larger PAHs, some of which are not even detectable in the parent fuel. These concentrations are low, however, and often just above the detection limit. Overall, *in-situ* burning destroys more PAHs than are created (Fingas 1998).

In several studies, volatile organic compounds (VOCs) have been measured from *in-situ* burn emissions. While concentrations of these compounds are about the same in either a crude or diesel burn, concentrations appeared to be under human health limits even at very close monitoring stations (~30 meters). Concentrations of VOCs are about three times higher when the oil is not burning and just evaporating (Fingas 1998).

Burn Residue: Generally, the composition of burn residue is similar to that of the original oil, except that the residue contains less volatile hydrocarbons with low boiling points and it is denser and more viscous than unburned oil. Burn residues either float or sink following a burn, although the eventual fate of the residue could also be determined by how long the residue remains in the aquatic environment. Some residues can stay afloat while warm, but then sink as they cool off. Generally, following an *in-situ* burn, a small quantity of burn residue remaining in the boom is manually recovered for disposal.

The advantages of *in-situ* burning may outweigh the potential drawbacks of burn residue, including the possible environmental harm if the burn residue sinks. A study focusing on the physical properties of residue from *in-situ* burning found that residues from thick slicks of heavier crude oil may sink in salt water (Buist *et al*. 1995), especially after cooling.

Mesoscale experiments have shown that the chemical composition of burn residue can differ substantially from that of the parent (*i.e.* unburned) oil. For example, *in-situ* burning depletes the residue of short-chain alkanes and cycloalkanes relative to the parent oil. Concentrations of volatile organic compounds are also reduced, although some of this reduction can be attributed to evaporation. On the other hand, some metals were enriched in the burn residue by a factor of 2 to 4, but because the concentrations of metals in one study barely exceeded the level of detection, it was difficult to draw conclusions (*in* Buist *et al*. 1994).

Table 2-2 shows the amount of residue produced during the NOBE; for both burns, the oil was reduced by 99%. In addition, the chemical composition and physical properties were significantly different than the original characteristics of the oil. During a burn, the lighter, lower-boiling-point hydrocarbons are eliminated, while residue remaining includes a concentration of heavier, higher-boiling-point hydrocarbons. The majority of burn residues are composed of non-volatile compounds with boiling points greater than 538°C. Burn residues from crude oils contained no volatiles with burning points less than 204°C; all contained some portion of the medium-volatility compounds with boiling points between 204°C and 538°C. Because the lower-boiling point volatiles such as benzene, naphthalene, and benzopyrenes are absent, burn residues have been determined to be less toxic than the original oils (Ross 1997 *in* Alaska Dept. of Environmental Conservation 2001).

Table 2-2 Residue produced during the Newfoundland Offshore Burn Experiment

Variable	Burn 1	Burn 2
Volume of oil discharged (m^3)	48.3	28.9
Burn and pump time	1.5 hours	1.3 hours
Residue in fireproof boom after the burn (m^3)	0.2 (max)	0.1 (max)
Residue in backup boom after the burn (m^3)	0.2 (max)	0.3 (max)
Burn efficiency	>99%	>99%
Density (g/mL at 15°C) (density of sea water is 1.025)	0.9365	

Source: Fingas *et al*. 1994

Aquatic Toxicity: To assess the effects of *in-situ* burning on aquatic toxicity in the water column and the subsequent effects to aquatic organisms, Daykin *et al*. (1994) performed both chemical analysis and toxicity testing on laboratory-generated burn samples and on full-scale field samples (NOBE). In general, results from these experiments showed that *in-situ* burning did not adversely affect the underlying water column beyond those effects already associated with the unburned oil. From water samples collected in the vicinity of unburned and burned crude oil slicks in the open sea, lethal and sublethal toxicity levels[22] and concentrations of petroleum hydrocarbons were extremely low, with no significant differences found between the unburned and burned oil samples.

[22]Statistical analyses of the test samples (*i.e.* pre-ignition, burn period and post-burn) were performed to calculate the "no observed effect concentration," which is the highest concentration of toxicant to which organisms are exposed in a full life-cycle or partial life-cycle test which causes no statistically significant adverse effect on the observed parameters (usually hatchability, survival, growth and reproduction). Effective concentration values ("EC50" - the concentration that results in 50% abnormal development or unfertilized eggs in the test population) were also calculated (Daykin *et al*. (1994).

In water samples from a closed-system, small-scale laboratory study, toxicity and petroleum hydrocarbon concentrations were higher than those found in the field study. The data indicated a weak trend of increasing toxicity and PAH concentrations from samples beneath unburned oil and those beneath burned oil. However, the values were still very low and the field experiments represent more "real life" conditions in the open water. For example, natural mixing and dilution normally occurs in the open sea. Therefore, laboratory-generated samples could be compared to a worst-case scenario for burning in shallow confined waters (Daykin *et al.* 1994).

Effects to Large Whales

While large whales have been documented swimming through and feeding in oiled waters (*in* Geraci and St. Aubin 1990), little is known regarding the behavior of these large marine mammals when confronted with fire. It is also unknown whether or not large whales can detect and avoid an *in-situ* burn when underwater, or nearby.

Ingestion of Burn Residue: If an *in-situ* burn takes place in or near an area where there are large whales migrating or foraging, there is a potential for baleen whales or sperm whales to ingest burn residue that is floating, sinking, or has sunk to the bottom. Baleen whales primarily forage on euphausiids and copepods in the upper surface layers of the ocean, although they do feed on pelagic schooling fish such as anchovies and deeper-dwelling fish and mollusks such as squid. In addition, humpbacks in the Atlantic Ocean have been documented feeding on the bottom (*in* Perry *et al*. 1999), although whether humpback whales in the Pacific feed in this manner is currently unknown. Sperm whales are known for their deep-foraging dives, targeting primarily squid but also consuming octopus, other invertebrates, and fish. Given these foraging strategies, baleen whales are most likely to ingest burn residue that is floating or sinking, while sperm whales would be likely to encounter burn residue near the bottom of the ocean. Burn residue ingested by baleen whales may also foul their baleen plates, reducing their ability to forage efficiently.

Because of the small relative area of an *in-situ* burn compared to the available foraging area in an the open ocean, the likelihood that a large whale would encounter burn residue is very low. In addition, responders make every attempt to retrieve floating burn residue, and any residue that sinks will occupy a fraction of the ocean floor. As described earlier, aside from the small increase in metal concentration in burn residue compared to the parent (*i.e.* unburned) oil, most of the toxic properties of the burn residue are much less than that found in the parent oil. Therefore, the risk of exposure to contaminants is less than it would be if large whales encountered unburned oil.

Inhalation of Emissions: In the course of coming to the surface to breathe, large whales may inhale some of the particulates produced by the *in-situ* burn. Depending on the activity level or the type of activity (*e.g.* foraging, migrating, resting, socializing), baleen whales breathe several times at the surface before submerging again for an extended period of time, exchanging 80 to 90% of their lung air volume with each breath (humans exchange only about 17 to 20% of their lung air with each breath). Sperm whales studied in the Atlantic Ocean averaged

7 to 10.5 minutes between repeated longer dives, and spent longer times at the surface when resting or socializing with conspecifics. Whales spent time at the surface 20.4 to 22.6% of the total time, and more time at the surface was spent during the daytime (Watkins *et al*. 1999). Therefore, while humans and pinnipeds on land may breathe air constantly, large whales spend much of their time underwater, swimming and/or foraging, and when coming to the surface to breathe, inhale large quantities of air.

While it is not known what size or level of particulates might impair the ability of a large whale to breathe, compromise their health, or otherwise undertake normal activities, only those whales surfacing very close to the burn (within 1/4 mile or so) risk exposure to soot and gas emissions. As discussed above, the toxicity of the PAHs and volatile organic compounds is generally lower in the emissions compared to the unburned oil, but again, it is not known what levels may cause lethal or sublethal effects to whales. Due to the boat activity, and the anomalous nature of a burn in the open ocean, it is likely that whales will avoid an *in-situ* burn, which would lower their risk to emissions.

Physical Disturbance: Large whales near the area in which an *in-situ* burn is taking place may react by changing the direction of their movements, diving deeper and for longer periods, or increasing their swimming speed. Mothers and calves are not likely to be separated, as a mother will instinctively protect her calf when she perceives a threat. Any reactions are likely to be temporary (*i.e.* the duration will last as long as the whale perceives a threat or is disturbed by the action, which is likely to be short if the whale swims away from the burn). Furthermore, any large whale that avoids an area in which an *in-situ* burn is taking place will benefit by reducing the risk of inhalation of emissions, or ingestion of burn residues. Disturbances to large whales due to vessel activity are discussed in the Section 2.1.5.18.

<u>Effects to Steller Sea Lions</u>

Ingestion of Burn Residue: If an *in-situ* burn takes place in or near Steller sea lion haulouts or foraging areas, there is a potential that Steller sea lions could ingest burn residue that is floating, sinking, or has sunk to the bottom. Ingestion of the more solid form of burn residue could occlude the digestive tract. Because of the small relative area of an *in-situ* burn compared to the available foraging area in an the open ocean and the fact that Steller sea lions are not bottom feeders and unlikely to forage on non-moving objects, this potential for ingestion is extremely low. Furthermore, as described earlier, aside from the small increase in metal concentration in burn residue compared to the parent (*i.e.* unburned) oil, most of the toxic properties of the parent oil are much less than that found in burn residue. Therefore, the risk of exposure to contaminants is less than it would be if Steller sea lions encountered unburned oil.

Inhalation of Particulates and Gases: Because Steller sea lions breathe air constantly and are generally stationary while hauled out, they are more likely to inhale particulates or gaseous emissions from a nearby *in-situ* burn than if they were in water, where they are moving and not always breathing. While there are no air emission standards for pinnipeds, any effects of air emissions from an *in-situ* burn on humans are likely to be applicable to pinnipeds, since pinnipeds depend as much on breathing as humans, when on land. Pups in particular are likely

to be compromised by the inhalation of particulates and toxic gases due to their developing lungs and respiratory system.

Some of the constituent gases that may be released during a burn may be toxic to Steller sea lions. For example, sulfur dioxide (SO_2) may severely irritate the eyes and respiratory tract, although high water solubility may cause it to react with the mucous lining of the respiratory tract, preventing it from reaching the deeper portion of the lungs. The concentration of SO_2 in the smoke plume will depend on the sulfur content of the oil, but it is expected to be a low levels of concern several miles downwind of the burn. Nitrogen dioxide (NO_2) is also a gaseous byproduct of oil combustion and can strongly irritate the eyes and respiratory tract, having the potential to cause fatal pulmonary edema at low concentrations. Sampling has shown that the concentration of NO_2 in a burned oil smoke plume is low; therefore it is not likely to be a threat to Steller sea lion populations downwind. The low levels of PAHs expected from the burn may present a small exposure hazard; however, it is generally long-term exposure to higher molecular weight PAHs that present a concern. Carbon monoxide (CO) is a byproduct of incomplete combustion and can be toxic to animals by causing oxygen deprivation. Experiments and field trials have shown that levels of CO generated from *in-situ* burns are much below those considered to be dangerous (*in* Shigenaka and Barnea 1993).

Most human health experts agree that the most significant human health risk resulting from *in-situ* burning is the inhalation of fine particulates, which are major components of the smoke produced. As discussed in the description of *in-situ* burning, particulates at or below 10 microns may be inhaled and may become a burden on a respiratory system. Particulates that are 5 to 10 microns in diameter may be inhaled, but most are only deposited in the upper part of the respiratory tract and can be cleared by mucociliary action, which is efficient and relatively quick. Only particulates that are smaller than 5 microns in diameter may reach the sensitive aveolar portion of the lungs. It is much more difficult and less efficient to clear these particulates. Heavy deposition of small particulates can cause narrowing of the airways and higher resistance to airflow. Such accumulation can also cause the secretion of large amounts of mucous, which may also accumulate in the airwaves. Both processes are reversible, and once particulates are removed by a clearing mechanism (mostly macrophages), the constriction will ease (*in* Shigenaka and Barnea 1993). Small particulates which can be inhaled deeply into the lungs are considered to pose the greatest risk to humans and nearby wildlife such as Steller sea lions.

Physical Disturbance: Steller sea lions in the water or hauled out on land that are in the area of an *in-situ* burn are likely to be disturbed, either visually from the fire or as a result of smoke and particulate inhalation. In addition to the actual burn, the presence and noise that will accompany the response has the potential to disturb Steller sea lions, particularly during the breeding and pupping season (May through August), a particularly sensitive time of the year for pinnipeds. Disturbance to Stellers could be significant, depending on the number of people in the area, the type of equipment used, and the duration of the response, all of which depend on the size and extent of the oiled area.

Disturbance of Steller sea lions on rookeries may result in stampeding, especially if the response is sudden and unexpected. Effects of stampeding are discussed in the Section 2.1.5.3 and will not be repeated here.

Effects to Salmonids

The impacts of *in-situ* burning in the open ocean to listed salmonids are considered negligible, primarily because they are widely and pelagically distributed compared to the small surface area where a burn may take place. While in the open ocean, salmonids feed on a wide variety of pelagic schooling fish, and these prey species do not depend on the upper few inches of the water column, where temperatures may increase during a burn, nor do they depend on the ocean bottom, where burn residue may impact; therefore, no effects to salmonid prey species are likely in deep water.

If *in-situ* burning occurs in shallow water habitats, including nearshore environments, rivers, streams, small lakes, and marshes, salmonids may be adversely affected, due to increased water temperatures, reduced vegetative habitat, aquatic toxicity, or introduction of burn residue into the benthic habitat (*i.e.* smothering of benthic resources).

Increased Water Temperatures: As noted above, water temperatures may increase significantly up to several inches immediately below the burning oil. High temperatures above ambient may be lethal to salmonids; therefore, salmonid fry that are foraging in the upper few inches of the water column may risk injury or death. Adult salmon migrating upstream or in a shallow portion of an estuary or nearshore that may already be subjected to higher temperatures (due to season or depth of water) may be subjected to increased temperatures or adversely affected by fire.

Reduced Vegetation: The fire of an *in-situ* burn conducted in a stream or estuary which has aquatic and shoreline vegetation may directly harm or kill flora, including algae, mosses, and vascular plants. Burning can initially cause substantial damage to plants because the above-ground or above-water vegetation is removed. In shallow water, the below-ground or below-water plant parts (*e.g.* roots) can be destroyed in a burn. Any impacts to shoreline vegetation or riparian areas may result in increased erosion (causing increasing sedimentation), expansion of invasive species, loss of shade and increased stream temperatures, and loss of fish habitat, including protection from predators and refuge from fast moving currents.

Effects to vegetation can be learned from past fires, including a 1999 gasoline leak and subsequent fire in Whatcom Creek, near Bellingham, Washington, which resulted in extensive damage to vegetation. This fire was unplanned and for a time, uncontrolled; therefore, it was not an *in-situ* burn. According to the Restoration Plan and Environmental Assessment, "the primary injury pathway resulted from the fire rather than a toxicological response from the gasoline released during the rupture. In addition, the destroyed vegetation resulted in increased erosion and sedimentation potentials (NOAA *et al*. 2002).

Burning oil in a stream can result in a burned watershed, particularly if not controlled. Burned watersheds are more prone to erosion compared to fully vegetated watersheds due to:

(1) Presence of ash, which is easily mobilized by rainfall and runoff; (2) a lack or absence of vegetative cover, which normally functions to break up the impact of raindrops, which can dislodge ash and soil particles; (3) decreased infiltration and increased runoff due to physical changes in the surface soil conditions resulting from the fire; and (4) presence of water-repellant layers within the soil profile, which decreases infiltration. In addition, invasive species are often better able to exploit disturbed areas such as those that have been burned. Invasive species can out-compete and prevent the re-establishment of native species (NOAA *et al*. 2002). Indirect effects can also include increased stream temperatures, decreased fish and macroinvertebrate abundance, and degradation of instream habitat (*in* Gresswell 1999; *in* Spina and Tormey 2000).

A field study comparing eelgrass sensitivity to oiling versus *in-situ* burning of crude oil found that while both oiling and *in-situ* burning of oil had short-term detrimental effects on the salt marsh, measured responses were not significantly different in either the control or the experiment. Measured responses included plant /stem height, live stem density, carbon fixation and biomass. The authors concluded that intervention (through *in-situ* burning) of an oil spill in a marsh may not be required, although if spill conditions require a rapid response to control contaminant spread or protect other sensitive resources, burning may be a clean-up operation to consider (Lindau *et al*. 1999).

Aquatic Toxicity: In-situ burning results in higher concentrations of metals in burn residue and the higher molecular weight hydrocarbons in air emissions, which can enter the aquatic environment through sinking, or attached to soot. Higher molecular-weight aromatic hydrocarbons, such as those which are produced by the combustion of petroleum, have been associated with tumors and possibly with reproductive disorders in marine fish species (Shigenaka and Barnea 1993). Due to the greater proportion of the heavier aromatic hydrocarbons, precipitated material from the plume of a controlled burn of crude oil was found to have caused genetic mutations in fish, an indication of possible carcinogenicity (Sheppard and Georghiou 1981 *in* Shigenaka and Barnea 1993). Long-term exposure to hydrocarbons have resulted in tumors in fish. Given the relatively short time frame of an *in-situ* burn, the low detection levels found in the field and laboratory experiments, and the fact that responders make every attempt to retrieve burn residue, the risk of toxicologically significant exposures to fish are low.

Burn Residue Impacts: Any burn residue left over after an *in-situ* burn that is not collected by responders may sink and smother benthic organisms and salmonid habitat. While the toxic effects of the residue on benthic habitats are not well studied, field and laboratory experiments have shown that the toxic properties of burn residue are generally lower than that of the parent (*i.e.* unburned) oil. Smothering of benthic habitats can kill organisms that salmonids depend on for forage, and in spawning beds, burn residue may fill in gravel interstices, killing eggs or alevins.

<u>Beneficial Effects of the Response</u>

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species in the action area. The objective of this response is to remove floating oil from the

water surface. If oil were allowed to remain in the environment (weeks to months in open water habitats), it is likely that the oil would either strand on a shoreline habitat, disperse into the water column, or both, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.7 Chemical Dispersants

As described in more detail in Section 1.2.3.5, the objective of this response is to reduce the impact to sensitive shoreline habitats and animals that use the water surface by chemically dispersing oil into the water column. Dispersants are chemicals that reduce the oil/water interfacial tension, thereby decreasing the energy needed for the slick to break into small droplets and mix into the water column.

Affected Habitats - Dispersant Use Policy

In Washington, dispersants may be implemented in offshore marine waters when particular conditions are met (see Section 1.2.3.5). The state prohibits the use of dispersants in Puget Sound waters east of Port Angeles any time of the year except in Haro Strait (see below). Chemical dispersion is generally pre-approved for use in outer shelf and shelf edge offshore waters summer through winter months (June to February) because these areas meet specified criteria (WADOE 1993). These offshore waters may be approved for use of chemical dispersants on a case-by-case basis in the spring (March to May).

Inner shelf and continental slope offshore waters may be approved for dispersant use on a case-by-case basis throughout the year. In addition, the following three areas may be approved for dispersant use on a case-by-case basis only in the specified months: (1) The outer Strait of Juan De Fuca between September to November; and (2) Haro Strait between March to May and September to November.

Oregon considers each request for approval of dispersant use on a case-by-case basis. Dispersants have not been approved for use in any fresh or brackish open water areas any time of year in either Washington, Oregon, or Idaho.

General Effects of the use of Chemical Dispersants

Field trials by McAuliffe *et al*. (1981) in California indicated that dispersed oil concentrations were not likely to exceed 1 ppm at depths of 10 m or greater. Results from modeling conducted by Mearns *et al*. (2001b) in Puget Sound, WA were consistent with the results of the field test, indicating that dispersed oil does not penetrate below approximately 10 meters in depth in measurable concentrations. Dispersed oil is unlikely to "behave" any differently in other bodies of water than those already tested or modeled due to pressure differences associated with this

depth (A. Mearns, personal communication. October 10, 2002). As a result, the effects of dispersed oil are likely to be confined to the top 10 meters of the water column of any given body of water.

Listed species may experience two levels of effects from the use of chemical dispersants, direct and indirect. In addition, listed species may be affected by the chemicals that constitute the dispersant, the oil that is subsequently dispersed into the water column, or both.

Toxicity of Dispersants: Both fresh oil and dispersants are toxic to marine organisms. Although the NWACP authorizes the use of other dispersants, availability limits those used in the Northwest Region to two: COREXIT 9500 and COREXIT 9527. A limited amount of toxicity data exists on the EPA websites (http://www.epa.gov/oilspill/ncp/corex950.htm) and http://www.epa.gov/oilspill/ncp/corex952htm), where the 48 hour and 96 hour LC50 concentrations for two marine species are 14 ppm and 24 ppm for Corexit 9527 and 25 and 32 ppm for Corexit 9500. (The LC50 is the concentration that was lethal to 50% of a test population). An updated complete review of Corexit toxicity is given in George-Ares and Clark (2000), which indicates how toxicity varies with species and decreases with decreasing exposure time.

An analysis was conducted on each dispersant to test for the presence of heavy metals, cyanide and chlorinated hydrocarbons. The results of the analysis are summarized in Table 2-3. On application, these concentrations are rapidly diluted at the same rate as the dispersant itself. In addition to the toxicity data collected, data on each dispersant's effectiveness relative to different oils were also collected. These data and others can be viewed on the EPA website.

Table 2-3 Analysis for heavy metals, cyanide and chlorinated hydrocarbons. (Table modified from tables found at websites).

Compound	COREXIT 9500 (ppm)	COREXIT 9527 (ppm)
Arsenic	0.16	< 0.005
Cadmium	N/D	< 0.01
Chromium	0.03	< 1.0
Copper	0.10	< 0.2
Lead	N/D	< 0.1
Mercury	N/D	< 0.003
Nickel	N/D	< 0.1
Zinc	N/D	0.1
Cyanide	N/D	< 0.01
Chlorinated Hydrocarbons	N/D	< 0.01

Toxicity of Dispersed Oil: The Corexit dispersants are much less toxic than most oils such that the primary factor leading to toxic responses is the oil. This is evident in examples of data in Table 2-4. Here, under constant exposure, Corexit 9500 was much less toxic (30 to150 ppm) than dispersed Prudhoe Bay Crude Oil (BC, 1 ppm to 8 ppm) and other crude oils.

Table 2-4 Ranges of 96-hour constant and spike EC50s and LC50s for 7 species of juvenile fish and invertebrates. Source: taken from Mearns *et al*. (2001b), and based on data in Coelho and Aurand (1998).

	Type of Exposure/LC50 in ppm (mg/L)	
Treatment	**Constant**	**Spiked**
Corexit 9500	30 - 150	90 - 1000
Prudhoe Bay crude oil	3 - 15	8 - 26
Prudhoe Bay crude + C9500	1 - 8	5 - 18
Arabian	0.6 - 6	15 - 80
Arabian + C9500	0.8 - 1.6	29 - 58
Venezuelan	0.2 - 0.4	1
Venezuelan + C9500	no data yet	no data yet

Mearns *et al*. (2001b) modeled the concentration and movement of 500 bbl of dispersed oil in Puget Sound, Washington (as discussed previously in the description of the dispersion response). The mean peak concentration of dispersed oil (10.8 ppm [range = 2.2 ppm to 53.8 ppm]) was reached about 1 hour after the application of dispersants (Mearns *et al*. 2001b). Within 6 hours the mean concentration was 2.3 ppm, while between 24 and 72 hours of dispersant application, mean concentrations decreased from 0.23 ppm (at 24 hours) to 0.03 ppm (at 72 hours) (Mearns *et al*. 2001). Data presented in Mearns *et al*. (2001a, 2001b) also indicate that the toxicity of a given dispersant may or may not be greater than that of the dispersed oil plume, and that it may depend both on the properties of the dispersant used and the oil to which it is being applied, as well as the volume of each.

Concentrations of dispersed oil in the first hour following dispersant application that were reported in field studies (McAuliffe *et al*. 1980, McAuliffe *et al*. 1981, Lichtenthaler and Daling 1985, Coelho *et al*. 1995, Brandvick *et al*. 1995, Walker and Lunel 1995, Coelho *et al*. 2002), discussed in the description of this response, were in close agreement with those reported by Mearns *et al*. (2001b) for the same time period.

Assessing the toxicity of dispersed oil to organisms that may encounter it is problematic for several reasons: (1) Sublethal effects are sometimes difficult to identify; (2) toxicity data vary by taxonomic group, within taxonomic groups and by life stage; and (3) exposure times are likely to vary in each scenario. As a result, efforts to provide indices of toxicity across taxa have been criticized for their limitations, particularly as an accurate comparison to 'real' conditions at a spill.

