Refer to NOAA Fisheries No.:
2002/00251

December 6, 2004

Mr. Fred Patron
U.S. Department of Transportation
Federal Highway Administration
The Equitable Center, Suite 100
530 Center Street NE
Salem, Oregon 97301

Re: Biological and Conference Opinion on Statewide Drilling, Surveying, and Hydraulic Engineering Activities in Oregon Funded by the Federal Highway Administration.

Dear Mr. Patron:

The enclosed document contains a biological and conference opinion (Opinion) prepared by NOAA's National Marine Fisheries Service (NOAA Fisheries) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of statewide drilling, surveying, and hydraulic engineering activities completed in the State of Oregon and funded by the Federal Highway Administration (FHWA). In this Opinion, NOAA Fisheries concludes that the proposed action is not likely to jeopardize the continued existence of the Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR Fall-run Chinook salmon, Columbia River chum salmon (*O. keta*), Southern Oregon/Northern California Coasts coho salmon (*O. kisutch*), SR sockeye salmon (*O. nerka*), LCR steelhead (*O. mykiss*), UWR steelhead, Middle Columbia River steelhead, UCR steelhead, or SR Basin steelhead, or result in the destruction or adverse modification of critical habitat. Further, NOAA Fisheries concludes that the proposed action is not likely to jeopardize the continued existence of Oregon Coast (OC) coho salmon or LCR coho salmon, which are proposed for listing as threatened under the ESA.

As required by section 7 of the ESA, NOAA Fisheries included an incidental take statement with reasonable and prudent measures and nondiscretionary terms and conditions that are necessary to minimize the impact of incidental take associated with this action. However, the incidental take statement does not become effective for OC or LCR coho salmon until NOAA Fisheries adopts this conference opinion as a biological opinion, after the listings are final. Until the time those species are listed, the prohibitions of the ESA do not apply to them.

This document also includes the results of our consultation on the action's likely effects on essential fish habitats (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects to EFH. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NOAA Fisheries within 30 days after receiving these recommendations. If the response is inconsistent with the recommendations, the Federal Highway Administration must explain why the recommendations will not be followed, including the justification for any disagreements over the effects of the action and the recommendations.

If you have questions regarding this consultation, please contact Tom Loynes in the Oregon State Habitat Office at 541-957-3380.

Sincerely,

D. Robert Lohn
Regional Administrator

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Greg Apke, ODOT
Nick Testa, ODOT
Mike Long, ODOT
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F/PR3 - Chief of Endangered Species
F/NWR4 - Web Page (electronic only)
GCNW - L. Van Atta

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File #: OHB2002-0087-RI
NMFS Tracking #: F/NWR/2004/01634

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Endangered Species Act - Section 7 Consultation
Programmatic Biological Opinion and Conference Opinion

&

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

Drilling, Surveying, and Hydraulic Engineering Activities
Funded by the Federal Highway Administration in Oregon

Agency: Federal Highway Administration

Consultation Conducted By: NOAA♣s National Marine Fisheries Service, Northwest Region

Date Issued: December 6, 2004

Issued by: __________________
D. Robert Lohn
Regional Administrator

Refer to: **2004/01634**

TABLE OF CONTENTS

INTRODUCTION

This document prepared by NOAA♣s National Marine Fisheries Service (NOAA Fisheries) includes a biological and conference opinion (Opinion) and incidental take statement in accordance with section 7(b) the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq*.), and implementing regulations at 50 C.F.R. 402, but does not rely on the regulatory definition of ♧adverse modification or destruction♣ of critical habitat recently at issue in the 9th Circuit Court of Appeals case *Gifford Pinchot Task Force, et. al, vs. U.S. Fish and Wildlife Service,* No. 03-35279, August 6, 2004. The essential fish habitat (EFH) consultation was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq*.) and implementing regulations at 50 C.F.R. 600. The administrative record for this consultation is on file at the Oregon State Habitat Office, Portland, Oregon.

Background and Consultation History

On February 6, 2003, NOAA Fisheries issued a biological opinion (refer to NOAA Fisheries No.: 2002/00251) on the effects of drilling, surveying, and hydraulic engineering activities in Oregon funded by the Federal Highway Administration (FHWA).[1] Although only one project was completed under that Opinion, on August 14, 2003, the FHWA requested that the consultation be reinitiated to expand the geographic scope of actions covered to include estuarine and saltwater areas. This Opinion does that, and includes other modifications necessary to reflect changes in the status of listed species that have occurred since the original Opinion was issued.

Proposed Action

For purposes of these consultations, the proposed action is Federal Highway Administration (FHWA) funding of the following actions related to geological drilling and surveying in Oregon: (1) Access road construction; (2) drill pad preparation; (3) access road and drill pad reclamation; (4) drilling and sampling operations; (5) mobilization and set up; (6) de-mobilization; (7) boring abandonment; (8) project development surveys; (9) construction surveys; and (10) boundary surveys.

Program Administration

[1] NOAA Fisheries, Endangered Species Act Section 7 Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the Federal Highway Administrations♣ Programmatic Consultation for Statewide Drilling, Surveying, and Hydraulic Engineering Activities in Oregon (February 6, 2003).

Each project will be individually reviewed by the FHWA to ensure that all adverse effects to ESA-listed salmon and steelhead and their designated critical habitats are within the range of effects considered in this Opinion and that each applicable term and condition will be included as a final project specification for projects by the FHWA. Further, the FHWA will ensure that all necessary project notification, monitoring, and reporting information will be collected and forwarded to NOAA Fisheries as required, including an individual project notification, copies of necessary project plans (*i.e.*, pollution and erosion control, work area isolation, stormwater management, site restoration, compensatory mitigation) commensurate with the size of the project, project completion report or memo to file, a site restoration and/or compensatory mitigation report, and an annual program report. Unless waived by NOAA Fisheries, the FHWA and NOAA Fisheries will complete an annual coordination meeting to discuss the annual monitoring report and any actions that will improve conservation or make the program more efficient or more accountable. If the FHWA chooses to continue programmatic coverage under this Opinion, it will reinitiate consultation within three years of the date of issuance.

Drilling, Surveying, Stormwater and Hydraulic Engineering Operations

Access Road Construction. In most cases, the construction of access roads for drill vehicles will not be necessary because of favorable topography at the site. Any access roads that are constructed will be in place only for the duration of the drilling period, unless additional drilling, instrument installation, monitoring, highway improvements, or other work is anticipated

Construction of the access roads will involve removing impassable objects and creating a flat surface. Access roads are typically 4.3 meters (m) wide. In some cases crushed rock is necessary to provide a stable driving surface. Geotextile material will be used to reduce the amount of crushed rock needed, and to make removal and reclamation easier once construction is finished. Truck-mounted drills may require more extensive access road work due to grade limitations and traction requirements for those types of vehicles. Track-mounted drills can generally cross steeper, more uneven and less stable ground with fewer disturbances. Additionally, water tankers and support vehicles may need to access the drill site depending on site conditions and the type of operation.

Drill Pad Preparation. Drill pads are the areas where the drill rig and support equipment are parked when the drill is operating. Usually, the pad is twice the size of the drill equipment to accommodate site safety requirements, and tool and supply storage, but the drill pads are reduced in size whenever possible to reduce ground disturbance.

The drilling rig is stabilized using hydraulic leveling jacks, which require a level pad to work on for both types of drilling equipment. If a pad must be placed on irregular or steep terrain, the site will be graded to provide a level surface for placement of the drill equipment. The leveling is critical to drilling success and time spent.

<u>Access Road and Drilling Pad Reclamation</u>. All disturbed areas (*i.e.*, access roads, drill pads) will be re-graded to pre-project contours at project completion. Access roads and drill pads constructed as part of a proposed roadway project that will be constructed within 18 months of the drilling activity will be reseeded for erosion and sediment control. For projects where construction is not anticipated for more than 24 months, all disturbed habitat functions (not just erosion and sediment control) will be replaced, particularly where riparian vegetation has been removed during drilling activities. Monitoring and maintenance of restoration areas planted with woody vegetation will be conducted for a period of 5 years.

<u>Drilling and Sampling Operations, Mobilization, and Setup</u>. Drilling and sampling methods vary depending on the project. The method selected depends on the anticipated subsurface conditions at the site. Methods of drilling may vary from air rotary drilling where the boring is advanced using air-powered hammer and rotation, in which compressed air blows out of the bottom of the bit and blasts cuttings back to the surface, to water or mud rotary drilling where the rotating drill steel is advanced into the ground, applying downward pressure and washing the cuttings out of the boring with water or a drilling mud. Sampling techniques involve inserting and retrieving sampling instruments in the boring during the drilling process. Other exploration methods might include digging test pits with tire or track-mounted backhoes, or shallow borings with hand tools (hand augers or probes). Drilling and sampling techniques are described in detail in Appendix A of the BA.

On the typical exploratory operation, the drill rig is driven onto the site and drill pad. Sometimes drill pads are necessary when there is uneven ground surface conditions. The mast is raised and the drill rig is leveled using hydraulic leveling jacks. Wooden blocks and/or metal plates are placed under the jacks to reduce the potential for jacks sinking into the soil. If there is no drilling pad, then the site is cleared around the sides and back of the drill to allow room to work. Typically, this requires cutting brush and removing obstacles for a few feet on each side of the drill rig, and in an area (approximately 9 m x 2.5 m) at the rear of the drill. This varies per site and per drilling method. This site preparation is necessary to assemble the drill steel needed to work on site and to provide a safe working area. If the site is muddy, setup may also require spreading straw around the rig to provide a slip-free working area.

If water is required for drilling, a water tanker is parked as close to the drill rig as possible. If necessary, small ditches are dug or soil berms are constructed to channel water from the drilling process away from the work site. Erosion or sediment control measures are employed as needed. A support vehicle is usually parked as near to the drill as possible to provide easy access to tools and supplies. If this is not possible, supplies are either hand carried or loaded on a small, tracked ATV and shuttled into the drill site.

Most impacts associated with mobilization and setup occur during the construction and reclamation of the drill pad. If a drill pad is not constructed, impacts that may occur during drill set-up include vegetation removal for access, and sediment run-off from ditches excavated to keep the site dry.

Auger Drilling. Auger drilling involves attaching an auger, with a carbide-toothed bit attached at the bottom, to the rotary drive spindle of the drill. The drilling is accomplished by rotation and downward pressure applied to the auger by the drill. If more depth is required than can be accommodated with the lead flight of auger (normally 1.5 m maximum), additional flights of auger (normally 1.5 m length) are attached, and the drilling is advanced to the necessary depth.

Typically, soil recovered from the drilling is spread out over the site and stabilized by seeding and mulching. The material can be removed from the site by placing it in barrels, which are later removed from the drill site. If no instrumentation is installed in the drill borings, the borings are typically abandoned by filling them with bentonite chips, pellets, or cement-bentonite grout.

Typical equipment used in this type of drilling operation includes a truck or track mounted drill with either solid or hollow stem augers (with/without continuous sampler apparatus), support vehicle(s), and a shovel (this will be the minimum equipment needed for this drilling activity).

Water or Mud Rotary Drilling. This method of drilling consists of advancing drill steel into the ground by applying rotation and downward pressure to the drill steel and bits. Water or drilling mud (fluid) is pumped down the inside of the drill steel to the bottom of the boring where it exits the bit. The fluid lubricates the bit and forces drill cuttings up through the boring annulus (area between the drill steel and the edges of the drill boring) and toward the ground surface. From 0 to 18,900 (L) per day of drilling fluid can be generated during this type of drilling. However, frequently after drilling begins, the drill fluid return ceases as the fluid is lost through more permeable zones of subsurface materials.

- Infiltration of drilling sediment. When drill fluid returns to the surface, it may be allowed to free flow out of the boring and across the ground surface through the existing vegetation or through a "dirt bag" before leaving the work site. The sediment laden water will typically sheet flow over the ground surface before infiltrating into the ground. This method is typically used where the threat to fish habitat is minimal, usually away from streams. The ♣dirt bag♣ is used in more sensitive environments where sediment retention is essential. With this process, the returned drilling fluid is contained and forced to flow through the sediment filter that removes the larger particles of the sediment from the fluid and allows the filtered fluids to flow through the existing vegetation. The filter and collected sediment are then removed from the site.

- Routing the drill fluid return to a sediment retention structure. Alternatively, the drill fluid may be directed to a temporary sediment pond or containment system where the sediment-laden water is held. The sediment settles to the base of the containment system and the water infiltrates into the ground. The water remaining in the pond may be reused in the drilling process. These ponds are constructed in areas that are already impacted or will create minimal new impacts.

  When drilling is complete, the water in the containment system is allowed to infiltrate or it can be pumped to an acceptable location on site for disposal on the natural ground. Sediments remaining in the containment system can either be buried at the pond location or removed from the site. When buried on site, the disturbed material is stabilized by seeding and mulching. The drilling fluid is diverted to avoid environmentally sensitive areas (wetlands, vernal pools, streams).

- Re-circulating the drilling fluid by filtering it and then reusing the fluid. In this method, drilling fluids are captured, isolated and recirculated as they flow out of the boring. The drill cuttings settle within the tank and an adequate supply of water is maintained for drilling. When drilling is complete, the fluid is either disposed of at the site through existing upland vegetation, or is pumped to an approved location for disposal. Sediments collected are buried or mounded on site, and the area is seeded and mulched.

In-water Drilling. There are two primary situations where drilling is done in a wetted stream channel: (1) When an area that was expected to be dry is wet due to wetter-than-normal water years, or (2) when there is a need to drill within the margin of the wetted stream channel. In these cases, the drilling equipment is isolated from the water via a small platform or in the dry behind a coffer dam. A sleeve or casing is then placed where the drilling will occur. This casing enables collection of drilling fluids similar to methods 2 and 3, outlined above. The drilling fluids are disposed of periodically at an upland location. A small pulse of turbidity may result when the drill penetrates the top layer of the substrate. When the sleeves are removed after drilling, some residual fluids may escape. Upon completion, each boring is filled with bentonite. The drill crew and geology manager pay close attention to flow stage and weather conditions to maintain an environmentally safe work site. Borings generally take from 1 to 3 days to complete.

Alternatively, drilling is often completed from the deck of a highway bridge. A diamond-cutting device is used to cut through the concrete and rebar in the bridge deck. Containment measures are placed to capture any debris from the cutting of the bridge deck. A casing of sufficient size is extended from the deck to the bottom of the waterway. This casing is embedded into the substrate, providing a seal that isolates the drill steel and the fluids from the water. The drilling fluids are returned up through the casing to the bridge deck and captured in a collection tank. The drilling fluids are disposed of periodically at an upland location. In some cases, an additional casing is needed to adequately contain the drilling fluids. A small pulse of turbidity may result when the drill penetrates the top layer of the substrate. When the sleeves are removed after drilling, some residual fluids may escape. Upon completion, each boring is filled with bentonite. The drill crew and geology manager pay close attention to flow stage and weather conditions to maintain an environmentally safe work site. Borings generally take from 1 to 3 days to complete.

Environmental (Hazardous Material) Drilling. Environmental drilling is conducted using a variety of methods, primarily geoprobe drilling or auger drilling. Fluids are not typically used when drilling for hazardous materials samples. A geoprobe is used for hazardous material exploration and is mounted on the back of a standard pickup or similar vehicle. Sampling is conducted by driving a 2.5 cm steel probe into the ground. Samples are collected in hollow tubes and capped for later analysis. This activity uses no fluids. When auger drilling, the cuttings are placed on plastic sheeting and covered, or in labeled barrels. Soil samples are lab-tested and properly disposed of under Oregon Division of Environmental Quality (ODEQ) guidelines.

Decontamination is required during environmental drilling operations. Decontamination is achieved as follows:

1. Decontamination of split spoons between samples. The split spoon is submersed in a bucket of soapy water and scrubbed off between samples, then rinsed in deionized water. The soap breaks down petroleum products into inert organic compounds. If the contamination is petroleum-based and at low levels, the waste water is dumped on site. If the contamination is other than petroleum, the water is contained in a barrel on site, the barrel is labeled, and a sample is obtained for lab testing. If the lab determines that the sample is not contaminated, the water is discharged on site. If the sample is contaminated, the barrels are removed from the site and handled per DEQ and Environmental Protection Agency (EPA) specifications for the waste product. The typical amount of water produced through this activity is approximately 15 L per boring.

2. Decontamination of drilling steel and bits between borings. The drill steel and bits are generally decontaminated at the drill site, but occasionally they are hand-loaded onto a trailer on a sheet of plastic and hauled to the steam cleaner nearby or at a maintenance station. The steel parts are loaded onto the steam cleaner rack for cleaning. The waste wash-water or water with Alconox[2] is contained in a holding tank attached to the steam cleaner. If the steel is too big to fit over the holding tank, it is washed in a portable tank consisting of plastic sheeting surrounded by straw bales to contain the water. The used wash water is usually

[2] Alconox is a detergent used to clean sampling equipment.

stored onsite in labeled barrels for lab testing. In rare cases, it is stored in the tank and allowed to evaporate.

In situations where the water is likely contaminated, the barrels are stored in a secondary containment area to avoid spills (this is typically plastic sheeting which is bermed with straw bales on all edges to create a ♣tank♣). The amount of water varies (76 to 380 L), depending on the amount of steel being cleaned and the amount of soil adhering to the steel. The water testing takes approximately 5 days. If the tests indicate the water is clean, it is typically discharged on site. If the water is contaminated, the barrels are lifted onto a trailer and hauled offsite and disposed of as per DEQ regulations for the waste product. If the water is stored and allowed to evaporate, the residue is tested and hauled offsite for disposal.

Drill Boring Instrumentation. This activity consists of placing materials, instruments and/or equipment into a completed boring (air or water/mud rotary, auger, or geoprobe) for the purpose of measuring or monitoring various *in situ* parameters over an extended period. Placement of instruments is usually done immediately upon completion of the boring utilizing most of the same equipment that was used in the drilling process. Borings are often backfilled with grout once the instruments have been installed. Grout is either mixed with a grout pump that is trailer mounted which is towed to the site behind a support vehicle or in a tank or trough with a hand mixer.

Materials used during boring instrumentation include grout made from Portland cement and powdered bentonite. In some cases, all or part of a bore hole is backfilled with clean silica sand or bentonite pellets, rather than grout.

Casing installed in instrumented borings ranges from 1.3 to 20 cm (plastic) inclinometer casing or smaller diameter schedule 40 PVC. Flush-mount monument covers made of steel or concrete are installed to protect against accidents or vandalism.

No additional impacts are caused by this activity beyond those described above for drilling operations.

Air Rotary Drilling. Air rotary drilling equipment ranges in size from small skid or track mounted rigs to large air rotary rigs used for water well drilling. This method of drilling uses an air powered hammer and compressed air. The air is forced down the casing and through the bit, blasting the cuttings back to the surface. No drilling fluids are used, however, a foaming agent is often added to help float the cuttings out of the boring. Once the boring advances below the water table, water is blasted (usually as a mist) out of the boring along with cuttings.

Test Pits. Test pits are dug using a trackhoe or rubber-tired backhoe to determine subsurface conditions and provide detailed, large-scale geologic information. This data is gathered from examination of the excavation walls and material. These pits are typically less than 6 m deep and about the width of the bucket. The soil from the pit is side-cast beside the boring and placed back into the boring at completion.

Soil Testing. Soil testing is conducted by lowering a split spoon sampler in the boring and hammering repeatedly with a 64 kg mechanical hammer until the split spoon penetrates 0.5 m into the soil at the bottom of the boring. The hollow sampler attains the desired sample. This test is generally performed many times at regular depth intervals within the test boring.

Several types of testing and sampling are discussed in the BA including: Vane Shear testing, pressure meter testing, Shelby (thin-wall) tube sampling, and cone penetrometer testing. Typical equipment used for soil testing includes a drill rig, support truck, drilling steel and bits, and drill steel racks.

De-mobilization and Boring Abandonment. During de-mobilization, the drill rig tower is lowered, the leveling jacks are retracted, and all tools and supplies are loaded onto the drilling rigs and support vehicles. All waste is removed, sometimes including soil and water. The boring is abandoned and vehicles are removed from the site. Erosion control devices that are no longer needed are removed. Any absorbent materials used to contain leaks are removed and disposed of away from the site.

Borings are abandoned after completion of boring and the boring is no longer needed. Abandonment is required under Oregon Department of Water Resource (ODWR) regulations. This consists of removing any temporary instrumentation, usually by drilling out whatever has been installed and filling the boring with grout, bentonite chips or pellets, or similar material. The boring must be backfilled to prevent groundwater migration between aquifers, any increased vertical mobility of groundwater compared to conditions before the boring, and prevent surface water from entering the boring.

Materials used for boring abandonment include cement grout, bentonite pellets or powder, concrete, and native material.

Project Development, Construction, and Boundary Surveys

Project Development Surveys. Surveying for project development is essential to provide designers information on all the features within the project area. Components of these surveys are fully described in the BA, and include:

1. Roadside inventory, utilities surveys, project control establishing vertical and horizontal benchmarks, topographic surveys, drainage studies, stream profile analysis, photogrammetry, and cadastral surveys (described in the BA).

2. Size of culverts, direction of flow and position of any drainage features in the stream or waterbody. Stormwater and hydraulic field activities may also include:

Investigating the condition of hydraulic structures and adjacent ground and vegetation either visually and/or by probing, sampling channel material, streamflow gaging, water sampling, turbidity monitoring, photographing features, and identification and temporary flagging of geomorphic features such as high-water marks.

3. Stream profile analysis provides information on the open water features of a stream such as channel width and depth, ordinary high water mark, and meander channel.

<u>Construction Surveys</u>. Surveying for construction control is necessary to provide contractors precise information on where and how a roadway is to be constructed. Stakes are placed along the proposed roadway routes that provide contractors specific details for the construction of the road. Components of construction control include: Relocating control points, establishing centerlines, placing slope stakes and temporary stakes for right-of-way (ROW) and easements, staking for water detention ponds/bioswales, staking for wetland/stream mitigation, stream relocation, erosion control boundaries, determining drainage patterns, and staking for structures including bridges, culverts, and grade hubs.

<u>Boundary Surveys</u>. Boundary surveys are conducted to establish or re-establish a boundary line on the ground or to obtain data for constructing a map or plat showing a boundary line. Boundary surveys are to determine property ownership along a specific route and establish ROW rights along the route.

Conservation Practices for Effects Associated With Drilling and Surveying Activities

The following conservation practices will apply to all of the activities associated with drilling and surveying wherever applicable. These activities will be coordinated with the biologist before completing in-water work; removal of riparian vegetation; or installation of access roads near riparian areas, streams, or wetlands. These conservation practices are in addition to those listed in ♣Routine Road Maintenance♣ (Water Quality and Habitat Guide Best Management Practices) by ODOT, revised in 2004. The primary intent of these conservation practices is to limit or reduce sediment and drilling fluid escape and prevent petroleum from entering aquatic resources and to reduce disturbance of suitable habitat.

<u>Access Roads</u>.

- No in-water work (inside of the ordinary high water mark) will occur outside of the in-water work window for individual streams without NOAA Fisheries♣ and/or U.S. Fish and Wildlife♣s (USFWS) written approval. Any actions that require placement of temporary fill in streams or wetlands areas will require completion of a U.S. Army Corps of Engineers (USACE) Clean Water Act (404) permit.

Instream habitat and bank conditions will be restored in any disturbed aquatic system.

- When stream crossings are encountered for access to sites, a fisheries biologist will be consulted before crossing and/or placement of temporary (<18 months) or permanent culverts in the stream channel, and will contact NOAA Fisheries to determine potential impacts to listed species and the course of action that should be taken.
- Culvert installation will be conducted in accordance with guidance from the regulatory agencies. Culverts will be installed so as to not block fish passage in accordance with NOAA Fisheries guidance, *Guidelines for Salmonid Passage at Stream Crossings*.
- The number and size of entry points or access roads into work areas will be limited to the fewest number feasible.
- Temporary roads installed over wetland resources, native shrub species (*e.g.*, willow), or other resilient natural areas will use geotextile material as a base to reduce impacts and reduce restoration requirements, unless the equipment can drive over natural ground without impacts. If used, geotextile and temporary road material will be entirely removed after the temporary access is abandoned.
- Pad construction will use the same conservation practices developed for road construction, including application of geotextile material and complete removal after the work is completed.
- When no other means of excavation is feasible without excessive damage, a spider hoe will be used to excavate test pits. A spider hoe "walks" on four hydraulically-controlled legs, two with wheels and two with claws, and can maneuver around trees and brush and ascend or descend steep slopes.
- When performing sub-surface investigations by excavating test pits, spider hoes will be used to eliminate the need for access road construction.
- When crossing a stream channel is absolutely necessary, the vehicle will be inspected for fluid leaks. Any leaks found during the inspection will be repaired. The vehicle will be steam-cleaned before entering the wetted channel. In addition, vehicles will be outfitted with absorbent media to prevent stream contamination. Portable devices will be employed to bridge the drilling rig from the water when crossing (*e.g.*, boards, metal rails, grates)
- When possible, a crane will be used to lower the drilling equipment and platform, and eliminate the need for access roads.
- Crossing of wetted areas (wetlands, ditches, stream crossings, *etc.*) will be avoided when feasible. When no practical access alternative through or across wetted areas is available, temporary portable crossing devices such as, culverts, boards, metal rails or grates, crane mats, bridges will be used. The purpose of the crossing device is to isolate the equipment from impacts to the wetted areas. If a temporary portable crossing device is deployed (particularly culverts), these devices must comply with state and Federal guidelines including fish passage statutes.

Contaminant Control.

- Whenever possible, equipment will be fully fueled before site access. If the vehicle will be crossing a stream, then it will be refueled only to the extent needed to finish the required borings. When refueling of the drilling equipment is required at the drill pad, within 150 feet of the stream, absorbent pads will be employed to ensure that any spilled fuel is contained on the drill pad.
- Drill rigs and equipment will have a daily maintenance and inspection schedule to detect and repair potential problems.
- If a contaminant release occurs, the vehicle or equipment will be immediately shut down, and the cause of the release will be repaired. In addition, plastic sheeting, absorbent pads and booms will be kept with the drilling supplies and will be deployed to contain or absorb the leaking fluids.
- When drilling near streams or waterbodies, appropriate isolation will be constructed between the drill and waterbody to direct spills away from the waterbody.
- Environmentally safe operating fluids (refer to the material safety data sheet) may be used when drilling within the wetted channel.
- Drill crews will use conservation practices to contain or control drill fluids that have the potential to enter a waterbody, river or wetland. This may entail the use of drill fluid recirculation, bio-bags, swale filtration, silt fencing, straw bails, or sediment ponds. Ditches and berms may also be used to direct and contain the fluids until they either evaporate or seep into the ground. Drill fluids will not be allowed to drain directly into aquatic resources.
- The drill crew will maintain and keep a spill cleanup kit at the drill site at all times. Crews will be trained and properly equipped to identify and cleanup spills.
- The drill crew personnel will make daily checks of the condition of storage containers on site.
- Contaminant releases will be cleaned up immediately when they are discovered.
- Contaminants will be disposed of in accordance with current Oregon Department of Environmental Quality (ODEQ) regulations. The drill crew will clean up any contaminant releases involving 10 gallons or less. A contaminant cleanup contractor will clean up releases over 10 gallons. A hazardous materials unit will be notified of all spills regardless of size.
- Collected contaminated materials will be stored securely until they can be appropriately removed from the site.
- Water used for decontamination will be contained on-site and secured. ODEQ requires that the water be stored on site until it is tested. Water is discharged on site if tested and found to be clean. If it is to be discharged on site, it will be allowed to slowly infiltrate into the ground, only at least 50 feet from waterbodies. If the water may be contaminated, the barrels will be stored in a secondary containment area (to reduce potential releases) until analytical testing is conducted. Should the collected water be positive for contaminants, it will be transported offsite for disposal. The barrels will be in a secondary containment area that is not likely to be disturbed by activities on the site.

- Manufacturer's recommendations will be followed for disposal of drilling fluids, lubricants, and other materials potentially toxic to the species listed in Table 1 of the BA.
- To reduce the potential for contamination, only enough products to complete a specific job will be stored onsite.
- Green or uncured cement grout within 24 hours of pouring will be prevented from coming into contact with any surface water.
- Excess grout produced during instrumentation or boring abandonment will be managed to keep it from reaching critical habitat such as wetlands or bodies of water.
- Tools used for cement grout work will not be washed in surface waterbodies. In addition, water used to wash tools used in concrete work will not be disposed in surface waterbodies.
- Dyes used in drainage studies will be non-toxic vegetable dyes or similar.
- The practice of using short pieces of plastic ribbon to determine flow patterns in drainage studies will not be used.

Erosion Control.

- Projects will follow the guidelines of ODOT's *Field Manual for Erosion and Sediment Control* (2000).
- To reduce the potential for erosion, the amount of vegetation removal for safe operations and installation of erosion control will be decreased whenever feasible. The trimming of woody vegetation will not include the removal of root material whenever possible.
- Ditching will be conducted in as small an area as possible to reduce vegetation and soil disturbance.
- Erosion control devices will be used (*e.g.*, straw bales, silt fences) when ground disturbances occur near aquatic resources. Erosion control devices will be sufficient to ensure negligible increases in turbidity in adjacent and downstream systems.
- Spoils produced by the drilling operation will be stored away from critical habitat areas (*e.g.*, streams, wetlands, and waterways). During rainy periods, spoils will be covered to prevent washing into environmentally sensitive areas.
- After drilling or surveying activities are completed, personnel will coordinate seeding and mulching of disturbed ground areas in accordance with ODOT's *Erosion Control Manual and Standard Environmental Specifications*.

In-water Drilling.

- When drilling is completed, attempts will be made to remove the remaining drilling fluid from the sleeve (via pumping, *etc.*) to reduce the pulse of turbidity when removing the sleeve.
- Work must be isolated from the wetted channel via sleeves, steel pile, sand bags, coffer dams or similar materials.
- Construction debris related to drilling through the bridge deck will be contained and taken offsite for disposal.

- Drilling equipment will be isolated from contact with the water, and the platform will be contained in case of a contaminant release.
- When deploying a sleeve or steel pile for isolation of drilling, measures (*e.g.*, screening) will be placed over the end to eliminate the risk for fish entrapment within the sleeve.

<u>General Conditions</u>. In addition to specific conditions for activities, FHWA also proposes to apply ODOT's Standard Environmental Specifications, as described in the BA, dated April 2, 2002.

Action Area

♧Action area♣ means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. 402.02). For purposes of this consultation, the action area consists of the combined actions areas of each project authorized under this Opinion. This includes all upland, riparian and aquatic areas affected by site preparation, construction, site restoration, and any offsite conservation measures at each project site. Individual action areas also cover up to 300 feet downstream from the project footprint where aquatic habitat conditions may be temporarily degraded by increased runoff and erosion until site restoration is complete. All projects authorized by this Opinion will occur within the range of ESA-listed salmon or steelhead, designated critical habitat, or EFH designated under the MSA.

The overall action area is used by 15 evolutionarily significant units (ESUs)[3] of juvenile and adult salmon and steelhead (Table 1) and includes designated critical habitat. The overall action area is also designated as EFH for Pacific Coast groundfish (PFMC 1998a), coastal pelagic species (PFMC 1998b), and Pacific Coast salmon (PFMC 1999), or is in an area where environmental effects of the proposed project may adversely affect designated EFH for those species.

ENDANGERED SPECIES ACT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with USFWS and NOAA Fisheries, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. Section 7(b)(4) requires the provision of an incidental take statement

[3] ♧ESU♣ means an anadromous salmon or steelhead population that is either listed or being considered for listing under the ESA, is substantially isolated reproductively from conspecific populations, and represents an important component of the evolutionary legacy of the species (Waples 1991). An ESU may include portions or combinations of populations more commonly defined as stocks within or across regions.

specifying the impact of any incidental taking and specifying reasonable and prudent measures to minimize such impacts.

Biological Opinion

This Opinion presents NOAA Fisheries' review of the status of each ESU considered in this consultation, the condition of designated critical habitat, the environmental baseline for the action area, all the effects of the action as proposed, and cumulative effects (50 C.F.R. 402.14(g)).

For the jeopardy analysis, NOAA Fisheries considers those combined factors to conclude whether the proposed action is likely to appreciably reduce the likelihood of both the survival and recovery of the affected ESA-listed species. The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for listed species by examining any change in the conservation value of the essential features of critical habitat. However, this analysis does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat recently at issue in the 9th Circuit Court of Appeals case *Gifford Pinchot Task Force, et. al, vs. U.S. Fish and Wildlife Service,* No. 03-35279, August 6, 2004. Instead, it focuses on the effects of the proposed action on critical habitat and on the role that designated critical habitat must play in the action area with respect to the survival or recovery of each listed ESU.

If the action under consultation is likely to jeopardize the continued existence of an ESA-listed species, or destroy or adversely modify critical habitat, NOAA Fisheries must identify any reasonable and prudent alternatives for the action that avoid jeopardy or destruction or adverse modification of critical habitat and meet other regulatory requirements (50 C.F.R. 402.02).

Status of the ESUs

This section defines range-wide biological requirements of each ESU, and reviews the status of the ESUs relative to those requirements. The present risk faced by each ESU informs NOAA Fisheries' determination of whether additional risk will "appreciably reduce" the likelihood that an ESU will survive and recover in the wild. The greater the present risk, the more likely any additional risk resulting from the proposed action's effects on the population size, productivity (growth rate), distribution, or genetic diversity of the ESU will be an appreciable reduction (McElhaney *et al.* 2000). All status information below is adapted from work by the West Coast Salmon Biological Review Team (BRT) reported in BRT (2003), with particular emphasis on population characteristics and risk factors.

Table 1. Federal Register Notices for Final Rules that list species, designate critical habitat, or apply protective regulations to ESUs considered in this consultation. (Listing status "T" means listed as threatened under the

ESA, ♣E♣ means listed as endangered, and ♣P♣ means proposed for listing; see, also, proposed listing determinations for 27 ESUs of West Coast salmonids, at 69 FR 33102, 6/14/04.)

Species ESU	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Lower Columbia River	T 3/24/99; 64 FR 14308	Not applicable	7/10/00; 65 FR 42422
Upper Willamette River	T 3/24/99; 64 FR 14308	Not applicable	7/10/00; 65 FR 42422
Upper Columbia River spring-run	E 3/27/99; 64 FR 14308	Not applicable	ESA section 9 applies
Snake River spring / summer run	T 4/22/92; 57 FR 14653	10/25/99; 64 FR 57399	7/10/00; 65 FR 42422
Snake River fall-run	T 6/3/92; 57 FR 23458	12/28/93; 58 FR 68543	7/10/00; 65 FR 42422
Chum salmon (*O. keta*)			
Columbia River	T 3/25/99; 64 FR 14508	Not applicable	7/10/00; 65 FR 42422
Coho salmon (*O. kisutch*)			
Lower Columbia River	P 6/14/04; 69 FR 33102	Not applicable	Not applicable
Oregon Coast	P 6/14/04; 69 FR 33102	Not applicable	Not applicable
Southern Oregon / Northern California Coasts coho	T 5/6/97; 62 FR 24588	5/5/99; 64 FR 24049	7/18/97; 62 FR 68479
Sockeye salmon (*O. nerka*)			
Snake River	E 11/20/91; 56 FR 58619	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 3/19/98; 63 FR 13347	Not applicable	7/10/00; 65 FR 42422
Upper Willamette River	T 3/25/99; 64 FR 14517	Not applicable	7/10/00; 65 FR 42422
Middle Columbia River	T 3/25/99; 64 FR 14517	Not applicable	7/10/00; 65 FR 42422
Upper Columbia River	E 8/18/97; 62 FR 43937	Not applicable	ESA section 9 applies
Snake River Basin	T 8/18/97; 62 FR 43937	Not applicable	7/10/00; 65 FR 42422

Chinook Salmon. Chinook salmon, also commonly referred to as king, spring, quinnat, Sacramento, California, or tyee salmon, is the largest of the Pacific salmon (Myers *et al.* 1998). The species historically ranged from the Ventura River in California, to Point Hope, Alaska, in North America, and in northeastern Asia from Hokkaido, Japan, to the Anadyr River in Russia (Healey 1991). Additionally, Chinook salmon have been reported in the Mackenzie River area of Northern Canada (McPhail and Lindsey 1970). Chinook salmon exhibit very diverse and complex life-history strategies. Healey (1986) described 16 age categories for Chinook salmon, seven total ages with three possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon, although sockeye salmon have a more extended freshwater residence period and use different freshwater habitats (Miller and Brannon 1982, Burgner 1991).

Two generalized freshwater life-history types were initially described by Gilbert (1912): ♧stream-type♣ Chinook salmon reside in freshwater for a year or more following emergence, whereas ♧ocean-type♣ Chinook salmon migrate to the ocean predominately within their first year. Healey (1983, 1991) has promoted the use of broader definitions for ♧ocean-type♣ and ♧stream-type♣ to describe two distinct races of Chinook salmon. This racial approach incorporates life-history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of Chinook salmon populations. For this reason, the BRT has adopted the broader ♧racial♣ definitions of ocean- and stream-type for this review.

Of the two life-history types, ocean-type Chinook salmon exhibit the most varied and plastic life-history trajectories. Ocean-type Chinook salmon juveniles emigrate to the ocean as fry, sub-yearling juveniles (during their first spring or fall), or as yearling juveniles (during their second spring), depending on environmental conditions. Ocean-type Chinook salmon also undertake distinct, coastally oriented, ocean migrations. The timing of the return to freshwater and spawning is closely related to the ecological characteristics of a population♣s spawning habitat.

Five different run times are expressed by different ocean-type Chinook salmon populations: spring, summer, fall, late-fall, and winter. In general, early run times (spring and summer) are exhibited by populations that use high spring flows to access headwater or interior regions. Ocean-type populations within a basin that express different runs times appear to have evolved from a common source population. Stream-type populations appear to be nearly obligate yearling outmigrants (some 2-year-old smolts have been identified), they undertake extensive off-shore ocean migrations, and generally return to freshwater as spring-run- or summer-run fish. Stream-type populations are found in northern British Columbia and Alaska, and in the headwater regions of the Fraser River and Columbia River interior tributaries.

Before development of the ESU policy (Waples 1991), NOAA Fisheries recognized Sacramento River winter-run Chinook salmon as a ♧distinct population segment♣ under the ESA (NMFS 1987). Subsequently, in reviewing the biological and ecological information concerning West Coast Chinook salmon, BRTs have identified additional ESUs for Chinook salmon from Washington, Oregon, and California: Snake River (SR) fall-run (Waples *et al.* 1991a), SR spring- and summer-run (Matthews and Waples 1991), and Upper Columbia River (UCR) summer-run and fall-run Chinook salmon (originally designated as the mid-Columbia River summer-run and fall-run Chinook salmon, Waknitz *et al.* 1995), Puget Sound Chinook salmon, Washington Coast

Chinook salmon, Lower Columbia River (LCR) Chinook salmon, Upper Willamette River (UWR) Chinook salmon, Middle Columbia River (MCR) spring-run Chinook salmon, UCR spring-run Chinook salmon, Oregon Coast Chinook salmon, Upper Klamath and Trinity Rivers Chinook salmon, Central Valley fall-run and late-fall-run Chinook salmon, and Central Valley spring-run Chinook salmon (Myers *et al.* 1998), the Southern Oregon and Northern California Chinook salmon, California Coastal Chinook salmon, and Deschutes River (NMFS 1999a).

Of the 17 Chinook salmon ESUs identified by NOAA Fisheries and listed as threatened or endangered under the ESA, four occur in the overall action area (Table 1). NOAA Fisheries convened a BRT to update the status of listed Chinook salmon ESUs in Washington, Oregon, California, and Idaho. The Chinook salmon BRT met in January, March, and April of 2003 in Seattle, Washington, to review updated information on each of the ESUs under consideration (BRT 2003).

Snake River (SR) Fall-run Chinook salmon. SR fall-run Chinook salmon enter the Columbia River in July and August. The Snake River component of the fall Chinook salmon run migrates past the Lower Snake River mainstem dams from August through November. Spawning occurs from October through early December. Juveniles emerge from the gravels in March and April of the following year. SR fall-run Chinook salmon are sub-yearling migrants, moving downstream from natal spawning and early rearing areas from June through early fall.

Fall-run Chinook salmon returns to the Snake River generally declined through the first half of this century (Irving and Bjornn 1981). In spite of the declines, the Snake River Basin remained the largest single natural production area for fall-run Chinook salmon in the Columbia River drainage into the early 1960s (Fulton 1968). Spawning and rearing habitat for SR fall-run Chinook salmon was significantly reduced by the construction of a series of Snake River mainstem dams. Historically, the primary spawning fall-run Chinook salmon spawning areas were on the upper mainstem Snake River. Currently, natural spawning is limited to the area from the upper end of Lower Granite Reservoir to Hells Canyon Dam, the lower reaches of the Imnaha, Grande Ronde, Clearwater and Tucannon Rivers, and small mainstem sections in the tailraces of the Lower Snake hydroelectric dams.

Adult counts at Snake River dams are an index of the annual return of SR fall-run Chinook salmon to spawning grounds. Lower Granite Dam is the uppermost of the mainstem Snake River dams that allow for passage of anadromous salmonids. Adult traps at Lower Granite Dam have allowed for sampling of the adult run as well as for removal of a portion of non-local hatchery fish passing above the dam. The dam count at Lower Granite covers a majority of fall-run Chinook salmon returning to the Snake Basin. However, SR fall-run Chinook salmon do return to locations downstream from Lower Granite Dam and are therefore not included in the ladder count. Lyons Ferry Hatchery is on the mainstem Snake River below both Little Goose and Lower Monumental Dams. Although a fairly large proportion of adult returns from the Lyons

Ferry Hatchery program do stray to Lower Granite Dam, a substantial proportion of the run returns directly to the facility. In addition, mainstem surveying efforts have identified relatively small numbers of fall-run Chinook salmon spawning in the tailraces of lower Snake River mainstem hydroelectric dams (Dauble *et al.* 1999).

Lyons Ferry Hatchery was established as one of the hatchery programs under the Lower Snake Compensation Plan administered through the USFWS. SR fall-run Chinook salmon production is a major program for Lyons Ferry Hatchery, which is operated by the Washington Department of Fish and Wildlife (WDFW) and is along the Snake River mainstem between Little Goose Dam and Lower Monumental Dam. The WDFW began developing a SR fall-run Chinook salmon broodstock in the early 1970s through a trapping program at Ice Harbor Dam and Lower Granite Dam. The Lyons Ferry facility became operational in the mid-1980s and took over incubation and rearing for the SR fall Chinook mitigation/compensation program.

Previous Chinook salmon status reviews (Waples *et al.* 1991a, Myers *et al.* 1998) identified several concerns regarding SR fall-run Chinook salmon: (1) Steady and severe decline in abundance since the early 1970s; (2) loss of primary spawning and rearing areas upstream from the Hells Canyon Dam complex; (3) increase in non-local hatchery contribution to adult escapement over Lower Granite Dam; and (4) relatively high aggregate harvest impacts by ocean and in-river fisheries. Available habitat for SR fall-run Chinook salmon has not had any major changes since the previous status reviews.

On the positive side, the number of natural-origin spawners in 2001 was well in excess of 1000 for the first time since counts at Lower Granite Dam began in 1975. Management actions have reduced (but not eliminated) the fraction of fish passing Lower Granite Dam that are strays from out-of-ESU hatchery programs. Returns in the last two years also reflect an increasing contribution from supplementation programs based on the native Lyons Ferry Broodstock. With the exception of the increase in 2001, the ESU has fluctuated between approximately 500-1000 adults, suggesting a somewhat higher degree of stability in growth rate and trends than is seen in many other salmon populations.

In spite of the recent increases, however, the recent geometric mean number of naturally-produced spawners is still less than 1000, a very low number for an entire ESU. Because of the large fraction of naturally spawning hatchery fish, it is difficult to assess the productivity of the natural population. The moderately high risk estimate for spatial structure and diversity reflect the concerns of the BRT that a large fraction of historic habitat for this ESU is inaccessible, diversity associated with those populations has been lost, the single remaining population is vulnerable to variable environmental conditions or catastrophes, and continuing immigration from outside the ESU at levels that are higher than occurred historically. Some BRT members were concerned that the efforts to remove stray, out-of-ESU hatchery fish only occur at Lower Granite Dam, well upstream from the geographic boundary of this ESU. Specific concerns are that natural spawners in lower river areas will be heavily affected by strays from Columbia River hatchery programs, and that this approach effectively removes the natural buffer zone between the Snake River ESU and Columbia River ocean-type Chinook salmon. The effects of these factors on ESU viability are not known, as the extent of natural spawning in areas below Lower Granite Dam is not well understood, except in the lower Tucannon River.

A majority (60%) of the BRT votes for this ESU fell in the ♣likely to become endangered♣ category, with minorities falling in the ♣danger of extinction♣ and ♣not likely to become endangered♣ categories. This represented a somewhat more optimistic assessment of the status of this ESU than was the case at the time of the original status review, when the BRT concluded that SR fall-run Chinook salmon face a substantial risk of extinction if present conditions continue (Waples *et al.* 1991a). The BRT found moderately high risks in all Viable Salmonid Populations (VSP) elements, with risk estimates ranging from moderate for growth rate/productivity to moderately high for spatial structure.

Snake River (SR) spring/summer-run Chinook salmon. Spring and summer Chinook salmon runs returning to the major tributaries of the Snake River were classified as an ESU by NOAA Fisheries (Matthews and Waples 1991). This ESU includes production areas that are characterized by spring-timed returns, summer-timed returns, and combinations from the two adult timing patterns. Runs classified as spring Chinook salmon are counted at Bonneville Dam beginning in early March and ending the first week of June; runs classified as summer-run Chinook salmon return to the Columbia River from June through August. Returning fish hold in deep mainstem and tributary pools until late summer, when they emigrate up into tributary areas and spawn. In general, spring-run type Chinook salmon tend to spawn in higher elevation reaches of major Snake River tributaries in mid- through late August, and SR summer-run Chinook salmon spawn approximately 1 month later than spring-run fish.

Many of the Snake River tributaries used by spring and summer Chinook salmon runs exhibit two major features: extensive meanders through high elevation meadowlands and relatively steep lower sections joining the drainages to the mainstem Salmon (Matthews and Waples 1991). The combination of relatively high summer temperatures and the upland meadow habitat creates the potential for high juvenile salmonid productivity. Historically, the Salmon River system may have supported more than 40% of the total return of spring-run and summer-run Chinook salmon to the Columbia River system (*e.g.*, Fulton 1968).

The SR spring/summer-run Chinook salmon ESU includes current runs to the Tucannon River, the Grand Ronde River system, the Imnaha River and the Salmon River (Matthews and Waples 1991). The Salmon River system contains a range of habitats used by spring/summer-run Chinook salmon. The South Fork and Middle Fork tributaries to the Salmon currently support the bulk of natural production in the drainage. Two large tributaries entering above the confluence of the Middle Fork, the Lemhi and Pahsimeroi Rivers, drain broad alluvial valleys and are believed to have historically supported substantial, relatively productive anadromous fish runs. Returns into the upper Salmon River tributaries have re-established following the opening of passage around Sunbeam Dam on the mainstem Salmon River downstream from Stanley, Idaho. Sunbeam Dam in the Upper Salmon River was a serious impediment to migration of anadromous fish and may have been a complete block in at least some years before its partial removal in 1934 (Waples *et al.* 1991a).

Current runs returning to the Clearwater River drainages were not included in the SR spring/summer-run Chinook salmon ESU. Lewiston Dam in the lower mainstem of the Clearwater River was constructed in 1927, and functioned as an anadromous block until the early 1940s (Matthews and Waples 1991). Spring and summer Chinook salmon runs into the Clearwater system were reintroduced via hatchery outplants beginning in the late 1940s. As a result, Matthews and Waples (1991) concluded that even if a few native salmon survived the hydropower dams, the massive outplantings of non-indigenous stocks presumably substantially altered, if not eliminated, the original gene pool.

Spring-run and summer-run Chinook salmon from the Snake River Basin exhibit stream-type life history characteristics (Healey 1983). Eggs are deposited in late summer and early fall, incubate over the following winter, and hatch in late winter/early spring of the following year. Juveniles rear through the summer, overwinter and migrate to sea in the spring of their second year of life. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer rearing and/or overwintering areas. SR spring/summer-run Chinook salmon return from the ocean to spawn primarily as 4- and 5-year old fish, after 2 to 3 years in the ocean. A small fraction of the fish return as 3- year old ♣jacks♣, heavily predominated by males.

The 1991 ESA status review (Mathews and Waples 1991) of the SR spring/ summer-run Chinook salmon ESU concluded that the ESU was at risk based on a set of key factors. Aggregate abundance of naturally-produced SR spring/summer-run Chinook salmon runs had dropped to a small fraction of historical levels. Short-term projections (including jack counts, habitat/flow conditions in the broodyears producing the next generation of returns) were for a continued downward trend in abundance. Risk modeling indicated that if the historical trend in abundance continued, the ESU as a whole was at risk of extinction within 100 years. The review identified related concerns at the population level within the ESU. Given the large number of potential production areas in the Snake Basin and the low levels of annual abundance, risks to individual subpopulations may be greater than the extinction risk for the ESU as a whole. The 1998 Chinook salmon status review (Myers *et al.* 1998) summarized and updated these concerns. Both short and long-term abundance trends had continued downward. The report identified continuing disruption due to the impact of mainstem hydroelectric development including altered flow regimes and impacts on estuarine habitats. The 1998 review also identified regional habitat degradation and risks associated with the use of outside hatchery stocks in particular areas—specifically including major sections of the Grande Ronde River Basin.

Tributary habitat conditions vary widely among the various drainages of the Snake River Basin. Habitat degradation in many areas of the basin are a result of forest, grazing, and mining practices. Impacts relative to anadromous fish include lack of pools, increased water temperatures, low flows, poor overwintering conditions, and high sediment loads. Substantial portions of the Salmon River drainage, particularly in the Middle Fork, are protected in wilderness areas.

Direct estimates of annual runs of historical spring/summer-run Chinook salmon to the Snake River are not available. Chapman (1986) estimated that the Columbia River produced 2.5 million to 3.0 million spring-run and summer-run Chinook salmon per year in the late 1800s. Total spring-run and summer-run Chinook salmon production from the Snake River Basin contributed a substantial proportion of those returns; the total annual production of SR spring-run and summer-run Chinook salmon may have been in excess of 1.5 million adult returns per year (Matthews and Waples 1991). Returns to Snake River tributaries had dropped to roughly 100,000 adults per year by the late 1960s (Fulton 1968). Increasing hatchery production contributed to subsequent years' returns, masking a continued decline in natural production.

Although there are concerns about loss of an unquantified number of spawning aggregations that historically may have provided connectivity between headwater populations, natural spawning in this ESU still occurs in a wide range of locations and habitat types.

Like many others, this ESU saw a large increase in escapement in many (but not all) populations in 2001. The BRT considered this an encouraging sign, particularly given the record low returns seen in many of these populations in the mid-1990s. However, recent abundance in this ESU is still short of the levels that the proposed recovery plan for Snake River salmon indicated should be met over at least an 8-year period (NMFS 1995a). The BRT considered it a positive sign that the non-native Rapid River broodstock was phased out of the Grande Ronde system, but the relatively high level of both production/mitigation and supplementation hatcheries in this ESU leads to ongoing risks to natural populations and makes it difficult to assess trends in natural productivity and growth rate.

About two-thirds (68%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories. The BRT rated abundance and growth rate/productivity factors as moderately high risk, and spatial structure and diversity as moderately low risk.

Lower Columbia River (LCR) Chinook salmon. The status of LCR Chinook was initially reviewed by NOAA Fisheries in 1998 (Myers *et al.* 1998) and updated in that same year (NMFS 1998a). In the 1998 update, the BRT noted several concerns for this ESU. The 1998 BRT was concerned that there were very few naturally self-sustaining populations of native Chinook salmon remaining in the Lower Columbia River ESU. Naturally reproducing (but not necessarily self-sustaining) populations identified by the 1998 BRT were the Lewis and Sandy Rivers "bright" fall runs and the "tule" fall runs in the Clackamas, East Fork Lewis and Coweeman Rivers. These populations were identified as the only bright spots in the ESU. The few remaining populations of spring Chinook salmon in the ESU were not considered by the previous BRT to be naturally self-sustaining because of either small size, extensive hatchery influence, or both. The previous BRT felt that the dramatic declines and losses of spring-run Chinook salmon populations in the Lower Columbia River ESU represented a serious reduction in life-history diversity in the region. The previous BRT felt that the presence of hatchery Chinook salmon in this ESU posed an important threat to the persistence of the ESU and also obscured trends in abundance of native fish. The previous BRT noted that habitat degradation and loss due to extensive hydropower development projects, urbanization, logging, and agriculture threatened the Chinook salmon spawning and rearing habitat in the lower Columbia River. A majority of the previous (1998) BRT concluded that the Lower Columbia River ESU was likely to become endangered in the foreseeable future. A minority felt that Chinook salmon in this ESU were not presently in danger of extinction, nor were they likely to become so in the foreseeable future.