Spiked vs Constant Exposure: Most toxicity testing during the past several decades has been done exposing animals to constant concentrations over periods of 48 hours to 96 hours (2 to 4 days), represented by the middle column, labeled "constant," in Table 2-4. In an actual oil spill/dispersant application setting, however, organisms are not exposed to a constant concentration but rather to a rapid spike in dispersant/dispersed oil concentration that decays rapidly over time. For this reason, the LC50 values reported on the websites listed above, and in the left column of Table 2-4, are less realistic than those determined by more recent "spike" bioassays, which attempt to mimic real changes in dispersant/dispersed oil concentrations in the water column (A. Mearns, NOAA, personal communication, October 10, 2002). Table 2-4 compares lethal (LC50) concentration ranges for 7 species of juvenile fish and invertebrates, derived from both constant and spiked bioassays and indicates that the spike exposure is 4 to 40 times less toxic. Many such spiked-bioassay tests have been done during the past 5 years indicating that both the dispersant and dispersed oils are 4 to 40 times less toxic under spiked exposure conditions than constant exposure conditions.

Tjeerdema *et al*. (1990) exposed organisms to spiked concentrations of a dispersant in an attempt to simulate concentrations that are likely to result in the water column from chemical dispersion. The experiments indicated that spike exposure times result in very different effects than constant exposures for some species. Some findings of Tjeerdema *et al*. (1990) included delayed mortality in mysid shrimp of 72 hours to96 hours above the "no observed effects concentration" (NOEC) of 8.4 to 20.5 ppm after high initial survival and relatively high initial mortality of topsmelt (NOEC range 31.0 ppm to 89.8 ppm), but high survival of those that were not killed by the initial spike. These findings indicate that not only do lethal concentrations differ between taxa, but the timing of observed effects differs as well.

Application of Toxicity Data to Dispersant use Planning: The values reported in Tables 2-3 and 2-4 are important to this assessment for two reasons. First, ranges of LC50s reported for spiked concentrations (those thought to most closely represent real-world concentrations) are higher than those for constant exposure (Table 2-4). Second, the lethal concentration reported for various oils (*e.g.*, Prudhoe Bay crude (BC), Arabian) combined with COREXIT 9500 reported in Table 2-4 is greater than the concentration that would cause any level of concern to those polled in Table 2-5. It should further be noted that values in Table 2-5 were derived under the assumption that organisms would be present in the dispersed oil plume for the entire period of exposure. However, it is reasonable to assume that organisms will be absent from the plume to varying degrees, due to their transient natures and the probability that the plume will move with currents as well. It should be recognized, therefore, that this assumption provides a degree of conservatism into the values reported in Table 2-5.

Mearns *et al.* (2001a, b) described how resource managers used dispersed oil and dispersant toxicity data to derive consensus-based guidelines. Participants with expertise in the biology of marine invertebrates and fishes were familiarized with toxicity data of dispersants. Then they were asked to state at what dispersant concentration their level of concern would be high, medium or low, doing this at several time periods: 0, 3, 24, 96 and 168 hours following the application of dispersants (Mearns *et al.* 2001b). Table 2-5 shows the consensus concentrations that resulted from polling (*i.e.*, expert opinion). The values presented in Table 2-5 indicate that

the consensus opinion of experts is that zooplankton and the early life stages of crustaceans and fishes are the most sensitive to dispersed oil, adult crustaceans are intermediately sensitive and adult fish are the least sensitive of the three general categories. All polled experts indicated that persistent (96 hours or more) concentrations of dispersed oil would be cause for a high level of concern (Table 2-5).

Table 2-5 Saltwater-dispersed oil consensus concentrations (ppm) and exposure periods (hours) of concern relative to marine zooplankton and early life stages of fishes and invertebrates, adult crustaceans and adult fishes. Source: Mearns *et al.* (2001b).

Lowest used Level of Concern (ppm)									
Zooplankton, eggs, larvae				Adult Crustacea			Adult Fish		
Hour	High	Medium	Low	High	Medium	Low	High	Medium	Low
0	10	5	1	50	10	5	100	50	5
3	10	5	1	50	10	5	100	50	5
24	1	1	0.5	5	2	0.5	10	2	0.5
96	1			1	1		1	1	
168	0.5	0.5		0.5	0.5		0.5	0.5	

Comparison of these consensus guidelines and the mean concentrations of dispersed oil developed for the simulation in the Straits of Juan de Fuca indicate that managers had little or no concern about the toxicity of the oil to fish or crustaceans at any point during the dispersion event; however, they could have concern for zooplankton (sensitive life stages) during the first few hours (when mean concentrations dropped from 27 to 2.3 ppm).

Wells (1984) provided a summary of available toxicity data that included two categories of effects, lethal and sublethal, as well as a reference concentration of oil that would be expected to occur in the water column following chemical dispersion. For most species, including protozoans to birds, oil concentrations expected to result in both sublethal (>100 ppm) and lethal (100 ppm to 10,000 ppm) effects were greater than those concentrations of oil expected to be present in the water column (0.1 to 100 ppm) (Wells 1984), observed in field trials (McAuliffe *et al*. 1980, McAuliffe *et al*. 1981, Lichtenthaler and Daling 1985, Coelho *et al*. 1995, Brandvick *et al*. 1995, Walker and Lunel 1995, Coelho *et al*. 2002) and predicted by model outcomes (Mearns *et al*. 2001a, b).

The dispersed oil concentrations that resulted from modeling (Mearns *et al*. 2001a, b) and from field studies (McAuliffe *et al*. 1980, McAuliffe *et al*. 1981, Lichtenthaler and Daling 1985, Coelho *et al*. 1995, Brandvick *et al*. 1995, Walker and Lunel 1995, Coelho *et al*. 2002) indicate the use of dispersants has the potential to adversely affect some organisms that encounter a

dispersed oil plume. However, it is unlikely that oil concentrations will be great enough to result in adverse effects for most species, adverse effects will be spatially limited, and the likelihood for adverse effects associated with dispersed oil decreases with time. These effects will be discussed in terms of each listed species in the action area.

Effects to Large Whales

Listed large whales, including baleen whales and sperm whales, may be present in the areas where chemical dispersants are, or can be, approved for use. Therefore, the use of dispersants may be expected to affect listed cetaceans. However, marine mammal surveys are conducted prior to the application of dispersant, as described in the description of this response, so the likelihood of a listed cetacean coming into direct contact with the chemical and dispersed oil immediately following dispersant application is low. That said, listed large whales may enter the area affected by dispersants as they transit through the area, and as a result of the movement and expansion of the dispersed plume with time.

The potential effects of this response may be related to the dispersant or the presence of dispersed oil in the water column. However, the biological effects of dispersant use have been almost entirely attributed to the dispersed oil and not the dispersant itself (NRC 1989). Few data are available on the effects of dispersants relative to marine mammals. Data reported by Wells (1984), Mearns *et al*. (2001b) and several field tests (discussed in the description of this dispersion response) on dispersed oil concentration and associated levels of concern for fish and other vertebrates provide a useful point of reference. It should be noted that these results from test spills and modeling represent specific scenarios and the data generated from them are dependent upon several factors, such as the volume of oil spilled, the effectiveness of dispersion and environmental conditions. Some spill scenarios may result in higher or lower measurements than those presented in the referenced studies. During the first hour of modeled dispersion, oil spread to a depth of 1 meter with a mean concentration of 10.8 ppm. However, the maximum derived concentration was 54 ppm, exceeding the consensus guideline set for the only mature vertebrate studied, adult fish (50 ppm). Field trials, discussed previously in this document, yielded similar maximum dispersed oil concentrations. As a result, fish and other organisms present in the upper 1 meter of the water column may have been exposed to a concentration of dispersed oil that exceeded the threshold set for a medium level of concern for adult fish. This finding is useful in an assessment of the potential effects of dispersed oil on large whales.

Effects of Dispersed Oil on Large Whales: It is reasonable to expect that consensus guidelines for oil concentrations that would cause a low, medium or high level of concern relative to whales are at least as high as those reported for adult fish. This is a reasonable assumption for several reasons: (1) The sheer size and mass of whales compared to fish will provide greater resistance when exposed to the same concentration of oil; (2) whales are less likely to spend long periods of time at a single depth, or within a narrow range of depths, than most fish; and (3) fewer sensitive tissues are exposed to water in whales than most fish (*e.g.*, whales breathe air and their skin appears to be virtually impenetrable to toxicants [Geraci and St. Aubin 1990]). It has been estimated that a forty-ton whale (one-half the size of a right whale; one-quarter the size of a blue whale) would have to consume 150 gallons of oil to result in adverse effects (Geraci and St. Aubin 1990). Considering the relatively low concentration of oil in the water column reported as

a result of dispersion, the likelihood that large whales will be exposed to dispersed oil for short periods, consumption of this volume of oil is unlikely (NMFS and USFWS 1996). As a result, the concentration that is considered a medium level of risk to fish, for example, is likely to cause a lower level of risk to large whales.

Effects of Dispersed Oil on Prey of Large Whales: Dispersants increase the concentration of oil present in the water column below the slick in which they have been applied, primarily the first 10 meters (McAuliffe *et al*. 1981, NOAA 1992, Mearns *et al*. 2001b). Dispersion of oil into the water column is likely to increase its availability to fish and invertebrates that do not inhabit the surface of the water already affected by the floating oil slick. Increasing concentrations of oil in the top 10 meters of the water column is expected to affect some cetacean prey, such as euphausiids, copepods and forage fish that use this area. Sperm whales typically forage at great depth (up to 3000m) on cephalopods. As a result, sperm whale prey species are not likely to be adversely affected by the use of dispersants. Some baleen whales forage extensively at or near the surface (*e.g.*, right and humpback whales) and may be affected by temporary and relatively local decreases in abundance of some prey, if affected lethally by dispersed oil. However, given the transient foraging strategies of the cetaceans within the scope of this analysis, the effects of a localized and ephemeral decline in prey abundance is unlikely to adversely affect listed large whales (NMFS and USFWS 1996).

Large whale prey, such as plankton and small fishes, are not likely to accumulate surfactants from dispersants or hydrocarbons from dispersed oil (Neff 1990). As a result, the consumption of individuals of these prey that have been exposed to dispersants and dispersed oil does not pose a serious risk to the consumer (Neff 1990).

Modeling by Mearns *et al*. (2001a, b) and results from field trials (discussed previously in this document) indicate that dispersed oil concentrations have the potential to exceed guidelines corresponding to a medium level of concern for fish, as discussed earlier in this section. The guideline for the same level of concern for adult crustaceans (*e.g.*, shrimp) was also exceeded both by the mean concentration (10.8 ppm) during the first hour after dispersant application and by the maximum concentration (hour 1 = 53.7 ppm, hour 6 = 11.4 ppm) during the first 6 hours following application (Mearns *et al*. 2001b). In other words, adult crustaceans in the affected area (upper several meters of the water column during this time) may have been exposed to concentrations of dispersed oil that exceeded medium concern guidelines for up to 6 hours.

The guideline corresponding to a medium level of concern for zooplankton and early life stages of fish and invertebrates (5 ppm for the first 3 hours) was exceeded by the mean concentration and the maximal concentrations of dispersed oil over the first 2 hours and 6 hours, respectively, after dispersant application (Mearns *et al*. 2001b). The consensus guideline for a high level of concern for these taxa (10 ppm for the first 3 hours) was exceeded by the mean concentration for the first hour (10.7 ppm) and by the maximal concentrations for the first six hours. In other words, zooplankton and early life stages of fish and invertebrates present in the upper several meters of the water column were likely exposed to concentrations of dispersed oil characterized as causing a high and medium level of concern by those managing risk. Taxa exposed to

maximal concentrations may have been exposed to concentrations exceeding the guideline associated with a medium level of risk from hours 6 to 12 (Mearns *et al*. 2001b).

Indirect Effects: Indirect effects may exist in the future if the impacts of the response discussed previously result in delayed or sublethal effects to the listed species. For example, effects related to prey abundance or distribution, or the condition of large whales during sensitive developmental stages are often sublethal. It is possible that these sublethal effects could translate into depressed calving rates or survivorship after maturity or at some later life stage of the animals. These indirect effects are possible, but without knowing the severity of a particular perturbation it is difficult to determine the likelihood of indirect effects occurring. In general, the threat of significant indirect effects is expected to be minimal.

Interrelated Actions: Vessel activity and other motorized support are likely to accompany chemical dispersion. The potential effects of these support activities on listed large whales are discussed in the *Motorized Transportation / Support* section of this effects analysis.

Effects to Steller Sea Lions

Steller sea lions may be present in the areas where chemical dispersants are, or can be, approved for use. Therefore, the use of dispersants may be expected to affect Steller sea lions. Little data are available on the effects of dispersants relative to pinnipeds, other than fur seals. Dispersants are expected to adversely affect the thermal properties of some pinniped fur (NRC 1989). However, Steller sea lion fur does not provide significant protection against loss of heat. Instead this is accomplished by the presence of a thick blubber layer. As a result, dispersants are not thought to affect pinniped thermoregulation. Further, marine mammal surveys are conducted prior to the application of dispersant, so the likelihood of a Steller sea lion coming into direct contact with the chemical is low. That said, Steller sea lions may enter the area affected by dispersants as they transit through the area, and as a result of the movement and expansion of the dispersed plume with time.

The potential effects of this response may be related to the dispersant or the presence of dispersed oil in the water column. Few data are available on the effects of dispersants relative to marine mammals. Data reported by Mearns *et al*. (2001b), Wells (1984) and field trials (discussed in the description of the response) on dispersed oil concentration and associated levels of concern for fish and other vertebrates provide a useful point of reference. It should be noted that these results from test spills and modeling represent specific scenarios and the data generated from them are dependent upon several factors, such as the volume of oil spilled, the effectiveness of dispersion and environmental conditions. Some spill scenarios may result in higher or lower measurements than those presented in the referenced studies. During the first hour of modeled dispersion, oil spread to a depth of 1 meter with a mean concentration of 10.8 ppm. However, the maximum derived concentration was 54 ppm, exceeding the consensus guideline set for the only mature vertebrate studied, adult fish (50 ppm). As a result, fish, and other organisms present in the upper 1 meter of the water column may have been exposed to a concentration of dispersed oil that exceeded the threshold set for a medium level of concern for adult fish. However, only the consensus guideline relating to zooplankton was exceeded by

mean dispersed oil concentration. This finding is useful in an assessment of the potential effects of dispersed oil on Steller sea lions.

Effects of Dispersed Oil on Steller Sea Lions: It is reasonable to expect that consensus guidelines for oil concentrations that would cause a low, medium or high level of concern relative to Steller sea lions are at least as high as those reported for adult fish. This is a reasonable assumption for several reasons: (1) The sheer size and mass of sea lions compared to fish will provide greater resistance when exposed to the same concentration of oil; (2) Steller sea lions are less likely to spend long periods of time at a single depth, or within a narrow range of depths, than most fish; and (3) fewer sensitive tissues are exposed to water in sea lions than most fish (*e.g.*, sea lions breathe air and their pelage does not afford significant thermal protection (Geraci and St. Aubin 1990). As a result, the concentration that is considered a medium level of risk to fish is likely to cause a lower level of risk to Steller sea lions.

Effects of Dispersed Oil on Prey of Steller Sea Lions: Dispersants increase the concentration of oil present in the water column below the slick in which they have been applied, primarily the first 10 meters (McAuliffe *et al*. 1981, NOAA 1992, Mearns *et al*. 2001b). Dispersion of oil into the water column is likely to increase its availability to fish and invertebrates that do not inhabit the surface of the water already affected by the floating oil slick. Increasing concentrations of oil in the top 10 meters of the water column is expected to affect some sea lion prey, such as forage fish that use this area. Modeling by Mearns *et al*. (2001a, b) indicates that dispersed oil concentrations have the potential to exceed guidelines corresponding to a medium level of concern for fish, as discussed earlier in this section. Typically, sea lions do not feed within the top 10 meters of the water column, but exceptions have been observed (NMFS 2001). However, some prey of Steller sea lions may travel through or feed in the 10 meter water column region and may be exposed to both dispersant and dispersed oil. Given the transient foraging strategies of Steller sea lions and some of their prey, even if sea lions were foraging on species in the top 10 meters of the water column, the effects of a localized and ephemeral decline in prey abundance is unlikely to adversely affect sea lions. If sea lion prey were to come into contact with dispersants and dispersed oil, they are not likely to accumulate surfactants from dispersants or hydrocarbons from dispersed oil (Neff 1990). As a result, the consumption of individuals of these prey that have been exposed to dispersants and dispersed oil does not appear to pose a serious risk to the consumer (Neff 1990).

Indirect Effects: Indirect effects may exist in the future if the impacts of the response discussed previously result in delayed or sublethal effects to the listed species. For example, effects related to prey abundance or distribution, or the condition of sea lions during sensitive developmental stages are often sublethal. It is possible that these sublethal effects could translate into depressed pupping rates or survivorship after maturity or at some later life stage of the animals. These indirect effects are possible, but without knowing the severity of a particular perturbation it is difficult to determine the likelihood of indirect effects occurring.

Interrelated Actions: Vessel activity and other motorized support are likely to accompany chemical dispersion. The potential effects of these support activities on Steller sea lions are discussed in the *Motorized Transportation / Support* section of this effects analysis.

Effects to Salmonids

Listed juvenile outmigrants (smolts), subadult and adult salmonids may be present in the areas where chemical dispersants are, or can be, approved for use. Therefore, the use of dispersants may affect listed salmonids. If they are not already present in the affected area, listed salmonids may enter the area affected by dispersants as they transit through the area, and as a result of the movement and expansion of the dispersed plume with time.

Effects of Dispersed Oil on Listed Salmonids: The potential effects of this response may be related to the dispersant or the presence of dispersed oil in the water column. Data reported by Mearns *et al*. (2001b) and from field trials (discussed in the description of this response) on dispersed oil concentration and associated levels of concern for fish provide a useful point of reference. It should be noted that these results from test spills and modeling represent specific scenarios and the data generated from them are dependent upon several factors, such as the volume of oil spilled, the effectiveness of dispersion and environmental conditions. Some spill scenarios may result in higher or lower measurements than those presented in the referenced studies. During the first hour of modeled dispersion, oil spread to a depth of 1 meter with a mean concentration of 10.8 ppm. However, the maximum derived concentration was 54 ppm, exceeding the consensus guideline set for adult fish (50 ppm). As a result, fish present in the upper 1 meter of the water column may have been exposed to a concentration of dispersed oil that exceeded the threshold set for a medium level of concern for adult fish. However, only the consensus guideline relating to zooplankton was exceeded by mean dispersed oil concentration.

Effects of Dispersed Oil on Prey of Listed Salmonids: Dispersants increase the concentration of oil present in the water column below the slick in which they have been applied, primarily the first 10 meters (McAuliffe *et al*. 1981, NOAA 1992, Mearns *et al*. 2001b). Dispersion of oil into the water column is likely to increase its availability to fish and invertebrates below the water surface, already affected by the floating oil slick. Increasing concentrations of oil in the top 10 meters of the water column is expected to affect some prey of juvenile, subadult and adult salmonids, such as copepods and forage fish that use this area. Salmonids may be affected by temporary and localized decreases in abundance of some prey. However, salmonid prey are not likely to accumulate surfactants from dispersants or hydrocarbons from dispersed oil, if exposed (Neff 1990). As a result, the consumption of individuals of these prey that have been exposed to dispersants and dispersed oil does not pose a serious risk to the consumer (Neff 1990).

Modeling by Mearns *et al*. (2001a, 2001b) and results from field trials (discussed previously) indicate that dispersed oil concentrations have the potential to exceed guidelines corresponding to a medium level of concern for fish, other vertebrates and some invertebrates, as discussed earlier in this section.

The guideline for the same level of concern for adult crustaceans (*e.g.*, shrimp) was also exceeded both by the mean concentration (10.8 ppm) during the first hour after dispersant

application and by the maximum concentration (hour 1 = 53.7 ppm, hour 6 = 11.4 ppm) during the first 6 hours following application (Mearns *et al*. 2001b). In other words, adult crustaceans in the affected area (upper several meters of the water column during this time) may have been exposed to concentrations of dispersed oil that exceeded medium concern guidelines for up to 6 hours.

The guideline corresponding to a medium level of concern for zooplankton and early life stages of fish and invertebrates (5 ppm for the first 3 hours) was exceeded by the mean concentration and the maximal concentrations of dispersed oil over the first 2 hours and 6 hours, respectively, after dispersant application (Mearns *et al*. 2001b). The consensus guideline for a high level of concern for these taxa (10 ppm for the first 3 hours) was exceeded by the mean concentration for the first hour (10.7 ppm) and by the maximal concentrations for the first 6 hours. In other words, zooplankton and early life stages of fish and invertebrates present in the upper several meters of the water column were likely exposed to concentrations of dispersed oil characterized as causing a high and medium level of concern by those managing risk. These findings by Mearns *et al*. (2001b) are consistent with results of measurements of oil concentration from field trials. Taxa exposed to maximal concentrations may have been exposed to concentrations exceeding the guideline associated with a medium level of risk from hours 6 to 12 (Mearns *et al*. 2001b).

Concentrations of dispersed oil exceeding consensus guidelines associated with medium and high levels of concern for fish are likely to directly adversely affect listed salmonids, although these adverse effects will be limited spatially and temporally, and because this is a highly mobile species, the effects are likely to be further limited. Similarly, decreases in salmonid prey resulting from elevated concentrations of dispersed oil are likely to be ephemeral and localized spatially. Modeling by Mearns *et al*. (2001b) and measurements from field trials indicate that reaching or exceeding consensus guideline levels established for salmon and their prey corresponding to medium and high concern are reasonably likely to occur. However, dispersed oil concentrations exceeded these levels over a relatively short time period (1 hour to 6 hours). Further, levels were exceeded during the time immediately following dispersion, the time when the plume is most confined spatially. Over time, concentrations decreased as the plume expanded in the water column. As a result, if dispersed oil concentrations exceed guideline levels for medium and high concern, the adverse effects to listed salmonids and their prey are expected to be limited in time and space. This conclusion is consistent the findings of Tjeerdema *et al*. (1990), in which delayed effects, including mortality, to some invertebrates were limited to 73 hours to 96 hours after initial exposure.

Indirect Effects: Indirect effects to listed salmonids may result from this response. Although it is conceivable that this response will result in sublethal effects to salmonids or their prey, such an effect is unlikely in this scenario of exposure to oil in the water column. These sublethal effects, in turn, could result in depressed spawning success, retarded growth, or other effects that will not become apparent until after fish reach maturity or after the emergence of future year classes. While the indirect effects proposed in this section are possible, they are difficult to quantify without knowing the specific effects on salmonids. Some data are presented that illustrate the potential for indirect effects and possible consequences under specific situations

that may or may not be achieved as a result of the use of chemical dispersion in response to a real oil spill.

Data reported by Heintz *et al*. (2000) indicate that exposure of developing pink salmon eggs to low concentrations of PAHs in weathered oil in gravel over relatively long periods of time can have more severe and longer-term impacts than previously thought. The observed impacts included delayed effects associated with exposure to weathered oil, such as a reduction in reproductive fitness and retarded or reduced growth potential. Further, fertilized eggs of pink salmon exposed to an initial PAH concentration of 5.4 ppb while in weathered oil-contaminated gravel exhibited a 15% decrease in marine survival relative to control salmon after surviving initial exposure and release (Heintz *et al*. 2000). However, it is extremely important to understand that these effects were produced NOT as a result of exposure of juveniles, subadults or adults to oil in the water column (which would be the exposure scenario in the case of offshore application of oil dispersants), but as a result of actual or experimental long-term exposure of pink salmon eggs and embryos to weathered oil in the gravel of intertidal reaches of streams following the Exxon Valdez oil spill. In other words, the effects noted by Heintz *et al* (2000) were specifically a result of an egg and embryo exposure scenario which the judicious application of oil dispersants in offshore open waters is precisely designed to avoid. As stated by Moles (2001), "If the potentially affected area includes the type of natal or nursery fish habitat capable of retaining oil for long periods (armored beaches, soft sediment, mussel beds), preventing the oil from coming ashore could produce the best long-term outcome."

Similarly, studies conducted by Martin *et al*. (1989) on the behavior of adult pink salmon after exposure to oil in the water column indicated that: (1) Migrating adult pink salmon do not avoid aromatic hydrocarbon concentrations above the threshold at which they can be detected; (2) salmon do not avoid aromatic hydrocarbon concentrations between 1 and 10 ppb (0.001 and 0.01 ppm, respectively), but do become temporarily disoriented when exposed to those concentrations; (3) disoriented salmon showed an extended period of searching and appeared unable to detect home stream cues; and (4) disorientation disrupted migrations, but did not prevent an eventual return to their home stream. Data presented by Martin *et al*. (1989) illustrate that the presence of aromatic hydrocarbons in the water column may temporarily and reversibly disrupt salmonid migrations, as the hydrocarbon concentration reported may be achieved as a result of dispersant application. Disorientation during spawning migration and inability to reach natal streams may result in decreased reproductive success and reproductive condition, as well as delayed outmigration and reduced survival of their progeny. These effects would be an indirect result of exposure to dispersed oil. However, these potential effects could be at least partially mitigated by use of oil dispersants, by reducing the duration of oil exposure and therefore the duration of potential migratory disorientation. In addition, because the current geographical and water depth restrictions contained in the Dispersant Use Policy make it highly unlikely that dispersants would be applied in estuaries or coastal regions near streams or rivers in which adult salmon spawn, any effects of dispersed oil on adult salmon migration and homing to their spawning sites are not likely to be an issue of concern.