New data acquired for the BRT (2003) report includes spawner abundance estimates through 2001, new estimates of the fraction of hatchery spawners and harvest estimates. In addition, estimates of historical abundance have been provided by the WDFW. Information on recent hatchery releases was also obtained. New analyses include the designation of relatively demographically independent populations, recalculation of previous BRT metrics with additional years data, estimates of median annual growth rate under different assumptions about the reproductive success of hatchery fish, and estimates of current and historically available kilometers of stream.

The ESU exhibits three major life history types: fall-run ("tules"), late fall-run ("brights"), and spring-run. The ESU spans three ecological zones: Coastal (rain driven hydrograph), Western Cascade (snow or glacial driven hydrograph), and Gorge (transitioning to drier interior Columbia ecological zones). The fall Chinook populations are currently dominated by large scale hatchery production, relatively high harvest and extensive habitat degradation (discussed in previous status reviews). The Lewis River late fall Chinook population is the healthiest in the ESU and has a reasonable probability of being self-sustaining. The spring-run populations are largely extirpated as the result of dams which block access to their high elevation habitat. Abundances have largely declined since the last status review update (1998) and trend indicators for most populations are negative, especially if hatchery fish are assumed to have a reproductive success equivalent to that of natural-origin fish. However, 2001 abundance estimates increased for most LCR Chinook populations over the previous few years and preliminary indications are that 2002 abundance also increased (Rawding, personal communication, cited in BRT 2003). Many salmon populations in the Northwest have shown increases in abundance over the last few years and the relationship of these increases to potential changes in marine survival are discussed in the introduction to the BRT (2003) report.

A majority (71%) of the BRT votes for this ESU fell in the ♣likely to become endangered♣ category, with minorities falling in the ♣danger of extinction♣ and ♣not likely to become endangered♣ categories. Moderately high concerns for all VSP elements are indicated by estimates of moderate to moderately high risk for abundance and diversity. All of the risk factors identified in previous reviews were still considered important by the BRT. The Willamette/Lower Columbia River Technical Review Team has estimated that 8 to 10 historic populations in this ESU have been extirpated, most of them spring-run populations. Near loss of that important life history type remains in important BRT concern. Although some natural production currently occurs in 20 or so populations, only one exceeds 1000 spawners. High hatchery production continues to pose genetic and ecological risks to natural populations and to mask their performance. Most populations in this ESU have not seen as pronounced increases in recent years as occurred in many other geographic areas.

Upper Willamette River (UWR) Chinook salmon. The status of UWR Chinook was initially reviewed by NOAA Fisheries in 1998 (Myers *et al*. 1998) and updated in that same year (NMFS 1998a). In the 1998 update, the BRT noted several concerns for this ESU. The previous BRT was concerned about the few remaining populations of spring Chinook salmon in the Upper Willamette River ESU, and the high proportion of hatchery fish in the remaining runs. The BRT noted with concern that the Oregon Department of Fish and Wildlife (ODFW) was able to identify only one remaining naturally reproducing population in this ESU▪the spring Chinook salmon in the McKenzie River. The previous BRT was concerned about severe declines in short-term abundance that occurred throughout the ESU, and the McKenzie River population had declined precipitously, indicating that it may not be self-sustaining. The 1998 BRT also noted the potential for interactions between native spring-run and introduced fall-run Chinook salmon had increased relative to historical times due to fall-run Chinook salmon hatchery programs and the laddering of Willamette Falls. The previous BRT partially attributed the declines in spring Chinook salmon in the Upper Willamette River ESU to the extensive habitat blockages caused by dam construction. The previous BRT was encouraged by efforts to reduce harvest pressure on naturally-produced spring Chinook salmon in Upper Willamette River tributaries, and the increased focus on selective marking of hatchery fish should help managers targeting specific populations of wild or hatchery Chinook salmon. A majority of the previous (1998) BRT concluded that the UWR ESU was likely to become endangered in the foreseeable future. A minority felt that Chinook salmon in this ESU were not presently in danger of extinction, nor were they likely to become so in the foreseeable future.

New data for this update include spawner abundance through 2002 in Clackamas, 2001 in McKenzie, and 2001 at Willamette Falls. In addition, new data include updated redd surveys in the basin, new estimates of the fraction of hatchery-origin spawners in McKenzie and North Santiam from an otolith marking study, the first estimate of hatchery fraction in the Clackamas (2002 data), and information on recent hatchery releases. New analyses for this update include: the designation of relatively demographically independent populations, recalculation of previous BRT metrics in the McKenzie with additional years of data, estimates of current and historically available kilometers of stream, and updates on current hatchery releases.

The updated information provided in the BRT (2003) report, the information contained in previous UWR Chinook status reviews, and preliminary analysis by the Willamette/Lower Columbia Technical Review Team, indicate that most natural spring Chinook populations are likely extirpated or nearly so. The only population considered potentially self-sustaining is the McKenzie. However, its abundance has been relatively low (low thousands) with a substantial number of these fish being of hatchery origin. The population has shown a substantial increase in the last couple of years, hypothesized to be a result of increase ocean survival. It is unknown what ocean survivals will be in the future and the longterm sustainability of this population in uncertain.

Although the number of adult spring-run Chinook salmon crossing Willamette Falls is in the same range (about 20,000 to 70,000) it has been for the last 50 years, a large fraction of these are hatchery produced. The score for spatial structure reflects concern by the BRT that perhaps a third of the historic habitat used by fish in this ESU is currently inaccessible behind dams, and the BRT remained concerned that natural production in this ESU is restricted to a very few areas. Increases in the last 3 to 4 years in natural production in the largest remaining population (the McKenzie) were considered encouraging by the BRT. With the relatively large incidence of hatchery fish, it is difficult to determine trends in natural production.

A majority (70%) of the BRT votes for this ESU fell in the ♧likely to become endangered♣ category, with minorities falling in the ♧danger of extinction♣ and ♧not likely to become endangered♣ categories. The BRT found moderately high risks in all VSP elements, with risk estimates ranging from moderate for growth rate/productivity to moderately high for spatial structure.

Upper Columbia River (UCR) spring-run Chinook salmon. No estimates of historical abundance specific to this ESU are available before the 1930s. The drainages supporting this ESU are all above Rock Island Dam on the Upper Columbia River. Rock Island Dam is the oldest major hydroelectric project on the Columbia River; it began operations in 1933. Counts of returning Chinook salmon have been made since the 1930s. Annual estimates of the aggregate return of spring-run Chinook salmon to the Upper Columbia River are derived from the dam counts based on the nadir between spring and summer return peaks. Spring-run Chinook salmon currently spawn in three major drainages above Rock Island Dam: Wenatchee, Methow ,and Entiat Rivers. Historically, spring-run Chinook salmon may have also used portions of the Okanogan River.

Grand Coulee Dam, completed in 1938, formed an impassable block to the upstream migration of anadromous fish. Chief Joseph Dam was constructed on the mainstem Columbia River downstream from Grand Coulee Dam and is also an anadromous block. No specific estimates are available of historical production of spring-run Chinook salmon from mainstem tributaries above Grand Coulee Dam. Habitat typical of that used by spring-run Chinook salmon in accessible portions of the Columbia River Basin is found in the middle/upper reaches of mainstem tributaries above Grand Coulee Dam. It is possible that the historical range of this ESU included these areas; alternatively, fish from the upper reaches of the Columbia River may have been in a separate ESU.

Artificial production efforts in the area occupied by the UCR spring-run Chinook salmon ESU extend back to the 1890s. Hatchery efforts were initiated in the Wenatchee and Methow systems to augment catches in response to declining natural production (*e.g.*, Craig and Soumela 1941). While there are no direct estimates of adult production from early efforts, it is likely contributions were small.

In the late 1930s, the Grand Coulee Fish Maintenance Program (GCFMP) was initiated to address the fact that the completion of the Grand Coulee dam cut off anadromous access above site of the dam. Returning salmonids, including spring-run Chinook salmon, were trapped at Rock Island Dam and either transplanted as adults or released as juveniles into selected production areas within the accessible drainages below Grand Coulee Dam. Nason Creek in the Wenatchee system was a primary adult transplantation area in this effort. The program was conducted annually from 1938 until the mid-1940s.

The UCR spring-run Chinook salmon ESU was reviewed by the BRT in late 1998 (NMFS 1998a). The BRT was mostly concerned about risks falling under the abundance/distribution and trends/productivity risk categories for the ESU. Average recent escapement to the ESU has been less than 5,000 hatchery plus wild Chinook salmon, and individual populations all consist of less than 100 fish. The BRT was concerned that at these population sizes, negative effects of demographic and genetic stochastic processes are likely to occur. Furthermore, both long- and short-term trends in abundance are declining, many strongly so. The BRT noted that the implementation of emergency natural broodstocking and captive broodstocking efforts for the ESU indicates the severity of the population declines to critically small sizes. The BRT recognized that habitat degradation, blockages and hydrosystem passage mortality all have contributed to the significant declines in this ESU.

The WDFW, the Yakima Tribe, and the USFWS conduct annual redd count surveys in nine selected production areas within the geographical area encompassed by this ESU (Mosey and Murphy 2002, Hubble and Crampton 2000, Carie 2000). Before 1987, redd count estimates were single-survey peak counts. From 1987 on, annual redd counts are generated from a series of on-the-ground counts and represent the total number of redds constructed in any particular year. The agencies use annual dam counts from the mainstem Mid-Columbia River dams as the basis for expanding redd counts to estimates of total spring-run Chinook salmon returns. In the Wenatchee Basin, video counts at Tumwater Dam are available for recent years. Returns to hatchery facilities are subtracted from the dam counts before the expansion.

An initial set of population definitions for UCR spring-run Chinook salmon ESU along with basic criteria for evaluating the status of each population were developed using the VSP guidelines described in McElhany *et al.* (2000). The definitions and criteria are described in Ford *et al.* (2000) and have been used in the development and review of Mid-Columbia River Public Utility District plans and the Biological Opinion. The interim definitions and criteria are being reviewed as recommendations by the Interior Columbia Technical Recovery Team. Briefly, the joint technical team recommended that the Wenatchee River, the Entiat River, and the Methow River be considered as separate populations within the UCR Steelhead ESU. The historical status of spring-run Chinook salmon production in the Okanogan River is uncertain. The committee deferred a decision on the Okanogan to the Technical Recovery Team. Abundance, productivity, and spatial structure criteria for each of the populations in the ESU were developed and are described in Ford *et al.* (2001).

Many populations in this ESU have rebounded somewhat from the critically low levels that immediately preceded the last status review evaluation, and this was reflected in the substantial minority of BRT votes cast that were not cast in the “danger of extinction” category. Although this was considered an encouraging sign by the BRT, the last year or two of higher returns come on the heels of a decade or more of steep declines to all-time record low escapements. In addition, this ESU continues to have a very large influence by hatchery production, both from production/mitigation and supplementation programs. The extreme management measures taken in an effort to maintain populations in this ESU during some years in the late 1990s (collecting all adults from major basins at downstream dams) are a strong indication of the ongoing risks to this ESU, although the associated hatchery programs may ultimately play a role in helping to restore self-sustaining natural populations.

Assessments by the BRT of the overall risks faced by this ESU were divided, with a slight majority (53%) of the votes being cast in the “danger of extinction” category and a substantial minority (45%) in the ♣likely to be endangered♣ category. The risk estimates reflect strong ongoing concerns regarding abundance and growth rate/productivity (high to very high risk) in this ESU and somewhat less (but still significant) concerns for spatial structure (moderate risk) and diversity (moderately high risk).

Chum salmon. Chum salmon are semelparous, spawn primarily in freshwater, and apparently exhibit obligatory anadromy, as there are no recorded landlocked or naturalized freshwater populations (Randall *et al.* 1987). The species is known for the enormous canine-like fangs and striking body color (a calico pattern, with the anterior two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) of spawning males. Females are less flamboyantly colored and lack the extreme dentition of the males.

The species has the widest natural geographic and spawning distribution of any Pacific salmonid, primarily because its range extends further along the shores of the Arctic Ocean than other salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east, around the rim of the North Pacific Ocean, to Monterey Bay in California. Presently, major spawning populations are found only as far south as Tillamook Bay on the Northern Oregon coast. The species♣ range in the Arctic Ocean extends from the Laptev Sea in Russia to the Mackenzie River in Canada. Chum salmon may historically have been the most abundant of all salmonids; Neave (1961) estimated that before the 1940s, chum salmon contributed almost 50% of the total biomass of all salmonids in the Pacific Ocean. Chum salmon also grow to be among the largest of Pacific salmon, second only to Chinook salmon in adult size, with individual chum salmon reported up to 108.9 cm in length and 20.8 kg in weight (Pacific Fisherman 1928). Average size for the species is around 3.6 to 6.8 kg (Salo 1991).

Chum salmon spend more of their life history in marine waters than other Pacific salmonids. Chum salmon, like pink salmon, usually spawn in coastal areas, and juveniles out migrate to seawater almost immediately after emerging from the gravel that covers their redds (Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (*e.g.*, coastal cutthroat trout, steelhead, coho salmon, and most types of Chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means survival and growth in juvenile chum salmon depends less on freshwater conditions than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

In December 1997 the first ESA status review of west coast chum salmon (Johnson *et al.* 1997) was published which identified four ESUs: (1) The Puget Sound/Strait of Georgia ESU, which includes all chum salmon populations from Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca up to and including the Elwha River, with the

exception of summer-run chum salmon from Hood Canal; (2) The Hood Canal summer-run ESU, which includes summer-run populations from Hood Canal and Discovery and Sequim Bays on the Strait of Juan de Fuca;
(3) The Pacific coast ESU, which includes all natural populations from the Pacific coasts of California, Oregon, and Washington, west of the Elwha River on the Strait of Juan de Fuca; and (4) The Columbia River ESU.

In March 1998, NOAA Fisheries published a Federal register notice describing the four ESUs and proposed a rule to list two, the Hood Canal summer-run and the Columbia River ESUs, as threatened under the ESA (NMFS 1998b). In March 1999, the two ESUs were listed as proposed, with the exception that the Hood Canal summer-run ESU was extended westward to include summer-run fish recently documented in the Dungeness River (NMFS 1999b).

NOAA Fisheries convened a BRT to update the status of listed chum salmon ESUs coastwide. The chum salmon BRT1 met in January, March, and April 2003 in Seattle, Washington, to review updated information on each of the ESUs under consideration.

Columbia River (CR) chum salmon. NOAA Fisheries last provided an updated status report on CR chum in 1999 (NMFS 1999b). As documented in the 1999 report, the previous BRT was concerned about the dramatic declines in abundance and contraction in distribution from historical levels. The previous BRT was also concerned about the low productivity of the extant populations, as evidenced by flat trend lines at low population sizes. A majority of the previous BRT concluded that the CR chum salmon ESU was likely to become endangered in the foreseeable future and a minority concluded that the ESU was currently in danger of extinction.

New data include spawner abundance through 2000, with preliminary estimate of 2002, new information on the hatchery program, and new genetic data describing the current relationship of spawning groups. New analyses include designation of relatively demographically independent populations, recalculation of previous BRT metrics with additional years data, estimates of median annual growth rate, and estimates of current and historically available kilometers of stream.

Updated information provided in the BRT (2003), the information contained in previous status reviews, and preliminary analyses by the Willamette/Lower Columbia Technical Review Team suggest that 14 of the 16 historical populations (88%) are extinct or nearly so. The two extant populations have been at low abundance for the last 50 years in the range where stochastic processes could lead to extinction. Encouragingly, there has been a substantial increase in the abundance of these two populations. In addition there are the new (or newly discovered) Washougal River mainstem spawning groups. However, it is not known if the increase will continue and the abundance is still substantially below the historical levels.

Nearly all of the likelihood votes for this ESU fell in the ♣likely to become endangered♣ (63%) or ♣danger of extinction♣ (34%) categories. The BRT had substantial concerns about every VSP element, as indicated risk estimates scores that ranged from moderately high for growth rate/productivity to high to very high for spatial structure. Most or all of the risk factors identified previously by the BRT remain important concerns. The Willamette/Lower Columbia Technical Review Team has estimated that close to 90% of the historical populations in the ESU are extinct or nearly so, resulting in loss of much diversity and connectivity between populations. The populations that remain are small, and overall abundance for the ESU is low. This ESU has showed low productivity for many decades, even though the remaining populations are at low abundance and density dependent compensation might be expected. The BRT was encouraged that unofficial reports for 2002 suggest a large increase in abundance in some (perhaps many) locations. Whether this large increase is due to any recent management actions or simply reflects unusually good conditions in the marine environment is not known at this time, but the result is encouraging, particularly if it were to be sustained for a number of years.

Sockeye salmon. Sockeye salmon spawn in North America from the Columbia River in Oregon, north to the Noatak River in Alaska, and in Asia from Hokkaido, Japan, north to the Anadyr River in Russia (Atkinson *et al.* 1967, Burgner 1991). The vast majority of sockeye salmon spawn in inlet or outlet streams of lakes or in lakes themselves. The juveniles of these ♣lake-type♣ sockeye salmon rear in lake environments for 1 to 3 years, migrate to sea, and return to natal lake systems to spawn after 1 to 4 years in the ocean. However, some sockeye salmon populations spawn in rivers without juvenile lake rearing habitat. Their juveniles rear in slow velocity sections of rivers for 1 or 2 years (♣river-type♣) or migrate to sea as underyearlings and thus rear primarily in saltwater (♣sea-type♣) (Wood 1995). As with lake-type sockeye salmon, river/sea-type sockeye salmon return to natal spawning habitat after 1 to 4 years in the ocean.

Certain self-perpetuating, nonanadromous populations of sockeye salmon that become resident in lake environments over long periods of time are called kokanee in North America. Genetic differentiation among sockeye salmon and kokanee populations indicates that kokanee are polyphyletic, having arisen from sockeye salmon on multiple independent occasions, and that kokanee may occur sympatrically or allopatrically with sockeye salmon. Numerous studies (reviewed in Gustafson *et al.* 1997) indicate that sockeye salmon and kokanee exhibit a suite of heritable differences in morphology, early development rate, seawater adaptability, growth and maturation that appear to be divergent adaptations that have arisen from different selective regimes associated with anadromous vs. nonanadromous life histories. These studies also provide evidence that sympatric populations of sockeye salmon and kokanee can be both genetically distinct and reproductively isolated (see citations in Gustafson *et al.* 1997). Occasionally, a proportion of juveniles in an anadromous sockeye population will remain in the rearing lake environment throughout life and will be observed on the spawning grounds together with their anadromous siblings. Ricker (1938) first used the terms "residual sockeye" and "residuals" to refer to these resident, non-migratory progeny of anadromous sockeye salmon.

In April 1990, NOAA Fisheries initiated a status review of sockeye salmon in the Salmon River Basin and received a petition from the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation to list SR sockeye salmon as endangered under the ESA (NMFS 1990, 1991a). The NOAA Fisheries BRT conducted a status review and unanimously agreed that there was insufficient information available to determine with reasonable degree of certainty the origin of the current sockeye salmon gene pool in Redfish Lake (Waples *et al.* 1991b). After some discussion, the BRT reached a strong consensus that, in this instance, obligations as resource stewards required them to proceed under the assumption that recent sockeye salmon in Redfish Lake were descended from the original sockeye salmon gene pool. Therefore, as stipulated in the Species Definition Paper (Waples 1991), the anadromous component of sockeye salmon was considered separately from the non-anadromous (kokanee) component in determining whether an ESA listing was warranted. The decision to treat Redfish Lake sockeye salmon as distinct from kokanee led the BRT to conclude that the Redfish Lake sockeye salmon were in danger of extinction (Waples *et al.* 1991b). Subsequently, a proposed rule to list SR sockeye salmon as endangered was published (NMFS 1991a). After consideration of 183 written comments and testimony from public hearings, NOAA Fisheries published its final listing determination (NMFS 1991b) that designated SR sockeye salmon as an endangered species.

In September 1994, in response to a petition seeking protection for Baker Lake, Washington, sockeye salmon under the ESA and more general concerns about the status of West Coast salmon and steelhead, NOAA Fisheries initiated a coastwide status review of sockeye salmon in Washington, Oregon, and California, and formed a BRT to conduct the review. After considering available information on genetics, phylogeny and life history, freshwater ichthyo-geography, and environmental features that may affect sockeye salmon, the BRT identified six ESUs: Ozette Lake, Okanogan River, Lake Wenatchee, Quinault Lake, Baker River, and Lake Pleasant, and one provisional ESU, Big Bear Creek. The BRT reviewed population abundance data and other risk factors for these ESUs and concluded that one (Ozette Lake) was likely to become endangered in the foreseeable future, and that the remaining ESUs were not in significant danger of becoming extinct or endangered, although there were substantial conservation concerns for some of these (Gustafson *et al.* 1998). In March 1998, NOAA Fisheries published a proposed rule to list the Ozette Lake ESU as threatened under the ESA, and to place the Baker River ESU on the candidate list. Due to the lack of natural spawning habitat and the vulnerability of the entire population to problems in artificial habitats, NOAA Fisheries proposed to add the Baker River ESU to the list of candidate species (NMFS 1998c). Subsequently, based on the updated NOAA Fisheries status review (NMFS 1999c) and other information received, NOAA Fisheries published its final listing determination (NMFS 1999d) that designated the Ozette Lake sockeye salmon ESU as threatened and removed the Baker River ESU from the candidate list.

In considering the ESU status of resident forms of sockeye salmon, the key issue is evaluating the strength and duration of reproductive isolation between resident and anadromous forms. Many kokanee populations appear to have been strongly isolated from sympatric sockeye populations for long periods of time. Since the two forms experience very different selective regimes over their life cycle, reproductive isolation provides an opportunity for adaptive divergence in sympatry. Kokanee populations that fall in this category will generally not be considered part of sockeye ESUs. On the other hand, resident fish appear to be much more closely integrated into some sockeye populations. For example, in some situations, anadromous fish may give rise to progeny that mature in freshwater (as is the case with residual sockeye), and some resident fish may have anadromous offspring. In these cases, where there is presumably some regular, or at least episodic, genetic exchange between resident and anadromous forms, they should be considered part of the same ESU. The sockeye salmon BRT met in January, March, and April 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRTs.

Snake River (SR) sockeye salmon. The first formal ESA status review for salmon in the Pacific Northwest was conducted in response to a 1990 petition to list sockeye salmon from Redfish Lake in Idaho as an endangered species. The distinctiveness of this population became apparent early in the process; it spawns at a higher elevation (2,000 m), and has a longer freshwater migration (1,500 km) than any other sockeye salmon population in the world (Waples *et al.* 1991b). Nor was the precarious nature of the anadromous run in doubt; in the fall of 1990, during the course of the status review, no adults were observed at Lower Granite Dam or entering the lake, and only one fish was observed in each of the two previous years. However, a population of kokanee also existed in Redfish Lake, and the relationship between the sockeye and kokanee was not well understood. This issue was complicated by uncertainty regarding the effects of Sunbeam Dam, which stood for over 2 decades about 20 miles downstream from Redfish Lake. By all accounts, the dam was a serious impediment to anadromous fish, but opinions differed as to whether it was an absolute barrier. Some argued that the original sockeye population in Redfish Lake was extirpated as a result of Sunbeam Dam, and that adult returns in recent decades were simply the result of sporadic seaward drift of kokanee (Chapman *et al.* 1990). According to this hypothesis, the original sockeye gene pool was extinct and the remaining kokanee population was not at risk because of its reasonably large size (ca. 5,000 to 10,000 spawners per year). An alternative hypothesis held that the original sockeye salmon population managed to persist in spite of Sunbeam Dam, either by intermittent passage of adults or recolonization from holding areas downstream from the dam. The fact that the kokanee population spawns in the inlet stream (Fishhook Creek) in August- September and all the recent observations of sockeye spawning have been on the lake shore in October-November was cited as evidence that the sockeye and kokanee represent separate populations. According to this hypothesis, the sockeye population was critically endangered, and perhaps, on the brink of extinction.

At the time of the status review, the BRT unanimously agreed that there was not enough information to determine which of the above hypotheses were true (Waples 1991). Although the kokanee population had been genetically characterized and determined to be quite distinctive compared to other sockeye salmon populations in the Pacific Northwest, no adult sockeye were available for sampling, so the BRT could not evaluate whether the two forms shared a common gene pool. When pressed to make a decision regarding the ESU status of Redfish Lake sockeye salmon, the BRT concluded that, because they could not determine with any certainty that the original sockeye gene pool was extinct, they should assume that it did persist and was separate from the kokanee gene pool. This conclusion was strongly influenced by consideration of the irreversible consequences of making an error in the other direction (*i.e.*, if the species was not listed based on the assumption that kokanee and sockeye populations were a single gene pool and this later proved not to be the case, the species could easily go extinct before the error was detected).

The status review of Redfish Lake sockeye salmon is the only instance in which the BRT has been asked to apply the precautionary principle in its deliberations. In subsequent evaluations, when the ♧best available scientific information♣ was insufficient to distinguish with any certainty among competing hypotheses regarding key ESA questions, the BRT has simply reported this result and tried to characterize the degree of uncertainty in the team♣s conclusions. Decisions about how best to apply the precautionary principle in the face of uncertainty in making listing determinations have been left to the NOAA Fisheries management/policy arm. Based on results of the status review, NOAA Fisheries proposed a listing of Redfish Lake sockeye as endangered in April 1991. When finalized in late 1991, this represented the first ESA listing of a Pacific salmon population in the Pacific Northwest. At the time of the listing, the only population that the BRT and NOAA Fisheries were confident belonged in this ESU was the beach spawning population of sockeye from Redfish Lake. Historical records indicated that sockeye once occurred in several other lakes in the Stanley Basin, but no adults had been observed in these lakes for many decades and their relationship to the Redfish Lake ESU was uncertain.

Four adult sockeye returned to Redfish Lake in 1991; these were captured and taken into captivity to join several hundred smolts collected in spring 1991 as they outmigrated from Redfish Lake. The adults were spawned, and their progeny reared to adulthood along with the outmigrants as part of a captive broodstock program, whose major goal was to perpetuate the gene pool for a short period of time (one or two generations) to give managers a chance to identify and address the most pressing threats to the population. As a result of this program and related research, a great deal of new information has been gained about the biology of Redfish Lake sockeye salmon and limnology of the lakes in the Stanley Basin. Genetic data collected from the returning adults and the outmigrants showed that they were genetically similar but distinct from the Fishhook Creek kokanee. However, otolith microchemistry data (Rieman *et al.* 1994) indicated that many of the outmigrants had a resident female parent. These results inspired a search of the lake for another population of resident fish that was genetically similar to the sockeye. These efforts led to discovery of a relatively small number (perhaps a few hundred) kokanee-sized fish that spawn at approximately the same time and place as the sockeye. These fish, termed "residual" sockeye salmon, are considered to be part of the listed ESU.

Subsequent genetic analysis (Winans *et al.* 1996, Waples *et al.* 1997) has established the following relationships between extant populations of sockeye salmon from the Stanley Basin and other populations in the Pacific Northwest: (1) Native populations of sockeye salmon from the Stanley Basin (including Redfish Lake sockeye and kokanee and Alturas Lake kokanee) are genetically quite divergent from all other North American sockeye salmon populations that have been examined; (2) within this group, Redfish Lake sockeye and kokanee are genetically distinct, and Alturas Lake kokanee are most similar to Redfish Lake kokanee; (3) two gene pools of sockeye salmon have been identified in Stanley Lake—one may be the remnant of a native gene pool that survived rotenone treatments in the lake, while the other can be traced to introductions from Wizard Falls Hatchery in Oregon; and (4) no trace of the original gene pool of sockeye salmon has been found in Pettit Lake. The population that has spawned in Pettit Lake in recent decades can be traced to introductions of kokanee from northern Idaho, and those populations in turn can be traced to stock transfers of Lake Whatcom (Washington) kokanee early in the last century.

Between 1991 and 1998, 16 naturally-produced adult sockeye returned to the weir at Redfish Lake and were incorporated into the captive broodstock program. This program, overseen by the Stanley Basin Sockeye Technical Oversight Committee, has produced groundbreaking research in captive broodstock technology (Hebdon *et al.* 1999, Kline and Willard 2001, Frost *et al.* 2002) and limnology (Kohler *et al.* 2002). The program used three different rearing sites to minimize chances of catastrophic failure and has produced several hundred thousand eggs and juveniles, as well as several hundred adults, for release into the wild. A milestone was reached in 2000, when > 200 adults from the program returned to Redfish Lake. Currently, the captive broodstock program is being maintained as a short-term safety net, pending decisions about longer-term approaches to recovery of the ESU.

The Snake River Salmon Recovery Team (Bevan *et al.* 1994, NMFS 1995b) suggested that to be considered recovered under the ESA, this ESU should have viable populations in three different lakes, with at least 1,000 naturally-produced spawners per year in Redfish Lake and at least 500 in each of two other Stanley Basin lakes. As a step toward addressing this recommendation, releases of progeny from the Redfish Lake captive broodstock program have been made in Pettit Lake and Alturas Lake as well. In 1991, about 100 outmigrants from Alturas Lake were collected at the same time as the Redfish Lake outmigrants and reared to maturity as a separate population in captivity. However, because of funding and space limitations and uncertainties about priorities for propagating this population, the resulting adults were released into the lake rather than being kept for spawning and another generation of captive rearing. Because the Alturas Lake kokanee spawn earlier than Redfish lake sockeye and in the inlet stream, it is hoped that the introduction of Redfish Lake sockeye into Alturas Lake will not adversely affect this native gene pool.

<u>Steelhead</u>. ♧Steelhead♣ is the name commonly applied to the anadromous form of the biological species *Oncorhynchus mykiss*. The present distribution of steelhead extends from Kamchatka in Asia, east to Alaska, and down to southern California (NMFS 1999e), although the historical range of steelhead extended at least to the Mexico border (Busby *et al.* 1996). Steelhead exhibit perhaps the most complex suite of life-history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident (and under some circumstances, apparently yield offspring of the opposite form). Those that are anadromous can spend up to 7 years in fresh water before smoltification, and then spend up to 3 years in salt water before first spawning. The half-pounder life-history type in Southern Oregon and Northern California spends only 2 to 4 months in salt water after smoltification, then returns to fresh water and outmigrates to sea again the following spring without spawning. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus* except *O. clarki* spawn once and then die (semelparous). The anadromous form is under the jurisdiction of NOAA Fisheries, while the resident freshwater forms, usually called ♧rainbow♣ or ♧redband♣ trout, are under the jurisdiction of USFWS.

Although no subspecies are currently recognized within any of the species of Pacific salmon, Behnke (1992) has proposed that two subspecies of steelhead with anadromous life history occur in North America: *O. mykiss irideus* (the ♧coastal♣ subspecies), which includes coastal populations from Alaska to California (including the Sacramento River), and *O. mykiss gairdneri* (the ♧inland♣ subspecies), which includes populations from the interior Columbia, Snake, and Fraser Rivers. In the Columbia River, the boundary between the two subspecies occurs at approximately the Cascade Crest. A third subspecies of anadromous steelhead (*O. mykiss mykiss*) occurs in Kamchatka, and several other subspecies of steelhead are also recognized which only have resident forms (Behnke 1992).

Within the range of West Coast steelhead, spawning migrations occur throughout the year, with seasonal peaks of activity. In a given river basin there may be one or more peaks in migration activity, and since these runs are usually named for the season in which the peak occurs, some rivers may have runs known as winter, spring, summer, or fall steelhead. For example, large rivers, such as the Columbia, Rogue, and Klamath Rivers, have migrating adult steelhead at all times of the year. Names used to identify the seasonal runs of steelhead vary locally; in Northern California, some biologists have retained the use of the terms spring and fall steelhead to describe what others would call summer steelhead.

Steelhead can be divided into two basic reproductive ecotypes, based on the state of sexual maturity at the time of river entry, and duration of spawning migration (Burgner *et al.* 1992). The stream-maturing type (summer steelhead in the Pacific Northwest and

Northern California) enters fresh water in a sexually immature condition between May and October and requires several months to mature and spawn. The ocean-maturing type (winter steelhead in the Pacific Northwest and Northern California) enters fresh water between November and April with well-developed gonads and spawns shortly thereafter.

In basins with both summer and winter steelhead runs, it appears that the summer run occurs where habitat is not fully used by the winter run or a seasonal hydrologic barrier, such as a waterfall, separates them. Summer steelhead usually spawn farther upstream than winter steelhead (Withler 1966, Roelofs 1983, Behnke 1992). Coastal streams are dominated by winter steelhead, whereas inland steelhead of the Columbia River Basin are almost exclusively summer steelhead. Winter steelhead may have been excluded from inland areas of the Columbia River Basin by Celilo Falls or by the considerable migration distance from the ocean. The Sacramento-San Joaquin River Basin may have historically had multiple runs of steelhead that probably included both ocean-maturing and stream-maturing stocks (CDFG 1995, McEwan and Jackson 1996). These steelhead are referred to as winter steelhead by the CDFG, however, some biologists call them fall steelhead (Cramer *et. al* 1995). It is thought that hatchery practices and modifications in the hydrology of the basin caused by large-scale water diversions may have altered the migration timing of steelhead in this basin (D. McEwan, personal communication, cited in BRT 2003).

Inland steelhead of the Columbia River Basin, especially the Snake River Subbasin, are commonly referred to as either A-run or B-run. These designations are based on a bimodal migration of adult steelhead at Bonneville Dam (235 km from the mouth of the Columbia River) and differences in age (1- versus 2-ocean) and adult size observed among SR steelhead. It is unclear, however, if the life-history and body size differences observed upstream are correlated back to the groups forming the bimodal migration observed at Bonneville Dam. Furthermore, the relationship between patterns observed at the dams and the distribution of adults in spawning areas throughout the Snake River Basin is not well understood. A-run steelhead are believed to occur throughout the steelhead-bearing streams of the Snake River Basin and the inland Columbia River; B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon Rivers (IDFG 1994).

The half-pounder is an immature steelhead that returns to fresh water after only 2 to 4 months in the ocean, generally overwinters in fresh water, and then outmigrates again the following spring. Half-pounders are generally less than 400 mm and are reported only from the Rogue, Klamath, Mad, and Eel Rivers of Southern Oregon and Northern California (Snyder 1925, Kesner and Barnhart 1972, Everest 1973, Barnhart 1986), however, it has been suggested that as mature steelhead, these fish may only spawn in the Rogue and Klamath River Basins (Cramer *et al.* 1995). Various explanations for this unusual life history have been proposed, but there is still no consensus as to what, if any, advantage it affords to the steelhead of these rivers.

In May 1992, NOAA Fisheries was petitioned by the Oregon Natural Resources Council (ONRC) and 10 co-petitioners to list Oregon's Illinois River winter steelhead (ONRC *et al.* 1992). NOAA Fisheries concluded that Illinois River winter steelhead by themselves did not constitute an ESA “species” (Busby *et al.* 1993, NMFS 1993). In February 1994, NOAA Fisheries received a petition seeking protection under the ESA for 178 populations of steelhead (anadromous steelhead) in Washington, Idaho, Oregon, and California. At the time, NOAA Fisheries was conducting a status review of coastal steelhead populations (*O. m. irideus*) in Washington, Oregon, and California. In response to the broader petition, NOAA Fisheries expanded the ongoing status review to include inland steelhead (*O. m. gairdneri*) occurring east of the Cascade Mountains in Washington, Idaho, and Oregon.

In 1995, the steelhead BRT met to review the biology and ecology of West Coast steelhead. After considering available information on steelhead genetics, phylogeny, and life history, freshwater ichthyo-geography, and environmental features that may affect steelhead, the BRT identified 15 ESUs—12 coastal forms and three inland forms. After considering available information on population abundance and other risk factors, the BRT concluded that five steelhead ESUs (Central California Coast, South-Central California Coast, Southern California, Central Valley, and Upper Columbia River) were presently in danger of extinction, five steelhead ESUs (Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California, and Snake River Basin) were likely to become endangered in the foreseeable future, four steelhead ESUs (Puget Sound, Olympic Peninsula, Southwest Washington, and Upper Willamette River) were not presently in significant danger of becoming extinct or endangered, although individual stocks within these ESUs may be at risk, and one steelhead ESU (Middle Columbia River) was not presently in danger of extinction but the BRT was unable to reach a conclusion as to its risk of becoming endangered in the foreseeable future.
Of the 10 steelhead ESUs identified by NOAA Fisheries and listed as threatened or endangered under the ESA, five occur in the overall action area (Table 1). The West Coast steelhead BRT met in January, March, and April 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRT (BRT 2003).

Lower Columbia River (LCR) steelhead. The status of LCR steelhead was initially reviewed by NOAA Fisheries in 1996 (Busby *et al.* 1996), and the most recent review occurred in 1998 (NMFS 1998d). In the 1998 review, the BRT noted several concerns for this ESU, including the low abundance relative to historical levels, the universal and often drastic declines observed since the mid-1980s, and the widespread occurrence of hatchery fish in naturally spawning steelhead populations. Analysis also suggested that introduced summer steelhead may negatively affect winter native winter steelhead in some populations. A majority of the 1998 BRT concluded that steelhead in the Lower Columbia ESU were at risk of becoming endangered in the foreseeable future.

New data available for this update included: recent spawner data, additional data on the fraction of hatchery-origin spawners, recent harvest rates, updated hatchery release information, and a compilation of data on resident steelhead. For many of the Washington Chinook salmon populations, the WDFW conducted analyses using the Ecosystem Diagnosis and Treatment (EDT) model (Busack and Rawding 2003). The EDT model attempts to predict fish population performance based on input information about reach-specific habitat attributes. New analyses for this update include the designation of demographically independent populations, recalculation of previous BRT metrics with additional years♣ data, estimates of median annual growth rate (ë) under different assumptions about the reproductive success of hatchery fish, and estimates of current and historically available kilometers of stream.

Based on the provisional framework discussed in the general Introduction to the BRT (2003) report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (*e.g.*, in upper Clackamas, Sandy, and some of the small tributaries of the Columbia River Gorge) are not. Case 3 resident fish above dams on the Cowlitz, Lewis, and Sandy Rivers are of uncertain ESU status.

A large majority (over 79%) of the BRT votes for this ESU fell in the ♣likely to become endangered♣ category, with small minorities falling in the ♣danger of extinction♣ and ♣not likely to become endangered♣ categories. The BRT found moderate risks in all the VSP categories, with mean risk matrix scores ranging from moderately low for spatial structure to moderately high for both abundance and growth rate/productivity. All of the major risk factors identified by previous BRTs still remain. Most populations are at relatively low abundance, and those with adequate data for modeling are estimated to have a relatively high extinction probability. Some populations, particularly summer run, have shown higher returns in the last 2 to 3 years. The Willamette/Lower Columbia River Technical Review Team (Myers *et al.* 2002) has estimated that at least four historical populations are now extinct. The hatchery contribution to natural spawning remains high in many populations.

Middle Columbia River (MCR) steelhead. The MCR steelhead ESU includes steelhead populations in Oregon and Washington drainages upstream from the Hood and Wind River systems to, and including, the Yakima River. The Snake River is not included in this ESU. Major drainages in this ESU are the Deschutes, John Day, Umatilla, Walla-Walla, Yakima, and Klickitat River systems. Almost all steelhead populations within this ESU are summer-run fish, the exceptions being winter-run components returning to the Klickitat, and Fifteen Mile Creek Watersheds. Most of the populations within this ESU are characterized by a balance between 1- and 2-year-old smolt outmigrants. Adults return after 1 or 2 years at sea.

Hatchery facilities are in a number of drainages within the geographic area of this ESU, although there are also subbasins with little or no direct hatchery influence. The John

Day River system, for example, has not been outplanted with hatchery steelhead. Similarly, hatchery production of steelhead in theYakima River system was relatively limited historically and has been phased out since the early 1990s. However, the Umatilla and the Deschutes River systems each have ongoing hatchery production programs based on locally-derived broodstocks. Moreover, straying from out-of-basin production programs into the Deschutes River has been identified as a chronic occurrence. The Walla Walla River (three locations in Washington sections) historically received production releases of Lyons Ferry stock summer steelhead from the Lower Snake River Compensation Program (LSRCP). Mill Creek releases were halted after 1998 due to concerns associated with the then pending listing of MCR steelhead under the ESA. A new endemic broodstock is under development for the Touchet River release site (beginning with the 1999/2000 return year). Production levels at the Touchet and Walla Walla River release site have been reduced in recent years (WDFW, cited in BRT 2003).

Blockages have prevented access to sizable steelhead production areas in the Deschutes River and the White Salmon River. In the Deschutes River, Pelton Dam blocks access to upstream habitat historically used by steelhead. Conduit Dam, constructed in 1913, blocked access to all but 2 to 3 miles of habitat suitable for steelhead production in the Big White Salmon River (Rawding 2001). Substantial populations of resident trout exist in both areas.

The previous reviews (BRT 1998, 1999) identified several concerns including relatively low spawning levels in those streams for which information was available, a preponderance of negative trends (10 out of 14), and the widespread presence of hatchery fish throughout the ESU. The 1999 BRT review specifically identified the serious declines in abundance in the John Day River Basin as a point of concern given that the John Day system had supported large populations of naturally-spawning steelhead in the recent past. Concerns were also expressed about the low abundance of returns to the Yakima River system relative to historical levels with the majority of production coming from a single stream (Satus Creek). The sharp decline in returns to the Deschutes River system was also identified as a concern.

The 1999 BRT review identified increases of stray steelhead into the Deschutes River as a ♣major source of concern.♣ The review acknowledged that initial results from radio tagging studies indicated that a substantial proportion of steelhead entering the Deschutes migrated out of the system before spawning. The previous BRT review identified a set of habitat problems affecting basins within this ESU. High summer and low winter temperatures are characteristic of production or migration reaches associated with populations within this ESU. Water withdrawals have seriously reduced flow levels in several Mid-Columbia drainages, including sections of the Yakima, Walla-Walla, Umatilla, and Deschutes Rivers. Riparian vegetation and instream structure has been degraded in many areas●the previous BRT report states that of the stream segments inventoried within this ESU, riparian restoration is needed for between 37% and 84% of the riverbank in various basins.

The John Day is the only basin of substantial size in which production is clearly driven by natural spawners. For the other major basin in the ESU, the Klickitat, no quantitative abundance information is available. The other difficult issue centered on how to evaluate contribution of resident fish, which according to Kostow (2003) and other sources are very common in this ESU and may greatly outnumber anadromous fish. The BRT concluded that the relatively abundant and widely distributed resident fish somewhat mitigated extinction risk in this ESU. However, due to significant threats to the anadromous component, the majority of BRT members concluded the ESU was likely to become endangered.

Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Based on the provisional framework discussed in the general Introduction to the BRT (2003), the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (*e.g.*, in Deschutes and John Day Basins) are not. Case 3 resident fish above Condit Dam in the Little White Salmon; above Pelton and Round Butte Dams (but below natural barriers) in the Deschutes; and above irrigation dams in the Umatilla Rivers are of uncertain ESU status.

A slight majority (51%) of the BRT votes for this ESU fell in the ♣likely to become endangered♣ category, with a substantial minority (49%) falling in the ♣not likely to become endangered♣ category. The BRT did not identify any extreme risks for this ESU but found moderately risks in all the VSP categories. This ESU proved difficult to evaluate for two reasons. First, the status of different populations within the ESU varies greatly. On the one hand, the abundance in two major basins, the Deschutes and John Day, is relatively high and over the last five years is close to or slightly over the interim recovery targets (NMFS 2002a). On the other hand, steelhead in the Yakima Basin, once a large producer of steelhead, remain severely depressed (10% of the interim recovery target), in spite of increases in the last 2 years. Furthermore, in recent years escapement to spawning grounds in the Deschutes River has been dominated by stray, out-of-basin (and largely out-of-ESU) fish●which raises substantial questions about genetic integrity and productivity of the Deschutes population.

Upper Columbia River (UCR) steelhead. The life-history patterns of UCR steelhead are complex. Adults return to the Columbia River in the late summer and early fall; most migrate relatively quickly up the mainstem to their natal tributaries. A portion of the returning run overwinters in the mainstem reservoirs, passing over the Upper Mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the calendar year following entry into the river. Juvenile steelhead spend 1 to 7 years rearing in freshwater before migrating to the ocean. Smolt outmigrations are predominately age 2 and age 3 juveniles. Most adult steelhead return after 1 or 2 years at sea, starting the cycle again.

Estimates of the annual returns of UCR steelhead populations are based on dam counts. Cycle counts are used to accommodate the prevalent return pattern in up-river summer steelhead (runs enter the Columbia River in late summer and fall, some fish overwinter in mainstem reservoirs migrating past the upper dams before spawning the following spring). Counts over Wells Dam are assumed to be returns originating from natural production and hatchery outplants into the Methow and Okanogan river systems. The total returns to Wells Dam are calculated by adding annual broodstock removals at Wells to the dam counts. The annual estimated return levels above Wells Dam are broken down into hatchery and wild components by applying the ratios observed in the Wells sampling program for run years since 1982.

Harvest rates on upper river steelhead have been cut back substantially from historical levels. Direct commercial harvest of steelhead in non-Indian fisheries was eliminated by legislation in the early 1970s. Incidental impacts in fisheries directed at other species continued in the lower river, but at substantially reduced levels. In the 1970s and early 1980s, recreational fishery impacts in the Upper Columbia escalated to very high levels in response to increasing returns augmented by substantial increases in hatchery production. In 1985, steelhead recreational fisheries in this region (and in other Washington tributaries) were changed to mandate release of wild fish. Treaty harvest of summer run steelhead (including returns to the Upper Columbia) occurs mainly in mainstem fisheries directed at up-river bright fall Chinook.

Hatchery returns predominate the estimated escapement in the Wenatchee, Methow and Okanogan River drainages. The effectiveness of hatchery spawners relative to their natural counterparts is a major uncertainty for both populations. Hatchery effectiveness can be influenced by at least three sets of factors: (1) Relative distribution of spawning adults;
(2) relative timing of spawning adults; and (3) relative effectiveness of progeny. No direct information is available for the Upper Columbia River stocks. Outplanting strategies have varied over the time period the return/spawner data were collected (1976-1994 broodyears). While the return timing into the Columbia River is similar for both wild and hatchery steelhead returning to the Upper Columbia, the spawning timing in the hatchery is accelerated. The long-term effects of such acceleration on the spawning timing of returning hatchery-produced adults in nature is not known. We have no direct information on relative fitness of UCR steelhead progeny with at least one parent of hatchery origin.

The 1998 steelhead status review identified a number of concerns for the UCR steelhead ESU. While the total abundance of populations within this ESU has been relatively stable or increasing, it appears to be occurring only because of major hatchery supplementation programs. Estimates of the proportion of hatchery fish in spawning escapement are 65% (Wenatchee River) and 81% (Methow and Okanogan Rivers). The major concern for this ESU is the clear failure of natural stocks to replace themselves. The BRT members are also strongly concerned about the problems of genetic homogenization due to hatchery supplementation, apparent high harvest rates on steelhead smolts in rainbow trout fisheries and the degradation of freshwater habitats within the region, especially the effects of grazing, irrigation diversions and hydroelectric Dams. The BRT also identified two major areas of uncertainty; relationship between anadromous and resident forms, and the genetic heritage of naturally spawning fish within this ESU.

Based on the provisional framework discussed in the general introduction to the BRT (2003) report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (*e.g.*, in the Entiat, Methow, and perhaps Okanogan Basins) are not. Resident fish potentially occur in all areas in the ESU used by steelhead. Case 3 resident fish above Conconully Dam are of uncertain ESU affinity. The BRT did not attempt to resolve the ESU status of resident fish residing above Grand Coulee Dam, as little new information is available relevant to this issue. Possible ESU scenarios for these fish include: (1) That they were historically part of the ESU and many of the remnant resident populations still are part of this ESU; (2) that they were historically part of the ESU but no longer are, due to either introductions of hatchery rainbow trout or rapid evolution in a novel environment; or (3) they were historically part of a separate ESU. For many BRT members, the presence of relatively numerous resident fish mitigated the assessment of extinction risk for the ESU as a whole.

A slight majority (54%) of the BRT votes for this ESU fell in the "danger of extinction" category, with most of the rest falling in the "likely to become endangered" category. The most serious risk identified for this ESU was growth rate/productivity, estimated to be high to very high; other VSP factors were also relatively high, ranging from moderate for spatial structure to moderately high for diversity. The last 2 to 3 years have seen an encouraging increase in the number of naturally-produced fish in this ESU. However, the recent mean abundance in the major basins is still only a fraction of interim recovery targets (NMFS 2002a). Furthermore, overall adult returns are still dominated by hatchery fish, and detailed information is lacking regarding productivity of natural populations. The ratio of naturally-produced adults to the number of parental spawners (including hatchery fish) remains low for UCR steelhead. The BRT did not find data to suggest that the extremely low replacement rate of naturally spawning fish (estimated adult: adult ratio was only 0.25-0.3 at the time of the last status review update) has improved substantially.

Upper Willamette River (UWR) steelhead. The status of UWR steelhead was initially reviewed by NOAA Fisheries in 1996 (Busby *et al.* 1996) and the most recent review occur in 1999 (NMFS 1999e). In the 1999 review, the BRT noted several concerns for this ESU, including the relatively low abundance and steep declines since 1988. The previous BRT was also concerned about the potential negative interaction between non-native summer steelhead and wild winter steelhead. The previous BRT considered the loss of access to historical spawning grounds because of dams a major risk factor. The 1999 BRT reached a unanimous decision that the UWR steelhead ESU was at risk is of becoming endangered in the foreseeable future.

New data for UWR steelhead include redd counts and dam/weir counts through 2000, 2001, or 2002, and estimates of hatchery fraction and harvest rates through 2000. New analyses for this update include the designation of demographically independent populations, and estimates of current and historically available kilometers of stream.

As part of its effort to develop viability criteria for UWR steelhead, the Willamette/Lower Columbia Technical Recovery Team has identified historically demographically independent populations (Myers *et al.* 2002). Population boundaries are based on an application of VSP definition (McElhany *et al.* 2000). Myers *et al.* (2002) hypothesized that the ESU historically consisted of at least four populations (Mollala, North Santiam, South Santiam and Calapooia) and possibly a fifth (Coast Range). The historical existence of a population in the coast range is uncertain. The populations identified in Myers *et al.* are used as the units for the new analyses in the BRT (2003) report.

Based on the updated information provided in the BRT (2003) report, the information contained in previous UWR steelhead ESU status reviews, and preliminary analyses by the Willamette/Lower Columbia Technical Review Team, we could not conclusively identify a single population that is naturally self-sustaining. All populations are relatively small, with the recent mean abundance of the entire ESU at less than 6,000. Over the period of the available time series, most of the populations are in decline. The recent elimination of the winter-run hatchery production will allow estimation of the natural productivity of the populations in the future, but the available time series are confounded by the presence of hatchery-origin spawners. On a positive note, the counts all indicate an increase in abundance in 2001, likely at least partly as a result of improved marine conditions. The issue of changing marine conditions is discussed in the introduction to this update report, as it is an issue for may ESUs.

Because coastal cutthroat trout is a dominant species in the basin, resident steelhead are not as widespread here as in areas east of the Cascades. Resident fish below barriers are found in the Pudding/Molalla, Lower Santiam, Calapooia, and Tualatin drainages, and these would be considered part of the steelhead ESU based on the provisional framework discussed in the general Introduction. Resident fish above Big Cliff and Detroit Dams on the North Fork Santiam and above Green Peter Dam on the South Fork Santiam are of uncertain ESU affinity. Although no obvious physical barrier separates populations upstream from the Calapooia from those lower in the basin, resident steelhead in these upper reaches of the Willamette Basin are quite distinctive both phenotypically and genetically and are not considered part of the steelhead ESU.

The majority (over 76%) of the BRT votes for this ESU fell in the ♧likely to become endangered♣ category, with small minorities falling in the ♧danger of extinction♣ and ♧not likely to become endangered♣ categories. The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories, ranging from moderately low for diversity to moderate spatial structure and growth rate/productivity. On a positive note, after a decade in which overall abundance (Willamette Falls count) hovered around the lowest levels on record, adult returns for 2001 and 2002 were up significantly, on par with levels seen in the 1980s. Still, the total abundance is small for an entire ESU, resulting in a number of populations that are each at relatively low abundance. The recent increases are encouraging but it is uncertain whether they can be sustained. The BRT considered it a positive sign that releases of the ♣early♣ winter-run hatchery population have been discontinued, but remained concerned that releases of non-native summer-run steelhead continue.