Interrelated Actions: Vessel activity and other motorized support are likely to accompany chemical dispersion. The potential effects of these support activities on listed salmonids are discussed in the *Motorized Transportation / Support* section of this effects analysis.

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species in the action area. Dispersion is likely to reduce the overall ecological impact of oil, especially in large bodies of water (NRC 1989). The objective of this response is to remove floating oil from the water surface, and the threat that it may enter more sensitive or expansive coastal or estuarine environments, including stranding on sensitive and productive shoreline habitats. This response is likely to benefit listed species by confining the effects of oil to less sensitive environments, as dispersed oil concentrations will dilute in a period of hours to days. The successful implementation of this response will result in a shorter presence of oil, and associated vapors, on the water surface. Exposure to oil on the water surface (where fouling can occur) will be reduced, if not eliminated, and transferred to the water column. This will reduce the threat of fouling to birds and the most vulnerable marine mammals (*i.e.*, fur seals and sea otters) (Boyd *et al*. 2001), including the habitats that they use for breeding and nurseries. The biodegradation of dispersed oil is thought to be at least as rapid as untreated oil (NRC 1989). Exposure to dispersed oil plumes may result in adverse effects to developmental life stages and plankton for the first hours or a day following dispersant application. Exposures to untreated floating oil and oil that has stranded may result in adverse effects and persist for years (Mearns *et al*. 2001a). As stated by Moles (2001), "Although a particular dispersant may have toxic properties, dispersants also minimize the amount of oil coming on shore, causing less habitat contamination, and lowering the potential for long-term impacts. In such instances, the use of dispersants may be appropriate, despite the potential for short-term damage, if it minimizes the amount of oil that finds its way into nearshore or estuarine rearing habitat."

2.1.5.8 Barriers/Berms and Underflow Dams

As described in Section 1.2.3.6, the objective of this response action is to prevent entry of oil into a sensitive area or to divert oil to a collection area. A physical barrier is placed across an area of moving water to prevent moving oil from passing. Barriers can consist of earthen berms, filter fences, boards or other solid barriers. Because of the time and labor required to construct berms, they are likely to be in place for 1 5 weeks, depending on the specific event. This response is more likely to be implemented in shallow and small waterbodies than deep ones.

If it is necessary for water to pass because of water flow volume or downstream needs, underflow dams (for low flow rates) can be used. This response action is used in small rivers and streams, or at the entrances to shallow sloughs when the flow of oil threatens sensitive habitats.

Effects to Large Whales

Because this action is performed in small streams, where large whales are not found, this response action is not likely to affect large whales.

Effects to Steller Sea Lions

Because this action is performed in small streams, where Steller sea lions are not likely to be found, the impacts of this action on Steller sea lions are considered negligible. Furthermore, while Steller sea lions in the Pacific Northwest do prey on salmonids (Riemer *et al*. 2001), they also prey on a variety of other species; therefore, any temporary adverse effects to a local salmonid population due to this action is not likely to manifest in a local Steller sea lion population.

Effects to Salmonids

Because this response may be used in small streams and rivers in the Pacific Northwest, there is a strong likelihood that salmonids will be present in varying life stages, in the form of eggs, fry, smolts, juveniles and spawning adults.

While specific flow requirements vary for each species, life history stage, and time of year, salmonids have general requirements to ensure their survivability to the next life stage. Migrating adults need sufficient streamflow to allow passage over physical barriers. On the spawning grounds, spawning adults need sufficient water depth and current velocity to ensure that there is enough space to spawn, that gravel beds are receiving a continuous supply of dissolved oxygen, that wastes are being eliminated, and that sediments are prevented from filling in gravel interstices. For juveniles and adult resident salmonids, water flow must be sufficient enough to allow movement within the habitat, maintain temperature, and allow access to available prey species. Streamflow for migrating juveniles is important in facilitating and stimulating downstream movement (*in* Spence *et al*. 1996).

This response method is likely to adversely affect salmonids directly, impeding salmonid migration and/or movement, and increasing their vulnerability to predation and to collected oil. This response may also adversely modify salmonid critical habitat, through disruption and modification of water flow. These direct effects are further discussed below.

Physical Impedance to Salmonids: Salmonids depend on stream systems with sufficient flow conditions and depth sizes to reach spawning grounds as adults or to enter estuaries or the ocean as fry and juveniles. Culverts and other barriers have been shown to impede salmonid migrations by blocking or delaying upstream and downstream fish passage (Spence *et al.* 1996). For spawning adults, timing for entry into freshwater is dependent on several factors, including temperature, flow, and basic homing instincts. Any delays or barriers imposed on the instream migration could compromise the health of an individual fish, or reduce their chances of successfully returning to the spawning grounds. Depending on the species, most salmonid fry or fingerling smolts will begin to migrate downstream once they have reared successfully in freshwater and are physically prepared (*i.e.* large enough) to forage in estuarine waters. Instream factors such as temperature and flow also play a part in stimulating out-migration (*e.g.*, Whalen *et al*.1999; Antonsson and Gudjonsson 2002). While the timing of seaward migration for fry and smolts may not be as crucial as that of an adult spawning migration, salmonid fry may be more directly affected by any stream barriers through increased vulnerability to collected oil and predators (both discussed below).

Although underflow dams are designed to allow some water to flow at depth, the pipes or openings are most likely not large enough in diameter to assist passage of salmonids through the system. Juvenile salmon may become entrained or impinged at the opening, if the flow is sufficient. Entrainment can occur when the fish is drawn into the opening, while impingement can occur when a fish is not able to avoid contact with the opening. Either can cause bruising, descaling, and other injuries. Impingement, especially if prolonged, repeated, or occurring at high velocities, can cause direct mortality.

Increased Vulnerability to Predation: The construction of physical barriers in small streams is likely to impede salmonid movements, resulting in an aggregation of fish behind the barrier. This aggregation is likely to increase the vulnerability of the affected salmonids to predation. Migrations often cue the movements of predators, such as eagles, bears, and larger fish, and draw attention to areas of concentrated prey. This effect is likely to be exacerbated by barriers that impede fish movements and aggregate them further.

Salmonids that do successfully make it through underflow dams or over the berm/barrier may be stressed, which may increase their vulnerability to predators. Mesa (1994) found that juvenile chinook salmon who were subjected to stressor(s) for up to an hour were more likely to be eaten by predators than the unstressed fish.

Increased Vulnerability to Collected Oil: Because the purpose of a barrier or berm is to collect oil flowing downstream, any salmonids upstream of the berm may become vulnerable to oil that has been collected, prior to it being removed by sorbents or other collection devices. Combined with currents and wind, a barrier or berm can cause the oil to entrain, pushing it deeper into the water column at shallow depths, where salmonids may be accumulating, increasing their risk of exposure to oil. Earlier life stages such as newly emerged fry may be the most vulnerable, since they may lack the ability to sustain upstream movement away from the collected oil.

Increased Contamination of Sediments: An earthen berm left in place for a sufficient enough period of time to contain oil may cause those sediments on the oiled side of the berm to become contaminated. If not removed and disposed of properly, the resuspension of exposed oil and oiled sediments could move downstream, contaminating otherwise clean water and habitat. If the shoreline is not protected from the contained oil, it too can become more contaminated than it would have been if the oil had been allowed to move naturally, or another response was chosen.

Disruption or Alteration of Water Flow: Barriers, berms, and to a lesser degree, underflow dams are likely to reduce or stop stream flow. Reduced water flow may have several adverse effects on salmonids. First, salmonid movements downstream may be compromised due to insufficient flow. Secondly, with lower levels of water downstream of the berm, water temperatures may increase. Salmonids are very sensitive to temperature changes and may move out of an area towards habitats with cooler temperatures. The range of water temperatures that are suitable for salmonids is narrow (*e.g.*, sockeye smolts typically migrate between 2°C and 10°C (Burgner 1991) and the range that may be "preferred" is likely to be even smaller. Further, natural changes in water temperature often cue movements of juveniles, so those associated with

anthropogenic activities may be expected to disrupt natural movement patterns. Third, pool formation may be affected by lack of sufficient water and altered flow dynamics, reducing the available habitat for rearing and protection (Spence *et al.* 1996).

Beneficial Effects of the Response: This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and/or critical habitat in the action area. The objective of this response is to contain or divert floating oil, usually from entering more sensitive marine or freshwater environments. As a result, this response is likely to benefit listed species by confining the effects of oil to less sensitive environments, and to environments in which removal of the oil may be expedited. The successful implementation of this response will result in a shorter presence of oil in the environment and a shorter exposure time to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment (if untreated, weeks to months in open water habitats or months to years in shoreline habitats), as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

Because this response method may involve the use of heavy equipment, the effects of this activity is included in Section 2.1.5.19.

2.1.5.9 Vegetation Cutting (kelp)

Responders may cut vegetation to remove oil trapped in the canopy of kelp beds, to prevent the oiling of wildlife or remobilization of trapped oil. Thick layers of oil may adhere to kelp fronds or collect under the kelp canopy. The upper 1 to 2 feet of the kelp canopy is cut away by hand (*e.g.* for bull kelp) or a mechanical kelp harvester (*e.g.* for giant kelp). The oiled kelp cuttings are removed for disposal.

General Effects of Vegetation (kelp) Cutting: In addition to its role as an essential marine habitat, coastal kelp canopies exhibit some of the highest primary productivities of any ecosystem on earth. Kelp provides food for the food chain in three ways: (1) Directly, while the kelp is still attached; (2) indirectly, by providing detritus that is eaten after it has fallen to the bottom; and (3) by producing dissolved organic matter that is food for many microorganisms. Kelp forests also provide three-dimensional habitats in the water column of the nearshore. Many species of larval fish use kelp as habitat for settlement, and adult fish hide and feed in kelp fronds. Important functions of kelp forests in the Pacific Northwest include the following: (1) Substrate for herring spawning; (2) fish habitat, especially for rockfish, but also salmonids; (3) contribution to pelagic food webs through particulate and dissolved carbon; (4) primary production; (5) wave and current energy buffering; and (6) substrate for secondary production.

Two main species of kelp which may be found in the action area include giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis luetkeana*). Bull kelp is much more abundant in Washington, while giant kelp is only found on the outer Strait of Juan de Fuca and the open coast (where bull kelp is also found). Bull kelp is also common in central and north Puget Sound. Because the two types of kelp have very different structures and life histories (including

reproduction), harvest (*i.e.* cutting the canopy) of the species can result in very different impacts. For example, giant kelp are perennial (has a life span of 2 or more years) species, while bull kelp is an annual species. In addition, the reproductive structures of giant kelp, termed sporophylls, are above the apex of the holdfast and produce and liberate spores continuously throughout the year (Anderson and North 1967, *in* California Department of Fish and Game [CDFG] 2001). Bundles of fronds extend up vertically through the water column. Therefore, even removing the upper 4 feet of canopy (standard commercial harvest practice) leaves the rest of the plant essentially intact. In addition, giant kelp has the ability to regenerate its canopy rapidly due to the continuous production of new fronds. In contrast, the sporophytes of bull kelp possess a single stipe and pneumatocyst (air bladder), which gives rise to short branches, from which between 30 to 64 blades are borne. Reproduction is cyclical, where during the sporophytic phase, spore production begins several weeks after the blades reach the surface. Spores are formed within fertile patches ("sori") on the blades, and as the sori progress towards the blade tip, the spores mature and the sori are abscised from the blades (*in* CDFG 2001). Harvest of bull kelp could result in the loss of the entire canopy because when this single surface float is also removed, the entire plant will eventually sink to the bottom.

Effects to Steller Sea Lions

While the importance of kelp forests as an essential habitat feature for Steller sea lions has not been established, pinnipeds such as harbor seals and California sea lions are often observed in giant kelp beds, foraging and milling. As with grey whales and their calves, kelp also may provide protection for Steller sea lions from top predators such as killer whales and sharks. In addition, kelp forests provide habitat for important prey species of Steller sea lions, including rockfish, herring, and salmonids.

With best management practices in place for cutting kelp, any harvest is likely to have little impact on the overall habitat, since kelp grows rapidly and can recover quickly. Based on the limited information available, the impacts of removal of a portion of available kelp habitat to Steller sea lions is considered negligible.

Kelp that is removed near a Steller sea lion breeding ground or rookery may disturb animals, if present. The effects of disturbance due to the presence of humans or vessels are described in Section 2.1.5.3 and will not be repeated here.

Effects to Salmonids

Salmon fry and juveniles use kelp as protection from predators before heading out into the open ocean for their adult lives. Kelp also buffers against wave and current activity and can provide an important source of primary and secondary production for salmonids. Most of the studies of the effect of kelp harvest on fish populations have looked at non-salmonid species.

While several earlier studies of the effect of giant kelp harvest showed no measurable effect on fish populations associated with the kelp (*e.g.* Limbaugh 1955, Quast 1968 and Davis 1968 all *in* CDFG 2001), some researchers have found that kelp harvest affected the distribution of fish. For example, juvenile rockfishes tended to move either vertically or horizontally away from the impacted area. Furthermore, studies have shown that the removal of canopy cover may also

contribute to greater predator success in harvested areas versus non-harvest areas (Miller and Geibel 1973 and Houk and McCleneghan 1993, both *in* CDFG 2001). The overall conclusion by CDFG (2001) was that fish may be temporarily displaced following giant kelp harvest, and that cutting kelp canopies may open up some areas to predation that would otherwise not be readily accessible.

General harvest of bull kelp results in the loss of the entire canopy since the single surface float is removed, causing the entire plant to sink to the bottom. Studies of the effect of harvesting bull kelp on fish species showed both positive and negative short-term effects, and effects may be highly site-specific and time-dependent. For example, experimental removal of bull kelp resulted in an increase in bottom cover of understory seaweeds (Thom 1978). Based on the lack of information in the research, CDFG (2001) could not reach a conclusion as to whether or not the harvest of bull kelp had a significant effect on fish populations.

Because of the different characteristics of the two main kelp species that may be cut by oil spill responders, the effect on salmonids will depend on the kelp species. While the cutting of the canopy of giant kelp will still leave much of the plant intact, bull kelp harvest will result in loss of the entire canopy. Based on the information provided in CDFG (2001), kelp removal may temporarily displace salmonids that depend on the habitat for cover, protection, and a source of food. Since cutting the entire canopy of bull kelp will result in permanent loss of this plant, the effects to salmonids are likely to be greater than cutting the canopy of giant kelp.

While the importance of kelp forests to salmonids is not well studied, research conducted on the effects of kelp removal on non-salmonid species show that kelp harvest may temporarily displace them and expose them more to predators. NOAA Fisheries also recognizes that the purpose of kelp removal during an oil spill is to remove oil that is trapped in the kelp. This response action may therefore benefit local fish populations by removing oil from their aquatic habitat. Based on all of the above, NOAA Fisheries concludes that kelp removal is not likely to adversely affect listed salmonids or their habitat.

<u>Beneficial Effects of the Response</u>
This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and/or critical habitat in the action area. The objective of this response is to remove kelp fronds that have been contaminated by oil or that might impede oil removal efforts. If oiled kelp fronds are allowed to remain intact, it is likely that the oil adhering to them will be remobilized, possibly adversely affecting other habitats and species. As a result, this response is likely to benefit listed species by confining the effects of oil to less sensitive environments, and to environments in which removal of the oil may be expedited. The successful implementation of this response will result in a shorter presence of oil in the environment and shorter exposure time to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment (if untreated, weeks to months in open water habitats or months to years in shoreline habitats), as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.10 Removal of Surface Oil

The objective of this response method to remove oil stranded on the shoreline with a minimum of sediment, using either hand tools (hands, rakes, shovels, and other manual means), passive sorbents (*e.g.* snares), or vacuum (*e.g.* duckbill). Collected oil is placed in bags or containers and removed from the shoreline. No mechanized machinery is used, with the possible exception of ATVs (effects discussed in Section 2.1.5.19). Removal of surface oil is not recommended for mud flats, because of the potential for mixing the oil down into the soft sediments. For similar reasons, removal of surface oil is typically only used along the edges of sheltered vegetated low riverbanks and marshes, and must be closely monitored. Removal of surface oil is not recommended for use on tidal flats.

Habitats Used: Removal of surface oil is recommended for use on: (1) Sheltered rocky shores and solid man-made structures; and (2) sheltered rubble slopes. This variation is conditionally recommended for use on: (1) Rocky shorelines, (2) sandy beaches, (3) gravel beaches, (4) sheltered vegetated low banks, and (5) marshes. Passive sorbents are recommended for use on: (1) Sand beaches, (2) gravel beaches, (3) sheltered rocky shores and solid man-made structures, (4) sheltered rubble slopes, (5) sheltered vegetated low banks, and (6) marshes. Passive sorbents are conditionally recommended for use on: (1) Exposed rocky shorelines and (2) tidal flats. Lastly, vacuuming is conditionally recommended on all shoreline habitat types except for tidal flats.

Effects on Steller Sea Lions

Removal of surface oil is a response that is likely to be used on Habitats Used by Steller sea lions. Therefore, Steller sea lions are likely to be exposed to any potential effects of the manual removal of oil. Direct effects of this response on Steller sea lions may occur through disturbance (includes any variation of the response) or entanglement in collection equipment (passive sorbents). The impacts of this response action on prey species of the Steller sea lion are considered negligible, since any prey collected is likely to be heavily oiled and dead. This action is not likely to adversely modify critical habitat.

Entanglement in Strings of Snares: Sorbent material, known as snares, may be tied in strings and placed along the intertidal zone. As described earlier, the snares collect oil along beaches where trapped oil becomes refloated over the course of several tidal cycles. If such collection devices are placed near a Steller sea lion haulout or rookery, the possibility exists that an animal or animals could become entangled in the strings, especially if the strings become unfastened from their holds (or anchors). However, entanglement is highly unlikely. First, Steller sea lions are naturally accustomed to avoiding obstacles and debris. Second, unlike fishing gear, which often has hooked or entangled fish (*i.e.* sea lion food) associated with it, snares are not likely to attract a sea lion. The USCG (2002) uses entanglement rates for Steller sea lions in lines associated with crab pots as an analog to infer entanglement rates in lines of snares. Loughlin *et al.* (1986) recorded entanglement rates of Steller sea lions at rookeries and haulouts in the Aleutian Islands. Of 30,117 sampled adults and pups (53% and 47% of the sample, respectively), only 11 adults showed signs of entanglement in any sort of debris, including nets and twine. These data indicate an entanglement rate of 0.00036, or less than 4 animals out of every 10,000.

Therefore, while the possibility exists that strung-up snares could entangle Steller sea lions, the available data indicate that entanglement is highly unlikely.

Disturbance: Because the manual removal of oil involves the use of personnel to collect/remove oil and deploy/remove sorbent materials, and machinery to vacuum oil from the shoreline or haul oil out of the contaminated area, any collateral activities performed near Steller sea lion haulouts or rookeries are likely to cause disturbance to these listed species. Disturbance to Stellers could be significant, depending on the number of people in the area, the type of equipment used, and the duration of the response, all of which depend on the size and extent of the oiled area.

Disturbance of Steller sea lions on rookeries, during breeding season (May to August), may have immediate and delayed effects. Such effects are discussed in Section 2.1.5.3 and will not be repeated here.

The effects of any motorized transport and support are discussed in the Motorized Transport and Support sections (Sections 2.1.5.18, 2.1.5.19 and 2.1.5.10) of this Opinion.

Effects on Salmonids

Because all life stages of salmonids may be present in habitat in which this response can take place, manual removal of oil, including the use of hand tools, passive sorbents, and vacuums, may affect but is not likely to adversely affect salmonids. While there is a potential for salmon fry to become entangled in snares, this likelihood is low, especially since there is sufficient space between the snares for salmonids to pass. In addition, any salmonid fry that are in an area where oil is being collected by snares are most likely already weakened or dead. Although prey species that are important to salmon are also expected to be present and dependent upon these nearshore areas, this response action (particularly vacuuming) is not likely to affect them, since they are likely to already be debilitated or killed by the oil. Because this action minimizes the removal of sediment or gravel along the shore, this action is not likely to adversely modify critical habitat of salmonids.

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove stranded oil from shoreline habitats for disposal. If oil were allowed to remain in the environment (months to years in shoreline habitats), it is likely that the oil would remobilize into freshwater or marine environments where it may disperse into the water column or strand on another shoreline, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the effects associated with its presence in the environment. Heavily oiled shorelines could result in chronic leaching of oil into the adjacent water column. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.11 Oiled Debris Removal

The objective of this response is the removal of oiled debris (organic and man-made) from the shoreline. Debris (*e.g.*, seaweed, trash and logs) is removed when it becomes heavily contaminated and when it is either a potential source of chronic oil release, an aesthetic problem, or a source of contamination for organisms on the shoreline.

Habitats Used: Oiled debris removal is recommended for use on: (1) Sand beaches, (2) gravel beaches, (3) sheltered rocky shore and solid man-made structures, and (4) sheltered rubble slope. Oiled debris removal is conditionally recommended for use on: (1) Exposed rocky shorelines, (2) tidal flats, (3) sheltered vegetated low banks, and (4) marshes.

Effects on Steller Sea Lions
Should this response take place in and around a Steller sea lion haulout or rookery, the only direct effect to this species is potential disturbance by personnel involved in the response, as well as any equipment that may be used to haul the debris out of the area. Among the factors that could exacerbate sea lion disturbance are the number of people involved in the response, and the duration of the removal procedure, both of which depend on the extent of the oiled area requiring attention. Because Stellers do not depend on natural debris such as logs or seaweed for their habitat, this action is not likely to adversely modify critical habitat.

Physical Disturbance: The effects of physical disturbance to Steller sea lions is discussed in Section 2.1.5.3 and will not be repeated here. While the effects of disturbance by oiled debris removal are similar to that of manual removal of oil, they are likely to be increased with the use of heavy equipment. The presence of forklifts and trucks in an area is likely to keep Steller sea lions from hauling out in the area until such equipment is removed. If there are few substitute areas nearby and it is during a season important for hauling out (*e.g.* breeding, pupping and molting), this effect could be detrimental to the health of an individual animal or a subpopulation.

Effects on Salmonids
Because all life stages of salmonids may be present in habitat in which this response can take place, the removal of oiled debris is likely to affect salmonids through disturbance. Interdependent direct effects may include disturbance and removal of prey attached to natural debris. This action is also likely to adversely modify critical habitat through the removal of important habitat features such as large woody debris.

Disturbance of Salmonids: If debris is removed from spawning beds during spawning events, personnel wading through streams may adversely affect salmonids by disturbing spawning events, impacting redds, and possibly harming or killing eggs or emerging fry. The effect of foot traffic on spawning beds is discussed in Section 2.1.5.20.

Disturbance and Removal of Prey Species and Their Habitat: The removal of oiled debris in the intertidal zone and other areas of shoreline habitats in coastal and freshwater environments may

disturb or remove features of the habitat (*e.g.*, logs, seaweed) that are important not only to salmonids, but also to their prey, including insect larvae, amphipods, copepods, fish larvae and euphausiids (Starkes 2001). Any prey species attached to oiled debris will also be removed and disposed of, although such species are most likely already debilitated or dead from exposure to oil. Removal of oiled debris such as vegetation may remove some of the habitat depended on by important prey species of juvenile salmonids. Terrestrial insects, which serve as important prey of juvenile chinook and chum salmon in subestuaries and nearshore reside in marine riparian vegetation. In addition, other invertebrates such as mysids and amphipods are connected to vegetation via detritus-based food webs and young salmon may be affected by lack of availability of prey.

Removal of Essential Habitat Features (e.g. large woody debris): Natural debris such as large woody debris (LWD) may serve as an important habitat feature for salmonids of all life stages, both in stream habitats and in the nearshore marine or estuarine environment. For the purposes of this Opinion, "large wood" is defined as a log that: (1) Is dead; (2) has a root system (if present) that no longer supports the weight of the stem/bole; (3) has a minimum diameter of 0.1 meters (10 centimeters) along 2 meters of its length; and (4) has a minimum 0.1 meter of length extending into the bankfull channel.

Combined with other natural channel-forming features such as boulders and bedrock, LWD in streams helps to create different types of pool habitats (*e.g.* plunge pools, scour pools, eddy pools) and to increase hydraulic heterogeneity. Pools associated with LWD are preferred habitats for various age classes of juvenile coho salmon and steelhead, and higher volumes of LWD have been correlated with higher densities of juvenile salmonids in winter (*in* Beechie and Sibley 1997). Cederholm *et al*. (1997) found that winter populations of juvenile coho salmon increased significantly in stream sites that had LWD added to create an increase in pool surface area. Large wood and associated pool habitats created from them provide cover from predators and refuge habitats during storm events (Everest *et al*. 1985 *in* Spence *et al*. 1996). Large wood also forms channel units and specific microhabitats, creating a complexity that allows multiple species to coexist. The LWD also retains sediment and particulate organic matter (*in* Beechie and Sibley 1997) and protects against anchor ice formation during winter months. Undercut banks and overhanging vegetation also serve as cover for juvenile anadromous and resident adult salmonids. Any shading provided by woody debris can enhance salmonid habitat by reducing in-water temperatures, especially during the warmer months of the year.