Snake River Basin (SR) steelhead. The SR steelhead ESU is distributed throughout the Snake River drainage system, including tributaries in southwest Washington, eastern Oregon and north/central Idaho (NMFS1996). SR steelhead migrate a substantial distance from the ocean (up to 1,500 km) and use high elevation tributaries (typically 1,000-2,000 m above sea level) for spawning and juvenile rearing. SR steelhead occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead ESUs. SR steelhead are generally classified as summer run, based on their adult run timing patterns. Summer steelhead enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn during the following spring (March to May). Managers classify up-river summer steelhead runs into to groups based primarily on ocean age and adult size upon return to the Columbia River. A-run steelhead are predominately age-1 ocean fish while B-run steelhead are larger, predominated by age-2 ocean fish.

With the exception of the Tucannon River and some small tributaries to the mainstem Snake River, the tributary habitat used by SR steelhead ESU is above Lower Granite Dam. Major groupings of populations and/or subpopulations can be found in: (1) The Grande Ronde River system; (2) the Imnaha River drainage; (3) the Clearwater River drainages; (4) the South Fork Salmon River; (5) the smaller mainstem tributaries before the confluence of the mainstem;
(6) the Middle Fork salmon production areas, (7) the Lemhi and Pahsimeroi valley production areas, and (8) upper Salmon River tributaries.

Resident steelhead are believed to be present in many of the drainages used by SR steelhead. Very little is known about interactions between co-occurring resident and anadromous forms within this ESU. The following review of abundance and trend information focuses on information directly related to the anadromous form.

Although direct historical estimates of production from the Snake Basin are not available, the basin is believed to have supported more than half of the total steelhead production from the Columbia Basin (Mallet 1974). Some historical estimates of returns are available for portions of the drainage. Lewiston Dam, constructed on the Lower Clearwater, began operation in 1927. Counts of steelhead passing through the adult fish ladder at the dam reached 40 to 60,000 in the early 1960s (Cichosz *et al.* 2001). Based on relative drainage areas, the Salmon River Basin likely supported substantial production as well. In the early 1960s, returns to the Grande Ronde River and the Imnaha River may have exceeded 15,000 and 4,000 steelhead per year, respectively

(ODFW 1991). Extrapolations from tag/recapture data indicate that the natural steelhead return to the Tucannon River may have exceeded 3,000 adults in the mid-1950s (WDF 1991). The previous status review noted that the aggregate trend in abundance as measured by ladder counts at the uppermost Snake River dam (Lower Granite Dam since 1972) has been upward since the mid-1970s while the aggregate return of naturally-produced steelhead was downward for the same period. The decline in natural production was especially pronounced in the later years in the series.

The primary concern regarding SR steelhead identified in the 1998 status review was a sharp decline in natural stock returns beginning in the mid-1980s. Of 13 trend indicators at that time, nine were in decline and four were increasing. In addition, Idaho Department of Fish and Game parr survey data indicated declines for both A and B run steelhead in wild and natural stock areas. The high proportion of hatchery fish in the run was also identified as a concern, particularly because of the lack of information on the actual contribution of hatchery fish to natural spawning. The review recognized that some wild spawning areas have relatively little hatchery spawning influence (Selway River, Lower Clearwater River, the Middle and South Forks of the Salmon River and the Lower Salmon River). In other areas, such as the Upper Salmon River, there is likely little or no natural production of locally native steelhead. The review identified threats to genetic integrity from past and present hatchery practices as a concern. Concern for the North Fork Clearwater stock was also identified. That stock is currently maintained through the Dworshak Hatchery program but cut off from access to its native tributary by Dworshak Dam. The 1998 review also highlighted concerns for widespread habitat degradation and flow impairment throughout the Snake Basin as well as for the substantial modification of the seaward migration corridor by hydroelectric power development on the Snake and Columbia mainstems.

Estimates of annual returns to specific production areas are not available for most of the Snake River ESU. Estimates are available for two tributaries below Lower Granite Dam (Tucannon and Asotin Creek). Annual ladder counts at Lower Granite Dam and associated sampling information allows for an estimate of the aggregate returns to the Snake River Basin. In addition, area specific estimates are available for the Imnaha River and two major sections of the Grande Ronde River system. Returns to Lower Granite Dam remained at relatively low levels through the 1990s; the 2001 run size at Lower Granite Dam was substantially higher relative to the 1990s. The recent geometric mean abundance was down for the Tucannon River relative to the last BRT status review. Returns to the Imnaha River and to the Grande Ronde River survey areas were generally higher relative to the early 1990s.

Overall, long-term trends remained negative for four of the nine available series (including aggregate measures and specific production area estimates). Short-term trends improved relative to the period analyzed for the previous status review. The median short-term trend was +2.0% for the 1990-2001 period. Five out of the nine data sets showed a positive trend.

Based on the provisional framework discussed in the general introduction to the BRT (2003) report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (*e.g.*, in the Palouse and Malad Rivers) are not. Recent genetic data suggest that native resident steelhead above Dworshak Dam on the North Fork Clearwater River should be considered part of this ESU, but hatchery rainbow trout that have been introduced to that and other areas would not. The BRT did not attempt to resolve the ESU status of resident fish residing above the Hell♣s Canyon Dam complex, as little new information is available relevant to this issue. However, Kostow (2003) suggested that, based on substantial ecological differences in habitat, the anadromous steelhead that historically occupied basins upstream from Hells Canyon (*e.g.*, Powder, Burnt, Malheur, Owhyee Rivers) may have been in a separate ESU. For many BRT members, the presence of relatively numerous resident fish mitigated the assessment of extinction risk for the ESU as a whole.

On a more positive note, sharp upturns in 2000 and 2001 in adult returns in some populations and evidence for high smolt-adult survival indicate that populations in this ESU are still capable of responding to favorable environmental conditions. In spite of the recent increases, however, abundance in most populations for which there are adequate data are well below interim recovery targets (NMFS 2002a).

A majority (over 70%) of the BRT votes for this ESU fell in the ♣likely to become endangered♣ category, with small minorities falling in the ♣danger of extinction♣ and ♣not likely to become endangered♣ categories. The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories, ranging from moderately low risk for spatial structure to moderate risk for growth rate/productivity. The continuing depressed status of B-run populations was a particular concern. Paucity of information on adult spawning escapements to specific tributary production areas makes a quantitative assessment of viability for this ESU difficult. As indicated in previous status reviews, the BRT remained concerned about the replacement of naturally-produced fish by hatchery fish in this ESU; naturally-produced fish now make up only a small fraction of the total adult run. Again, lack of key information considerably complicates the risk analysis. Although several large production hatcheries for steelhead occur throughout this ESU, relatively few data exist regarding the numbers and relative distribution of hatchery fish that spawn naturally, or the consequences of such spawnings when they do occur.

Coho salmon. Coho salmon is a widespread species of Pacific salmon, occurring in most major river basins around the Pacific Rim from Monterey Bay in California, north to Point Hope, Alaska, through the Aleutians, and from Anadyr River south to Korea and northern Hokkaido, Japan (Laufle *et al.* 1986). From central British Columbia south, the vast majority of coho salmon adults are 3-year-olds, having spent approximately 18 months in freshwater and 18 months in saltwater (Gilbert 1912, Pritchard 1940, Sandercock 1991). The primary exceptions to this pattern are "jacks," sexually mature males that return to freshwater to spawn after only 5 to 7 months in the ocean. However, in southeast and central Alaska, the majority of coho salmon adults are 4-year-olds, having spent an additional year in freshwater before going to sea (Godfrey *et al.* 1975, Crone and Bond 1976). The transition zone between predominantly 3-year-old and 4-year-old adults occurs somewhere between central British Columbia and southeast Alaska.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves *et al.* 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. West Coast coho smolts typically leave freshwater in the spring (April to June) and re-enter freshwater when sexually mature from September to November and spawn from November to December and occasionally into January (Sandercock 1991). Stocks from British Columbia, Washington, and the Columbia River often have very early (entering rivers in July or August) or late (spawning into March) runs in addition to "normally" timed runs.

The status of coho salmon for purposes of ESA listings has been reviewed many times, beginning in 1990. The first two reviews occurred in response to petitions to list coho salmon in the Lower Columbia River and Scott and Waddell Creeks (central California) under the ESA. The conclusions of these reviews were that NOAA Fisheries could not identify any populations that warranted protection under the ESA in the Lower Columbia River (Johnson *et al.* 1991), and that Scott and Waddell Creeks' populations were part of a larger, undescribed ESU (Bryant 1994).

A review of West Coast (Washington, Oregon, and California) coho salmon populations began in 1993, in response to several petitions to list numerous coho salmon populations and NOAA Fisheries' own initiative to conduct a coastwide status review of the species. This coastwide review identified six coho salmon ESUs, of which the three southern-most were proposed for listing, two were candidates for listing, and one was deemed "not warranted" for listing (Weitkamp *et al.* 1995). In October 1996, the BRT updated the status review for the Central California ESU, and concluded that it was at risk of extinction (NMFS 1996b). In October 1996, NOAA Fisheries listed this ESU as threatened (Table 1).

In December 1996, the BRT updated the status review update for both proposed and candidate coho salmon ESUs (NMFS 1996b). However, because of the scale of the review, co-managers♣ requests for additional time to comment on the preliminary conclusions, and NOAA Fisheries♣ legal obligations, the status review was finalized for proposed coho salmon ESUs in 1997 (NMFS 1997), but not for candidate ESUs. In May 1997, NOAA Fisheries listed the Southern Oregon/Northern California Coasts ESU as threatened, while it announced that listing of the Oregon Coast ESU was not warranted due to measures in the ♣Oregon Coastal Salmon Restoration Initiative♣ (Oregon Plan 1997, now referred to as the ♣Oregon Plan for Salmon and Watersheds♣). This finding for OC coho salmon was overturned in August 1998, and the ESU listed as threatened (Table 1).

The process of updating the coho salmon status review began again in October 1998 for coho salmon in Washington and the Lower Columbia River. However, this effort was terminated before the BRT could meet, due to competing activities with higher priorities.

In response to a petition by (Oregon Trout *et al.* 2000), the status of Lower Columbia River coho salmon was revisited in 2000, with BRT meetings held in March and May 2001 (NMFS 2001a). The BRT concluded that splitting the Lower Columbia River/Southwest Washington coast ESU to form separate Lower Columbia River and Southwest Washington coast coho salmon ESUs was most consistent with available information and the Lower Columbia River ESU was at risk of extinction. Like the 1996 status review update, these results were never finalized.

The coho salmon BRT met in January, March, and April 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRTs.

Southern Oregon/Northern California Coasts (SONC) coho salmon. The SONC coho salmon ESU extends from Cape Blanco in southern Oregon, to Punta Gorda in northern California (Weitkamp *et al.* 1995). The status of coho salmon coastwide, including the SONC coho ESU, was formally assessed in 1995 (Weitkamp *et al.* 1995). Two subsequent status review updates have been published by NOAA Fisheries, one addressing all West Coast coho salmon ESUs (NMFS 1996c) and a second specifically addressing the Oregon Coast and SONC ESUs (NMFS 1997).

In the 1995 status review, the BRT was unanimous in concluding that coho salmon in the SONC coho ESU were not in danger of extinction but were likely to become so in the foreseeable future if present trends continued (Weitkamp *et al.* 1995). In the 1997 status update, estimates of natural population abundance in this ESU were based on very limited information. Favorable indicators included recent increases in abundance in the Rogue River and the presence of natural populations in both large and small basins, factors that may provide some buffer against extinction of the ESU. However, large hatchery programs in the two major basins (Rogue and Klamath/Trinity) raised serious concerns about effects on, and sustainability of, natural populations.

New data on presence/absence in northern California streams that historically supported coho salmon were even more disturbing than earlier results, indicating that a smaller percentage of streams in this ESU contained coho salmon compared to the percentage presence in an earlier study. However, it was unclear whether these new data represented actual trends in local extinctions, or were biased by sampling effort. This new information did not change the BRT♣s conclusion regarding the status of the SONC coho ESU. Although the Oregon Plan for Salmon and Watersheds (1997) proposals were directed specifically at the Oregon portion of this ESU, the harvest proposal would affect ocean harvest of fish in the California portion as well. The proposed hatchery reforms can be expected to have a positive effect on the status of populations in the Rogue River Basin. However, the BRT concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

One effect of the Oregon Plan for Salmon and Watersheds (1997) has been increased monitoring of salmon and habitats throughout the Oregon coastal region. Besides continuation of the abundance data series analyzed in the 1997 status update, Oregon has expanded its random survey monitoring to include areas south of Cape Blanco, including monitoring of spawner abundance, juvenile densities, and habitat condition.

New data for the SONC coho salmon ESU includes expansion of presence-absence analyses, a limited analysis of juvenile abundance in the Eel River Basin, a few indices of spawner abundance in the Smith, Mad, and Eel River Basins, and substantially expanded monitoring of adults, juveniles, and habitat in southern Oregon. None of these data contradict conclusions reached previously by the BRT. Nor do any of recent data (1995 to present) suggest any marked change, either positive or negative, in the abundance or distribution of coho salmon within the SONC coho ESU. Coho salmon populations continued to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. Although the 2001 broodyear appears to be the one of the strongest perhaps of the last decade, it follows a number of relatively weak years. The Rogue River stock is an exception; there has been an average increase in spawners over the last several years, despite two low years (1998, 1999).

Risk factors identified in previous status reviews, including severe declines from historical run sizes, the apparent frequency of local extinctions, long-term trends that are clearly downward, and degraded freshwater habitat and associated reduction in carrying capacity continue to be of concern to the BRT. Termination of hatchery production of coho salmon at the Mad River and Rowdy Creek facilities has eliminated potential adverse risk associated with hatchery releases from these facilities. Likewise, restrictions on recreational and commercial harvest of coho salmon since 1994 have undoubtedly had a substantial positive impact on coho salmon adult returns to SONC streams. An additional risk factor that has been identified within the SONC coho ESU is predation resulting from the illegal introduction of non-native Sacramento pikeminnow (*Ptychocheilus grandis*) to the Eel River Basin (NMFS 1998e). Sacramento pikeminnow were introduced to the Eel River via Pillsbury Lake in the early 1980s and have subsequently spread to most areas within the basin. The rapid expansion of pikeminnow populations is believed to have been facilitated by alterations in habitat conditions (particularly increased water temperatures) that favor pikeminnow (Brown *et al.* 1994, NMFS 1998e).

The BRT remained concerned about low population abundance throughout the ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally-produced spawners in most basins continued to hinder assessment of risk. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are upward in the Rogue, however, the positive trends reflect effects of reduced harvest (rather than improved freshwater conditions) since trends in pre-harvest recruits are flat. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others.

Additionally, the BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37% and 61% from broodyear 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU. The relatively strong 2001 broodyear, likely the result of favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years.

The moderate risk matrix scores for spatial structure reflected a balancing of several factors. On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). The BRT also remains concerned about the possibility that losses of local populations have been masked in basins with high hatchery output, including the Trinity, Klamath, and Rogue systems. The extent to which strays from hatcheries in these systems are contributing to natural production remains uncertain, however, it is generally believed that hatchery fish and progeny of hatchery fish constitute the majority of production in the Trinity River, and may be a significant concern in parts of the Klamath and Rogue systems a well. On the positive side, extant populations can still be found in all major river basins within the ESU. Additionally, the relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon. The BRT♣s concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity systems was also evident in the moderate risk rating for diversity.

A majority (67%) of BRT votes fell into the ♣likely to become endangered♣ category, while votes in the ♣endangered♣ category outnumbered those in the ♣not warranted♣ categories by 2-to-1. The BRT found moderately high risks for abundance and growth rate/production, with mean matrix scores of 3.5 to 3.8, respectively, for these two categories. Risks to spatial structure and diversity were judged by the BRT to be moderate.

Lower Columbia River (LCR) coho salmon. The status of LCR coho salmon was initially reviewed by NOAA Fisheries in 1996 (NMFS 1996c), and the most recent review occured in 2001 (NMFS 2001a). In the 2001 review, the BRT was very concerned that the vast majority (over 90%) of the historical populations in the LCR coho salmon ESU appear to be either extirpated or nearly so. The two populations with any significant production (Sandy and Clackamas) were at appreciable risk because of low abundance, declining trends, and failure to respond after a dramatic reduction in harvest. The large number of hatchery coho salmon in the ESU was also considered an important risk factor. The majority of the 2001 BRT votes were for ♣at risk of extinction♣ with a substantial minority in ♣likely to become endangered.♣

New data include spawner abundance estimates through 2002 for Clackamas and Sandy populations (the previous status review had data just through 1999). In addition, the ODFW conducted surveys of Oregon LCR coho salmon using a stratified random sampling design in 2002, which provided the first abundance estimates for lower tributary populations (previously only limited index surveys were available. Estimates of the fraction of hatchery-origin spawners accompany the new abundance estimates. In Washington, no surveys of natural-origin adult coho salmon abundance are conducted. Updated information through 2002 on natural-origin smolt production from Cedar, Mill, Germany, and Abernathy Creeks and the Upper Cowlitz River were provided by the WDFW.

New analyses include the tentative designation of demographically-independent populations, the recalculation of metrics reviewed by previous BRTs with additional years of data, estimates of median annual growth rate under different assumptions about the reproductive success of hatchery fish, a new stock assessment of Clackamas River coho by the ODFW (Zhou and Chilcote 2003), and estimates of current and historically available kilometers of stream.

As part of its effort to develop viability criteria for Lower Columbia River salmon and steelhead, the Willamette/Lower Columbia Technical Recovery Team has identified historically demographically independent populations of ESA-listed salmon and steelhead in the Lower Columbia River (Myers *et al.* 2002). Population boundaries are based on an application of VSP definition (McElhany *et al.* 2000). Based on the Willamette/Lower Columbia Technical Review Team♣s framework for Chinook and steelhead, the BRT tentatively designated populations of LCR coho salmon. A working group at the Northwest Fisheries Science Center hypothesized that the Lower Columbia River coho salmon ESU historically consisted of 23 populations. These population designations have not yet been reviewed by the Willamette/Lower Columbia Technical Review Team.

Previous BRT and ODFW analyses have treated the coho in the Clackamas River as a single population (see previous status review updates for more complete discussion and references). However, recent analysis by the ODFW (Zhou and Chilcote 2003) supports the hypothesis that coho salmon in the Clackamas River consist of two populations, an early run and a late run. The late run population is believed to be descendant of the native Clackamas River population, and the early run is believed to descend from hatchery fish introduced from Columbia River populations outside the Clackamas River Basin. The population structure of Clackamas River coho is uncertain, therefore, in the BRT (2004) report, analyses on Clackamas River coho are conducted under both the single population and two population hypotheses for comparison.

For other salmonid species, the Willamette/Lower Columbia Technical Review Team partitioned Lower Columbia River populations into a number of "strata" based on major life-history characteristics and ecological zones (McElhany *et al.* 2003). These analyses suggest that a viable ESU would require a number of viable populations in each of these strata. Coho salmon do not have the major life-history variation seen in LCR steelhead or Chinook, and would thus be divided into strata based only on ecological zones.

On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas, and evidence for limited natural production has been found in some areas outside the Sandy and Clackamas. The paucity of naturally-produced spawners in this ESU can be contrasted with the very large number of hatchery-produced adults. Although the scale of the hatchery programs, and the great disparity in relative numbers of hatchery and wild fish, produce many genetic and ecological threats to the natural populations, collectively these hatchery populations contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally-spawning populations.

The status of LCR coho was reviewed by the BRT in 2000, so relatively little new information was available. A majority (68%) of the likelihood votes for LCR coho salmon fell in the "danger of extinction" category, with the remainder falling in the "likely to become endangered" category. As indicated by the risk matrix totals, the BRT had major concerns for this ESU in all VSP risk categories (risk estimates ranged from high risk for spatial structure/connectivity and growth rate/productivity to very high for diversity). The most serious overall concern was the scarcity of naturally-produced spawners throughout the ESU, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally-produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short and long-term trends are negative and productivity (as gauged by preharvest recruits) is down sharply from recent (1980s) levels.

Oregon Coast (OC) coho salmon. The OC coho ESU has been assessed in three previous status reviews (Weitkamp *et al.* 1995, NMFS 1996b, 1997). In the 1995 status review (Weitkamp *et al.* 1995), the BRT considered evidence from many sources to identify ESU boundaries in coho populations from Washington to California. For the most part, evidence from physical environment, ocean conditions/upwelling patterns, marine and coded wire tag recovery patterns, coho salmon river entry and spawn timing as well as estuarine and freshwater fish and terrestrial vegetation distributions were the most informative to the ESU delineation process. Genetic information was used for an indication of reproductive isolation between populations and groups of populations. Based on this assessment, six ESUs were identified, including the OC coho ESU, which includes naturally-spawning populations in Oregon coastal streams north of Cape Blanco, to south of the Columbia River.

In 1997, there were extensive survey data available for coho salmon in this region. Overall, spawning escapements had declined substantially during the century, and may have been at less than 5% of their abundance in the early 1900s. Average spawner abundance had been relatively constant since the late 1970s, but pre-harvest abundance had declined. Average recruits-per-spawner may also have declined. Coho salmon populations in most major rivers appeared to have had heavy hatchery influence, but some tributaries may have been sustaining native stocks.

For this ESU, information on trends and abundance were better than for the more southerly ESUs. Main uncertainties in the assessment included the extent of straying of hatchery fish, the influence of such straying on natural population trends and sustainability, the condition of freshwater habitat, and the influence of ocean conditions on population sustainability. Total average (5-year geometric mean) spawner abundance for this ESU in 1996 was estimated at about 52,000. Corresponding ocean run size for the same year was estimated to be about 72,000; this corresponds to less than one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one-third of those in the 1950s (ODFW 1995). Total freshwater habitat production capacity for this ESU was estimated to correspond to ocean run sizes between 141,000 under poor ocean conditions and 924,000 under good ocean conditions (Oregon Coastal Salmon Restoration Initiative Science Team 1996c). Abundance was unevenly distributed within the ESU at this time, with the largest total escapement in the relatively small Mid/South Coast Gene Conservation Group and lower numbers in the North/Mid Coast and Umpqua Gene Conservation Groups.

Trend estimates using data through 1996 showed that for all three measures (escapement, run size, and recruits-per-spawner), long-term trend estimates were negative. More recent escapement trend estimates were positive for the Umpqua and Mid/South Coast Monitoring Areas, but negative in the North/Mid Coast. Recent trend estimates for recruitment and recruitsper-spawner were negative in all three areas, and exceed 12% annual decline in the two northern areas. Six years of stratified random survey population estimates showed an increase in escapement and decrease in recruitment.

To put these data in a longer-term perspective, ESU-wide averages in 1996 that were based on peak index and area under the curve escapement indices, showed an increase in spawners up to levels of the mid-to-late 1980s, but much more moderate increases in recruitment. Recruitment remained only a small fraction of average levels in the 1970s. An examination of return ratios showed that spawner-to-spawner ratios had remained above replacement since the 1990 brood year as a result of higher productivity of the 1990 broodyear and sharp reductions in harvest for the subsequent broods. As of 1996, recruit-to-spawner ratios for the 1991to 1994 broods were the lowest on record, except for 1988 and, possibly, 1984. The 1997 BRT considered risk of extinction for this ESU under two scenarios: first, if present conditions and existing management continued into the foreseeable future and, second, if certain aspects of the Oregon Plan for Salmon and Watersheds (1997) relating to harvest and hatchery production were implemented.

With respect to habitat, the BRT had two primary concerns: first, that the habitat capacity for coho salmon within this ESU has significantly decreased from historical levels; and second, that the Nickelson and Lawson (1998) model predicted that, during poor ocean survival, only high quality habitat is capable of sustaining coho populations, and subpopulations dependent on medium and low quality habitats would be likely to go extinct. Both of these concerns caused the BRT to consider risks from habitat loss and degradation to be relatively high for this ESU.

In 1997, the BRT concluded that, assuming that 1997 conditions continued into the future (and that proposed harvest and hatchery reforms were not implemented), this ESU was not at significant short-term risk of extinction, but that it was likely to become endangered in the foreseeable future. A minority felt that the ESU was not likely to become endangered. Of those members who concluded that this ESU was likely to become endangered, several expressed the opinion that it was near the border between this and a ♣not at risk♣ category.

The BRT generally agreed that implementation of the harvest and hatchery proposals of the Oregon Plan for Salmon and Watersheds (1997) would have a positive effect on the status of the ESU, but the BRT was about evenly split as to whether the effects would be substantial enough to move the ESU out of the ♣likely to become endangered♣ category. Some members felt that, in addition to the extinction buffer provided by the estimated 80,000 naturally-produced spawners in 1996, the proposed reforms would promote higher escapements and alleviate genetic concerns so that the ESU would not be at significant risk of extinction or endangerment. Other members saw little reason to expect that the hatchery and harvest reforms by themselves would be effective in reducing what they viewed as the most serious threat to this ESU●declining recruits-per-spawner.

If the severe declines in recruits-per-spawner of natural populations in this ESU were partly a reflection of continuing habitat degradation, then risks to this ESU might remain high even with full implementation of the hatchery and harvest reforms. While harvest and hatchery reforms may substantially reduce short-term risk of extinction, habitat protection and restoration were viewed as key to ensuring long-term survival of the ESU, especially under variable and unpredictable future climate conditions. The BRT therefore concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

The Oregon Plan for Salmon and Watersheds (1997) is the most ambitious and far-reaching program to improve watersheds and recover salmon runs in the Pacific Northwest. It is a voluntary program focused on building community involvement, habitat restoration, and monitoring. All state agencies with activities affecting watersheds are required to evaluate their operations with respect to salmon impacts and report on actions taken to reduce these impacts to the Governor on a regular basis. The original Oregon Plan was written in 1997, so the Plan has been in operation for about 7 years. As a result of the plan, watershed councils across the State have produced watershed assessments of limiting factors for anadromous salmonids on both public and private land.

The State of Oregon has dedicated about $20 million/year to implement restoration projects and is developing a system to link project development with whole-watershed assessments. The ODEQ and the Oregon Department of Agriculture are implementing regulatory mechanisms to reduce non-point-source pollution. If these efforts are successful Oregon could see a widespread improvement in water quality. Nonetheless, reporting of watershed assessment results, limiting factors, and identification of actions to be taken or progress made in addressing these limiting factors can be improved. While this is a significant recovery effort in the Pacific Northwest, and an extensive, coordinated monitoring program is in place, measurable results of the program will take years or decades to materialize.

The regime shift in 1976 was the beginning of an extended period of poor marine survival for coho salmon in Oregon. Conditions worsened in the 1990s, and hatchery survival reached a low of 0.006 adults per smolt in 1997 (1996 ocean entry). Coastal hatcheries appear to have fared even worse, although adult counts at these facilities are often incomplete, biasing these estimates low. Following an apparent shift to a more productive climate regime in 1998 marine survival has started to improve, reaching 0.05 for adults returning in 2001. The Pacific Decadal Oscillation had been in a cold, productive phase for about 4 years and in August reversed indicating a warm, unproductive period. This reversal may be short-lived; the Pacific Decadal Oscillation historically has shown a 20 to 60 year cycle. However, the rising influence of global warming should throw up a big caution sign to us when trying to use past decadal patterns as predictive models for the future (Nathan J. Mantua, personal communication, cited in BRT 2003).

A long-term understanding of the prospects for OC coho can be constructed from a simple conceptual model incorporating a trend in habitat quality and cyclical ocean survival (Lawson 1993). Short-term increases in abundance driven by marine survival cycles can mask longer-term downward trends resulting from freshwater habitat degradation or longer-term trends in marine survival that may be a consequence of global climate change. Decreases in harvest rates can increase escapements and delay ultimate extinction. Harvest rates have been reduced to the point where no further meaningful reductions are possible. The current upswing in marine survival is a good thing for OC coho, but will only provide a temporary respite unless other downward trends are reversed.

This ESU continues to present challenges to those assessing extinction risk. The BRT found several positive features compared to the previous assessment in 1997. Adult spawners for the ESU in 2001 and 2002 exceeded the number observed for any year in the past several decades, and pre-harvest run size rivaled some of the high values seen in the 1970s. Some notable increases in spawners have occurred in many streams in the northern part of the ESU, which was the most depressed area at the time of the last status review evaluation. Hatchery reforms have continued, and the fraction of natural spawners that are first-generation hatchery fish has been reduced in many areas compared to highs in the early to mid 1990s.

On the other hand, the recent years of good returns were preceded by three years of low spawner escapements—the result of three consecutive years of recruitment failure, in which the natural spawners did not replace themselves the next generation, even in the absence of any directed harvest. These three years of recruitment failure, which immediately followed the last status review in 1997, are the only such instances that have been observed in the entire time series of data collected for OC coho salmon. Whereas the recent increases in spawner escapement have resulted in long-term trends in spawners that are generally positive, the long-term trends in productivity in this ESU are still strongly negative.

As indicated in the risk matrix results, the BRT considered the decline in productivity to be the most serious concern for this ESU with a moderate risk estimate. With all directed harvest for these populations already eliminated, harvest management can no longer compensate for declining productivity by reducing harvest rates. The BRT was concerned that if the long-term decline in productivity reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinctions during the next cycle of poor ocean conditions. With the cushion provided by strong returns in the last 2 to 3 years, the BRT had much less concern about short-term risks associated with abundance and assigned them a low risk estimate.

A minority of the BRT felt that the large number of spawners in the last few years demonstrate that this ESU is not currently at significant risk of extinction or likely to become endangered. Furthermore, these members felt that the recent years of high escapement, following closely on the heels of the years of recruitment failure, demonstrate that populations in this ESU have the resilience to bounce back from years of depressed runs.

The BRT votes reflected ongoing concerns for the long-term health of this ESU: a majority (56%) of the votes were cast in the "likely to become endangered" category, with a substantial minority (44%) falling in the "not likely to become endangered" category. Although the BRT considered the significantly higher returns in recent years to be encouraging, most members felt that the factors responsible for the increases were more likely to be unusually favorable marine productivity conditions than improvements in freshwater productivity. The majority of BRT members felt that to have a high degree of confidence that the ESU is healthy, high spawner escapements should be maintained for a number of years, and the freshwater habitat should demonstrate the capability of supporting high juvenile production from years of high spawner abundance.

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 (50 C.F.R. 402.02). For projects that are ongoing actions, the effects of all past actions are part of the environmental baseline and the effects of future actions over which the Federal agency has discretionary involvement or control will be analyzed as "effects of the action."

Analysis of the environmental baseline is guided by the specific habitat components necessary to support salmon and steelhead within the action area. When the environmental baseline departs from conditions that support those biological requirements, it becomes more likely that additional risk to the ESU resulting from the effects of the proposed action on the ESU or its habitat will result in jeopardy (NMFS 1999). The biological requirements of salmon and steelhead in the action area vary depending on the life history stage present and the natural range of variation present within that system (Groot and Margolis 1991, NRC 1996, Spence *et al.* 1996). Generally, during spawning migrations, adult salmon require clean water with cool temperatures or thermal refugia, dissolved oxygen near 100%, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. 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 substrate conditions (*e.g.*, gravel size, porosity, permeability, and oxygen levels), substrate stability during high flows, and, for most species, water temperatures of 13°C or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration of juveniles to rearing areas, whether the ocean, lakes, or other stream reaches, requires unobstructed access to these habitats. Physical, chemical, and thermal conditions may all impede migrations of adult or juvenile fish.

Each ESU considered in this Opinion resides in or migrates through the action areas. Thus, for this action area, the biological requirements for salmon and steelhead are the habitat characteristics that would support successful juvenile rearing, juvenile migration, juvenile growth and development to adulthood, adult migration, and spawning juvenile and adult migration.

The analysis presented here is based primarily on the *Oregon State of the Environment Report 2000* (the *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. The environmental baseline has not changed significantly since tthe *Report* was issued. Highlights of the *Report* follow.

Oregon♣s currently available water supplies are often fully or over-allocated during low flow months of summer and fall. In the Columbia Plateau ecoregion, less that 20% of instream water rights can expect to receive their full allocation nine 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. Increased demand for water is linked to the 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 ESUs. This may cause juvenile salmon mortality through:
(1) Migration delay resulting from insufficient flows or habitat blockages; (2) loss of sufficient habitat due to dewatering and blockage; (3) stranding of fish resulting from rapid flow fluctuations; (4) entrainment of juveniles into poorly screened or unscreened diversions; and
(5) increased juvenile mortality resulting from increased water temperatures (Spence *et al.* 1996). Reduced flows also negatively affected 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 late spring-summer-early fall runoff amounts in the coming decades.

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^{o}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 decreases winter water temperatures and put salmon at additional risk. Widespread channel widening and reduced base flows further exacerbate seasonal water temperature extremes.

Sedimentation from logging, mining, urban development, and agriculture are a primary cause of salmon habitat degradation. In general, effects of sedimentation on salmons are well documented and include: (1) Clogging and abrasion of gills and other respiratory surfaces; (2) adhering to the chorion of eggs; (3) providing conditions conducive to entry and persistence of disease-related organisms; (4) inducing behavioral modifications; (5) entombing different life stages; (6) altering water chemistry by the absorption of chemicals; (7) affecting useable habitat by scouring and filling pools and riffles and changing bedload composition; (8) reducing photosynthetic growth and primary production; and (9) affecting intergravel permeability and dissolved oxygen levels (Spence *et al.* 1996).

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 other 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.

Depending on the species, salmon spend from a few days to one or two 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. Despite these significant historical wetland conversions and continuing degradation by pollutants, 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.

Non-native species now comprise a significant portion of Oregon's estuarine flora and fauna. Some, such as the European green crab, 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 pressures associated with population and tourism growth.

Oregon contains approximately 114,500 miles of rivers and streams. No statewide measurements exist of 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 plan 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.

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.

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.

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 of 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.

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.

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 conditions 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.

Effects of the Action

"Effects of the action" means 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 (50 C.F.R. 402.02). If the proposed action includes offsite measures to reduce net adverse impacts by improving habitat conditions and survival, NOAA Fisheries will evaluate the net combined effects of the proposed action and the offsite measures as interrelated actions.

"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 C.F.R. 402.02). Future Federal actions that are not a direct effect of the action under consideration, and not included in the environmental baseline or treated as indirect effects, are not considered in this Opinion.

"Indirect effects" are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur (50 C.F.R. 402.02). Indirect effects may occur outside the area directly affected by the action, and may include other Federal actions that have not undergone section 7 consultation but will result from the action under consideration.

Effects on Listed Species and Their Habitat. The effects of the proposed actions are outlined by activity category. However, many of the effects may be valid for more than one category. For example, turbidity impacts resulting from in-water work may occur from the activities of drilling, sampling and drill pad reclamation. The effects may only be listed in one activity section, but are valid for all activities that effect the proposed drilling, surveying, and stormwater and hydraulic engineering program.

Access Road Construction. Access road construction can affect habitat quality through disturbance of riparian vegetation, increased sedimentation, and chemical contamination.

Riparian Vegetation.
Drilling, surveying, and stormwater and hydraulic engineering activity may require removal of vegetation above the ground surface. In most cases, the vegetation will be trimmed and will grow back.

The manipulation of vegetation and large woody material (LWM) associated with provision of site access, excavation, stockpiling, and construction of drilling pads in riparian areas and in stream channels can result in the destruction or removal of vegetation and LWM, as well as trampling of vegetation, shallow or temporary burial of vegetation by stockpiled material, temporary displacement of LWM, and trimming, mowing, and scraping of vegetation.

Vegetation in riparian areas provides soil and streambank stability, runoff infiltration, shade, LWM, and food for fish and their prey. In addition, riparian vegetation and LWM can provide low velocity shelter habitat for fish during periods of flooding, while instream LWM provides similar habitat at all flow levels, as well as shelter from predators, habitat for prey species, sediment storage, and channel stability (Spence *et al.* 1996).

NOAA Fisheries expects that effects on riparian vegetation and LWM recruitment will be minor, short-term, and local. The site restoration proposed will revegetate all riparian areas disturbed by construction activities at a 2:1 planting ratio, and will maintain or improve habitat conditions at project sites by potentially increasing plant densities in degraded areas or changing plant species at the site to those that are more beneficial to aquatic species.

Mechanized equipment can cause soil compaction, thus reducing soil permeability and infiltration, however, drilling equipment is relatively light and can walk over most vegetation with minimal impact due to low ground pressure.

<u>Sedimentation and Turbidity</u>.
Constructing access roads associated with drilling or surveying may increase sediment yield. Earth-disturbing activities, including excavation, stockpiling, vegetation manipulation and construction, can increase delivery of sediment to streams, and increase turbidity in the water column. The severity of the impact depends on numerous factors including the proximity of the action to the water, amount of ground-disturbing activity, slope, amount of vegetation removed, and precipitation. Sediment introduced into streams can degrade spawning and incubation habitat, and reduce primary and secondary productivity (Spence *et al.* 1996). Turbidity from increased fine sediment may disrupt salmonid feeding and territorial behavior. High fine sediment loads also can reduce rearing habitat as pools and interstitial rearing spaces are filled by sediment (Bjornn and Reiser 1991).

Suspended sediment and turbidity influences on fish reported in the literature range from beneficial to detrimental. Elevated total suspended solids (TSS) conditions have been reported to enhance cover conditions, reduce piscivorus fish/bird predation rates, and improve survival. Elevated TSS conditions have also been reported to cause physiological stress, reduce growth, and reduce survival. Of key importance in considering the detrimental effects of TSS on fish are the frequency and duration of exposure.

Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore *et al.* 1980, Birtwell *et al.* 1984, Scannell 1988). Salmonids have been observed to move laterally and downstream to avoid turbid plumes (McLeay *et al.* 1984, 1987, Sigler *et al.* 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1991). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, except when the fish need to traverse these streams along migration routes (Lloyd *et al.*

1987). In addition, a potentially positive reported effect is providing refuge and cover from predation (Gregory and Levings 1988).
Fish that remain in turbid, or elevated TSS, waters experience a reduction in predation from piscivorus fish and birds (Gregory and Levings 1998). In systems with intense predation pressure, this provides a beneficial trade-off (*e.g.*, enhanced survival) to the cost of potential physical effects (*e.g.*, reduced growth). Turbidity levels of about 23 Nephalometric Turbidity Units (NTU) have been found to minimize bird and fish predation risks (Gregory 1993). Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991). However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd 1987, Redding *et al.* 1987, Servizi and Martens 1991).

Newly-emerged salmonid fry may be vulnerable to even moderate amounts of turbidity (Bjornn and Reiser 1991). Other behavioral effects on fish, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985).

Excavation, stockpiling, vegetation manipulation, and construction within the bed of a waterbody or in its adjacent riparian area may introduce sediment into the waterbody or expose sediment which is already present, but below the surface of the bed. For example, while accessing a drill site there may be some disturbance within the riparian zone, as well as the removal of vegetation on the streambank and riparian zone, which may facilitate the transport of sediment into the stream channel by precipitation run-off and/or by high stream flows. The manipulation of LWM in riparian areas may also affect sediment input to streams, while disturbance or removal of LWM in stream channels may mobilize previously stable accumulations of sediment, or may increase bank erosion.

Auger drilling produces 1.5 to 11.5 cubic meters (m^3) of spoils that could be washed into nearby streams or wetlands, if they are not stabilized or removed from the site. Effects of these disturbances are described above. In addition, drilling is usually related to other activities, such as bridge construction within floodplains, that may affect ESA-listed fish or any designated critical habitats. Bare soil is seeded and mulched after construction to establish vegetative growth and reduce surface erosion.

Potential impacts from water- or rotary mud-drilling technique include erosion from water running off the drill site, sedimentation from drilling mud, and vegetation and soil disturbance from erosion control placement, ditching, and site access. In addition, this method has the potential for contamination of nearby streams and/or wetlands from non-contained or filtered drilling fluids. Occasionally, drilling fluid may travel along a subsurface soil layer and exit in a stream or wetland. When this occurs, sediments are deposited in the stream. Occasional operating fluid leaks or spills from the drilling and other equipment also pose a contamination hazard to nearby streams or wetlands.

Excavating test pits eliminates vegetation in the excavated area and can cause vegetation compaction along wheel tracks and in excavated spoils placement areas. Typically, spoils do not erode into streams or wetlands since this material is placed back into the test pit once the investigation or sampling has been completed (usually within a 2-hour time period), and the disturbed area is stabilized by seeding and mulching. In cases where test pits are left open for longer time periods, sediments washed from the spoils piles could enter nearby streams or wetlands, especially during the winter rainy season. Effects from soils testing are similar to those described above for drilling operations.

The conservation practices that will be used on actions funded under this Opinion will substantially reduce adverse effects to ESA-listed salmonids and their critical habitats. For example, drilling in the dry, or the recycling of drilling fluids in water-drilling operations should eliminate the potential for direct adverse effect on individual fish. This requirement will also substantially reduce the potential for short-term adverse effects on water quality. Restoration of the contours, topsoil presence, and vegetation will reduce the likelihood of long-term damage to instream and riparian habitat, as will the erosion control conditions.

The effect of sediment on ESA-listed fish from the proposed action will be minimal due to construction and drilling occurring during the time of year when fish are least likely to be present. Sediment created by the drilling process will be isolated from the water and will have a minor effect on any fish present.

<u>Chemical Contamination</u>.
Construction of access roads near waterbodies increases the risk that toxic or harmful substances will fall or drain into streams and rivers. Wet concrete may accidentally fall into the water and untreated water used to cure concrete may drain into streams, altering the pH of the water and potentially creating an acutely toxic condition for fish. Equipment operation may introduce hazardous materials, including fuel, lubricants, hydraulic fluids, and coolants into streams. These can be acutely toxic to fish at high levels of exposure, and can cause acute and chronic effects to salmonids, aquatic invertebrates, and aquatic and riparian vegetation.

Direct harm to listed fish from chemical contamination while making stream or channel crossings is unlikely because these activities will occur when the stream is dry or when listed fish are generally present at low densities in the stream reaches beside covered activities.

In-water work may be required to access drilling areas. The operation of equipment in the stream may kill or injure listed fish, and is likely to disrupt normal behavior. Operation of equipment in the channel or in riparian areas increases the risk that fuel, lubricants, hydraulic fluids, or coolants may enter streams killing or injuring aquatic organisms including ESA-listed salmonids. Conservation practices that include diapering the equipment and eliminating direct contact with the flowing channel will reduce the potential for harassment of listed fish.

Use of heavy equipment, drilling rigs, supply and equipment vehicles, cranes and other equipment during construction 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. Discharge of construction water used for vehicle washing, concrete washout, pumping for work area isolation, and other purposes can carry sediments as well as a variety of contaminants to the riparian area and stream. Additional direct effects can include spills of these materials into the floodplain with delayed transmittal to the stream, eventually resulting in injury or mortality of aquatic organisms. The production of spoils, contaminated lubricants, and other drilling waste produced by boring also can kill or injure fish if the materials are introduced into the water.

The use of roads constructed for drilling also can result in leakages of fuel, lubricants, *etc.* that can be transmitted to waterbodies if a hydrologic connection (*e.g.*, ditch) or a ford exists. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons (PAHs) which can cause acute toxicity to salmonids at high levels of exposure and can also cause chronic lethal as well as acute and chronic sublethal effects to aquatic organisms (Neff 1985). Herbicides used to clear vegetation from and maintain utility right-of-ways may be deliberately used in riparian areas, where they may enter waterbodies. Exposure to herbicides can have lethal and sublethal effects on salmonids, aquatic invertebrates, aquatic vegetation, as well as target and non-target riparian vegetation (Spence *et al.* 1996).

During environmental (hazardous material) drilling all water is contained during the decontamination process to reduce any impacts. The water discharged on site may create erosion if not discharged properly. Alconox water is environmentally inert (See, Material Data Safety Sheets list). Additional vegetation removal may be necessary to provide a storage area for water barrels. Other effects on vegetation, water, and ground surface are similar to those listed above for other drilling activities. Since this type of testing involves potentially contaminated soils, there is potential for contamination to be spread to nearby water sources.

Air rotary drilling produces dust, flying sand-sized rock particles, foaming additives, and fine water spray that could be deposited in streams or wetlands if a collection device is not used. The distance that cuttings and liquids (*e.g.*, water, foaming additives) can be ejected out of the boring depend on the size of the drilling equipment. Unrestrained, larger equipment will disperse particles up to 6.1 m, while smaller equipment will typically expel particles 3 m. Operating fluid leaks or spills from the drilling rig and other on-site equipment could pose a contamination hazard to nearby streams or wetlands.

During boring abandonment, when the boring is situated near streams or wetlands, excess grout may not be contained in the area of the boring (especially during rainy periods) and may potentially contaminate these areas. Boring abandonment may not occur for months or even years after the drilling has been completed. If this is the situation, then vegetation may be affected when workers re-enter the site. These effects will be similar to those described above for site access. In addition, under certain circumstances, the instruments may need to be drilled out. When this occurs, effects are similar to those described above for the particular drilling operation.

The likelihood of effects from chemical contamination in drilling projects is very low, due to the drilling usually taking place in the dry. Drilling pads will be set up to contain any spills that may occur. The conservation practices that have been proposed are likely to reduce the opportunity for contaminants to come into contact with the water and affect ESA-listed fish.

Drill Pad Preparation. Drill pad preparation can cause habitat effects including disturbances of riparian vegetation and floodplains, sedimentation, and chemical contamination, as well as direct effects on listed species, such as harm and harassment. The effects associated with riparian vegetation disturbance, sedimentation, and chemical contamination are described above. Additional effects are listed below.

Soil and Floodplain Hydrologic Functions.
Most of the actions under this program will be small and discrete, and dispersed among multiple watersheds and ESUs. Hard armoring or riprap is not necessary during drilling or surveying activities. Low ground pressure vehicles will be used, thereby reducing any soil compaction. FHWA has proposed conservation practices in the BA to avoid and reduce loss of vegetation. Site remediation will be implemented for some projects, on a case-by case basis, potentially reducing any cumulative impacts. Overall, NOAA Fisheries does not expect significant effects on soil and floodplain hydrologic functions that will degrade the habitat of listed salmon or steelhead.

Harm and Harassment.
In-water work associated with reclamation activities could disturb, kill or injure ESA-listed salmonids through turbidity, noise, contact (or near-contact) with equipment, compaction and disturbance of instream gravel from heavy equipment, and modification of adjacent riparian areas. Juvenile fish that may be rearing in the action areas are likely to be displaced rather than killed or injured. Fish densities are likely to be low during the required in-water work period because this timing generally avoids the spawning period, and most smolt out-migration has already occurred.

The greatest direct effects of the proposed actions on individual listed salmon and steelhead will likely be caused by the isolation of in-water areas. Although work area isolation is itself a conservation measure intended to reduce the adverse effects of erosion and runoff on the population, any individual fish present in the work isolation area will be captured and released. Capturing and handling fish causes stress, although fish typically recover fairly rapidly from the process, and therefore the overall effects of the procedure are generally short-lived (NOAA Fisheries 2002a). The primary contributing factors to stress and death from handling are differences in water temperatures and dissolved oxygen concentration between the river where the fish are captured and the container they are held in before release, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18E C or if dissolved oxygen is below saturation. Fish transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis.

Drilling and Sampling, Mobilization, Setup, De-mobilization and Boring Abandonment Operations. Actions related to geotechnical drilling, including excavation, fill placement, stockpiling of excavated material, vegetation removal and modification, construction of access roads, and the actual drilling may introduce sediment, turbidity, and contaminants into waterbodies, and may disturb or destroy riparian vegetation. These effects are discussed above.

Drilling in navigable waters is an impact primarily affecting benthic and water-column habitats in the course of constructing bridges. Routine drilling, that is, the excavation of soft bottom substrates, is used to analyze the geological composition below the surface.

The effects of drilling can include: (1) Direct removal/burial of organisms; (2) turbidity/siltation effects, including light attenuation from turbidity; (3) contaminant release and uptake, including nutrients, metals, and organics; (4) release of oxygen consuming substances; (5) entrainment;
(6) noise disturbances; and (7) alteration to hydrodynamic regimes and physical habitat.

Many estuarine species forage on infaunal and bottom-dwelling organisms. Drilling may adversely affect these prey species at the site by directly removing or burying immobile invertebrates such as polychaete worms, crustacean, and other estuarine prey types (Newell *et al.* 1998, Van der Veer *et al.* 1985). Similarly, the drilling activity may also force mobile animals such as fish to migrate out of the project area.

Recolonization studies of invertebrates suggest that recovery may not be quite as straightforward. Physical factors including particle size distribution, currents, and compaction/stabilization processes following deposition reportedly can regulate recovery after drilling events. Rates of recovery listed in the literature range from several months for estuarine muds to up to 2 to 3 years for sands and gravels.

The use of drilling equipment can result in elevated levels of fine-grained mineral particles or suspended sediment concentration (SSC), usually smaller than silt, and organic particles in the water column. If suspended sediments loads remain high, fish may suffer reduced feeding ability (Benfield and Minello 1996) and be prone to fish gill injury (Nightingale and Simenstad 2001a).

Sensitive habitats such as submerged aquatic vegetation beds provide food and shelter. Eelgrass beds are critical to nearshore food web dynamics (Murphy *et al.* 2000). The contents of the suspended material may react with the dissolved oxygen in the water and result in short-term oxygen depletion to aquatic resources (Nightingale and Simenstad 2001a). Drilling can also disturb aquatic habitats by resuspending bottom sediments and, thereby, recirculate toxic metals (*e.g.*, lead, zinc, mercury, cadmium, copper, *etc*.), hydrocarbons (*e.g.*, polyaromatics) hydrophobic organics (*e.g.*, dioxins), pesticides, pathogens, and nutrients into the water column (EPA 2000). Toxic metals and organics, pathogens, and viruses, absorbed or adsorbed to fine-grained particulates in the material, may become biologically available to organisms either in the water column or through food chain processes.

Drilling, and equipment used in the process, can damage or destroy spawning, nursery, and other sensitive habitats such as emergent marshes and subaquatic vegetation, including eelgrass beds and kelp beds. The discharge of drilling fluids and materials subsequent to drilling operations or the use of fill material in the construction/development of drilling operations (*e.g.*, drilling pads, access roads) covering or smothering existing submerged substrates. Usually these covered sediments are of a soft-bottom nature as opposed to rock or hard-bottom substrates.

The discharge of drilling fluids and materials can result in greatly elevated levels of fine-grained mineral particles, usually smaller than silt, and organic particles in the water column (*i.e.*, turbidity plumes). These suspended particulates may reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area if suspended for lengthy intervals. Aquatic vegetation such as eelgrass beds and kelp beds may also be affected. Managed fish species may suffer reduced feeding ability, leading to limited growth and lowered resistance to disease if high levels of suspended particulates persist. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion. Toxic metals and organics, pathogens, and viruses absorbed or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or through food chain processes.

The discharge of drilling fluids or fill materials can change the chemistry and the physical characteristics of the receiving water at the disposal site by introducing chemical constituents in suspended or dissolved form. Reduced clarity and excessive contaminants can reduce, change or eliminate the suitability of waterbodies for populations of groundfish, other fish species and their prey. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as polychaetes or algae to the detriment of other types.

Project Development, Construction, Boundary Surveys, and Stormwater and Hydraulic Engineering Surveys. The various surveys included in this Opinion will have minor, short-term, local affects on habitat elements. Some of these surveys will require minor vegetation removal and some minor ground disturbance (installing survey stakes, utility locates, *etc.*) that could lead to sedimentation. These effects are described above. Hydraulic engineering studies may include some instream measurements. If these surveys are done during spawning times, salmonid redds could be disturbed if they are walked on. This could kill eggs in the gravel and reduce emergence of fry out of the gravel. If these surveys involve in-water measurements, they will be done outside of the spawning and incubation season or with the accompaniment of a biologist that can recognize redds. This will reduce the potential for disturbance of redds.

Summary of Effects. The proposed actions are expected to adversely affect several habitat indicators in each of the main watersheds in which the activities occur, but NOAA Fisheries expects the effects to be minor, short-term, and local. The majority of the drilling, surveying, and stormwater and hydraulic engineering actions affect a very small area, usually in habitats that have been already disturbed, such as near an existing bridge or an area where a new bridge will be constructed. Drilling procedures and accessing drill sites can degrade riparian areas, usually in the form of vegetation disturbance. Timing and construction restrictions will reduce these effects. Plantings and restoration of adjacent riparian areas will alleviate any long-term impacts to the existing riparian areas, and will potentially improve existing condition. Construction of drilling pads, access roads, and site restoration can have effects such as sedimentation and chemical contamination. Other activities associated with drilling and surveying activities may have effects including disturbance of riparian vegetation, possible reductions in LWM recruitment, increased turbidity and sedimentation, and increased risk of chemical contamination. Overall, the effects of the proposed action on listed species are likely to be minor, short-term, and local until habitat conditions at the site recover, and will be observable primarily as reductions in preferred food resources and available habitat, and behavioral avoidance of project areas.