On beaches, logs become embedded in beaches and serve an important function, trapping sediment that build the backshore and reducing wave-induced erosion. Any shade produced by marine vegetation can enhance the survival of beach-spawning surf smelt by reducing thermal stress and dessication.

Removing LWD from aquatic environments used by salmonids will most likely degrade the condition of the habitat by eliminating the multiplicity of functions provided by this important feature. That is, the following functions may be reduced or eliminated: Numbers and areas of pools, off-channel habitats, retention of sediments and organic materials (including salmonid carcasses), hydraulic and physical complexity and the overhead cover provided to salmonids.

Indirect, or long-term effects of the removal or reduction of debris, particularly LWD, include: (1) Decreased production of salmonids; (2) general reduced biological productivity; and (3) increased transfer of sediment from headwaters to downstream areas (*in* Murphy and Koski 1989).

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove shoreline debris that has been contaminated by oil. If oiled debris is allowed to remain intact (weeks to months in shoreline habitats), it is likely that the oil adhering to it will be remobilized, possibly adversely affecting other habitats and species. As a result, this response is likely to benefit listed species by confining the effects of oil to less sensitive environments, and to environments in which removal of the oil may be expedited. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.12 Trenching

This response involves the digging of trenches or wells down to the depth of the oil (or water table) to intercept oil migrating through the substrate. The oil collected in the trench or well is then recovered by vacuum pump or skimmer and disposed of off site.

Habitats Used: Trenching and recovery wells are conditionally recommended for: (1) Sand beaches, (2) gravel beaches (pebble- to cobble-size substrate), and (3) vegetated low banks.

Effects on Steller Sea Lions

If trenches and recovery wells are dug in or near areas of Steller sea lion haulouts, breeding grounds, or rookeries, this response may have a direct effect on Stellers in the form of disturbance and entrainment of pups.

Physical Barrier and Trap: If trenches and wells are dug on a Steller sea lion rookery, it is possible that sea lion pups could be trapped in trenches if they fell or crawled into ones that were sufficiently deep. Entrapment could lead to abandonment, starvation or drowning, if the trench reached the depth of the water table and filled with water.

Disturbance: Because digging trenches and recovery wells involves people and equipment, this response has the potential to disturb Steller sea lions if performed in or near a sea lion haulout or rookery. The level and extent of disturbance will depend on the season (*i.e.* breeding, molting), the number of people in the area, the number and type of equipment used, and the duration of the procedure, all of which depend on the size and extent of the oiled area requiring treatment.

The effects of disturbance to Steller sea lions is discussed in Section 2.1.5.3. The effects of disturbance by trenching are likely to be increased with the use of heavy equipment such as backhoes and tractors - the effects of the use of heavy equipment on Steller sea lions is discussed in Section 2.1.5.19.

Effects on Salmonids

The process of digging trenches and recovery wells is limited to the upper intertidal zone, and responders will not dig in the lower portions of the beach, where attached plants and organisms are likely to be found. In addition, while trenching may enhance the penetration of oil and increase the amount of contaminated sediment, lining the trenches with impermeable material such as plastic should minimize any effects. These conditions should minimize effects to salmonids found in the nearshore area. Potential direct effects to salmonids that could occur include: Stranding at low tide, and inundation of sediments into the nearshore aquatic habitat.

Stranding at low tide: If juveniles or fry are present in the nearshore area, they could become stranded at low tide if wells have been inundated with water during a high tide and they are trapped. Chinook fry are probably the most vulnerable in intertidal habitats, as these species have been found among the last fish to vacate tidal channels when the channels dried up at low tide. At high tide, the young chinook tended to scatter along the edges of marshes at the highest points reached by the tide. As the tide receded, the chinook retreated into tidal channels and creeks that dissect the marsh areas and retain water at low tide (*in* Groot and Margolis 1991). Salmonids that are stranded in these trenches could face an increased risk of prolonged exposure to the oils that have collected within, predation, low oxygen, and elevated temperatures.

Inundation of Sediments: Since trenching and digging recovery wells involves the removal of sediment, the removed sediment, if not covered or made inaccessible by an incoming tide or rainfall, could be transported into the nearshore waters. In addition, digging trenches or wells on an unstable shoreline, or a shoreline that is already at risk from erosion can reduce the stability of the bank, increasing the potential for erosion, and inundation of sediments into the nearshore aquatic environment. While the effects of increased sediment into the environment are expected to be localized and temporary, any increase in turbidity or sediment in a sensitive area such as a spawning bed could have adverse effects to salmonids. The effects of sedimentation on salmonids and critical habitat is discussed in Section 2.1.5.14 (Flushing with Ambient Water) and will not be repeated here.

Heavy equipment could be used to dig trenches and recovery wells. The effects of heavy equipment on salmonids and critical habitat are discussed in the Section 2.1.5.19.

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove oil that has penetrated into subsurface sediments for disposal. If oil were allowed to remain in the environment (months to years in shoreline habitats), it is likely that the oil would remobilize into aquatic or marine environments where it may disperse into the water column or strand on another shoreline, likely adversely affecting additional habitats and species. In addition, subsurface oil may persist for longer periods of time than oil stranded on the surface of a

substrate, as subsurface oil is less exposed to environmental processes that naturally break it down. As a result, this response is likely to benefit listed species by removing oil and the effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.13 Removal of Oiled Sediment

The objective of this response method is to remove oiled surface sediments by either hand tools or mechanical use of various kinds of motorized equipment. Oiled sediment removal is restricted to the supratidal and upper intertidal areas to minimize disturbance of biological communities in the lower intertidal and subtidal. After removal, oiled sediments are transported and disposed of off site. New sediments are not typically transported to replace those that were removed; however, a variation of this response that includes sediment replacement is used for beaches with low natural replenishment rates or high rates of erosion. Oiled sediments are excavated using heavy equipment on the beach at low tide. After removal of the oiled sediment, new clean sediment of similar composition is brought in for replacement. A second variation of this response is sediment "reworking," where oiled sediments are re-worked by roto-till or other mechanical equipment to break up oil deposits, increase surface area, and mix oxygen into deep subsurface oil layers.

Habitats Used: Oiled sediment removal is conditionally recommended for use on: (1) Sand beaches, (2) gravel beaches, (3) sheltered rubble slope, and (4) sheltered vegetated low banks. Reworking of oiled sediment is conditionally recommended for use on: (1) Sand beaches and (2) gravel beaches. Oiled sediment removal with replacement is conditionally recommended for use on: (1) Sand beaches, (2) gravel beaches, and (3) sheltered rubble slope.

Effects on Steller sea lions
If mechanical removal of oiled sediment takes place near Steller sea lion haulouts, breeding grounds, or rookeries, this response may have a direct effect on Stellers in the form of disturbance. If a significant amount of sediment is removed without replacement, such that available haulout area is reduced, this response may adversely modify critical habitat.

Physical Disturbance: The mechanical removal of oiled sediment from shorelines requires the use of mechanical equipment (*e.g.* backhoes, trucks, roto-tillers) and the personnel to operate the equipment. The presence of humans and machinery, along with the noise associated with the response, is likely to disturb Steller sea lions if they are hauled out nearby. Effects will be magnified if the response takes place during sensitive time of the year for Stellers, such as the breeding/pupping season (May through August). Effects of disturbance are discussed in Section 2.1.5.3 and will not be repeated here.

Effects on Salmonids

The removal of oiled sediments could adversely affect listed salmonids or their critical habitat through sedimentation, increased erosion of shorelines, and introduction of oil into the aquatic environment.

Sedimentation: The removal of oiled sediment is not expected to increase sediment transport to the nearshore environment. First, the removal of sediment is minimized in all cases. Secondly, affected habitats are monitored closely (described previously in the description of this response) during sediment removal, as well as after removal has been completed, to ensure that sedimentation and erosion are not occurring. However, this response can take place between the mid- and upper-intertidal zones, collecting oiled sediments stranded within this zone. As a result, the potential for sedimentation exists. The effects of sedimentation are described extensively in the following section (Section 2.1.5.14 - Flushing with Ambient Water) and will not be repeated here.

In rare cases, sediment that is oiled and removed may be replaced with clean sediment. This action requires consultation with the United States Army Corps of Engineers, and may be preferred in habitats with low rates of natural replenishment or a high risk of erosion. In these cases, replacement of sediment is expected to improve shoreline stability and minimize loss of sediment into the nearshore habitat. While no sedimentation is expected to occur as a result of this action, the introduced sediment is expected to go though a natural sorting process with existing sediments.

Increased Erosion of Shoreline: Sediment that is removed from a stable shoreline, particularly in a vegetated area, may increase the potential for erosion of that shoreline. This can occur by disrupting the stability of the shoreline (*i.e.* removing compacted sediment), or removing the vegetation that helps to stabilize the shoreline. Increasing the vulnerability of a shoreline to erosion may introduce more sediments into the nearshore waters. The effects of sedimentation are discussed in the Section 2.1.5.14 (Flushing with Ambient Water).

Introduction of Oil into the Aquatic Environment: Sediments contaminated with oil that are "re-worked" can be resuspended by an incoming tide or winter flood and can subsequently inundate the adjacent water. Oil introduced into the aquatic environment may adversely affect salmonids, particularly juveniles in the surface waters or surface dwelling organisms which salmonids depend on for prey. The embryonic stage of salmonids may be especially vulnerable, with far-reaching effects evidenced through low survival rates and/or low rates of return back to the stream (*e.g.* Wertheimer *et al*. 2000).

Heavy Equipment: The effects of heavy equipment on or near salmonid habitat are discussed in Section 2.1.5.19.

Beneficial Effects of the Response

This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove oiled sediments for disposal. If oil were allowed to remain in the environment (weeks to months

in open water habitats or months to years in shoreline habitats), it is likely that the oil would remobilize into freshwater or marine environments where it may disperse into the water column or strand on another shoreline, likely adversely affecting additional habitats and species. In addition, subsurface oil may persist for longer periods of time than oil stranded on the surface of a substrate, as subsurface oil is less exposed to environmental processes that naturally break it down. As a result, this response is likely to benefit listed species by removing oil and the effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.14 Flushing with Ambient Water

The objective of this response action is to remobilize oil stranded on surface substrate, as well as oil from crevices and rock interstices, to the water's edge for collection. Water is pumped from hoses onto an oiled beach, beginning above the highest level where the oil is stranded and slowly working down the water level. As described earlier, variations to this response include: (1) Flooding; (2) flushing with ambient water, low-pressure (<50 psi); and (3) flushing with ambient water, elevated-pressure (up to 100 psi - 1,000 psi). Increased water pressure may be needed to assist in the remobilization as the oil weathers and begins to harden on the substrate. Because of the potential for higher pressures to cause siltation and physical disruption of the softer substrates, flushing with higher pressures is restricted to rock or hard man-made substrates.

Habitats Used: Flooding is recommended for use on gravel beaches only. This response is conditionally recommended for use on: (1) Sand beaches, (2) sheltered rocky shores and man-made structures, (3) sheltered rubble slopes, (4) sheltered vegetated low banks and (5) marshes. Low-pressure flushing is conditionally recommended for all shoreline habitats except for tidal flats. High-pressure flushing is conditionally recommended for use on: (1) Exposed rocky shores; (2) gravel beaches, particularly those consisting of cobble and boulder-size rocks, and rip-rap; (3) sheltered rocky shores and man-made structures; and (4) sheltered rubble slopes.

Effect on Steller Sea Lions

Because Steller sea lions use a variety of substrates as haulouts and rookeries, they may be present during an oil spill response involving flushing of all variations (flooding, low-pressure, and elevated pressure). Direct Effects to Steller Sea Lions from this response may include harassment. The impacts of any introduction of sediment into the nearshore environment on Steller sea lions, their habitat, or their prey are considered negligible, as this action is expected to be temporary and localized, and most prey targeted by sea lions (*e.g.* herring, rockfish, squid, *etc.*) can be found readily offshore.

Physical Disturbance: The act of flushing oil from a variety of habitats in which Steller sea lions may reside requires additional support, which may consist of mechanical equipment and the personnel to operate it. Should oil become stranded on a Steller sea lion haulout or rookery, the flushing response, particularly the presence of humans and equipment, would likely disturb sea lions hauled out on adjacent land. In addition, the use of hoses has been included in NOAA Fisheries' 1995 draft list of acceptable "reactive deterrents," which can be used without causing an animal serious injury or death (Federal Register: May 5, 1995, Volume 60, Number 87, pages 22345-22348). Thus, the agency recognizes that spraying water at or near animal(s) may deter the animal(s) from the area. The effects of physical disturbance on Steller sea lions due to this response is discussed in Section 2.1.5.3 and will not be repeated here.

Effect on Salmonids

Flushing substrate in or near habitat where listed salmonids may be found may adversely affect a particular ESU and/or may adversely modify critical habitat, primarily through sedimentation, erosion of the shoreline, and re-introduction of oil into the aquatic environment. Given that salmonids may be present, the level of adverse effects will primarily depend on the habitat in which this response or variation of response is used. For example, low-pressure flushing on a sand beach, a vegetated low bank, or a marsh, may introduce more sediments and oil into the adjacent water, disrupt existing vegetative structure, and increase erosion.

Sedimentation: Oil spill responders take care to prevent sediment from being flushed into the aquatic and marine environment through the flushing techniques used and by monitoring treated areas. However, even low-pressure flushing of some types of habitat, such as sandy beaches or the intertidal zone may result in an influx of some sediments into a stream system or subtidal areas nearshore before personnel can respond and alter or terminate the activity. Because high-pressure flushing is conditionally recommended on gravel beaches, the possibility exists that underlying sediment could be mobilized and may enter an adjacent stream or nearshore waters.

Increased levels of fine sediment can impact the feeding and growth of all life stages of salmonids by reducing the availability of prey species, impacting spawning and incubation habitats, decreasing the available shelter, and disrupting basic biological functions such as respiration, migration, and foraging. Juveniles may be particularly susceptible, as they feed opportunistically on available prey species and depend heavily on habitat for rearing, cover, and growth.

Increased concentrations of sediments may alter substrate composition and fill substrate interstices, which may decrease the total abundance, diversity, and concentration of invertebrate prey. When fine sediment is deposited on gravel, species diversity and density drops significantly, probably due to a combination of factors. First, deposited sediment can reduce the accessibility to microhabitats by embedding the edges of cobbles. Secondly, sediment can entomb benthic invertebrates, which can then die of reduced oxygen levels or oxygen depletion. Particulate matters can physically abrade and mechanically disrupt respiratory surfaces (*e.g.*

epithelia of benthic macroinvertebrates) of aquatic vertebrates and invertebrates. Moving sediment can also grind and dislodge algae, reducing the available forage for aquatic invertebrates, which in turn, may reduce abundance of these species for salmonids.

Turbidity may also reduce light penetration, which in turn can limit the production of benthic algae and change plant species composition. Light reductions may also decrease the reactive distance of juvenile and adult salmonids to prey; drifting insects or zooplankton may pass by unnoticed by salmonids due to turbid conditions.

Increased sediment levels in gravel beds can impact all life stages of salmonids. Survival of eggs and fry are compromised when gravel beds are inundated with sediment due to smothering of eggs and impeding emergence of fry. Phillips *et al*. (1966 *in* Spence *et al*. 1996) found that the emergence of coho fry decreased as the percentage of fine sediment in the gravel increased, probably due to the reduced oxygen content and the increased difficulty of fry in reaching the surface. In addition, organic materials associated with increased sedimentation can enter the interstices of the substrate and use up oxygen as they decompose, creating a reduction in dissolved oxygen levels, compromising salmonid embryos (Bjornn and Reiser 1991 *in* Spence *et al*. 1996).

Sediment can also cover intergravel crevices used by salmonids for shelter, thus decreasing the carrying capacity of streams for young salmon and trout. Gammon (1970 *in* Spence *et al*. 1996) found that fish vacated pools in summer after high sediment accumulation, and salmonids have been shown to avoid areas with high percentages of sand, silt, and clay (Burner 1951 and Stuart 1953 *in* Spence *et al*. 1996). Elevated sediment loads can also affect salmonid habitat by increasing the frequency of channel scour and fill events, increasing channel width through aggradation, and decreasing the stability of woody debris.

In general, salmon tend to avoid water with high concentrations of suspended sediment (Burner 1951, Stuart 1953). Studies on the effects of turbidity on salmon spawning migrations have been inconclusive; while some salmon runs appeared to be unaffected, other runs strayed to nearby streams during times of high turbidity (Quinn and Fresh 1984). For juvenile salmonids, Lloyd *et al*. (1987 *in* Spence *et al*. 1996) found that the fish avoided chronically turbid streams. Studies on fry migrations have indicated that high concentrations of suspended sediments may have the opposite effect, as the number of migrations increased during times of high turbidity (*e.g.* Thomas 1975). Diel migrations of salmon, while normally observed at night, appeared to be more evenly spread throughout the day with increased turbidity (Burgner 1991). Thus, turbidity may provide protection from predation or obscure the visual cues that normally prompt diel migrations. In a laboratory setting, however, increased turbidity has shown reduced growth rates of juvenile coho salmon and steelhead trout. In addition, emigration rates in turbid streams were higher than in clear streams (Sigler *et al* 1984 *in* Spence *et al*. 1996).

High level of suspended solids can also influence respiration of salmonids by abrading or clogging gill surfaces (Warren 1971 *in* Spence *et al*. 1996). Suspended solids having a high

colloidal content may also increase the exposure of fish to heavy metals in the water column adsorbing to colloidal materials.

Overall then, an increase in the introduction of suspended sediment, or increased turbidity, is likely to adversely affect salmon throughout each stage of its life history and is likely to adversely affect critical habitat.

Erosion of the Shoreline: Flushing or flooding water over an already eroded shoreline may further exacerbate the effects of erosion. Low-pressure flushing is conditionally recommended for use on sheltered vegetated low banks; therefore, the possibility exists that plants that stabilize the shoreline could be impacted (*e.g.* dislodged or uprooted), increasing the possibility of further erosion. Erosion of a streambank may increase sedimentation, which, as discussed previously in this section, may adversely affect salmonids and their critical habitat.

Impingement or Entrainment of Juvenile Salmonids: Depending on the circumstances of a given spill, the water used for flushing a contaminated shoreline may be taken from the surrounding uncontaminated waters. This method of water collection requires that water be pumped into 8-inch diameter hoses or tanks and dispensed on the contaminated substrate. To prevent the intake of fish, other aquatic organisms, and debris, screens are attached to the hoses. Although the screen design may vary, the largest openings are 1 $inch^2$. While differences exist among salmonid species, fry emerging from the gravel are about 30 mm (1.2 inches) (*in* Groot and Margolis 1991). Therefore, if this response is used in a stream containing newly emerged or developing fry and if the intake flow is sufficient, the fish may become entrained or impinged at the screen opening. Entrainment can occur when the fish is drawn into any of the openings, while impingement can occur when a fish is not able to avoid contact with the opening. Either can cause bruising, descaling, and other injuries. Impingement, especially if prolonged, repeated, or occurring at high velocities, can cause direct mortality.

Water Quality: In situations where water cannot be pumped from the surrounding environment and used to flush oil, water may be brought from off-site in tanks mounted on trucks. Water brought in from off-site is not treated and has not been chlorinated. Furthermore, water used to flush marine environments is saline, while that used to flush freshwater environments is also fresh. As a result, when used in salmonid critical habitat, the use of water from an off-site site location is not expected to adversely affect listed salmonids.

Reintroduction of Oil into the Aquatic Environment: The purpose of flushing oil off the shoreline is to mobilize it into the aquatic environment, where it can be contained by booms and picked up by sorbent, vacuum, skimmer, *etc.* Without these available response methods, the influx of oil into a stream or nearshore area where listed salmonids are present could adversely affect these species. Salmonids in the embryonic stage may be especially vulnerable, and effects could be evident through decreased survival rate or returning run size into a particular stream system (Wertheimer *et al.* 2000). However, as noted earlier, NOAA Fisheries assumes that the proper cleanup methods and procedures are imposed by the responders and their administrators; therefore, any effects will be minimized through prompt cleanup of oil.

Vessel activity and other motorized support are likely to accompany the ambient water flushing response. The potential effects of these support activities on listed salmonids are discussed in Sections 2.1.5.18 (Watercraft), 2.1.5.19 (ATVs and Heavy Equipment) and 2.1.5.20 (Foot Traffic) of this Opinion.

Beneficial Effects of the Response
This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove stranded oil from shoreline habitats for disposal. If oil were allowed to remain in the environment (weeks to months in open water habitats or months to years in shoreline habitats), it is likely that the oil would remobilize into freshwater or marine environments where it may disperse into the water column or strand on another shoreline, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the adverse effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.15 Warm-Water, Moderate-Pressure Washing

As described earlier, the objective of this response method is to mobilize thick and weathered oil that has adhered to rock surfaces, prior to flushing it to the water's edge for collection. Seawater is heated (typically between ambient and 90ºF) and applied at moderate pressure to mobilize weathered oil that has adhered to rocks. If the warm water is not sufficient to flush the oil down the beach, flooding or additional low or high-pressure washing may be used to float the oil to the water's edge for pickup. Oil is then trapped by boom and may be picked up with skimmers or sorbents. A variation of this response is using hot water (90ºF to 170ºF), with moderate pressure to dislodge and mobilize trapped and weathered oil from inaccessible locations and surfaces. Water heaters are mounted offshore on barges or small land-based units.

Habitats Used: Warm water, moderate-pressure washing is conditionally recommended for use on: (1) Exposed rocky shores, (2) gravel beaches (including rip-rap), and (3) sheltered rocky shores and man-made structures. Hot water flushing is conditionally recommended for use on: (1) Exposed rocky shorelines; (2) gravel beaches (specifically rip-rap); and (3) sheltered rocky shores and man-made structures.

Effects on Steller Sea Lions
The warm and hot water flushing responses may be utilized in some of the shoreline types utilized by Steller sea lions. Consequently, the potential for flushing to affect Steller sea lions exists. The effects of warm and hot water flushing relative to Steller sea lions are expected to be the same as those caused by ambient water flushing (*i.e.*, physical disturbance of adult sea lions,

as well as pups). The potential effects of introducing water above the ambient temperature are discussed below.

Increased Water Temperature: The application of warm or hot water (relative to the ambient temperature) is not likely to result in adverse impacts on Steller sea lions or their critical habitat. A small volume of hot water may be applied to shoreline substrate to loosen thick or weathered oil, but it will be cooled quickly as it enters the ocean, a vast heat sink. Furthermore, warm/hot water flushing is usually only used in conjunction with ambient water flooding. As a result, the water dispensed in flooding will cool the small volume of hot water substantially before it washes off the shoreline substrate and into aquatic areas used by foraging Steller sea lions. The temperature and volume of the water entering the nearshore environment are not expected to affect Steller sea lions or their critical habitat.

Vessel activity and other motorized support are likely to accompany warm water, moderate-pressure washing. The potential effects of these support activities on Steller sea lions are discussed in the Sections 2.1.5.18 and 2.1.5.19 of this Opinion.

Effects on Salmonids

Many of the effects of warm/hot water flushing on salmonids are expected to be the same as those for ambient water flushing. However, flushing with warm or hot water could cause water temperatures in the nearshore aquatic environment to rise. The effects of increased water temperatures are discussed below.

Increased Water Temperature: In warm/hot water flushing, a small volume of hot water may be applied to shoreline substrate. Ambient water flooding is often done in conjunction with warm/hot water flushing not only to help flush the softened oil from the shoreline substrate, but also to minimize the amount of water above the ambient temperature that enters the environment. Although, warm/hot water flushing is not expected to increase the ambient water temperature significantly, the potential exists. If salmonids are present in nearshore waters, an increase in temperature may adversely affect them. The following discussion includes direct and indirect (*i.e.* long term) effects of increased temperature on salmonids; however, NOAA Fisheries recognizes that most of the studies in the field or in the laboratory have looked at temperature effects in a much larger environment and over a much longer term period than would be expected during an oil spill response and cleanup.

As evidenced by the wide range of spawning temperatures, salmonids have evolved to persist in a variety of thermal environments. However, water temperature is of critical importance to salmonid survival. Salmonid species have a range of temperatures that are preferred or tolerated. Above or below these limits, their health and survival may be compromised. Upper and lower temperature thresholds exist for adult migrations (Spence *et al.* 1996), egg development (Seymour 1956, Combs 1965), juvenile and adult residence (Bjornn and Reiser 1991), and juvenile migrations (Groot 1982). Water temperatures that exceed these thresholds in either extreme are likely to result in adverse effects on salmonids.

Increasing water temperatures generally increase the ingestion rates of fish; however, when temperatures exceed the thermal optimum for the population or species, their ability to forage is severely compromised. Similarly, growth rates increase with elevated water temperatures, up to a thermal optimum - above this level, reductions in appetite and increasing metabolic demands combine to reduce the growth and development rate. For salmonid populations that have specifically adapted to warm or cool environments, changes in enzyme activity in response to altered temperatures can prove to be ecologically damaging, even though such changes may not be evident in the form of acute or chronic physiological stress (Spence *et al*. 1996).

Water temperatures play a very important part in duration of egg incubation and emergence of Pacific salmonids, as well as determining the size of the emerging fry. "The development time decreases in an asymptotic fashion with increasing incubation temperatures with the rate of change in development time relative to temperature increase being greatest at the low end of the tolerable temperature range" (*in* Spence *et al.* 1996). Thus, small increases in temperature at the low end of the tolerable range can substantially modify the time of hatching and emergence. Early emergence may increase the exposure of fry to high-flow events or to predators. Temperatures may also influence the size of emerging fry; for example, warm temperatures tended to produce smaller reared coho salmon, while pink salmon fry tended to be larger when reared at warmer temperatures (pink reared at 8°C were larger than those reared at 4°C) (*in* Spence *et al*. 1996).

Increasing or decreasing the normal water temperatures within an aquatic ecosystem may also change the food webs, including predator-prey relationships and/or inter and intra-specific competition. Changing water temperatures can alter the composition of algal assemblages, disrupt the development and life-history patterns of benthic macroinvertebrates and zooplankton, and decrease the abundance and availability of important prey species for salmonids. Competitive interactions within and between species can also be affected, causing fish communities to be re-structured. For example, a particular species may be a more effective predator at higher temperatures than another species; therefore, this first species would be at an advantage with warmer waters. Similar, because increasing temperatures generally increases metabolic demands, young salmonids may be more vulnerable to piscivorous fish with higher temperatures (*in* Spence *et al*. 1996).

Changing water temperatures can greatly influence the susceptibility of Pacific salmonids to diseases. Numerous studies indicate that water temperature greatly influences the immune system of fish, the number and virulence of pathogens, and for microparasites, the occurrence of infective life stages in natural and aquacultural environments. Therefore, changes in water temperature through warm or hot-water flushing can directly alter the susceptibility of salmonids to infection by these pathogens and or increase the mortality of infected salmonids, Indirectly sublethal chronic infections may impair the ability of salmon to perform in the wild (*e.g.* increased vulnerability to predators, decreased ability to compete with other species, inability to reproduce), which may be evidenced in reduced future survival or reproductivity rates.

Vessel activity and other motorized support and the use of heavy equipment are likely to accompany warm or hot water, moderate-pressure washing. The potential effects of these support activities on listed salmonids are discussed in Section 2.1.5.18 and 2.1.5.19 of this Opinion.

Beneficial Effects of the Response
This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove stranded oil from shoreline habitats for disposal. If oil were allowed to remain in the environment (weeks to months in open water habitats or months to years in shoreline habitats), it is likely that the oil would remobilize into freshwater or marine environments where it may disperse into the water column or strand on another shoreline, likely adversely affecting additional habitats and species. As a result, this response is likely to benefit listed species by removing oil and the adverse effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.16 Vegetation Cutting

As described earlier, the objective of this response method is the removal of oiled vegetation attached to the shoreline to prevent the oiling of wildlife or remobilization of trapped oil. The upper parts of the oiled plant are cut away using hand tools or "weed eater" type power tools. The oiled plant cuttings are raked up and removed for disposal. This response method is generally used when large quantities of potentially mobile oil is trapped in the vegetation or when the risk of oiled vegetation contaminating wildlife is greater than the value of the vegetation that is to be cut, and there is no less destructive method to remove the oil. When conducted in marshes, boards are generally laid down for workers to walk; this distributes the worker's weight to prevent damage to plant root system and to avoid working oil deeper into the soft sediments.

Habitats Used: This response is conditionally recommended for use on: (1) Exposed rocky shorelines; (2) gravel beaches; (3) sheltered rocky shores and man-made structures; (4) sheltered rubble slopes; (5) sheltered vegetated low banks; and (6) marshes.

Effects on Steller Sea Lions
If vegetation cutting occurs in or near a Steller sea lion haulout or rookery when animals are present, this response action may directly affect these listed species through disturbance. The amount or extent of the disturbance will depend on the number of personnel involved, and the equipment used. The effects of disturbance to Steller sea lions is discussed in the Section 2.1.5.3 and will not be repeated here.

Effects on Salmonids

Cutting vegetation in the aquatic and marine nearshore and intertidal or subtidal areas may adversely affect salmonids by decreasing the availability and production of salmonid prey. This response may adversely modify salmon critical habitat through removal of important structure and features provided by vegetation.

Decrease in Food Availability and Production: Loss of vegetation through cutting and removal may have an adverse effect on juvenile salmon in particular by reducing the amount of organic input and food (*e.g.* insects). Juvenile salmonids depend on vegetation in both streams, estuaries, and in the nearshore marine environment. For example, Chapman (1965 *in* Groot and Margolis 1991) demonstrated that there was a positive correlation between the amount of terrestrial insect parts found in juvenile coho stomachs and the extent to which the Oregon streams were overgrown with vegetation. Life history research of chum shows that fry leave the rivers and begin feeding in estuaries and shallow nearshore marine habitats on epibenthic and neritic food resources, and the food web in the estuarine environment appears to be detritus-based, from production of macrophytic algae and eelgrass (*in* Groot and Margolis 1991). The resulting plant detritus sustains a rich invertebrate fauna, and much of the small crustaceans and aquatic insects are an important food source for juvenile salmon. Juvenile salmon experience the highest growth rates of their lives while in estuaries and nearshore waters, particularly because of the complex detritus-based food web, which provides rich and abundant prey. Food production by marsh plants, seaweed, eelgrass, epiphytes, and sediment microalgae surpasses food production in open waters.

Eelgrass beds are particularly important for salmonids, generating food and nutrients for the soft bottom community through primary productivity and plant decay. Its productivity can equal or exceed the productivity rates of most other aquatic plants, with rates reported in the Pacific Northwest ranging from 200 to 806 g C^{-2} yr^{-1} (*in* Williams and Thom 2001). Eelgrass provides living space and structure for many prey species of salmonids, which grow on or among its blades, on its roots, or in the stabilized substrate it colonizes. Dense beds serve as a refuge for small fish and invertebrates. Eelgrass beds also serve as a nursery for herring, an important prey of salmon, which use eelgrass as a spawning substrate.

While not well studied, the role of leaf litter and insects dependent on vegetation for substrate and food is likely important in nearshore and stream detritus production and food webs. Leaf litter is often the natural substrate of salmonids beginning to feed themselves, and newly emerged coho fry in captivity appear to have a higher survival rate when leaf litter is present. Parker *et al*. (1990) speculated that the presence of leaf litter may provide natural nutrients and odors and thus facilitate the transition to feeding during this critical period of development. Leaf litter may provide the base of a food chain containing insects and benthic invertebrates (Durbin *et al*. 1979 *in* Parker *et al*. 1990). Outmigrating smolts have been found to forage on insects produced in the riparian zone (Miller and Simenstad 1997 and Simenstad and Cordell 2000, both *in* Williams and Thom 2001).

Impacts to Habitat: Fish habitats are enhanced by the diversity of habitats at land-water interfaces and adjacent banks. Streamside vegetation provides shade that reduces water temperature and helps to stabilize shorelines and banks. Overhanging branches and inwater vegetation provide cover from predators. Insects and other invertebrates that fall from overhanging branches may be preyed upon by fish, or provide food sources for other prey organisms. In a marsh environment, the top portion of herbaceous plants serves several important functions, including the dissipation of wave energy and the reduction of sediment transport, while the dense "root-rhizome mat" adds stability to shore sediments (Knutson and Woodhouse 1983 *in* Williams and Thom 2001). Upper intertidal plants such as the pickleweed can provide detritus, prey production habitat, and juvenile salmon refuge capability.

Vegetation cutting may destroy habitat for salmon and species upon which salmon rely. Removal of vegetation may result in habitat losses on shorter time scales (*e.g.*, less than a growing season) or longer time scales (*e.g.*, several seasons or more if plants die or are eradicated from localized areas). Loss of habitat affects both salmonids and their prey. With less refugia, salmonids may be more susceptible to predation and exposed to higher water temperatures. Salmon prey may be affected by a loss of spawning substrate that could affect recruitment for as long as habitat has been altered. Banks that lose vegetation may be at risk of erosion, which would increase the level of sediments into the adjacent aquatic environment. The removal of vegetation on stream banks can increase the amount of water that infiltrates the soil and ultimately reaches the stream by reducing the water losses from evapotranspiration.

<u>Beneficial Effects of the Response</u>
This method of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The objective of this response is to remove vegetation after it has been oiled or to prevent it from being oiled. If oiled vegetation were allowed to remain in the environment (weeks to months in open water habitats or months to years in shoreline habitats), it is likely that the oil would remobilize into freshwater or marine environments where it may disperse into the water column or strand on another shoreline, likely adversely affecting additional habitats and species. In addition, removing vegetation prior to its becoming oiled is likely to expedite the removal of oil from the environment, as well as the efficiency with which it is removed. As a result, this response is likely to benefit listed species by removing oil and the adverse effects associated with its presence in the environment. The successful implementation of this response will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment, as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.17 Motorized Transport - Aircraft

Aircraft such as planes or helicopters may be used during a response to survey the oil spill trajectory, to aid in the search for sensitive species or habitat, or to transfer personnel.

Effects to Large Whales
The only potential effect of the use of aircraft near large whales is likely to be harassment. Whales may react to the sound generated by the propellers or the presence of the aircraft by changing the direction of their movements, diving deeper and for longer periods or increasing their swimming speed. These reactions are likely to be temporary, especially if aircraft fly relatively high over the whales and relatively quickly over the area. Given these conditions, this activity is not likely to adversely affect large whales.

Effects to Steller Sea Lions
Steller sea lions on land are likely to be disturbed by a plane or helicopter flying low or hovering over a haulout. Such disturbance could lead to stampeding into the water. During the breeding and pupping season, this physical disturbance could be detrimental to individuals or a subpopulation, as it could lead to injury, abandonment, or death of pups, disruption of the mating process and injury or harm to all life stages. Outside of the breeding season, effects to individual Steller sea lions and subpopulations may be less severe. A more thorough discussion of these effects is contained in Section 2.1.5.3 and will not be repeated here.

Effects to Salmonids
The impacts of the use of aircraft during an oil spill response on salmonids are considered negligible.

2.1.5.18 Motorized Transport - Boats

Watercraft may be used as platforms for vacuums and skimmers, for towing boom, and/or to deploy equipment and personnel to areas inaccessible by land. Watercraft have the potential to adversely affect listed species through disturbance and physical alteration of habitat.

Effects to Large Whales
Large whales may be disturbed or harassed by boat operations used in oil spill response in the open water. They may also risk collision with moving vessels.

Collision: Based on evidence gathered from stranding networks throughout the country, marine mammals, including large ESA-listed whales, have been injured or killed by ship strikes (see Carretta *et al*. 2001). These events are rare and the vessel involved is usually much larger than that which would be typically used in an oil spill response. However, the potential does exist, and with more vessels in the marine environment, the frequency of ship strikes appear to be increasing, especially off the Pacific Northwest.

Physical Disturbance: Large whales may react to noise generated from, or the presence of, watercraft by changing the direction of their movements, diving deeper and for longer periods or increasing their swimming speed. These reactions are likely to be temporary. In cases where watercraft is used for transportation to and from the site of a response or for a survey of species and habitats in the vicinity of the affected area, the presence of equipment relative to large

whales will be nearly instantaneous. In cases where watercraft are used as a part of the response (*e.g.*, skimming, booming, a platform for personnel), the presence of the vessel(s) is likely to be longer, so the extent of the disturbance to large whales may also be greater. However, the area affected by the use of this equipment is small relative to the marine areas used by large whales in the action area and beyond its boundaries. As a result, any effects that may result through use watercraft during a response are likely to be minimal. Furthermore, any large whale that avoids an area in which vessels are responding to an oil spill is benefitting from the response by not subjecting itself to the effects of the oil.

Effects to Steller Sea Lions

Steller sea lions are most likely to be present in offshore marine waters, nearshore marine waters, bays and estuaries and shorelines within the action area. Steller sea lions may be transient through aquatic environments when feeding, but they are largely confined to small land areas (*i.e.*, rookeries and haulouts) within the action area, especially during the breeding season. The potential direct effect to Stellers through the use of vessels near haulouts or breeding areas when animals are present is physical disturbance.

Physical Disturbance: Physical disturbance is the most likely effect to result from the use of motorized equipment for transportation or support. In situations where watercraft is used for transportation to and from the site of a response or for a survey of species and habitats in the vicinity of the affected area, the presence of equipment relative to Steller sea lions will be nearly instantaneous. In cases where watercraft are used as a part of the response (*e.g.*, skimming, booming, a platform for personnel), the presence of the equipment is likely to be longer, so extent of the disturbance, depending on the movements of the animals, may also be greater.

In water, Steller sea lions may react to noise generated from, or the presence of, watercraft by changing the direction of their movements, diving deeper and for longer periods or increasing their swimming speed. These reactions are likely to be temporary and effects are likely to be minimal, especially since Steller sea lions in the Pacific Northwest are accustomed to encountering boats.

The potential effects of the use of watercraft near aggregations of sea lions on land are likely to be more severe. The extent of the effects could vary substantially depending on several factors, including number of watercraft in the area, the level of noise they generate, the duration of their presence, and whether the disturbance takes place during the breeding season.

Disturbance of adult sea lions on rookeries, during breeding season (May through August), could lead to the abandonment of pups by mothers, trampling of pups by bulls and disruption of the mating process. In cases one and two, these results may lead to increased mortality of pups, while disruption of the mating process could result in a depressed pupping rate. Sea lion pups are also likely to be disturbed by the presence of watercraft. If pups are forced to enter the water before they have developed adequate swimming skills, mortalities may increase as a result of drowning. Furthermore, a large number of pups in the water surrounding a rookery could be susceptible to increased predation by sharks and transient killer whales.

Effects to Salmonids

Vessels operating in shallow water environments that overlap areas where listed salmonids or their critical habitat may be found may affect salmonids and their critical habitat by increasing turbidity, destroying eelgrass beds, and crushing benthic invertebrates.

Increasing Turbidity: Increased turbidity may result from a watercraft propeller or prop wash coming in contact or close proximity with benthic sediments, especially those that are fine-grained. The setting and possible dragging of an anchor and/or its chain can also disrupt benthic sediments, causing an increase in turbidity. Increased turbidity may impact salmonids in nearshore habitats throughout each stage of its life history. Increased turbidity caused by vessel movements and activities is likely to be localized and temporary; therefore, any effects to salmonids will be minimal.

Impacts to Benthic Invertebrates: Anchors used in the course of oil spill response hold a vessel or a boom in place. However, in the course of operation, strong currents or tides can cause the anchor and/or its chain to drag along the bottom. The setting and consequent dragging of an anchor and/or its chain can crush or smother benthic organisms, which can serve as important prey items of salmonid fry. The staples of chum salmon fry, for example, include benthic chironomids (*in* Groot and Margolis 1991). Since anchors are set in small areas relative to even small streams or lakes, the loss of up to a few hundred benthic invertebrates will not adversely affect listed salmonids.

Destruction of Submerged Aquatic Vegetation: Anchoring in an eelgrass or kelp bed can destroy the plants that serve as important habitat for salmonids and their prey. Anchors and anchor chains can badly damage vegetation by dislodging and breaking up the underground stems, which then get washed away and die. In addition, watercraft propellers have the potential to destroy eelgrass or kelp beds during the course of their use in support of oil spill response. The importance of kelp and eelgrass to salmonids have been described in sections 2.1.5.9 and 2.1.5.16, respectively.

Beneficial Effects of the Response

The use of watercraft in support of oil spill response is likely to have far-reaching positive effects to potentially all listed species and critical habitat in the action area. The use of this equipment is necessary to expedite the transport of personnel and equipment to affected areas and make open water and shoreline habitats accessible to response techniques that might not otherwise be so. Therefore, the use of this equipment potentially enables more rapid and thorough removal and containment of spilled oil. The use of watercraft is likely to benefit listed species by increasing the potential to remove oil and the adverse effects associated with its presence in the environment. The use of this equipment will result in a shorter presence of oil in the environment and exposure to oil that is limited to the environment in which oil is contained and collected. Limiting the persistence of oil in the environment (weeks to months in open water habitats or months to years in shoreline habitats), as well as the area affected by spilled oil, will reduce the likelihood of individuals of a listed species contacting oil or consuming prey that has been contaminated by oil.

2.1.5.19 Motorized Transport – ATVs and Heavy Equipment

ATVs may be used for a variety of purposes, including the transportation of response personnel and for the collection and disposal of oil, oiled sediments or oiled debris in support of response activities in nearshore open water and on shorelines. The use of ATVs is often dependent upon the accessibility of the site (*e.g.*, proximity of roads) to this type of vehicle and the type of shoreline in which they are to be used. Heavy equipment such as backhoes and tractors may be used to dig trenches or recovery wells, or remove oiled sediment. Storage containers may be temporarily put in place to hold oil, contaminated debris or sediment.

Effects to Steller Sea Lions

The noise and presence of ATVs in the vicinity of a Steller sea lion rookery and haulout while animals are present is likely to cause disturbance (described in detail in Section 2.1.5.3). The presence of forklifts and trucks in an area is likely to keep Steller sea lions from hauling out in the area until such equipment is removed. If there are few substitute areas nearby and it is during a season important for hauling out (*e.g.* breeding, pupping and molting), this effect could be detrimental to the health of an individual animal or a subpopulation.

Effects to Salmonids

The use of heavy equipment such as ATVs, tractors, backhoes, and graders, which may be used in responses such as personnel transport, sediment reworking, or trench digging, may adversely affect salmonids and their habitat through soil compaction and incidental discharges. The use of storage or settling tanks could also have an adverse impact on salmonid habitat through soil compaction.

Soil Compaction: Heavy equipment, including storage and settling tanks, can cause soil compaction, reducing soil permeability and infiltration, which can increase the rate and volume of runoff. During and after wet weather, increased runoff can suspend and transport more sediment to nearby streams and shores, increasing turbidity, reducing water quality, and modifying important salmon habitat, such as riffles and pools. Increased runoff can also increase the frequency and duration of high stream flows and wetland inundation. The reduction of water infiltration can hinder the re-establishment of seedlings or the growth of existing vegetation.

The degree of compaction due to ground-based equipment is influenced by a number of factors, including the total area compacted, the moisture content and soil type, the equipment used, and the number of passes the vehicle makes over the site. While oil spill response is generally short-term compared to logging practices, it is noteworthy that studies have revealed that 10 to 40% of a harvest area may be compacted during tractor logging and that recovery times can be from 10 to 50 years to as long as 90 to 110 years in arid, high-elevation sites (*in* Spence *et al*. 1996).

Incidental Discharges: As described in the description of skimmers, "incidental discharges" may include "...oil and oily water returns associated with runoff from vessels and equipment operating in an oiled environment and the wash down of vessels, facilities and equipment used in the response. Incidental discharges, as addressed by this policy, do not require additional

permits and do not constitute a prohibited discharge. The use of heavy equipment creates the opportunity for accidental spills of fuel, lubricants, hydraulic fluid and similar contaminants into the riparian zone or water where they can injure or kill aquatic organisms or impair their health.

2.1.5.20 Support – Foot traffic

Personnel participating in an oil spill response may traverse over all types of habitat in the course of cleanup and response. Depending on the location, the habitat, and the time of year, foot traffic may adversely affect listed species and their habitat.

Effect on Salmonids

Disturbance or Injury of Salmonids: Depending on the time of year, responders wading in salmonid spawning areas to remove oiled debris, deploy booms, deploy sorbents, *etc.* could adversely affect salmonids directly by disturbance of spawning adults or injuring or killing developing eggs and pre-emergent fry. Roberts and White (1992) studied the effects of angler wading on trout eggs and pre-emergent fry in artificial redds. They found that twice-daily wading through the development stage killed up to 96% of eggs and pre-emergent fry. A single wading just before hatching killed up to 43%. Eggs or fry were most vulnerable from the time of chorion softening to the start of emergence from the gravel. Any disturbance to adults during spawning events could occur if competing males are prevented from accessing females, if females are denied access to spawning habitat, and/or if newly dug redds are disturbed.

Indirect effects of foot traffic in spawning habitat during spawning events or during development may be evidenced by decreased spawning success, lower survival of early salmonid life stages, and a less successful run size in subsequent years.

Impacts to Habitat: Foot traffic on particular shoreline habitats may increase the potential for oil to be worked into the sediment. For example, sand, gravel, vegetated banks, tidal areas (including mud flats), and marshes are all non-solid substrates and therefore subject to increased oil contamination through foot traffic. Foot traffic on vegetated low banks may impact vegetation that is important to salmonids and their prey by dislodging or uprooting plants.

2.1.5.21 Summary of Effects to Listed Species

Effects to listed species through the spill response measures identified in the proposed actions range from short term effects upon behavior or habitat use, to potentially lethal consequences. Most response actions, such as deploying and operating boom and skimmers, involve in-water disturbance in locations expected to be occupied by listed species. These actions, which include ancillary effects from operating boats and other machinery within the vicinity of listed species, can cause species to shift habitat usage and avoid disturbed areas. This can cause short-term additional energy expenditures, increased vulnerability to predation, and decreased consumption of food sources. Given that the project area has been, or may soon be (absent the recovery measures covered within the proposed action), subject to oil contamination, these alterations of behavior may provide a net beneficial effect as species are forced to utilize habitats that are

potentially not contaminated, or subjected to less acute effects from contamination. In some instances, lethal effects could occur to listed species from the proposed actions. These instances are expected to relatively infrequent, and nonetheless reduce the overall lethal effects to populations of listed species that would otherwise occur absent the respective response measure(s).

2.1.5.22 Summary of Effects to Habitat and Designated Critical Habitat

Effects to habitat and designated critical habitat are varied within the response measures identified within the proposed action. Some of the response measures offer temporal degradation of some habitat functions, including designated critical habitat. These temporal impacts can alter habitat functions beneficial to listed species or their prey. For instance, the clearing of some riparian vegetation contaminated with oil can decrease bank stability or reduce shade. In these instances, the temporal loss of function are compensated for by starting the long-term recovery of habitats compromised by oil contamination. Within the example, the oiled vegetation would likely die or go into a period of reduce or no growth, while the oil would continually contaminate localized habitat and listed species and their prey sources. The removal of this vegetation removes oil from the environment, and allows the establishment of new riparian vegetation, in
essence expediting natural process. By preventing and removing contamination from oil spills, the proposed actions are likely to contribute to the long term recovery of functions essential for listed species, and in turn, not result in adverse modification of designated critical habitat.

2.1.6. Cumulative Effects

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." Other activities within the inland waters of Washington, Oregon, and Idaho and the coastal areas and offshore of Washington and Oregon have the potential to impact listed large whales, Steller sea lions and their critical habitat, and listed salmonids and their critical habitat. Future Federal actions, including the ongoing operation of hydropower systems, hatcheries, fisheries, and land management activities will be (or have been) reviewed through separate section 7 consultation processes.

Non-federal activities within the action area are expected to increase with increasing human populations in Washington, Oregon, and Idaho. Population projections estimate that the human populations in Washington, Oregon and Idaho will increase 33%, 28% and 29%, respectively, over the next 25 years (from 2000 to 2025)[23]. Therefore, NOAA Fisheries assumes that future private and State actions will continue within the action area, but at increasingly higher levels as population density mounts.

[23]From United States Census Bureau at: http://www.census.gov/population/projections/state/stpjpop.txt

2.1.7 Conclusion

NOAA Fisheries' evaluation has determined that the likelihood that response actions will exacerbate the effects of oil spills is minimal, rather, while response actions may have short term adverse effects, they collectively benefit listed species and habitat through minimizing the greater environmental risk from spills. After reviewing the best scientific and commercial information available regarding the current status of listed species considered in this consultation, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NOAA Fisheries' opinion that the action, as proposed, is not likely to jeopardize the continued existence of these species, or result in the adverse modification of designated critical habitat.

This conclusion is based on the following assumptions:

1. Responders are familiar with and follow best management practices, as outlined in the proposed action.

2. Responders weigh the environmental benefits and tradeoffs when deciding to respond to an oil spill and when choosing a particular response method or combination of methods.

3. Responders will prioritize protection of listed species in selecting response measures.

4. Responders will have accurate and up-to-date information regarding shoreline mapping and the location of natural resources, including listed species.

5. Responders will have active participation by NOAA experts, including those knowledgeable with regard to listed species, in selecting and implementing response measures that require tiered consultation (as detailed in section 2.2.3-1.c Table 2.6).