Effects on Critical Habitat. ESA section 3(5)(a) defines "critical habitat" as the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection, and specific areas outside the geographical area occupied by the species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species. Therefore, this analysis of the effects of the proposed action critical habitat focuses on the role that designated critical habitat must play in the action area with respect to the survival or recovery of SONC coho, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon, and does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat recently issue in the 9th Circuit Court of Appeals case *Gifford Pinchot Task Force, et al., vs. USFWS,* No. 03-35279, August 6, 2004.

Essential habitat for SONC coho juvenile summer and winter rearing areas, juvenile migration corridors, areas for growth and development to adulthood, and adult migration corridors, and spawning areas. Juvenile summer and winter rearing areas and spawning areas are often in small headwater streams and side channels, while juvenile migration corridors and adult migration corridors include these tributaries, mainstem reaches and estuarine areas. Growth and development to adulthood occurs primarily in near- and off-shore marine water, although final maturation takes place in freshwater tributaries when the adults return to spawn. Essential habitat for SR salmon consists of spawning and rearing areas, juvenile migration corridors, areas for growth and development to adulthood, and adult migration corridors. Of these, the action area has been designated as essential for spawning and rearing, juvenile migration, and adult migration. The Pacific Ocean areas used by listed salmon for growth and development to adulthood are not well understood, and essential areas and features have not been identified for this life stage.

The essential features of critical habitat for SONC coho salmon are substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. The essential features of spawning and rearing habitat for SR spring/summer run and fall-run Chinook salmon are spawning gravel, water quality, water quantity, water temperature, cover/shelter, food, riparian vegetation, and space. Essential features of spawning and rearing areas for SR sockeye salmon are similar, but also include access and do not include cover/shelter or space. Essential features of juvenile and adult migration habitats for all three SR salmon are the same and consist of substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food (juvenile life stages only), and safe passage conditions.

Projects authorized by this Opinion may occur in each of these essential habitats. Special management consideration for these essential habitats and features is necessary to ensure that they are maintained or restored. As described in the Environmental Baseline section, above, the status of these ESUs is such that, to meet their biological requirements, a significant improvement is needed in the environmental conditions that SONC coho salmon, SR spring/summer run and fall-run Chinook salmon encounter in their juvenile rearing areas, and that SONC coho salmon, SR spring/summer run and fall-run Chinook salmon and SR sockeye salmon encounter in their juvenile migration corridors. Any further degradation of these conditions would have a significant impact due to the amount of risk they presently face under the environmental baseline. However, as noted in the Effects of the Action section, the effects of the proposed action, on these conditions are likely to be short-term, minor, and local, or else offset through a combination of conservation measures and compensatory mitigation such that conditions necessary for SONC coho salmon and these SR salmon to complete life history requirements for survival or recovery will not be diminished.

Because the proposed action will not have a significant adverse effect on the essential features of critical habitat, and thus will not reduce the value of affected essential habitat for spawning, rearing or migration, or reduce the likelihood of survival or recovery of these ESUs, NOAA Fisheries finds that the proposed action is not likely to destroy or adversely modify critical habitat.

Cumulative Effects

♣Cumulative effects♣ are 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 (50 C.F.R. 402.02). Cumulative effects that reduce the capacity of listed ESUs to meet their biological requirements in the action area increase the risk to the ESU that the effects of the proposed action on the ESU or its habitat will result in jeopardy (NMFS 1999).

Between 1990 and 2000, the population of the State of Oregon increased by 20.4%.[4] Thus, NOAA Fisheries assumes that future private and state actions will continue within the action area, increasing as population density rises. As the human population in the action area continues to grow, demand for agricultural, commercial, or residential development is also likely to grow. The effects that new development have that are caused by that demand are likely to further reduce the conservation value of habitat within the action area.

Although quantifying an incremental change in survival for the ESUs considered in this consultation due to the cumulative effects is not possible, it is reasonably likely that those effects within the action area will have a small, long-term, negative effect on the likelihood of their survival and recovery.

[4] U.S. Census Bureau, State and County QuickFacts, Oregon. Available at https://www.census.gov/quickfacts/or

Conclusion

After reviewing the best available scientific and commercial information regarding the biological requirements and the status of the 15 ESUs considered in this Opinion, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, NOAA Fisheries concludes that the action, as proposed, is not likely to jeopardize the continued existence of these species, and is not likely to destroy or adversely modify critical habitat.

These conclusions are based on the following considerations: (1) Individual review is required of each project that will be covered by this Opinion to ensure that it is within the range of actions analyzed in this Opinion, and that each applicable conservation measure (reiterated here as reasonable and prudent measures and terms and conditions) is included as an enforceable condition of the funding instrument; and (2) taken together, the conservation measures applied to each project will ensure that any short-term effects to water quality, habitat access, habitat elements, channel conditions and dynamics, flows, and watershed conditions will be brief, minor, and scheduled to occur at times that are least sensitive for the species♣ life-cycle.

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 the threatened and endangered species. NOAA Fisheries has no conservation recommendations to make at this time.

Reinitiation of Consultation

Reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) If the identified action is subsequently modified in a manner that has an effect to the listed species or critical habitat that was not considered in the biological opinion; or (d) If a new species is listed or critical habitat designated that may be affected by the identified action (50 C.F.R. 402.16).
If the FHWA fails to provide specified monitoring information annually by February 15, NOAA Fisheries will consider that a modification of the action that causes an effect on listed species not previously considered and causes the incidental take statement of the Opinion to expire. Consultation also must be reinitiated 3 years after the date this Opinion is signed. To reinitiate consultation, contact the Oregon State Habitat Office of NOAA Fisheries.

Incidental Take Statement

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

This incidental take statement does not become effective for OC coho salmon or LCR coho salmon until the conference opinion for those ESUs is adopted as a biological opinion, after the listing is final. Prohibitions of the ESA will not apply to OC coho or LCR coho salmon until they are listed.

Amount or Extent of Take

Individuals of one or more of the 15 ESUs considered in this consultation are likely to be present in the action area during part of the year when at least some of the habitat-related effects of each proposed action will occur. Because these effects will injure or kill, or increase the likelihood that individuals will be injured or killed, take is reasonably certain to occur. The relationship between habitat conditions and the distribution and abundance of those individuals in the action area is imprecise such that a specific number of individuals taken cannot be practically obtained.
However, in this case, the extent of take may be described as a limit on the number of projects each year that may be authorized, and an estimate that up to 1,700 juvenile individuals of the ESUs considered in the consultation will be captured, injured or killed as a result of activities necessary to isolate in-water work areas (Table 2).

Table 2. Estimate of amount and extent of take associated with projects proposed for authorization using this Opinion. Consultation must be reinitiated if the amount or extent of take is exceeded for any geographic area.

Geographic Area	Projected Projects for 2004-2005	Projects that Require In-Water Drilling	Projects In Estuarine Areas	Capture and Release ESA-Listed Fish
ODOT Region 1	18	2	0	200
ODOT Region 2	8	3	3	300
ODOT Region 3	16	6	4	600
ODOT Region 4	25	6	0	600
ODOT Region 5	7	1	0	100

Because the individual fish that are likely to be captured, injured, or killed by this action are from different ESUs that are similar to each other in appearance and life history, and to unlisted species that occupy the same area, it is not possible to assign this take to individual ESUs. This estimate is based on the following assumptions: (1) A total of 74 projects are expected to be authorized using this Opinion; (2) each project requiring in-water work area isolation is likely to capture fewer than 100 juvenile salmonids; (3) of the ESA-listed fish to be captured and handled in this way, 98% or more are expected to survive with no long-term effects and 1 to 2% are expected to be injured or killed, including delayed mortality because of injury. Nonetheless, the more conservative estimate of 5% lethal take will be used here to allow for variations in experience and work conditions. Capture and release of adult fish is not expected to occur as part of the proposed isolation of in-water work areas. Thus, NOAA Fisheries does not anticipate that any adult fish will be taken.

The number of projects to be authorized by the action and the estimated number of fish taken by work area isolation and the removal of fish are thresholds for reinitiating consultation. Should any of these limits be exceeded during project activities, the reinitiation provisions of this Opinion apply.

Reasonable and Prudent Measures

Reasonable and prudent measures are non-discretionary measures to avoid or minimize take that must be carried out by cooperators for the exemption in section 7(a)(2) to apply. The FHWA has the continuing duty to regulate the activities covered in this incidental take statement where discretionary Federal involvement or control over the action has been retained or is authorized by law. The protective coverage of section 7(a)(2) may lapse if the FHWA fails to exercise its discretion to require adherence to terms and conditions of the incidental take statement, or to exercise that discretion as necessary to retain the oversight to ensure compliance with these terms and conditions. Similarly, if any applicant fails to act in accordance with the terms and conditions of the incidental take statement, protective coverage may lapse. The following reasonable and prudent measures are necessary and appropriate to minimize the impact on listed species of incidental taking caused by take of listed species resulting from completion of the proposed action.

The FHWA shall:

1. Minimize incidental take from programmatic drilling, surveying, and hydraulic engineering activities in Oregon by ensuring effective administration of the funding program, including completion of a comprehensive monitoring and reporting program.

2. Minimize incidental take from individual drilling, surveying, and hydraulic engineering actions by excluding certain harmful actions from approval under this Opinion , and by applying funding conditions or project specifications that avoid or minimize adverse effects to riparian and aquatic systems.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the FHWA 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 are applicable to more than one category of activity. Therefore, terms and conditions listed for one type of activity are also terms and conditions of any category in which they would also minimize take of listed species or their habitats.

45. To implement Reasonable and Prudent Measure #1 (programmatic administration), the FHWA shall ensure that:

    a. Confirmation of fish presence. Contact a fish biologist from the NOAA Fisheries, ODFW, or ODOT Geo-Environmental Section, as appropriate for the action area, if necessary to confirm that a project is within the present or historic range of a listed species or designated critical habitat.

b. Individual project review. Each project must be individually reviewed by the FHWA to ensure that all adverse effects to ESA-listed salmon and steelhead and their designated critical habitats are within the range of effects considered in this Opinion.

   i. Full implementation required. For regulatory projects, each applicable term and condition in this incidental take statement must be included as an enforceable part of the funding document. Failure to comply with all applicable terms and conditions may invalidate protective coverage of ESA section 7(a)(2) regarding 'take' of listed species, and may lead NOAA Fisheries to a different conclusion regarding the effects of a specific project.

   ii. Project access. Ensure reasonable access[5] to projects authorized by this Opinion to monitor the use and effectiveness of these terms and conditions.

   iii. Salvage notice. Provide a copy of the following notice in writing to the supervisor for each project authorized under this Opinion.

   NOTICE. If a sick, injured or dead specimen of a threatened or endangered species is found, the finder must notify the Vancouver Field Office of NOAA Fisheries Law Enforcement at 360/ 418-4246. The finder must 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.

c. Failure to provide timely reporting may cause incidental take statement to expire. The following project notification and reporting information must be collected and forwarded to NOAA Fisheries, as necessary, and that the annual coordination meeting between NOAA Fisheries and the FHWA must take place, or NOAA Fisheries may assume the action has been modified in a way that invalidates this incidental take statement.

d. Project notification form. Before issuing funds under this Opinion, the FHWA must submit an electronic Project Notification Form (Appendix A) to NOAA Fisheries at odot.drilling.nwr@noaa.gov, including an electronic copy of any plan

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[5] 'Reasonable access' means with prior notice to the applicant, the FHWA and NOAA Fisheries may at reasonable times and in a safe manner, enter and inspect authorized projects to ensure compliance with the reasonable and prudent measures, terms and conditions, in this Opinion.

these terms and conditions require for that project (*i.e.*, pollution and erosion control, work area isolation, and site restoration).

e. Request for variance. A request for approval of an alternative conservation measure that is identified in these terms and conditions as appropriate for "approval in writing by NOAA Fisheries" may be included in the Project Notification Form or other appropriate means. The request must be in writing and include the following information. Any variance that will result in greater effects or greater take than provided in the biological opinion is not authorized by this Opinion. NOAA Fisheries will approve or disapprove the request, in writing, within 30 calendar days of receipt of the variance request.
   i. Justification for the proposed variance.
   ii. Description of additional actions necessary to offset any likely adverse effects of the variance, as appropriate.
   iii. An explanation of how the resulting effects are within the range of effects considered in this Opinion.

f. Project completion report. Each project funded by the FHWA under this Opinion must require the applicant to submit a project completion report to the FHWA within 60 days of finishing work. Each report must contain the following information and be available for inspection on request by NOAA Fisheries.
   i. Applicant's name and project number (if any).
   ii. FHWA contact person.
   iii. Project name.
   iv. Type of activity.
   v. Project site by 5th field HUC.
   vi. Start and end dates for work completed.
   vii. Photos of habitat conditions at the project site before, during, and after project completion.[6]

[6] Relevant habitat conditions may include characteristics of channels, eroding and stable streambanks in the project area, riparian vegetation, water quality, flows at base, bankfull and over-bankfull stages, and other visually discernable environmental conditions at the project area, and upstream and downstream from the project. Include general views and close-ups of the project and project area, including pre- and post-construction. Label each photo with date, time, project name, photographer's name, and a comment about the

viii. Projects with the following work elements must include these data.

(1) Work cessation ■ Dates work ceased due to high flows.[7]

(2) Fish screen ■ Proof of compliance with NOAA Fisheries fish screen criteria.[8]

(3) Pollution control ■ A summary of pollution and erosion control inspections, including any erosion control failure, contaminant release, and correction effort.

(4) Drilling ■ Describe the drilling method and steps taken to isolate drilling operations, fluids, slurry and spoils from flowing water.

(5) Pilings ■ The number, type, and diameter of pilings removed, broken during removal, and installed; and any sound attenuation measures used.

(6) Site preparation ■ Riparian area cleared within 150 feet of ordinary high water; upland area cleared; new impervious area created.

(7) Streambank stabilization ■ Type and amount of materials used; project size (one bank or two, width and linear feet).

(8) Road construction, repairs and improvements ■ Rationale for any new permanent road crossing design.

(9) In-water and over-water structures ■ Area of new in-water or over-water structure.

g. Site restoration report, Each applicant must submit a site restoration report by December 31 each year after the project is completed until the FHWA approves that the site restoration performance standards have been met. This report must describe the date and purpose of each visit to a restoration site, site conditions observed during that visit, and any corrective action planned or taken.

h. Annual program report. An annual monitoring report must be completed by February 15 each year that describes the FHWA♣ efforts to carry out this Opinion.

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subject.

[7] ♣High flows♣ means any flow likely to rise above the top of an work isolation area or otherwise inundate a work area that would normally be dry.

[8] 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), or as amended (https://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_passage_design_criteria.pdf).

The report must include an assessment of overall program activity, cumulative effects, and any other data or analyses the FHWA deems necessary or helpful to assess habitat trends as a result of actions authorized by this Opinion. Submit an electronic copy of the annual report to odot.drilling.nwr@noaa.gov.

i. Annual coordination meeting. Unless waived by NOAA Fisheries in writing, a coordination meeting must take place with NOAA Fisheries by March 31 each year to discuss the annual monitoring report and any actions that will improve conservation or make the program more efficient or more accountable.

j. Reinitiation. If the FHWA chooses to continue programmatic coverage under this Opinion, formal consultation on Drilling and Surveying must be reinitiated within 3 years of the date of issuance. This term and condition is in addition to reinitiation requirements described in the Reinitiation of Consultation section, above.

46. To implement Reasonable and Prudent Measure #2 (general conditions for surveying, exploration, construction, operation and maintenance), the FHWA shall ensure that:

a. Exclusions. Any exploration or construction activity, including surface water diversion and release of construction discharge water, within 300 feet upstream from any occupied redd until fry emerge, or within 300 feet of native submerged aquatic vegetation is not authorized by this Opinion, unless otherwise approved in writing by NOAA Fisheries. Requests for approval should be submitted with the project notification form. Funding for the following types of exploration, construction, and mitigation actions are not authorized by this Opinion.

    i. Use of pesticides.
    ii. Use of short pieces of plastic ribbon to determine flow patterns.
    iii. Temporary roads or drilling pads built on steep slopes, where grade, soil types, or other features suggest a likelihood of excessive erosion or failure
    iv. Exploratory drilling in estuaries that cannot be conducted from a work barge, or an existing bridge, dock, or wharf.
    v. Drilling or sampling in an EPA-designated Superfund Site, a state-designated clean-up area, or the likely impact zone of a significant contaminant source, as identified by historical information or the FHWA♣ best professional judgment.

b. Pollution and erosion control plan. A pollution and erosion control plan must be prepared and carried out to prevent pollution caused by surveying or construction operations. The pollution and erosion control plan must contain the pertinent elements listed below, and meet requirements of all applicable laws and regulations. Submit an electronic copy of this plan with the project notification form.

    i. Goal. The goal is to avoid or minimize the adverse effects of pollution and erosion by limiting soil disturbance, scheduling work when the fewest number of fish are likely to be present, managing likely pollutants, and limiting the harm that may be caused by accidental discharges of pollutants and sediment.

ii. Responsible party. The name, address, and telephone number of the person responsible for accomplishment of the pollution and erosion control plan.

iii. Minimum area. Practices to confine vegetation removal and soil disturbance to the minimum area necessary to complete the project, and otherwise prevent erosion and sedimentation associated with access roads, stream crossings, drilling sites, construction sites, borrow pit operations, haul roads, equipment and material storage sites, fueling operations, staging areas, and roads being decommissioned.

iv. In-water work timing. Develop a schedule to complete all work below ordinary high water, except hydraulic and topographic measurements within the wetted channel,[9] inside the most recent ODFW-preferred in-water work period,[10] as appropriate for the project area, unless otherwise approved in writing by NOAA Fisheries. Requests for approval should be submitted with the project notification form.

v. Cease work during high flows. Project operations must cease under high flow conditions that may inundate the project area, except for efforts to avoid or minimize resource damage.

vi. Concrete, cement, and grout. Practices to confine, remove and dispose of excess concrete, cement, grout, and other mortars or bonding agents, including measures for washout facilities.

vii. Drilling mud. Practices to confine, remove and dispose of drilling mud.

viii. Construction debris. Practices to prevent construction debris from dropping into any stream or waterbody, and to remove any material that does drop with a minimum disturbance to the streambed and water quality.

ix. Hazardous materials. A description of any regulated or hazardous products or materials that will be used for the project, including procedures for inventory, storage, handling, and monitoring.

x. Spill containment. A spill containment and control plan with notification procedures, specific cleanup and disposal instructions for different products, a description of quick response containment and cleanup supplies that will be available on the site, including a supply of sediment control materials (*e.g.*, a silt fence, straw bales,[11] an oil-absorbing, floating

[9] Hydraulic and topographic measurements within the wetted channel may be completed anytime except during the spawning period, unless a fisheries biologist verifies that no redds are occupied within 300 feet downstream from the measurement site.

[10] ODFW, Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources (June 2008), at https://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_Work2008.pdf, or as amended.

[11] When available, certified weed-free straw or hay bales must be used to prevent introduction of noxious weeds.

boom whenever surface water is present), proposed methods for disposal of spilled materials, and employee training for spill containment.

c. Work area isolation plan. Completed in compliance with all other relevant terms and conditions, a work area isolation plan must be prepared and carried out for any project that requires work below ordinary high water where adult or juvenile fish are reasonably certain to be present or 300 feet or less upstream from spawning habitats, unless otherwise approved in writing by NOAA Fisheries. The work area isolation plan must contain the pertinent elements listed below, and meet requirements of all applicable laws and regulations. Submit an electronic copy of this plan with the project notification form.

   i. Goal. The goal is to minimize the adverse effects of erosion and other types of pollution by removing from flowing water and fish from the work area.

   ii. Responsible party. The name and address of the person responsible for meeting each component of the work area isolation plan, including a fishery biologist experienced with work area isolation and competent to ensure the safe handling of all ESA-listed fish that will be responsible for the capture and release operation.

   iii. Flow conditions. An estimate of the range of flows likely to occur during isolation.

   iv. Plan view. A plan view of all isolation elements and fish release areas.

   v. Equipment and materials list. A list of equipment and materials that are necessary to complete work area isolation, including a fish screen for any pump used to dewater the isolation area, and that will be available on site to provide appropriate redundancy of key plan functions (*e.g.*, operational, properly-sized, back-up pumps and generators).

   vi. Sequence and schedule. The sequence and schedule of dewatering and rewatering activities.

   vii. Capture and release. Before and intermittently during isolation of an in-water work area, fish trapped in the area must be captured using a trap, seine, electrofishing, or other methods as are prudent to minimize risk of injury, then released at a safe release site.

      (1) Do not use electrofishing if water temperatures exceed 18^{o}C, or are expected to rise above 18^{o}C, unless no other method of capture is available.

      (2) If electrofishing equipment is used to capture fish, comply with NOAA Fisheries' electrofishing guidelines.[12]

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

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[12] National Marine Fisheries Service Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act (June 2000) https://www.arlis.org/docs/vol1/230935595.pdf

(4) Ensure water quality conditions are adequate in buckets or tanks used to transport fish by providing circulation of clean, cold water, using aerators to provide dissolved oxygen, and minimizing holding times.

(5) Release fish into a safe release site as quickly as possible, and as near as possible to capture sites.

(6) Do not transfer ESA-listed fish to anyone except NOAA Fisheries personnel, unless otherwise approved in writing by NOAA Fisheries. Requests for approval should be submitted with the project notification form.

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

(8) Allow NOAA Fisheries or its designated representative to accompany the capture team during the capture and release activity, and to inspect the team's capture and release records and facilities.

(9) Submit an electronic copy of the Salvage Report Form (Appendix B) to NOAA Fisheries within 10 calendar days of completion of the salvage operation.

viii. Fish passage. Safe passage around or through the project area must be provided for any adult and juvenile salmon or steelhead species present during construction, unless passage did not previously exist, or as otherwise approved in writing by NOAA Fisheries. Requests for approval should be submitted with the project notification form.

(1) Fish ladders (*e.g.*, pools and weirs, vertical slots, Denil fishways) and fish trapping systems are not authorized by this Opinion.

(2) After project completion, adult and juvenile passage must not be impaired for the life of the project.

d. Site restoration plan. A site restoration plan must be prepared and carried out to ensure that all streambanks, soils and vegetation disturbed by the project are cleaned up and restored as follows. The site restoration plan must contain the pertinent elements listed below, and meet requirements of all applicable laws and regulations. Submit an electronic copy of this plan with the project notification form.

i. Goal. The goal is to reestablish habitat access, water quality, production of habitat elements (*e.g.*, large wood), channel conditions, flows, watershed conditions and other aquatic habitat forming processes that were harmed during project completion.

ii. Responsible party. The name, address, and telephone number of the person responsible for accomplishment of the site restoration plan, including providing and managing any financial assurances and monitoring necessary to ensure restoration success.

iii. <u>Baseline information</u>. This information may be obtained from existing sources (*e.g.*, land use plans, watershed analyses, subbasin plans), where available.

(1) A functional assessment of adverse effects, *i.e.*, the location, extent and function of the riparian and aquatic resources that will be adversely affected by construction and operation of the project.

(2) The location and extent of resources surrounding the restoration site, including historic and existing conditions.

iv. <u>Objectives</u>. Restoration objectives that describe the extent and methods of site restoration necessary to offset adverse effects of the project, by aquatic resource type.

(1) Restore damaged streambanks to a natural slope, pattern and profile suitable for establishment of permanent woody vegetation, unless precluded by pre-project conditions (*e.g.*, a natural rock wall).

(2) Replant each area requiring revegetation before the first April 15 following construction. Use a diverse assemblage of species native to the project area or region, including grasses, forbs, shrubs and trees. Noxious or invasive species may not be used.

(3) Use as much as possible of the large wood, native trees, native vegetation, topsoil, and native channel material that was stockpiled during site preparation.

(4) Do not apply surface fertilizer within 50 feet of any stream channel.

(5) Prevent access as necessary to revegetated sites by livestock or unauthorized persons.

v. <u>Performance standards</u>. Use the following standards to help design the plan and to assess whether the restoration goal is met. While no single criterion is sufficient to measure success, the intent is that these features should be present within reasonable limits of natural and management variation.

(1) Human and livestock disturbance, if any, is confined to small areas necessary for access or other special management situations.

(2) Areas with signs of significant past erosion are completely stabilized and healed; bare soil spaces are small and well dispersed

(3) Soil movement, such as active rills and soil deposition around plants or in small basins, is absent or slight and local.

(4) Native woody and herbaceous vegetation, and germination microsites, are present and well distributed across the site.

(5) Plants have normal, vigorous growth form, and a high probability of remaining vigorous, healthy and dominant over undesired competing vegetation.

(6) Vegetation structure is resulting in rooting throughout the available soil profile.

(7) Plant litter is well distributed and effective in protecting the soil with little or no litter accumulated against vegetation as a result of active sheet erosion ("litter dams").

(8) A continuous corridor of shrubs and trees appropriate to the site are present to provide shade and other habitat functions for the entire streambank.

(9) Streambanks are stable, well vegetated, and protected at margins by roots that extend below baseflow elevation, or by coarse-grained alluvial debris.

vi. <u>Work plan</u>. Develop a work plan with sufficient detail to include a description of the following elements, as applicable.

(1) Water supply source, if necessary.

(2) Boundaries for the restoration area.

(3) Restoration methods, timing, and sequence.

(4) Geomorphology and habitat features of stream or other open water.

(5) Site management and maintenance requirements, including a plan to control exotic invasive vegetation.

(6) Elevation and slope of the restoration area to ensure they conform with required elevation and hydrologic requirements of target plant species.

(7) Woody native vegetation appropriate to the restoration site.[13] This must be a diverse assemblage of species that are native to the project area or region, including grasses, forbs, shrubs and trees. This may include allowances for natural regeneration from an existing seed bank or planting.

vii. <u>Five-year monitoring and maintenance plan</u>. Develop a five-year monitoring and maintenance plan with the following elements, as applicable.

(1) A schedule to visit the restoration site annually for five years or longer as necessary to confirm that the performance standards are achieved. Despite the initial five-year planning period, site visits and monitoring must continue from year-to-year until the FHWA certifies that site restoration performance standards have been met.

(2) During each visit, inspect for and correct any factors that may prevent attainment of performance standards (*e.g.*, low plant survival, invasive species, wildlife damage, drought).