Our conclusions are based on the following considerations: (1) The EPA or the USCG will individually review each oil spill response to ensure that the proposed action is covered by this Opinion and that the effects to listed species has been analyzed; (2) taken together, the conservation measures applied to each response action will ensure that any short-term effects to listed species and their habitat (including important prey species) will be brief and minor, particularly for sensitive life stages and seasons; (3) given that oil spills can have severe impacts to listed species and their habitat, the underlying result of oil spill response, which are designed to minimize, (and in some cases avoid) these impacts, will have beneficial long-term effects to listed species and their habitat; and (4) the individual and combined effects of all spill response actions are not expected to impair currently properly functioning habitats, appreciably reduce the functioning of already impaired habitats, or retard the long-term progress of impaired habitats toward proper functioning condition essential to the long-term survival and recovery at the population or ESU scale.

2.1.8 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitats, or to develop additional information. NOAA Fisheries believes the following conservation recommendations are consistent with these obligations, and therefore should be carried out by the USCG and the EPA. This information will help reduce uncertainty about the effects of past and ongoing human and natural factors leading to the status of listed species, their habitats, and the aquatic ecosystem within the action area.

1. The USCG and the EPA should explore non-toxic dispersant technology to be used in oil spill response.

2. The USCG and the EPA should work with the Salmon Technical Recovery Teams, which convenes regularly to work on the long term recovery of and prioritize areas of protection for listed salmonid ESUs and their habitat, or critical habitat, where applicable. Enhanced protection areas may be created in areas where the risk of oil spill is greater, or where salmonid populations may be more vulnerable or are vital to the recovery of a particular ESU.

2.1.9 Reinitiation of Consultation

Consultation must be reinitiated if: (1) new information reveals effects of the action may affect listed species in a way not previously considered; (2) the action is modified in a way that causes an effect on listed species that was not previously considered; or (3) a new species is listed or critical habitat is designated that may be affected by the action (50 CFR 402.16).

Consultation must be reinitiated 5 years after the date this Opinion is signed. To reinitiate consultation, contact the Habitat Conservation Division (Oregon State Office) of NOAA Fisheries.

2.2 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, spawning, rearing, migration, feeding and sheltering. Harass is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is defined as take of listed species that results from, but is not the purpose of, the Federal agency or the applicant carrying

out an otherwise lawful activity. The ESA at section 7(o)(2) removes the prohibition from any incidental taking that is in compliance with the terms and conditions specified in this section 7(b)(4) incidental take statement.

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply to implement the reasonable and prudent measures.

This incidental take statement does not cover all spill response actions undertaken by the USCG and/or the EPA. Some potential response actions have not been included as part of the proposed action. These response actions are listed in Section 1.2 of the Biological Opinion. Use of these methods will require separate consultation.

The USCG and/or the EPA may use a response method that has been included as part of the proposed action but for which the effects to listed species and/or critical habitat have not been fully analyzed because site-specific application may vary significantly. As described in Section 1.2.2 of the Biological Opinion, these response actions are appropriate for tiered consultation. Additional effects analysis will be conducted and a separate incidental take statement will apply. Emergency consultation under 50 CFR 402.02 may be used for these actions if they must be conducted immediately after the spill to protect public health or safety.

2.2.1 Amount or Extent of the Take

Incidental take could occur as a result of adverse effects on habitat parameters (*e.g.*, water quality, habitat elements, flow/hydrology, and watershed conditions) that directly affect the life history of aquatic species. Lethal take is expected to be low because of the previously disturbed nature of the action area; fish, whales and Steller sea lions not affected by the oil itself will likely have left the area during or prior to the spill response activity. As stated in section 1.2.1, incidental take for response methods for spills that originated within the action area and subsequently entirely or partially drift outside of the Washington or Oregon portion of the EEZ, or to California waters, is not addressed within this Opinion[24]. For spill response actions outside of the action area of this Opinion, the MOA will be implemented as applicable.

Although take through death or injury may occur to salmon and steelhead addressed in this Opinion, the more probable and frequent pathway of take to fish (and marine mammals) will likely occur through harm of essential behavioral patterns. Harm due to the response measures outlined in the proposed action could temporarily impair essential behavioral patterns of marine mammals, including foraging and migration, and salmon and steelhead through foraging,

[24] Example: For a spill that occurs off the coast of southern Oregon, the Coast Guard would be covered for response actions within waters of the EEZ off Oregon that comply with the ITS. If that same spill drifts to waters off California, the Coast Guard and NOAA Fisheries may utilize the MOA as appropriate and this Opinion does not apply.

migration, refuge from predators, and spawning. These effects have been discussed qualitatively in the preceding sections. Effects of actions such as those addressed in this Opinion are largely unquantifiable. Therefore, even though NOAA Fisheries expects some incidental take to occur due to the actions covered by this Opinion, the best scientific and commercial data available are not sufficient to enable NOAA Fisheries to estimate a specific amount of incidental take of listed salmon and steelhead and marine mammals at any life stage.

Take caused by habitat modification or degradation by these actions is largely unquantifiable. The vast majority of spill response methods offer minimal adverse effects to aquatic habitat and improve habitat conditions by facilitating the removal of oil that is acutely toxic to aquatic species and can accumulate in their habitat. Therefore, although NOAA Fisheries expects these actions to result in some habitat modification, the best scientific and commercial data available are not sufficient to enable NOAA Fisheries to estimate a specific amount of incidental take. In instances such as these, NOAA Fisheries designates the expected level of take as "unquantifiable." NOAA Fisheries believes take caused by habitat modification will be very low. Furthermore, the following reasonable and prudent measures reduce the level of incidental take of listed species likely to be associated with the proposed action.

2.2.2 Reasonable and Prudent Measures

The measures described below are non-discretionary. They must be implemented so that they become binding conditions in order for the exemption of subsection 7(o)(2) to apply. The USCG and the EPA have the continuing duty to regulate the activities covered in this incidental take statement, including the implementation of best management practices, as identified in the proposed action. If the USCG and the EPA fail to retain the oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

NOAA Fisheries believes that the following reasonable and prudent measures are necessary and appropriate to avoid or minimize the amount or extent of take of Steller sea lions and listed salmonids resulting from implementation of this Opinion.

The Coast Guard and EPA shall:

1. Minimize incidental take from administration of the Northwest Area Contingency Plan established by the Northwest Area Committee under the Clean Water Act (33 USC 1251-1376).

2. Minimize incidental take from general spill response methods by conducting work which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

3. Minimize incidental take from booming by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

4. Minimize incidental take from skimming by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

5. Minimize incidental take from sorbent use by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

6. Minimize incidental take from *in-situ* burning by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

7. Minimize incidental take from the use of chemical dispersants by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

8. Minimize incidental take from berm/barriers by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

9. Minimize incidental take from vegetation cutting (offshore kelp), nearshore, and shoreline or riparian vegetation) by conducting work in a manner which avoids or minimizes adverse effects to riparian and aquatic systems.
10. Minimize incidental take from manual removal of oil by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

11. Minimize incidental take from oiled debris removal by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

12. Minimize incidental take from trenching/recovery wells by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

13. Minimize incidental take from oiled sediment removal, reworking, or removal with replacement by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

14. Minimize incidental take from flushing with ambient water (flooding, flushing with low-pressure, flushing with high pressure) or washing with warm or hot water (moderate-pressure) by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

15. Minimize incidental take from watercraft by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

16. Minimize incidental take from aircraft by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

17. Minimize incidental take from vehicles and equipment use by conducting work in a manner which avoids or minimizes adverse effects to listed species, and their riparian and aquatic habitats.

18. Ensure completion of a comprehensive monitoring and reporting program to confirm this Opinion is meeting its objective of minimizing take from permitted activities.

2.2.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the USCG and EPA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary and, in relevant part, apply equally to proposed actions in all categories of activity.

1. To implement Reasonable and Prudent Measure #1 (implementation of the proposed action), the USCG and the EPA shall:

   A. Training and Education. The USCG and EPA shall, within their level of discretion and full extent of their authority, ensure training and education is provided to all delegated agencies and contract personnel involved with oil spill response on: (1) "Best Management Practices," as outlined in the proposed action; and (2) Reasonable and Prudent Measures and their corresponding Terms and Conditions, as outlined in this Biological Opinion.

   B. Contracts. The USCG and EPA shall, within their level of discretion and full extent of their authority, include as part of any contractual agreement with third parties involved in oil spill response: (1) "Best Management Practices," as outlined in the proposed action; and (2) Reasonable and Prudent Measures and their corresponding Terms and Conditions, as outlined in this Biological Opinion.

   C. Individual Spill Response Review. For those spill response actions in which the USCG and EPA exercise the authority of the OPA and/or the CWA, they shall individually review each spill response to ensure that all adverse effects to listed species and their habitats are within the range of effects considered in this Opinion. This programmatic consultation will cover an oil spill of up to 250,000 gallons offshore, and up to 10,000 gallons inland of the coastal zone.

D. Full Implementation Required. Departure from full implementation of the applicable terms and conditions of the following incidental take statement will result in the lapse of the protective coverage of section 7(o)(2) regarding "take" of listed species and may lead NOAA Fisheries to a different conclusion as to the effects of the continuing action, including findings that specific projects will jeopardize listed species.

E. Tiered Consultation. The USCG/EPA shall conduct Tiered Consultation with NOAA Fisheries during circumstances indicated within the table below and reiterated within each term and condition, as appropriate. Tiered Consultation will be conducted in the following manner and to accomplish the below measures:

1. Whenever possible, the USCG/EPA shall document in writing the proposed response method and site-specific conditions, and supply these documents to NOAA Fisheries for Tiered Consultation review as soon as practicable, prior to conducting the proposed response method. In-person meetings or phone calls may be used to expedite Tiered Consultation response, NOAA Fisheries may request supplemental information be provided in these circumstances. The USCG/EPA shall document in writing the substance and subsequent agreements of the Tiered Consultation when personal communication is used.

2. Tiered Consultation will determine if the effects associated with the proposed response is within the range of effects analyzed within this Opinion, and may defer to independent emergency consultation after recovery work.

3. Tiered Consultation will explore methods to further minimize effects from spill response based on site-specific conditions and species use.

4. State biologists with ODFW, WDFW, local government or response staff and others may assist with data request and methods to minimize impacts.

5. In cases where emergency conditions do not allow for tiered consultation to occur prior to implementing one of the measures below, the USCG/EPA and NOAA Fisheries will determine whether the effects of the action fit within this Opinion, or whether independent consultation is warranted.

Table 2-6 Spill Response Scenarios Requiring Tiered Consultation.

Response Method	Action Requiring Tiered Consultation[1]
Booming	Within rivers and streams with out-migrating/rearing salmon[2] and steelhead, when booms leave less than 18 inches of clearance underneath, including tidal cycles/river stages, within 50 feet of shoreline for more than 24 consecutive hours.
In-situ Burning	Prior to consideration of *In-situ* Burning.
Chemical Dispersants	When, during monitoring, large feeding aggregations (>5 whales or >10 Steller sea lions) of listed marine mammals are sighted in the area (within 1 mile of proposed application site) in which chemical dispersants are being considered.
Berms and Barriers	Within rivers and streams with out-migrating/rearing salmon[2] and steelhead, prior to berm and barrier construction.
Oiled Debris Removal	Prior to removal of large wood[3] that is a structural component[4] of streams/nearshore habitat.
Oiled Sediment Removal, Reworking, and Removal with Replacement	Prior to work in lower intertidal[5] and sub-tidal zones.
Flushing with Warm or Hot Water	Prior to warm and hot water, moderate-pressure washing in waters that host migrating or rearing salmon/steelhead and/or critical habitat that may be adversely modified by an influx of warm or hot water.

[1] Tiered Consultation is required for these actions and circumstances only. Actions consistent with these terms and conditions outside of Table 2-6 above do not need Tiered Consultation. Refer to section 1-e below for Tiered Consultation requirements relative to Steller sea lions.

[2] "Salmon" refers to all species of salmon that may be found in the action area, including chinook, chum, coho, pink and sockeye. This definition has been used because of the difficulty of determining whether an individual fish is listed under the ESA within the wild. Within site specific settings, the determination of whether individual fish are listed under the ESA may be more practicable. No stock of pink salmon are listed under the ESA, but they have been included here because of their coverage under the MSA.

[3] "Large wood" is defined as a log that is: 1) dead; 2) root system (if present) no longer supports the weight of the stem/bole; 3) minimum diameter of 0.1 meters (10 centimeters) along 2 meters of its length; and 4) minimum 0.1 meter of length extending into the bankfull channel.

[4] "Structural component" is defined as large wood that is partially or wholly embedded within a bank or channel substrate, or caught upon other wood, rock or channel feature so that it does not readily move in most flow conditions. In most marine, estuary and freshwater environments it is evident that water flows around the wood by pool formation, collection of debris, and/or deposition of sediment.

[5] Lower intertidal is defined as below the mean tide level in tidally influenced areas, or ordinary high water marks in non-tidally influenced waters.

6. Tiered Consultation--Steller Sea Lions. Tiered Consultation shall occur prior to oil spill response work within 500 feet from or on Steller sea lion rookeries or major haulouts when animals are present, or near (within 500 feet) rookeries during the breeding season (May 1 through August 31). Initial Emergency work is allowed for all spill response methods covered in this Opinion except vegetation cutting, manual removal of oil, and oiled debris removal.

7. Confirmation of Species Presence. Contact a fish biologist from NOAA Fisheries, ODFW or WDFW, as appropriate for the project and action area, if necessary, to confirm that a spill response is within the present or historic range of a listed species or a designated critical habitat.

8. Geographic Response Plans. Within 90 days from the issuance of this Opinion, provide a schedule of revisions of GRPs within the range of listed species or critical habitats within the next five years. NOAA Fisheries will assist revision of GRPs as appropriate. This schedule shall be refined within the annual reports.

9. Species Collection. The USCG and EPA shall ensure that if a sick, injured or dead specimen of a threatened or endangered species, or their prey species[25], is found, the finder shall notify the following NOAA Fisheries Law Enforcement field offices: for spills in Oregon and the Columbia River basin - Vancouver Field Office - (360) 418-4246; for spills in Puget Sound or the Olympic Peninsula - Seattle Field Office - (206) 526-6133 Idaho office: 208-321-2956 – or Hotline # 1-800-853-1964. The finder shall take care in handling of sick or injured specimens to ensure effective treatment, and in handling dead specimens to preserve biological material in the best possible condition for later analysis of cause of death. The finder also has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not disturbed unnecessarily.

2. To implement Reasonable and Prudent Measure #2 (general conditions for spill response), the USCG and EPA shall ensure that:

[25]"Prey species" includes only important salmonid prey species, including surf smelt, sand lance, and herring.

A. Fish Screens. All water intakes used during oil spill response shall have a fish screen installed in freshwater, estuarine and nearshore environments that may have juvenile salmon/steelhead and/or prey species that could be harmed by the pumps. Water intake devices shall be operated and maintained according to NOAA Fisheries' fish screen criteria[26] Water intakes that occur in water 100 feet from shorelines and in depths greater than 40 feet do not need to be screened for juvenile salmon/steelhead.

B. Shore Oil Collection and Response Sites. Shore oil collection and response sites shall be placed in previously disturbed areas, such as roads and parking lots, whenever possible. Collection sites shall be lined with an impervious material, and surrounded by temporary berms to prevent secondary contamination from runoff. Upon completion of spill response, collection and response staging sites shall be restored to their original condition.

C. Site Access. The USCG and EPA shall ensure that damage to sensitive environments is minimized and avoided by the following measures:

1. Foot Traffic. Foot traffic through oiled areas and non-solid substrate is minimized to decrease the likelihood that oil will be further mixed into the sediment.

2 Foot Traffic/Sensitive Areas. Foot traffic near salmon and steelhead redds, intertidal areas, spawning locations for salmon/steelhead prey, and marshes shall be minimized, or concentrated on marked paths, to decrease the likelihood of aquatic habitat damage.

3. To implement Reasonable and Prudent Measure #3 (booming), the USCG and EPA shall ensure that:

A. Deployment. Boom shall be deployed and used to direct oil away from nearshore habitats and shorelines whenever possible.

B. Shoreline Recovery Locations. Collection sites shall be directed away from riparian and nearshore habitats and shorelines whenever possible. If

[26]National Marine Fisheries Service, *Juvenile Fish Screen Criteria* (revised February 16, 1995) and *Addendum: Juvenile Fish Screen Criteria for Pump Intakes* (May 9, 1996) (guidelines and criteria for migrant fish passage facilities, and new pump intakes and existing inadequate pump intake screens) http://www.nwr.noaa.gov/1hydrop/hydroweb/ferc.htm.)

collection sites are unavoidable in these settings, the recovery location shall be limited to the smallest size possible while allowing for efficient and effective cleanup efforts.

C. Salmon/Steelhead Migration. Within rivers and streams with out-migrating/rearing salmon/steelhead, Tiered Consultation shall occur when booms leave less than 18 inches of clearance underneath, including tidal cycles/river stages, within 50 feet of shoreline for more than 24 consecutive hours.

D. Benthic Habitat. When the boom is in contact with the bottom, boom shall not be dragged, towed, or pulled across substrate containing fine or medium grained sediments and eelgrass beds, unless otherwise unavoidable.

4. To implement Reasonable and Prudent Measure #4 (skimming), the USCG and EPA shall ensure that:

A. Intake of Water. The intake of water shall be minimized to decrease return waters from decanting.

B. Decanting. Effects from decanting shall be minimized and avoided by the following methods:

1. Location. Decanting shall be done in a designated "response areas" within a collection area, vessel collection well, recovery belt, weir area, or directly in front of a recovery system.

2. Vessel Location. Vessels employing sweep booms with recovery pumps in the apex of the boom should decant forward of the recovery pump.

3. Retention Time. Vessels, motor vehicles, and other equipment not equipped with an oil/water separator shall allow sufficient retention time for oil held in internal or portable tanks before decanting commences.

4. Containment Boom. A containment boom will be deployed at the collection area to minimize loss of inadvertently decanted oil into the surrounding environment whenever possible.

5. Monitoring. Visual monitoring of the decanting area shall be maintained so that discharge of oil in the decanted water is detected promptly and operations shut down.

6. Non-Vessel Decanting. Decanting in areas where vacuum trucks, portable tanks or other collection systems are used for shore cleanup will be subject to the same rules as vessels.

5. To implement Reasonable and Prudent Measure #5 (sorbent use), the USCG and EPA shall ensure that:

   A. Collection. Regularly monitor and collect saturated sorbents to prevent them from contributing to the aquatic environment or nearshore/riparian areas as nondegradable oily debris.

6. To implement Reasonable and Prudent Measure #6 (*in-situ* burning), the USCG and EPA shall ensure that:

   A.. Tiered Consultation Only. Tiered Consultation will occur prior to any *in-situ* burning to determine if this response method is appropriate, given location and species use.

   B. Recovery. Maximum recovery of burned residue shall occur given site constraints and weather conditions.

   C. Steller Sea Lions.

      1. Monitoring. Prior to any *in-situ* burning, monitor for Steller sea lions within one mile of the proposed burn site. Delay *in-situ* burning until animals have left the site area. Tiered Consultation shall occur prior to intentionally harassing animals from the area.

      2. Plume Modeling within the Range of Steller Sea Lions. Prior to any *in-situ* burning, smoke plume modeling shall be conducted to predict if any Steller sea lions on rookeries or haulouts may be exposed to air emissions from an *in-situ* burn. Steller sea lions on rookeries or haulouts shall not be exposed to small particles (PM-10) greater than 150 $\mu g/m^3$, averaged over a 24 hour period.

7. To implement Reasonable and Prudent Measure #7 (chemical dispersant use), the USCG and EPA shall ensure that:

   A. Monitoring. Prior to using chemical dispersants, monitor for large whales and Steller sea lions within one mile of the proposed application site. Tiered Consultation shall occur if large (>5 whales, >10 Steller sea lions) feeding aggregations of listed marine mammals are sighted in the area.

8. To implement Reasonable and Prudent Measure #8 (berms and barriers), the USCG and EPA shall ensure that:

A. Materials. Berm materials shall be non-toxic to the aquatic environment. If treated wood is used, it shall not be in contact with water.

B. Berm and Barrier Use. Within rivers and streams with listed out-migrating/rearing salmon and/or steelhead (within anadromous zone), prior to berm installation, Tiered Consultation shall occur to ensure that these terms and conditions are followed, and to further minimize effects to aquatic species whenever possible. Berms and barriers that are built within waterways that host salmon/steelhead may be installed without Tiered Consultation only in initial emergency situations to avoid imminent harm to public health and/or aquatic resources from oil contamination.

C. Location and Design. Effects from berms and barriers shall be minimized and avoided by the following methods:

1. Fish Passage. Berms and barriers shall be located where they do not block fish passage during adult or juvenile salmon/steelhead migration periods and locations. If berms must be installed during periods and locations of adult and juvenile salmon/steelhead migration, they shall be designed and maintained to provide upstream adult passage and downstream juvenile passage[27].

2. Reinforcement. Earthen berms and barriers shall be fortified with reinforced sandbags (i.e triple bagged) or geotextile fabric (fabric or synthetic material that enhances water movement and retards soil movement).

D. Construction. Effects from berms and barrier construction shall be minimized and avoided by the following methods:

1. Work Site Isolation. Prior to in-water work, to prevent siltation, berm and barrier construction locations shall be isolated (*i.e.* water deflected around the site, or other applicable methods) from active flows, whenever possible.

2. Erosion Control. Silt fences, settling ponds and/or other erosion control measures shall be used to contain any suspended sediments that may be mobilized in the water while the berm is being constructed.

[27]NOAA Fisheries would provide engineering expertise to ensure berms and barriers are designed to ensure fish passage, where appropriate.

E. Operation. Recovery of collected oils shall commence as soon as practicable to minimize entrainment of oil into the water column, or to surrounding waters of shorelines.

F. Removal. When berms and barriers are removed, the following conditions apply:

1. Timely Removal. Berms and barriers shall be removed upon termination of response work during periods when adverse effects from removal are minimized, such as low tides and/or river stages or State in-water work periods[28]. The USCG and EPA shall ensure that removal actions occur to achieve bottom and bank contours, substrate type, and submerged, emergent and bank vegetation conditions similar to pre-berm and barrier response action conditions, or, if applicable, consistent with Damage Assessment and Restoration Program mitigation plans or emergency restoration actions under section 990.26 of OPA.

2.. Work Site Isolation. Prior to removal, to prevent siltation, whenever possible, berms and barriers shall be isolated from active water flow prior to removal.

3.. Erosion Control. Silt fences, settling ponds and/or other erosion control measures shall be used to contain any suspended sediments that may be mobilized in the water while the berm is being removed.

9. To implement Reasonable and Prudent Measure #9 (vegetation cutting), the USCG and EPA shall ensure that:

A. Cutting Kelp. Cutting and removal of oiled kelp fronds or parts shall be restricted to kelp contaminated with oil to minimize reductions in the quantity and quality of aquatic habitat provided by kelp.

1. Bull Kelp. Cut only blades, the base of bull kelp blades shall be left intact to include the growing zone for the blade, stipe and pneumatocyst intact.

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[28]Oregon Department of Fish and Wildlife, *Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources*, 12 pp (June 2000) (identifying work periods with the least impact on fish) (http://www.dfw.state.or.us/ODFWhtml/InfoCntrHbt/0600_inwtrguide.pdf). Washington State Department of Fish and Wildlife, in-water work periods for construction projects (http://www.wa.gov/wdfw/hab/hpa/). State of Idaho: NOAA Fisheries in may be contacted at (208) 756 to6472 for appropriate in water work periods.

2.. Giant Kelp. The cutting of giant kelp shall be limited to the top four feet.

B. Aquatic Vegetation. When cutting emergent aquatic vegetation in marshes or nearshore environments, effects to non-oiled vegetation shall be minimized and avoided by the following methods:

1. Protection. Boardwalks or other measures shall be used to distribute weight and minimize disruption of soft sediments, prevent damage to plant root systems, and prevent introduction of oil deeper into sediments where appropriate.

2.. Equipment. Equipment used shall be as small as practicable to minimize non-oiled vegetation disturbance.

3. Eelgrass. Eelgrass roots shall be left in place whenever possible.

C. Riparian Vegetation. Cutting of shoreline riparian vegetation, including tree limbs and shrubs, shall be minimized and avoided by the following methods.

1. Contaminated Vegetation Only. Cutting or removing riparian or shoreline vegetation shall be limited to contaminated (oiled) vegetation.

2. Tree Cutting and Pruning. Cutting of trees shall be limited to oiled branches when trees are over 10 centimeters diameter at [average human] breast height.

3.. Root Retention. Roots of riparian vegetation shall be left intact to retain bank stability and facilitate re-growth whenever possible.

10. To implement Reasonable and Prudent Measure #10 (Manual Removal of Oil), the USCG and EPA shall ensure that:

A. Tidal Flats. Manual removal of oil using hand tools or vacuuming shall not be used on tidal flats or mud substrate when the threat of mixing oil into substrate is greater than benefits gained through oil collection.

B. Sediment Removal. Minimize the amount of sediment removed to the greatest extent practicable.

11. To implement Reasonable and Prudent Measure #11 (Oiled Debris Removal), the USCG and EPA shall ensure that:

A.. Prevention of Contamination. If oils spill trajectories show that a beach is likely to become oiled, debris shall be removed prior to contamination whenever possible. Large wood that is a structural component of the stream or nearshore/estuarine bank shall be left in place.

B. Contaminated Large Wood. Attempts to clean large wood that is a structural component of the stream or nearshore/estuarine environment shall occur prior to removal. Tiered Consultation shall occur prior to the removal of large wood that is a structural component of stream, nearshore, or estuarine habitats.

C. Replacement[29]. Locations of all removed large wood or ecologically important debris, such as boulders, shall be documented. The USCG and EPA shall ensure that materials that are functionally equivalent to those removed are replaced, or, if applicable, consistent with Damage Assessment and Restoration Program mitigation plans or emergency restoration actions under section 990.26 of the OPA. Replacement shall occur during times that minimize and avoid effects to listed species and their habitat, such as State in-water work periods, low tides and river stages.

12. To implement Reasonable and Prudent Measure #12 (Trenching and Recovery Wells), the USCG and EPA shall ensure that:

A.. Lining. Trenches and recovery wells that do not reach the water table shall be lined with plastic to prevent collected oil from penetrating deeper into substrate.

B.. Salmon/Steelhead Stranding. Where trenches and recovery wells are used in areas that may become inundated from tides or river stages, salmon/steelhead exclusion devices or methods shall be used and monitoring shall take place to prevent salmon/steelhead stranding.

C. Decommissioning. Upon completion of trench and recovery well use, the substrate shall be restored to original grade and composition.

13. To implement Reasonable and Prudent Measure #13 (Oiled Sediment Removal, Reworking, or Removal with Replacement), the USCG and EPA shall ensure that:

[29]Replacement of oily debris as defined in this document refers to debris that are not replaced, or identified within Damage Assessment and Restoration Program mitigation actions.

A. Increased Oil Runoff/Sheening. When conducting oiled sediment removal, reworking, or removal with replacement in or near salmon/steelhead spawning or rearing habitat, salmon/steelhead prey spawning habitat, or other sensitive environments, deploy appropriate combination of boom, silt curtains, sorbents and other measures to prevent or minimize additional contamination from oil runoff and sheening.

B. Location. Restrict oiled sediment removal, reworking, or removal with replacement to mean high water or above in tidally influenced areas, or ordinary high water marks in non-tidally influenced water to minimize disturbance of aquatic habitat in lower intertidal and sub tidal zones. Tiered Consultation shall occur prior to oiled sediment removal, reworking, or removal with replacement below the ordinary high water mark or mean high water.

C. Oiled Sediment Removal Without Replacement. Oiled sediment removal without replacement shall be limited to sand/mud substrates not subject to high rates of erosion. Oiled sediment removal without replacement on gravel substrates (or rip rap) is limited to non-salmon/steelhead spawning areas, and where removal of substrate will not result in decreased substrate and/or bank stability that could lead to erosion.

D. Oiled Sediment Removal and Replacement. Effects from oiled sediment removal and replacement shall be minimized and avoided by the following methods:

1. Location. Work shall occur in locations where removal without replacement would result in a loss of salmon/steelhead spawning substrate or salmon/steelhead prey species spawning substrate and/or bank or substrate instability.

2. Sediment Composition. Replacement sediments shall occur in the same area of removal, and be of similar size, composition and volume to those removed.

3. Sediment Quality. Replacement sediments shall be clean and non-toxic to aquatic life.

4. Timing. Sediment replacement shall occur during times, such as low tides and river stages or during state in water work periods (see footnote #22), when minimal impacts will occur to aquatic life.

14. To implement Reasonable and Prudent Measure #14 (Flushing with Ambient Water or Washing with Warm/Hot Water), the USCG and EPA shall ensure that:

A. Increased Oil Runoff/Sheening. Prior to flushing with ambient water in or near salmon/steelhead spawning or rearing habitat, salmon/steelhead prey spawning habitat, or other sensitive environments, deploy appropriate combination of boom, silt curtains, sorbents and other measures to prevent or minimize additional contamination from oil runoff and sheening.

B.. Water Level. When flushing with ambient water above mean water level, work shall occur during higher tidal stages/river levels to minimize mixing oil into sediments or damaging aquatic vegetation whenever practicable.

C. Substrate Protection. Water shall be directed above or behind contaminated areas to create a sheet of water that re-mobilizes and carries oil to a pre-established containment area. Avoid directing the stream of water directly into the substrate so as to prevent pushing or mixing of oil deeper into substrates.

D. Flooding. Flooding of contaminated areas shall be minimized and avoided by the following methods:

1. Location. Flooding shall not be used on fine to coarse grained sand beaches.

2. Monitoring and Adaptive Management. Monitor and manage flooding to avoid siltation or contamination of sediments to the subtidal zone.

E. Flushing with Ambient Water, Low Pressure. Flushing with ambient water, low pressure shall not be used on sand beaches (fine to coarse grained) and mud flats.

F. High Pressure Washing. Restrict flushing with ambient water, high pressure to rocky and rip rapped shorelines and hard, manmade structures such as seawalls, bulkheads, and docks.

G. Warm and Hot Water, Moderate-Pressure Washing. Adverse effects associated with warm and hot water, moderate-pressure washing shall be minimized and avoided by the following methods:

1. Location. This response method shall be restricted to heavily oiled gravel beaches, riprap and hard, vertical, manmade structures such as seawall, bulkheads and docks.

2. Salmon/Steelhead Presence. Tiered Consultation shall occur prior to using this response method within streams that contain migrating or rearing salmon/steelhead, and/or critical habitat that may be adversely modified by an influx of warm or hot water.

15. To implement Reasonable and Prudent Measure #15 (watercraft), the USCG and EPA shall ensure that:

A. Steller Sea Lions. Vessels shall not operate within 500 feet of Steller sea lion haulouts and rookeries when animals are present, except during initial emergency oil spill response operations.

B. Anchoring. Vessels shall avoid anchoring in eelgrass beds whenever possible.

16. To implement Reasonable and Prudent Measure #16 (aircraft), the USCG and EPA shall ensure that:

A. Steller Sea Lions. Aircraft shall avoid flying lower than 1000 feet within a horizontal distance of 100 yards from Steller sea lion rookeries or haulouts when animals are present, and during breeding seasons (May 1 through August 31) except during initial emergency oil spill response operations.

17. To implement Reasonable and Prudent Measure #17 (vehicles and equipment), the USCG and EPA shall ensure that:

A.. Type of Equipment. When heavy equipment must be used, the equipment selected shall have the least adverse effects on the environment (*e.g.*, minimally-sized, rubber-tired).

B. Vehicle Staging. Vehicles shall be fueled, operated, maintained and stored as follows:

1. Location. Vehicle staging, cleaning, maintenance, refueling, and fuel storage shall take place in a vehicle staging area placed 150 feet or more from any stream, waterbody or wetland.

2. Inspection. All vehicles operated within 150 feet of any stream, waterbody or wetland shall be inspected daily for fluid leaks before leaving the vehicle staging area. Any leaks detected shall be repaired in the vehicle staging area before the vehicle resumes operation.

C. In-Water Work. All equipment operated instream or below the ordinary high water line, shall be cleaned before beginning operations below the bankfull elevation to remove all external oil, grease, dirt, and mud.

D. Stationary Power Equipment. Stationary power equipment (*e.g.*, generators, cranes) operated within 150 feet of any stream, waterbody or wetland shall be diapered to prevent leaks.

E. Temporary Roads. Temporary roads shall be removed and the area restored to its natural condition after response action is concluded.

18. To implement Reasonable and Prudent Measure #18 (monitoring, documentation, and reporting), the USCG and EPA shall ensure that for those spill response actions in which the USCG and EPA exercise the authority of the OPA and/or the CWA, the USCG and EPA shall document effects to listed species and habitat [*e.g.* see Section 2.1.5.2] utilized by listed species or their prey species from each oil spill, and from the response methods. Reports shall contain the following:

A.. Species Affected. Number or estimates of species taken ("take" as defined under the ESA) from the oil spill and response methods, to the extent possible.

B.. Habitat Volume and Type. The volume and type of habitat affected by the spill and response methods.

C. Temporal Effects. The anticipated temporal extent of impacts from the oil spill and response methods.

D. Annual Monitoring Report. Provide NOAA Fisheries with an annual monitoring report that incorporates monitoring reports from each spill response by January 31 of each year that describes the USCG/EPA's efforts carrying out this Opinion. The report will also provide an overall assessment of program activity and cumulative effects. A copy of the annual report will be submitted to the Idaho, Oregon and Washington Offices of NOAA Fisheries.

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3. MAGNUSON-STEVENS ACT

3.1 Background

The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

- Federal agencies must consult with NOAA Fisheries on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2)).

- NOAA Fisheries must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A)).

- Federal agencies must provide a detailed response in writing to NOAA Fisheries within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NOAA Fisheries' EFH conservation recommendations, the Federal agency(ies) must explain its reasons for not following the recommendations (§305(b)(4)(B)).

The EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH: "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; "spawning, breeding, feeding, or growth to maturity" covers a species' full cycle (50 CFR 600.10). "Adverse effect" means any impact which reduces quality and/or quantity of EFH and may include direct (*e.g.* contamination or physical disruption), indirect (*e.g.* loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

The EFH consultation with NOAA Fisheries is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affected designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

3.2 Identification of EFH

Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for federally-managed fisheries within the waters of Washington, Oregon, and California. Designated EFH for groundfish and coastal pelagic species encompasses all waters from the mean high water line, and upriver extent of saltwater intrusion in river mouths along the coasts of Washington, Oregon and California, seaward to the boundary of the United States exclusive economic zone (PFMC 1998a, 1998b). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other waterbodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable artificial barriers (as identified by PFMC 1999), and longstanding, naturally-impassable barriers (*i.e.* natural waterfalls in existence for several hundred years) (PFMC 1999). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California north of Point Conception to the United States-Canadian border (PFMC 1999).

Detailed description and identifications of EFH are contained in the fishery management plans for groundfish (PFMC 1999), coastal pelagic species (PFMC 1998b), and Pacific salmon (PFMC 1999). Casillas *et al*. (1998) provides additional detail on the groundfish EFH habitat complexes. Assessment of the potential adverse effects to these species' EFH from the proposed action is based, in part, on these descriptions and on information provided in USCG (2002). Table 3-1 contains a list of species with designated EFH potentially affected by this proposed action.

Table 3-1 Species with designated EFH in the waters of Idaho, Oregon and Washington

Groundfish Species	blue rockfish *S. mystinus*	shortbelly rockfish *S. jordani*	flathead sole *Hippoglossoides elassodon*
leopard shark *Trakis semifasciata*	Bocaccio *S. paucispinis*	shortraker rockfish *S. borealis*	Pacific sanddab *Citharichthys sordidus*
soupfin shark *Galeorhinus galeus*	brown rockfish *S. auriculatus*	silverygray rockfish *Sebastes brevispinis*	petrale sole *Eopsetta jordani*
spiny dogfish *Squalus acanthias*	canary rockfish *S. pinniger*	speckled rockfish *S. ovalis*	rex sole *Glyptocephalus zachirus*
big skate *Raja binoculata*	chilipepper *S. goodei*	splitnose rockfish *S. diploproa*	rock sole *Lepidopsetta bilineata*
California skate *R. inornata*	China rockfish *S. nebulosus*	squarespot rockfish *S. hopkins*	sand sole *Psettichthys melanostictus*
longnose skate *R. rhina*	copper rockfish *S. caurinus*	stripetail rockfish *S. saxicola*	starry flounder *Platichthys stellatus*
ratfish *Hydrolagus colliei*	darkblotched rockfish *S. crameri*	tiger rockfish *S. nigrocinctus*	
finescale codling *Antimora microlepis*	grass rockfish *S. rosenblatti*	vermilion rockfish *S. miniatus*	
Pacific rattail *Coryphaenoides acrolepis*	greenspotted rockfish *S. chlorostictus*	widow rockfish *S. entomelas*	**Coastal Pelagic Species**
lingcod Ophiodon elongatus	greenstriped rockfish S. elongatus	yelloweye rockfish S. ruberrimus	northern anchovy *Engraulis mordax*
cabezon *Scorpaenichthys marmoratus*	harlequin rockfish *S. variegatus*	yellowmouth rockfish *S.reedi*	Pacific sardine *Sardinops sagax*
kelp greenling *Hexagrammos decagrammus*	Pacific ocean perch *S. alutus*	yellowtail rockfish *S. flavidus*	Pacific (chub) mackeral *Scomber japonicus*
Pacific cod *Gadus macrocephalus*	quillback rockfish *S. maliger*	longspine thornyhead *Sebastolobus altivelis*	jack mackeral *Trachurus symmetricus*
Pacific whiting (hake) *Merluccius productus*	redbanded rockfish *S. babcocki*	shortspine Thornyhead *Sebastolobus alascanus*	market squid *Loligo opalescens*
sablefish *Anoplopoma fimbria*	redstripe rockfish *S. proriger*	arrowtooth flounder *Atheresthes stomias*	
aurora rockfish *Sebastes aurora*	rosethorn rockfish *S. helvomaculatus*	butter sole *Isopsetta isolepis*	**Pacific Salmon Species**
bank rockfish *S. rufus*	rosy rockfish *S. rosaceus*	curlfin sole *Pleuronichthys decurrens*	chinook salmon *Oncorhynchus tshawytscha*
black rockfish *S. melanops*	rougheye rockfish *S. aleutianus*	Dover sole *Microstomus pacificus*	coho salmon *O. kisutch*
blackgill rockfish *S. melanostomus*	sharpchin rockfish *S. zacentrus*	English sole *Parophrys vetulus*	Puget Sound pink salmon *O. gorbuscha*

3.3 Proposed Action

The proposed actions and action areas are described in Section 1.2 of the Biological Opinion. The action area includes habitats that have been designated as EFH for various life-history stages of groundfish, coastal pelagic species, and Pacific salmon (Table 3-1).

3.4 Effects of the Proposed Action

Assessment of the potential adverse effects of the managed species' EFH from the proposed actions is based, in part, on the habitat descriptions in section 3.2 and on information provided in USCG (2002). As described in detail in Section 2.1.5 of this Opinion, the proposed action may result in short and long-term adverse effects to a variety of habitat parameters. These adverse effects are:

1. Removal of important habitat features (*e.g.* large woody debris).

2. Increases in turbidity.

3. Increases in temperature.

4. Modification of flow regimes and impacts on fish passage.

5. Modification of stream morphology.

6. Modification of nearshore habitat (*e.g.* kelp harvest, oiled sediment removal, impacts to eelgrass).

7. Introduction of chemicals into waterbodies.

3.5 Conclusion

NOAA Fisheries concludes that the proposed action may adversely affect the EFH for the groundfish, coastal pelagic, and Pacific salmon species listed in Table 3-1.

3.6 EFH Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NOAA Fisheries is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. The Terms and Conditions outlined in Section 2.2.3 are generally applicable to designated EFH for the species in Table 3-1, and address these adverse effects. Consequently, NOAA Fisheries recommends that they be implemented as EFH conservation measures.

3.7 Statutory Response Requirement

Pursuant to the MSA (§305(b)(4)(B) and 50 CFR600.920(j), Federal agencies are required to provide a detailed written response to NOAA Fisheries' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that 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.

3.8 Supplemental Consultation

The USCG and/or the EPA must reinitiate consultation with NOAA Fisheries if the proposed action is substantially revised in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries' EFH conservation recommendations (50 CFR 600.920(k)).

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Appendix A

Recent Notable Oil Spill Responses in the Northwest

M/V New Carissa, Coos Bay, Oregon, 1999

On February 4, 1999, the M/V New Carissa was driven aground north of Coos Bay, Oregon as a result of gale force conditions acting on an anchored vessel. At the time of the grounding, the vessel contained 359,000 gallons of heavy fuel oil in six tanks and 37,400 gallons of fuel oil in one tank. Attempts to tow the stranded vessel failed, and on February 8, the New Carissa began to leak oil. Soon, tar balls began washing up on nearby beaches. On February 10, a major structural failure occurred in the engine room, and break-up was believed to be eminent. The decision was made to burn the oil on board, and roughly half of the oil (~200,000 gallons) were estimated to have been consumed in the fire, leaving approximately 130,000 gallons remaining in the bow section. The decision was then made to attempt to tow the bow section, along with the oil, out to sea and sink it offshore. On March 1, a tug began towing the bow section out to sea. Unfortunately, bad weather caused the wire strap connecting the towline to the tow to break, and on the morning of March 3, the bow section washed up on a sandy beach near Waldport, Oregon, spilling additional oil. Cleanup crews were relocated to the spill site. A second attempt to tow the bow section was made, and on March 11th, the bow section was sunk in over 10,000 feet of water 282 miles west of Waldport (The New Carissa Review Committee2000).

Whatcom Creek - Ruptured Pipeline, Washington, 1999

On June 10, 1999, a rupture occurred in a pipeline within the city of Bellingham, Washington, spilling a total of approximately 236,000 gallons of gasoline. The pipeline is owned by the Olympic Pipe Line Company and runs from Ferndale, Washington to Portland, Oregon. The released product saturated the ground and flowed both above ground and through subsurface pathways to nearby Hanna Creek, where it proceeded downstream into the creek. Less than 2 hours later, the fuel ignited, resulting in a fire, which, at its peak, spanned from the source location down Hanna Creek to Whatcom Creek and down the Creek for a distance of approximately 1.6 miles. The fire burned approximately 26 acres, and killed at least 100,000 fish, aquatic invertebrates and amphibians, including juvenile salmonids (coho, chinook, chum, sockeye, and steelhead). Impacts to stream habitat and nearby vegetation were severe. The primary cleanup was overseen by the Environmental Protection Agency (EPA) and included removing 6,500 cubic yards of contaminated soil, aerobically cleaning another 2,000 cubic yards, and recovering approximately 1,800 gallons of fuel. More than 36,000 trees were planted throughout the burn zone and stream habitat was rehabilitated and enhanced.

Clearwater River Diesel Spill, Idaho, 2002

On January 6, 2002, a tanker truck accident on Highway 12 near Kooskia, Idaho (milepost 83), spilled approximately 10,000 gallons of diesel fuel along and in the Middle Fork of the Clearwater River. Within a short period of time, a contractor had staged 2,700 ft of hard boom, two center-console watercraft, two skiffs, and a 3,000 gallon vacuum truck at the scene. Of the total amount of oil spilled, approximately 600 gallons of standing product was recovered from a ditch on the north side of the highway (opposite the river). The remaining product discharged directly into the river or soaked into the soil on both sides of the road. Within days, 1,650 yards of contaminated soil had been excavated at the accident site and removed by truck for disposal. In addition, the contractor built a recovery trench between the spill site and the river, and approximately 2,700 gallons of oil/water mixture had been recovered via vacuum truck, with nearly half of it fuel. The EPA served as the lead agency on this oil spill.

Historical Spill Data (for Washington State only)

Year	Location (County)	Source	# gallons/fuel
1964	Grays Harbor	Barge	1,200,000 gal diesel fuel
1971	Skagit County	Barge	230,000 gal diesel/gasoline
1972	Clallam County	Navy vessel	2,300,000 gal fuel oil
1973	Whatcom County	Pipeline	460,000 gal crude oil
1983		Pump station	168,000 gal diesel fuel
1984	Columbia River	Tanker	200,000 gal fuel oil
1985	King County	Pipeline	34,000 gal jet fuel
1985	Port Angeles	Tanker	239,000 gal crude oil
1986	King County	Pipeline	70,000 gal oil
1988	Skagit County	Barge	70,000 gal heavy oil
1988	Grays Harbor County	Barge	231,000 gal fuel oil
1990	Kitsap County	Supply Depot	70,000 gal diesel fuel
1990	Skagit County	Texaco	130,000 gal diesel fuel
1990	Pierce County	PNW Terminals	200,000 gal tallow
1991	Tacoma	US Oil Tacoma	600,000 gal crude oil
1991	Anacortes	Texaco Refinery	210,000 gal crude oil
1991	Canadian waters at entrance to Strait of Juan de Fuca	Barge	100,000 gal diesel and heavy oil
1992	Lincoln County	Pipeline	20,000 gal jet fuel
1993	Tacoma	Oil Refinery	264,000 gal crude oil
1993	Tacoma	Vessel	6,200 gal fuel oil
1993	Columbia River	Vessel	3,000 gal fuel oil
1994	Rosario Strait	Barge	26,900 gal diesel fuel
1994	Columbia River	An Ping (shipping?)	2,771 gal fuel oil
1996	Harbor Island, Seattle	GATX	49,000 gal unleaded gasoline
1999	Whatcom Creek, Bellingham	Pipeline	277,200 gal gasoline

Appendix B

Description of Open Water Environment and Shoreline Habitats

Open Water Environment

Marine and Brackish Open Water Environments

Offshore Waters
Offshore waters are those areas where the water depth is greater than 60 feet and there is no surrounding land. Transport of spilled oil is controlled largely by wind and ocean currents rather than by tides or mixing with freshwater outflows. In addition to waters off the outer coasts of Washington and Oregon, this habitat includes the deeper waters of the Straits and main basins of Puget Sound. Protected species using this habitat may include endangered and threatened marine mammals, sea turtles and salmon, and federally managed fish. Although species densities in this habitat are generally low, there may be times of localized high densities. For example, upwelling of nutrient rich, deep waters rapidly increases productivity of warmer surface waters. Evaluation of environmental impacts to open water habitats focuses on species in the water column and species inhabiting or using the sea surface.

Biological resources in the open water column are less vulnerable to spills than those inhabiting the nearshore environment. In the top few meters, where dissolved or dispersed oil concentrations are likely to be greatest, the organisms most vulnerable to exposure are poor or passive swimmers (planktonic forms). The potential for adverse impacts to organisms in the water column declines within hours or days after a spill, as most of the soluble and toxic components of the spilled oil are lost through evaporation.

Nearshore Waters
Nearshore waters are defined as marine water less than 60 feet in depth and adjacent to a shoreline. Transport of spilled oil is influenced by tidal and nearshore currents, winds and mixing with freshwater outflows. The shallow water depths increase the potential that an oil spill will affect both the water column and benthic habitats. The associated shallow water habitats may have a high total productivity and are often very important to nearshore and offshore fisheries.

Sea grasses are highly productive habitats that occur on intertidal flats and in shallow coastal waters. They help stabilize sediments, produce detritus to support the basis of food chain, and support a highly productive community of fish and invertebrates that lives on the surface of the plants. Kelp forests are found on hard subtidal substrates in exposed sections of the nearshore zone. Kelp forests support a diverse animal community, including fish, invertebrates and marine mammals, as well as important algal communities.

The nearshore waters are very important to outmigrating juvenile salmon, especially chum, coho, and chinook, which depend on habitat features present in the nearshore environment for rearing, protection and foraging.

Bays and Estuaries
Bays and estuaries are near coastal waters partially surrounded by land. They are more sheltered than the offshore habitat and have more limited circulation and flushing than offshore waters. Depths in this habitat are frequently less than 30 feet. Because of the likelihood of shallower depths in this habitat, benthic habitats may be adversely affected by the presence of oil. Eel grass beds and other shallow, submerged vegetation habitats may also be found in this environment. Tides and fresh water mixing influence the distribution of species and have a significant effect on spilled oil. Flushing and dilution rates vary greatly and suspended sediment concentrations can be high.

Estuaries and bays are used by commercially important finfish. Other organisms reside there or migrate seasonally into estuaries to use this habitat for a breeding and nursery area. Bays and estuaries are also home to marine mammals and sea turtles. Bays and estuaries can be highly sensitive to oil spills, particularly where flushing rates are low. Because early life stages of many organisms tend to concentrate in this habitat, the probability of contact with oil increases. Floating oil in these habitats has the greatest potential for impact to (1) all biological resources in the water column (lower water volumes for dilution), including salmonids and federally managed fish species; (2) benthic organisms (proximity of water bottom and high depositional areas that may concentrate oil); and (3) marine mammals.

Due to their anadromous life cycle, salmonids pass through estuaries as juveniles on their downstream migration to the ocean and as adults on their upstream migration to spawning grounds. As a result, estuaries are very important to adult salmon for staging and physiological transition, and to juveniles for foraging, physiological transition, and refugia. Chinook are the most estuarine-dependent of the salmonids, spending up to 160 days in the nearshore prior to migrating to sea. Chinook may enter the estuary immediately after emergence as fry (~40 mm), as fingerling smolts (60 to 80 mm), or yearling smolts (80 to 110 mm) (Healey 1982 in Aitkin 1998). Juveniles residing in the estuary tend to move with the tide - on flood tides, the juvenile chinook move into the marshes at the highest reaches of the tide, while on the ebb tide, the fish recede into tidal channels that can retain water at low tide. Chum also depend on estuaries to rear, moving downstream immediately after emergence (30 to 40 mm). Chum fry residing in estuaries occupy tidal creeks, sloughs, and marshes, exhibiting the same movements with the tide as chinook.

Fresh Water Open Water Environments

Oil spills into inland waters differ from coastal or marine spills for several reasons. First, inland spills are usually in freshwater habitats. Inland spills are also more frequent than marine spills, and they often involve smaller volumes of oil. Refined product spills are more common in freshwater, while crude oil spills comprise the majority of marine spills. Inland spills have a much higher potential to contaminate water supplies (surface as well as groundwater), to affect areas of concentrated populations, and to impact manmade structures and human activities. In coastal and marine environments, wave and tidal action are important mechanisms for dispersion

and transport of oil and in removing oil from shorelines. These mechanisms are less important in freshwater habitats, where currents and floods are more important factors.

Large Lakes
Open water environments exist in large waterbodies, such as Lake Ozette and Lake Washington, both in Washington State. Such large lakes have ocean-like wave and current conditions, although the currents are generally weak (less than one knot). Local weather conditions commonly cause sudden changes in sea state. Suspended sediment loads are highly variable, both spatially and temporally. Although all inland waters are surrounded by land, response operations for open-water environments are water-based; that is, protection and recovery equipment must be deployed from vessels rather than from shore.

Listed salmonids may be found in large lakes - for example, the listed Ozette Lake sockeye spends a large portion of its life in the lake, entering freshwater from April to early August, holding three to nine months in the lake prior to spawning in late October through January. Sockeye fry rear for one year before migrating out to sea for two winters (Gustafson *et al*. 1997).

Large Rivers
The Pacific Northwest contains several large rivers that may be categorized as open water. These rivers include the Columbia River, the Willamette River and the Snake River. Large rivers are not necessarily navigable to large vessels, although if they are, the environment can include locks, dams, pools and other manmade structures. Large rivers have varying salinities, meandering channels and high flow rates (currents greater than 1 knot). Water levels vary by season, with potential for reversal of water flow up tributaries and into backwater lakes during high water. Floodplains are common characteristics of large rivers. Floods generate high levels of suspended sediment and debris loads. In such conditions, river floodplains contain highly sensitive areas that are important habitats for many species.

High currents, eddies, mud-river bars and flooding may complicate the response methods used in this habitat. Water flows across weirs and dams are of special concern because they are often very turbulent and have the potential to emulsify or disperse oil slicks as they pass over these structures. In addition, oil can adsorb onto sediment particles, which can subsequently settle out in quiet backwaters, potentially contaminating these habitats.

Most listed salmonid species may be found in various life stages at all time of the year in large rivers. Most are either migrating upstream to spawn as adults, or migrating downstream as fry or smolts, and all could be affected to varying degrees by an oil spill and subsequent response methods.

Small Lakes and Ponds
Small lakes and ponds are standing bodies of water of variable size and water depth. Waves and currents are generally very low, although the surface of the water can become choppy. Water levels may fluctuate widely over time, particularly on manmade lakes. Smaller ponds may

completely freeze over in winter. Bottom sediments close to shore can be soft and muddy, while the surrounding land may include wet meadows and marshes. Floating vegetation can be common. In this habitat, the rate of water exchange is highly variable, ranging from days to years. These waterbodies can include sections of a river with low flow rates (*e.g.*, behind diversion dams) or that are somewhat isolated from regular flow (*e.g.*, backwater lakes or oxbow lakes).

Small lakes and ponds have medium to high sensitivity to oil spills because these habitats have low physical removal rates, limited dilution and flushing of oil into the water column, and high biological use. They provide valuable habitat for migrating and nesting birds, as well as mammals. Associated wetlands have an even greater sensitivity. In shallow water, boat operations would be limited and most response operations are typically conducted from shore.

Small Rivers and Streams
Small rivers and streams are characterized by shallow water (generally 1 to 2 meters) and narrow channels. Water flow can be highly variable, both throughout the seasons and with distance downstream. This category of open water includes a wide range of waterbodies, from fast-flowing streams with low falls and numerous rapids over bedrock and gravel to slow-moving streams bordered by low muddy banks and fringed with vegetation. Sections of these river channels may be "choked" with logjams and debris, and mid-channel bars and islands can divide water flow into multiple channels. Both boat and vehicular access can be very limited; often the only access may be at a bridge crossing.

Small rivers and streams have medium to high sensitivity to the impacts of oil spills. Oil spills may have a greater impact on small rivers and streams than on large rivers due to several factors, including lower flow conditions, lower dilution rates, lower overall energy, and a greater range of natural habitats associated with small rivers and streams. Fish spawn in streams and the tributaries of larger rivers; thus, the most sensitive, early life stages may be present in this habitat. Fringing wetlands and adjacent floodplains are closely connected to small rivers and streams; these are areas of high biological use and natural removal.

Shoreline Habitat

Introduction and Background

The Oil Pollution Act of 1990 (OPA 90) and similar state legislation established oil spill contingency planning requirements that necessitate information on the location of sensitive resources to be used as the basis for establishing protection priorities. Environmental Sensitivity Index (ESI) maps have served as an integral component of oil-spill contingency planning and response since 1979, when the first maps were quickly prepared in response to anticipating the arrival of oil slicks from a well blowout in the Gulf of Mexico. In the Pacific Northwest, a total of 161 maps have been prepared: 55 maps have been prepared for the Oregon/Washington outer coast (published in 1989), 26 maps have been prepared for Oregon/Washington and the Columbia River (published in 1989) and 36 and 44 maps have been prepared for the Strait of

Juan De Fuca / Northern Puget Sound (published in 1984) and Central / Southern Puget Sound (published in 1985), respectively, in Washington State.

The ESI maps are comprised of three general types of information: (1) Shoreline Classification - ranked according to a scale relating to sensitivity, natural persistence of oil, and ease of cleanup; (2) Biological Resources - including oil-sensitive animals and rare plants; and habitats, which are used by oil-sensitive species or are themselves sensitive to oil spills; and (3) Human-Use Resources - specific areas that have added sensitivity and value because of their use, such as beaches, parks and marine sanctuaries, water intakes, and archaeological sites. The classification system and sensitivity ranking is based on four general factors: (1) relative exposure to wave and tidal energy; (2) shoreline slope; (3) substrate type (grain size, mobility, penetration and or burial, and trafficability); and (4) biological productivity and sensitivity.

Shoreline habitats are at risk during oil spills due to the high likelihood of being directly oiled when floating slicks impact the shoreline. Because oil fate and effects vary significantly by shoreline type, many cleanup methods are shoreline-specific.

Along a coastline, wave and tidal action combine to produce a continuum of energy which can be broken down into classes of high, medium, or low energy. High-energy shorelines (ESI-1 and 2) are regularly exposed to large waves or strong tidal currents during all season, and most commonly occur along the outermost coastline of a region or where dominant winds cause waves to strike the shoreline directly or by wave refraction. Medium-energy shorelines (ESI-3 through 7) often have seasonal patterns in storm frequency and wave size. Low-energy shorelines (ESI-8 through 10) are sheltered from wave and tidal energy, except during unusual or infrequent events. Inherent in these energy classes are inferences to the persistence of stranded oil. In a high-energy shoreline, oil is removed rapidly (usually within days to weeks) using natural processes of wave action. In a low-energy shoreline, oil will undertake a slow, natural removal, usually within years. In a medium-energy shoreline, stranded oil will be removed when the next high-energy event occurs, which could be days or months after the spill.

Shoreline slope is the measure of the steepness of the intertidal zone between maximum high and low tides and can be characterized as steep (>30°), moderate (5°>x>30°), or flat (<5°). Steep intertidal areas are usually subject to abrupt wave run-up and breaking, even reflection in places, which enhances the natural cleanup of the shoreline. In contrast, flat intertidal areas promote dissipation of wave energy further offshore, which lets oil remain longer in the intertidal zone. In sheltered habitats, slope is a less important distinguishing factor with regard to oil-spill impacts, except that sensitive biological communities have more area to develop where slopes are flatter.

Substrate types are classified as: (1) Bedrock (which can be further subdivided into impermeable and permeable; (2) Sediments (further subdivided by grain size (*e.g.* mud, fine to medium-grained sand, coarse-grained sand, granule, pebble, cobble, and boulder); and (3) man-made materials (*e.g.* riprap, or broken rock of various sizes, usually cobble or larger, that are permeable to oil penetration; seawalls that are composed of solid material such as concrete or

steel, which are impermeable to oil penetration). Penetration occurs when oil stranded on the surface sinks into permeable sediments. The depth of the penetration will depend on the grain size of the substrate as well as the sorting (range of grain sizes in the sediments). Oil penetration is expected to be deepest in coarse sediments (gravel) that are most uniform in grain size (well-sorted). On gravel beaches, heavy oil accumulation can penetrate up to one meter. If the sediments are poorly sorted, such as mixed-sand-and-gravel beaches, oil usually penetrates less than 50 centimeters. Sandy beaches are also differentiated into grain-size categories that differ by permeability and thus potential depths of penetration. Muddy sediments have the lowest permeability and also tend to be saturated with water, so oil penetration is very limited. An exception to this is where infauna burrow into the substrate, with the burrows providing a mechanism for oil to penetrate an otherwise impermeable substrate.

Burial of oil can occur when clean sediments are deposited on top of oil layers. The rate of burial can vary widely and can be as short as 6 hours (one-half of a tidal cycle) after the initial stranding of oil. The most rapid burial usually occurs on coarse-grained sand beaches, because they have the highest mobility under normal wave and tidal conditions. Storms can mobilize gravel berms or bars, burying oil in gravel beaches. Along shorelines with strong seasonal storm patterns, there can be annual erosion or deposition cycles in the beach profile and sediment distribution patterns. These shorelines have the greatest potential for burial, particularly if the oil is stranded at the beginning of the depositional period.

Animals and their habitats that are potentially at risk from oil spills are segmented into seven elements on sensitivity maps, based on major taxonomic and functional groupings. Each element is further divided into groups of species or sub-elements with similar taxonomy, morphology, life history, and/or behavior relative to oil spill vulnerability and sensitivity. For the purposes of this consultation, marine mammals are further separated into pinnipeds and whales, and areas to be mapped include pinniped haulouts, pupping sites, and concentration areas, such as migratory corridors. Fish are further subdivided into sub-elements (*e.g.* anadromous marine resident fish, *etc.*) and areas/sites to be mapped include spawning and nursery areas, threatened, endangered, or rare occurrences, and other concentration areas. It is important to identify the types of species that tend to be vulnerable to spilled oil, the most sensitive life-stages, and in which habitats these life-stages occur, as habitat type plays in important role in the persistence of oil and species exposure to oil.

Biological resources are most at risk from oil spills when:

- Large numbers of individuals are concentrated in a relatively small area;
- Marine or aquatic species come ashore during special life stages or activities, such as pupping, resting, or molting (*e.g.* marine mammal haulout and pupping areas);
- Early life stages or important reproductive activities occur in sheltered, nearshore environments, or shallow water, where oil tends to accumulate;

- Limited suitable habitat exists within an area for specific life stages or along critical migratory routes;
- A species is threatened, endangered, or rare; or
- A significant percentage of the population is likely to be exposed to oil.

Associated with each species location and monthly presence are the time-periods when various life-history stages or activities occur. The life-history time periods listed are those that have resulted in the concentration of the species at the particular location (*e.g.* a pupping site, spawning site, or nursery area) and are often related to sensitive time periods associated with reproductive activities or early life-history stages.

Shoreline types labeled with ESI numbers are mapped in NOAA Sensitivity of Coastal Environments and Wildlife to Spilled Oil Atlases for Washington (Strait of Juan De Fuca/Northern Puget Sound); Washington (Central/Southern Puget Sound); Oregon/Washington (Outer Coast). Shoreline types labeled with Columbia River Environmental Sensitivity Index (CR-ESI) numbers are mapped in NOAA Sensitivity of Riverine Environments and Wildlife to Spilled Oil – Columbia River Atlas. This information on shoreline types has also been captured in the Geographical Response Plans (GRPs) developed for these areas. For areas where the shoreline types have not been mapped, shoreline types will be identified at the time of the spill using criteria from the NOAA Environmental Sensitivity Index Guidelines (Version 3.0), March 2002 (NOAA 2002)

The following shoreline types are the rankings, on a scale of 1 to 10, used on most ESI maps. Each ESI map has a legend that defines the shoreline ranking scale, describes the nature and distribution of each shoreline type in the area, predicts the behavior of oil on that shoreline type, and provides general cleanup recommendations. For the purposes of this programmatic consultation, the shoreline types included in this Biological Opinion are updated from existing ESI atlases for the following areas: the Strait of Juan de Fuca and Northern Puget Sound, Central and Southern Puget Sound, Oregon and Washington, and the Columbia River. Specifically, the Columbia River has six shoreline types: unvegetated steep banks and cliffs (ESI-3), sand/gravel beaches (ESI-5), rip rap (ESI-6C), flats (ESI-7), vegetated banks (ESI-9B), and marsh/swamp (ESI-10).

<u>ESI and CR-ESI Shoreline Type Designations</u>

ESI-1 Exposed Rocky Cliff Face and Vertical Sea Walls Or piers
This ESI shoreline type is composed of steep to vertical bedrock. The intertidal zone is steep (<30° slope) with very little width. These areas are exposed to high wave energy, so sediment accumulation is uncommon and temporary, as waves move debris that has slumped from eroding cliffs. This shoreline type is also frequently found interspersed with other shoreline types. The rock surfaces are colonized by barnacles, mussels, snails and algae, and many of the cliffs are used by marine birds and marine mammals. Exposed rocky shores are most common along the

Washington and Oregon outer coasts, but also present along the outer Strait of Juan de Fuca and the San Juan Islands.

Manmade seawalls and piers are composed on concrete and stone, wooden or metal bulkheads, and wooden pilings. They are common along inlets, urbanized areas, and developed beachfront sites. Organisms such as barnacles, shellfish, and algae may be common on pilings, while biota on concrete structures along the upper intertidal or supratidal zones is sparse.

ESI-2 Exposed Wave-cut Platforms
Within this ESI shoreline type, the intertidal zone consists of a flat rock bench of highly variable width. Along the Oregon and Washington coasts, the platform surface is irregular, and tidal pools are common. The shoreline may be backed by a steep scarp or low bluff. In Puget Sound, these areas are usually made up of low-lying bedrock or glacial till. There may be a narrow, perched beach of gravel- to boulder-sized sediments at the base of the scarp and pockets of sandy "tidal flats" can occur on the platform in less exposed settings. These habitats can support large populations of encrusting animals and plants, with rich tidal pool communities.

ESI-3 Fine to Medium Grained Sand Beaches and Unvegetated Steep River Banks
[CR-ESI-1 Unvegetated steep banks and cliffs]
This shoreline type consists of generally wide, hard-packed and flat (if fine-grained) or gentle sloping (slope <5°) (if medium-grained) sand beaches. When the sediments are fine-grained sand, beaches may be wide and flat; where the sediments are coarse-grained sand (ESI-4, below), they usually are steeper and narrower. They are commonly backed by dunes or seawalls along the exposed outer coast, while along sheltered bays, they are narrower and often fronted by tidal flats. They undergo active erosion, as indicated by the lack of vegetation. Sand beaches are common along the outer coast of Washington and Oregon, but not very common in Puget Sound. While the upper beach contains few fauna, the lower intertidal biota may include clams, worms, and amphipods.

ESI-4 Coarse-grained Sand Beaches
This ESI shoreline type is commonly found near headlands and along the southern Oregon coast. The beaches are moderate-to-steep, of variable width, and have soft sediments. The shoreline may consist of well-sorted sands of one principal size, or of poorly sorted mixtures of muddy sand, gravelly sand, or a combination of both. Sandy shorelines may be naturally eroding, accreting, or stable, and groins or breakwaters may be placed to trap sand and maintain some beaches. They may be present as pocket beaches or on top of bedrock platforms. Sand bars and banks along rivers are also included in this habitat.

Sand habitats have low to medium sensitivity to oil spills. They generally do not have sizable biological communities except where the habitat is protected. Coastal beaches are typically inhabited by razor clams, burrowing worms, and mysids. During small spills, oil will concentrate in a band along the swash line. Maximum penetration into fine-grained sand will be less than 15 centimeters; penetration in coarse sand can reach 25 centimeters or greater.

ESI-5 Mixed Sand and Gravel Beaches
[CR-ESI-2 Sand/gravel beaches]
This shoreline type consists of a narrow, moderately sloping beach and is composed of a mixture of sand (greater than 20%) and gravel (greater than 25%). It is the most common beach type in Puget Sound. It is found along the coast as extensive beaches along rocky shores, perched beaches on bedrock, and in the vicinity of river mouths along the southern Oregon coastline. The high-tide berm area is usually composed of sand or fine gravel (pebbles to cobbles), whereas the lower part of the beach is coarser, with cobbles to boulders. Because of the mixed sediment sizes, there may be zones of sand, pebbles, or cobbles. Because of sediment mobility and dessication on the exposed beaches, there are also low densities of attached animals and plants. The upper intertidal zone is used extensively by surf smelt and sand lance for spawning.

Mixed sand and gravel habitats have medium sensitivity to oil spills. Biological communities may be sparse due to sediment mobility, desiccation and low organic matter. Most invertebrates living in this habitat are deep burrowers, such as some oligochaete worms and insect larvae. Characteristic insects in freshwater systems include mayflies, stoneflies, caddisflies, and midges, although mayflies and stone flies are scarce or absent where silt is present. The nearshore habitat is used by fish for spawning and protects fry and larvae.

ESI-6A Gravel Beaches - Pebbles to Cobbles
This shoreline type includes fine-grained gravel beaches and is composed of sediments ranging in size from pebbles to cobbles (4 to 256 cm in diameter), with boulders comprising a small fraction. No sand is on the surface and less than 20% is in the subsurface. The beach slope is intermediate to steep (between 10° and 20°), with multiple wave-built berms forming the upper beach. Natural replenishment of sediments is extremely slow, and there is high annual variability in the degree of exposure and thus in frequency of mobilization by waves. Sediment mobility limits the amount of the attached algae, barnacles, and mussels to lower tidal levels. It is present along the coast of Washington.

Gravel habitats have medium sensitivity to oil spills. Biological communities are very sparse because of sediment mobility, desiccation, and low organic matter. In freshwater systems, characteristic insects are mayflies, stoneflies, caddisflies, and midges, all with larvae living among the sediments. The nearshore habitat is used by fish for spawning and provides protection for fry and larvae.

Gravel habitats are ranked higher in sensitivity than sand and gravel habitats because stranded oil can penetrate deep into the permeable substrate, resulting in long-term persistence. The slow natural replenishment rate makes removing oiled gravel highly undesirable.

ESI-6B Gravel Beaches - Cobbles to Boulders
This shoreline type is composed of sediments ranging in size from cobbles to boulders (4 to 256 cm in diameter). The beach slope is intermediate to steep (between 10° and 20°), with multiple wave-built berms forming the upper beach. Boulders dominate the lower intertidal zone. Boulder and cobble armoring of the surface of the middle to lower intertidal zone may

also be present. Of all the ESI-type beach habitats, this shoreline type has the slowest natural replenishment of sediments. There is also high annual variability in the degree of exposure, and thus in frequency, of mobilization by waves. There is also a higher amount of attached algae and epifauna due to increased stability of larger boulders.

ESI-6C Rip Rap
[CR-ESI-3 Rip-Rap]
Rip rap is angular rock similar in size to that described by ESI-6B, and is used for shoreline protection and inlet stabilization. Rip rap structures have generally steep slopes and are at the high tide line where the heaviest concentration of oil usually impacts. They are made up of boulders too large to be re-worked by waves. Due to the stability of rip rap, biota on the lower levels may be plentiful and varied. There is no natural replenishment of sediments in this shoreline type, and this habitat is generally in areas exposed to higher wave energy. There may also be a higher amount of attached algae and epifauna present due to the increased stability of larger boulders.

ESI-7 Exposed Tidal Flats
[CR-ESI-4 Flats]
Exposed tidal flats are composed primarily of sand and mud. The presence of sand indicates that tidal or wind-driven currents and waves are strong enough to mobilize the sediments. This habitat type is almost always associated with another shoreline type on the landward side of the flat. The sediments are water-saturated, with only the typographically higher ridges drying out during low tide. Biological utilization of this shoreline type can be very high with larger numbers of infauna and use by birds for roosting and foraging. Clams and worms are the most common fauna in this habitat. This shoreline type is particularly common in the eastern portion of Puget Sound and at the entrance to bays, estuaries, and river mouths along the coast.

ESI-8A Sheltered Vertical Rocky Shores and Solid Vertical, Man-Made Structures
This shoreline type is in calm, interior environments and is especially common within the interior portion of the San Juan Islands. It consists of bedrock shore of variable slope (from vertical cliffs to wide, rocky ledges) and is sheltered from exposure to most wave and tidal energy. It is uncommon along the coast and may occur along the inside of bays and coves. Species density and diversity vary greatly, but barnacles, snails, mussels, clams, periwinkles, amphipods, polychaetes, rockweed, and crabs are often very abundant.

Sheltered solid, vertical man-made structures consisting of short segments of seawalls, docks, and bulkheads are commonly found along the high tide line in harbors, industrial sites, and other developed areas. Biota along such structures along the upper intertidal or supratidal zones are sparse.

ESI-8B Sheltered Rubble Slope
This shoreline type consists of a relatively steep (>15°) and short rocky shore, covered by a thin-to-thick veneer of angular rubble without any evidence of rounding and sorting by sediment transport. It is generally sheltered from wave energy or strong tidal currents and is commonly

found in industrial waterways of northwest ports. Species diversity in this habitat vary greatly, but barnacles, snails, mussels, clams, periwinkles, amphipods, polychaetes, rockweed, and crabs are often very abundant.

ESI-9A Sheltered Tidal Flats of Sand and Mud
Sheltered tidal flats are present in calm-water habitats, sheltered from major wave activity, and are frequently fronted by marshes. Although wave energy is very low, flats may be exposed to moderate tidal or river currents. The substrate slope is flat (<3°) and can vary in width from a few meters to nearly one kilometer. Sediment is composed of water-saturated mud or muddy sand, so permeability is very low, except where burrowed. Sediments are very soft and cannot support even light foot traffic. Here, there are usually large populations of clams, crabs, oysters, worms, amphipods and snails, and many of these flats are commercially harvested. This habitat may also be used heavily by birds for feeding as well as a staging area during migration. This shoreline type is very common in bays and estuaries in Grays Harbor, Willapa Bay, Tillamook Bay, the Columbia River estuary, and upper Puget Sound. Eelgrass beds may be present and are important nursery areas for juvenile salmonids, dungeness crab, and various marine fish species.

ESI-9B Sheltered Vegetated Low Banks
[CR-ESI 5 Vegetated Banks]
This shoreline type is found at river mouths in the Puget Sound area, very common throughout the lower Columbia River and above the dams. It consists of either a low banks with grasses or low eroding banks with trees and tree roots exposed to the water, and is flooded occasionally by high water.

In freshwater systems, vegetated shoreline habitats are common features of river systems and lakes. Vegetation consists of grasses, bushes, or trees common to the adjacent terrestrial habitats. The substrate is not water-saturated and can range from clay to gravel. Along undeveloped shorelines, there can be leafy litter and woody debris trapped among the vegetation. In developed areas, yards and gardens may abut the lake or river.

Vegetated shoreline habitats have medium to high sensitivity to oil spills. Bank plants oiled during a flood period could be susceptible, especially if the flood rapidly subsides, allowing oil to penetrate into bank sediments and to contact root systems. Stranded oil could remain in the habitat until another flood reaches the same level and provides a mechanism for natural flushing. On low banks, there is greater potential for oil to accumulate in pools, penetrate the substrate, and coat large areas of vegetation, thus increasing the need for shoreline cleanup.

ESI-10 Salt and Fresh-water Marshes (Herbaceous and Woody Vegetation)
[CR-ESI 10 Marsh/swamp]
This shoreline type is commonly found along the coast and in Puget Sound at the head of many bays; extensive marshes are found in the Skagit River and Nisqually River delta areas, as well as the Columbia River estuary and river below Portland. Marshes are low energy, protected wetlands containing emergent, herbaceous and/or woody vegetation and are generally associated with river systems, bays, and estuaries. The width of the marsh can vary widely, from a narrow

fringe to extensive, and the substrate is generally silt and mud, with variable amounts of organic material. The moderate tidal range of coastal and estuarine marshes results in the presence of numerous tidal channels; frequently these are fronted by tidal flats. Resident flora and fauna are abundant and consist of numerous species. Marshes provide a nursery ground for numerous fish species and are heavily used by birds for nesting and feeding..

Marsh habitats are highly sensitive to oil spills and subsequent response activities. Shoreline sediments are likely to be rich in organic matter and support an abundance of infauna. Because of its low permeability and high water content, oil will not penetrate muddy sediments except through decaying root and stem holes or natural burrows. There can be high concentrations and pools of oil on the surface. Natural removal rates can be very slow, resulting in chronic exposure of sensitive resources to oil. The low-bearing capacity of these shoreline types means that response actions can easily leave long-lasting imprints, cause significant erosion, and mix the oil deeper into the sediments. When subsurface sediments are contaminated, oil will weather slowly and may persist for years. Response methods may be hampered by limited access, wide areas of shallow water, fringing vegetation, and soft substrate.