(3) Keep a written record to document the date of each visit, site conditions and any corrective actions taken.

e. <u>Surface water diversion</u>. Surface water may be diverted, consistent with Oregon law, to meet construction needs only if water from sources that are already

[13] Use references sites to select vegetation for the mitigation site whenever feasible. Historic reconstruction, vegetation models, or other ecologically-based methods may also be used as appropriate.

developed, such as municipal supplies, small ponds or reservoirs, or tank trucks, is unavailable or inadequate.

i. Alternative sources. When alternative surface sources are available, diversion shall be from the stream with the greatest flow.

ii. Fish screen. A temporary fish screen must be installed, operated and maintained according to NOAA Fisheries' fish screen criteria on any surface water diversion used to meet construction needs.

iii. Rate and volume. The rate and volume of pumping will not exceed 10% of the available flow. For streams with less than 5 cfs, drafting will not exceed 18,000 gallons per day, and no more than one pump will be operated per site.

f. Construction discharge water. All discharge water created by construction (*e.g.*, concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids) must be treated as follows.

i. Water quality treatment. Design, build, and maintain facilities to collect and treat all construction and drilling discharge water, using the best available technology applicable to site conditions, to remove debris, nutrients, sediment, petroleum products, metals, and other pollutants likely to be present.

ii. Return flow. If construction discharge water is released using an outfall or diffuser port, velocities may not exceed 4 feet per second, and the maximum size of any aperture may not exceed 1 inch.

iii. Pollutants. Do not allow pollutants such as green concrete, contaminated water, silt, welding slag, sandblasting abrasive, or grout cured less than 24-hours to contact any waterbody, wetland, or stream channel below ordinary high water.

iv. Drilling waste containment. All drilling equipment, drill recovery and recycling pits, and any waste or spoil produced, must be contained as necessary to prevent any drilling fluids or other wastes from entering the stream.

(1) All drilling fluids and waste must be completely recovered then recycled or disposed to prevent entry into flowing water.

(2) Drilling fluids must be recycled using a tank instead of drill recovery/recycling pits, whenever feasible.

(3) When drilling is completed, try to remove the remaining drilling fluid from the sleeve (*e.g.*, by pumping) to reduce turbidity when the sleeve is removed.

g. Heavy equipment. Use of heavy equipment is restricted as follows.

i. Choice of equipment. When heavy equipment will be used, the equipment selected must have the least adverse effects on the environment (*e.g.*, minimally-sized, low ground pressure equipment).

ii. Vehicle and material staging. Store construction materials, and fuel, operate, maintain and store vehicles as follows.

(1) To reduce the staging area and potential for contamination, ensure that only enough supplies and equipment to complete a specific job will be stored onsite.

(2) Complete vehicle staging, cleaning, maintenance, refueling, and fuel storage in a vehicle staging area placed 150 feet or more from any stream, waterbody, or wetland, unless otherwise approved in writing by NOAA Fisheries. Requests for approval should be submitted with the project notification form.

(3) Inspect all vehicles operated within 150 feet of any stream, waterbody or wetland daily for fluid leaks before leaving the vehicle staging area. Repair any leaks detected in the vehicle staging area before the vehicle resumes operation. Document inspections in a record that is available for review on request by FHWA or NOAA Fisheries.

(4) Before operations begin and as often as necessary during operation, steam clean all equipment that will be used below ordinary high water until all visible external oil, grease, mud, and other visible contaminates are removed. Compete all cleaning in the staging area.

(5) Diaper all stationary power equipment (*e.g.*, generators, cranes, stationary drilling equipment) operated within 150 feet of any stream, waterbody, or wetland to prevent leaks, unless suitable containment is provided to prevent potential spills from entering any stream or waterbody.

h. <u>Preconstruction activity</u>. The following actions must be completed before significant[14] alteration of the project area.

i. <u>Marking</u>. Flag the boundaries of clearing limits associated with site access and construction to prevent ground disturbance of critical riparian vegetation, wetlands, areas below ordinary high water, and other sensitive sites beyond the flagged boundary.

ii. <u>Temporary erosion controls</u>. All temporary erosion controls must be in-place and appropriately installed downslope of project activity until site restoration is complete.

i. <u>Site preparation</u>. Native materials, including large wood, native vegetation, weed-free topsoil, and native channel materials (gravel, cobble, and boulders), disturbed during site preparation must be conserved on site for site restoration.

i. If possible, leave native materials where they are found. In areas to be cleared, clip vegetation at ground level to retain root mass and encourage reestablishment of native vegetation

ii. If native materials are moved, damaged or destroyed, replace them with a functional equivalent during site restoration.

[14] 'Significant' means an effect can be meaningfully measured, detected or evaluated.

iii. Stockpile all large wood[15] taken from below ordinary high water and from within 150 feet of a stream, waterbody or wetland, native vegetation, weed-free topsoil, and native channel material displaced by construction for use during site restoration.

iv. As part of the site restoration, all large wood taken from the riparian zone or stream during construction must returned to those areas and placed in a natural configuration that may be expected to function naturally.

j. Temporary access roads and drilling pads. All temporary access roads and drilling pads must be constructed as follows.

i. Existing ways. Use existing roadways, travel paths, and drilling pads whenever possible, unless construction of a new way or drilling pad would result in less habitat take. When feasible, eliminate the need for an access road by walking a tracked drill or spider hoe to a survey site, or lower drilling equipment to a survey site using a crane.

ii. Soil disturbance and compaction. Minimize soil disturbance and compaction whenever a new temporary road or drill pad is necessary within wetlands or the riparian management area by clearing vegetation to ground level and placing clean gravel over geotextile fabric, unless otherwise approved in writing by NOAA Fisheries. Requests for approval should be submitted with the project notification form.

iii. Temporary stream crossings.

(1) Minimize the number of temporary stream crossings.

(2) Design temporary road crossings as follows.

(a) A qualified fish biologist will survey and map spawning habitat, any occupied spawning redds, and native submerged aquatic vegetation, within 300 feet upstream downstream and 100 feet upstream from a proposed crossing.

(b) Do not place a stream crossing within 300 feet downstream or 100 feet upstream from any occupied redd until fry emerge, or within 300 feet of native submerged aquatic vegetation.

(c) Design the crossing to provide for foreseeable risks (*e.g.*, flooding and associated bedload and debris, to prevent the

[15] 'Large wood' means a tree, log, or redwood big enough to dissipate stream energy associated with high flows, capture bedload, stabilize streambanks, influence channel characteristics, and otherwise support aquatic habitat function, given the slope and bankfull channel width of the stream in which the wood occurs. See, Oregon Department of Forestry and ODFW, A Guide to Placing Large Wood in Streams, May 1995. https://digital.osl.state.or.us/islandora/object/osl%3A20371/datastream/OBJ/download/Guide_to_placing_large_wood_in_streams.pdf

diversion of streamflow out of the channel and down the road if the crossing fails).

(d) Vehicles and machinery must cross riparian areas and streams at right angles to the main channel wherever possible.

iv. Obliteration. When the project is complete, obliterate all temporary access roads that will not be in footprint of a new bridge or other permanent structure, stabilize the soil, and revegetate the site.

k. Earthwork. Earthwork, including drilling, excavation, dredging, filling and compacting, must be completed as quickly as possible.

i. Site stabilization. Stabilize all disturbed areas, including obliteration of temporary roads, following any break in work unless construction will resume within 4 days.

ii. Inspection of erosion controls. Monitor instream turbidity and inspect all erosion controls daily during the rainy season, weekly during the dry season, or more often as necessary, to ensure the erosion controls are working adequately.[16]

(1) If monitoring or inspection shows that the erosion controls are ineffective, immediately mobilize work crews to repair, replace, or reinforce controls as necessary.

(2) Remove sediment from erosion controls before it reaches 1/3 of the exposed height of the control.

iii. Drilling, boring, jacking. If drilling, boring, or jacking is used, the following conditions apply.

(1) Isolate drilling operations in wetted stream channels using a steel pile, sleeve or other appropriate isolation method to prevent drilling fluids from contacting water.

(2) If it is necessary to drill through a bridge deck, use containment measures to prevent drilling debris from entering the channel.

(3) Sampling and directional drill recovery/recycling pits, and any associated waste or spoils must be completely isolated from surface waters, off-channel habitats, and wetlands. All waste or spoils must be covered if precipitation is falling or imminent. All drilling fluids and waste must be recovered and recycled or disposed to prevent entry into flowing water.

(4) If a drill boring conductor breaks and drilling fluid or waste is visible in water or a wetland, all drilling activity must cease pending written approval from NOAA Fisheries to resume drilling.

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[16] 'Working adequately' means that upland work is not contributing visible sediment to water, and in-water work does not increase ambient stream turbidity by more than 10% above background 100-feet below the discharge, when measured relative to a control point immediately upstream from the turbidity causing activity.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

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

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

The effects of the proposed action on EFH are likely to include degraded riparian areas, usually in the form of vegetation disturbance, reduced large wood recruitment, altered circulation patterns, increased turbidity and sedimentation, chemical contamination, and loss of benthic productivity by smothering immobile organisms (*e.g.*, invertebrate prey species) or forcing mobile animals (*e.g.*, benthic-oriented fish species) to emigrate from the area.

EFH Conservation Recommendations

NOAA Fisheries believes that actions described in the following terms and conditions in the ESA section of this document are necessary to avoid, mitigate, or offset the impact that the proposed action has on EFH:

1(b) Individual project review
1(d) Project notification form
1(e) Request for variance
1(f) Project completion report
1(g) Site restoration report
1(h) Annnual program report
1(i) Annual coordination meeting
2(a) Exclusions
2(b) Pollution and erosion control plan
2(c) Work area isolation plan
2(d) Site restoration plan
2(e) Surface water diversion
2(f) Construction discharge water
2(g) Heavy equipment
2(h) Presconstruction activity
2(i) Site preparation
2(j) Temporary access roads and drilling pads
2(k) Earthwork

Statutory Response Requirement

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

Supplemental Consultation

The FHWA must reinitiate EFH consultation with NOAA Fisheries if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries♣ EFH conservation recommendations [50 C.F.R. 600.920(k)].

DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

Utility: This ESA section 7 consultation and MSA EFH consultation on statewide drilling, surveying, and hydraulic engineering activities in Oregon funded by the FHWA concluded that the action will not jeopardize the continued existence of LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, SONC coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SR steelhead, or OC coho salmon and LCR coho salmon (proposed), or result in the destruction or adverse modification of critical habitat. Therefore, the FHWA may fund those actions. Pursuant to the MSA, NOAA Fisheries provided the FHWA with conservation recommendations to conserve EFH.

The intended users of these consultations are the FHWA and the Oregon Department of Transportation. Users of the interstate and state highway system in Oregon benefit from the consultation.

Individual copies were provided to the above-listed entities. This consultation will be posted on the NOAA Fisheries Northwest Region web site (https://www.nwfsc.noaa.gov/). The format and naming adheres to conventional standards for style.

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

Objectivity:

Information Product Category: Natural Resource Plan.

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

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

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

Review Process: This consultation was drafted by NOAA Fisheries staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

LITERATURE CITED

Abbott, R. and E. Bing-Sawyer. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Othodon microlepidotus*). Draft report prepared for Caltrans District 4. October 10, 2002.

Ainley, D.G. 1984. Cormorants Family Phalacrocoracidae. Pages 92- 101 in D. Haley ed. Seabirds of the eastern North Pacific and Arctic waters. Pacific Search Press, Seattle. 214 p.

Ainslie, B. J., J. R. Post, A. J. Paul. 1998. Effects of Pulsed and Continuous DC Electrofishing on Juvenile Rainbow Trout. North American Journal of Fisheries Management: Vol. 18, No. 4, pp. 905▪918.

Armstrong, D.A., B.G. Stevens, and J.C. Hoeman. 1982. Distribution and abundance of Dungeness crab and *Crangon* shrimp, and dredged-related mortality of invertebrates and fish in Grays Harbor, Washington. Tech. Rpt. School of Fisheries. Univ. of Washington, Washington Department of Fisheries, and Seattle District Corps of Engineers. 349 p.

Arseneault, J.S. 1981. Memorandum to J.S. Mathers on the result of the 1980 dredge monitoring program. Fisheries and Oceans, Government of Canada.

Atkinson, C. E., J. H. Rose, and O. T. Duncan. 1967. Salmon of the North Pacific Ocean--Part IV. Spawning populations of North Pacific salmon. 4. Pacific salmon in the United States. Int. North Pac. Fish. Comm. Bull. 23:43-223.

Barnhart, R. A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.60), 21 p.

Beamer, E.M. and R. A. Henderson. 1998. Juvenile salmonid use of natural and hydromodified stream bank habitat in the maintem Skagit River, northwest Washington. Miscellaneous Report. Skagit System Cooperative, LaConner, WA.

Beamesderfer, R.C. and B.E. Rieman. 1991. Abundance and Distribution of Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:439-447.

Bedford, B.L. 1996. The need to define hydrologic equivalence at the landscape scale for freshwater mitigation. Ecological Applications, 6(1)57-68.

Beechie, T.J. and T.H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Trans. Am. Fish. Soc. 126:217-229.

Behnke, R. J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. 6, 275 p. American Fisheries Society, Bethesda, MD.

Bell, M. C. 1991. Fisheries handbook of Engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers, North Pacific Division.

Berg, L. and T.G. Northcote. 1985. ■Changes In Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (Oncorhynchus kisutch) Following Short-Term Pulses of Suspended Sediment.• Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Bevan, D., J. Harville, P. Bergman, T. Bjornn, J. Crutchfield, P. Klingeman, and J. Litchfield. 1994. Snake Salmon Recovery Team: final recommendations to the National Marine Fisheries Service. May 1994. Rob Jones, Recovery Plan Coordinator. National Marine Fisheries Service, Portland, Oregon.

Bevelhimer, M.S. 1996. Relative importance of temperature, food, and physical structure to habitat choice by smallmouth bass in laboratory experiments. Trans. Am. Fish. Soc. 125:274-283.

Bilby, R.E. and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Trans. Am. Fish. Soc. 118:368-378.

Birtwell, I. K., G. F. Hartman, B. Anderson, D. J. McLeay, and J. G. Malick. 1984. ■A Brief Investigation of Arctic Grayling (Thymallus arcticus) and Aquatic Invertebrates in the Minto Creek Drainage, Mayo, Yukon Territory: An Area Subjected to Placer Mining.• Canadian Technical Report of Fisheries and Aquatic Sciences 1287.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, ed. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19:83-138.

Blackwell, B.F., W.B. Krohn, N.R. Dube and A.J. Godin. 1997. Spring prey use by double-crested cormorants on the Penobscot River, Maine, USA. Colonial Waterbirds 20(1):77-86.

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel, L. Talbot, and L. Simpson. 1995. Status and Future of salmon of Western Oregon and Northern California: Findings and Options. Report #8. The Center for the Study of the Environment, Santa Barbara, California. 300 p.

Boyd, F.C. 1975. Fraser River dredging guide. Tech. Rpt. Series No. PAC/T-75-2. Fisheries and Marine Service, Environment Canada.

Braun, F. 1974a. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase I. Department of Public Works, Pacific Region, Canada.

Braun, F. 1974b. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase II. Department of Public Works, Pacific Region, Canada.

Brown, L. R., P. B. Moyle, and R. M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. North American Journal of Fisheries Management 14: 237-261.

BRT (Biological Review Team). 2004. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead West Coast Salmon Biological Review Team. Northwest Fisheries Science Center, Seattle, Washington, Southwest Fisheries Science Center, Santa Cruz, California. (July 2003)

Bryant, G. J. 1994. Status review of coho salmon in Scott Creek and Waddell Creek, Santa Cruz County, California. Natl. Mar. Fish. Serv., SW Region, Protected Species Management Division, 102 p. (Available from NMFS, Southwest Region, 501 W. Ocean Blvd., Suite 4200, Long Beach, CA 90802.)

Burdick, D. and F. Short. 1998. The effects of boat docks on eelgrass in coastal waters of Massachusetts. Environmental Management.

Burgner, R.L. 1991. Life history of sockeye salmon (*Oncorhynchus nerka*). Pages 1-117 In: Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. Vancouver, British Columbia: University of British Columbia Press.

Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51, 92 p.

Busby, P. J., O. W. Johnson, T. C. Wainwright, F. W. Waknitz, and R. S. Waples. 1993. Status review for Oregon s Illinois River winter steelhead. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-10, 85 p.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261p.

Caltrans. 2001. Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project, August 2001. 9 pp.

Campbell, K.P. 1979. Predation principles in large rivers: A review. Pages 181-191 in R.H. Stroud and H. Clepper, editors. Predator-prey systems in fisheries management. Sport Fishing Institute, Washington D.C.

Cardwell, R.D., M.I. Carr, E.W. Sanborn. 1980a. Water quality and flushing of five Puget Sound marinas. Technical Report No. 56. Washington Department of Fisheries Research and Development. Olympia, Washington. 77p.

Cardwell, R.D., S.J. Olsen, M.I. Carr, E.W. Sanborn. 1980b. Biotic, water quality and hydraulic characteristics of Skyline Marina in 1978. Technical Report No. 54. Washington Department of Fisheries Research and Development. Olympia, Washington. 103p.

Carie, D. G. 2000. Spring and summer Chinook salmon spawning ground surveys on the Entiat River, 2000. U.S. Fish and Wildlife Service Rept. Mid-Columbia River Fishery Resource Office. Leavenworth, Washington. 17 pp.

Carlson, J.Y., C.W. Andrus and H.A. Froehlich. 1990. Woody debris, channel features, and macroinvertebrates of streams with logged and undisturbed riparian timber in northeastern Oregon, U.S.A. Can. J. Fish. Aquat. Sci., Vol. 47:1103-1110.

Carlson, T., G. Ploskey, R. L. Johnson, R. P. Mueller and M. A. Weiland. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Review draft report to the Portland District Corps of Engineers prepared by Pacific Northwest National Laboratory, Richland, Washington. 35 p.

Carrasquero, J. 2001. Overwater structures: Freshwater issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. Olympia, Washington.

Casillas, E., L. Crockett, Y. deReynier, J. Glock, M. Helvey, B. Meyer, C. Schmitt, M. Yoklavich, A. Bailey, B. Chao, B. Johnson and T. Pepperell. 1988. Essential Fish Habitat West Coast Groundfish Appendix. National Marine Fisheries Service, Montlake, Washington.

CDFG (California Department of Fish and Game). 1995. Letter to M. Schiewe for the ESA Administrative Record for west coast steelhead, dated 30 March 1995, 10 p. plus attachments. (Avail. from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Cederholm, C.J., L.G. Dominguez and T.W. Bumstead. 1997. Rehabilitating stream channels and fish habitat using large woody debris. Chapter 8 *In:* Slaney, P.A. and Zaldokas, D. (eds.) 1997. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. British Columbia Ministry of Environment, Lands and Parks. Vancouver, BC.

Chapman, D. W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Am. Fish. Soc. 115:662-670.

Chapman, D. W., W. S. Platts, D. Park, and M. Hill. 1990. Status of Snake River sockeye salmon. Final report, 90 p. (Available from Pacific Northwest Utilities Conference Committee, 101 SW Main Street, Suite 810, Portland, OR 97204.)

Christopherson, A. and J. Wilson, 2002. Technical Letter Report Regarding the San Francisco-Oakland Bay Bridge East Span Project Noise Energy Attenuation Mitigation. Peratrovich, Nottingham and Drage, Inc. Anchorage, Alaska. 27 pp.

Cichosz, T., D. Saul, A. Davidson, W. Warren, D. Rollins, J. Willey, T. Tate, T. Papanicolaou and S. Juul. 2001. Clearwater Subbasin Summary. Draft submitted to the Northwest Power Planning Council. Nov. 2001. 477 p.

Colle, D.E., R.L. Cailteux, and J.V. Shireman. 1989. Distribution of Florida largemouth bass in a lake after elimination of all submersed aquatic vegetation. N. Am. Journal of Fish. Mgmt. 9:213-218.

Collis, K., R.E. Beaty and B.R. Crain. 1995. Changes in Catch Rate and Diet of Northern Squawfish Associated With the Release of Hatchery-Reared Juvenile Salmonids in a Columbia River Reservoir. North American Journal of Fisheries Management 15:346-357.

Craig, J. A., and A. J. Suomela. 1941. Time of appearance of the runs of salmon and steelhead trout native to the Wenatchee, Entiat, Methow, and Okanogan Rivers. Cited In J. W. Mullan, K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre (editors). 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. U.S. Fish Wildl. Serv. Monograph I:J358-J380.

Cramer, S. P., and 12 co-authors. 1995. The status of steelhead populations in California in regards to the Endangered Species Act. Document prepared for Association of California Water Agencies, 167 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Crone, R. A., and C. E. Bond. 1976. Life history of coho salmon, *Oncorhynchus kisutch*, in Sashin Creek, southeastern Alaska. Fish. Bull., U.S., 74(4):897-923.

Dalbey, S. R., T. E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury to long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16:560-569.

Darnell, R. M. 1976. Impacts of construction activities in wetlands of the United States. U.S. Environmental Protection Agency, Ecological Research Series, Report No. EPA-600/3-76-045, Environmental Research Laboratory, Office of Research and Development, Corvallis, Oregon.

Dauble, D. D., R. L. Johnson, and A. P. Garcia. 1999. Fall Chinook salmon spawning in the tailraces of lower Snake River hydroelectric projects. Trans. Amer. Fish Soc. 128 (4): 672-679.

Derby, C.E. and J.R. Lovvorn. 1997. Predation on fish by cormorants and pelicans in a cold-water river: a field and modeling study. Can. J. Fish. Aquat. Soc. 54:1480-1493.

DeVore, P. W., L. T. Brooke, and W. A. Swenson. 1980. ▪The Effects of Red Clay Turbidity and Sedimentation on Aquatic Life In the Nemadji River System. Impact of Nonpoint Pollution Control on Western Lake Superior.• S. C. Andrews, R. G. Christensen, and C. D. Wilson. Washington, D.C., U.S. Environmental Protection Agency. EPA Report 905/9-79-002-B.

Dolat, S.W. 1997. Acoustic measurements during the Baldwin Bridge demolition (final, dated March 14, 1997). Prepared for White Oak Construction by Sonalysts, Inc, Waterford, CT.. 34 p. + appendices.Enger *et al.* 1992.

Duffy, D.C. 1995. Why is the double-crested cormorant a problem? Insights from cormorant ecology and human sociology. Pages 25-32 in The Double-crested Cormorant: biology, conservation and management (D.N. Nettleship and D.C. Duffy, eds.) Colonial Waterbirds 18 (Special Publication 1).

Dunne, T. and L. B. Leopold. 1978. Water in Environmental Planning. W. H. Freeman, San Francisco.

Dunsmoor, L.K., D.H. Bennett, and J.A. Chandler. 1991. Prey selectivity and growth of a planktivorous population of smallmouth bass in an Idaho reservoir. Pages 14-23 in D.C.

Jackson (ed) The First International Smallmouth Bass Symposium. Southern Division American Fisheries Society. Bethesda, Maryland.

Dutta, L.K., 1976. Dredging:Environmental effects and technology. Pages 301-319 *In:* Proceedings of WODCON VII. World Dredging Conference, San Pedro, California.

Dutta, L.K. and P. Sookachoff. 1975a. Assessing the impact of a 24" suction pipeline dredge on chum salmon fry in the Fraser River. Fish. And Marine Serv., Environment Canada, Tech. Rep. Ser. No. PAC/T-75-26. 24 p.

Dutta, L.K. and P. Sookachoff. 1975b. A review of suction dredge monitoring in the lower Fraser River, 1971-1975. Fish. And Marine Serv., Environment Canada, Tech. Rep. Ser. No. PAC/T-75-27. 100 p.

Dwyer, W. P. and R. G. White. 1997. Effect of Electroshock on Juveline Arctic Grayling And Yellowstone Cutthroat Trout Growth 100 Days after Treatment. North American Journal of Fisheries Management 17:174-177

Emmet, R.L., G.T. McCabe, Jr. and W.D. Muir. 1988. Effects of the 1980 Mount St. Helens eruption on Columbia River estuarine fishes: implications for dredging on Northwest estuaries. Pages 74-91 *In:* C. A. Simenstad (ed.) Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

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

Enger, P.S., H.E. Karlsen, F.R. Knudsen, and O. Sand. 1993. Detection and reaction of fish to infrasound. Fish Behaviour in Relation to Fishing Operations., 1993, pp. 108-112, ICES marine science symposia. Copenhagen vol. 196.

Everest, F. H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission, Fishery Research Report 7, Corvallis, 48 p.

Fausch, K.D. and T.G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Can. J. Fish. Aquat. Soc., Vol. 49:682-693.

Fedler, A.J. and S.L. Crookshank. 1992. Measuring the value of coastal fisheries habitat. Pages 23-30 in R.H. Stroud, editor Stemming the tide of coastal fish habitat loss. Proceedings of a symposium on conservation of coastal fish habitat. National Coalition for Marine Conservation, Inc., Savannah, Georgia.

Feist, B. E., J. J. Anderson, and R. Miyamoto. 1996. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. Report No. FRI-UW-9603. Fisheries Research Institute, School of Fisheries, University of Washington. Seattle, Washington.

Ferguson, R.L., G.W. Thayer and T.R. Rice. 1980. Marine Primary producers, pp. 9-69 in F.J. Vernberg and W. Vernberg eds. Functional adaptation of marine organisms, Academic Press, New York.

Fisher, J.P. and W.G. Pearcy. 1996. Dietary overlap of juvenile fall- and spring-run Chinook salmon *Oncorhynchus tshawytscha* in Coos Bay, Oregon. Fishery Bulletin 95:25-38.

Fonseca, M.S., J. Kenworthy, and G. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12. NOAA Coastal Ocean Office, Silver Spring, MD. 222 p.

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

Fox, W.W. Jr. 1992. Stemming the tide: Challenges for conserving the nation♣s coastal fish habitat. Pages 9-13 in R.H. Stroud, editor Stemming the tide of coastal fish habitat loss. Proceedings of a symposium on conservation of coastal fish habitat. National Coalition for Marine Conservation, Inc., Savannah Georgia.

Fredenberg, W.A. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife and Parks, Helena.

Frenkel, R.E. and J.C. Morlan. 1991. Can we restore our salt marshes? Lessons form the Salmon River, Oregon. Northwest Environmental Journal 7:119-135.

Frost, D. A., W. C. McAuley, D. J. Maynard, and T. A. Flagg. 2002. Redfish Lake sockeye salmon captive broodstock rearing and research, 2001, Annual Report. Report to Bonneville Power Administration, Contract No. 00004464, Project No. 199204000, 27 electronic pages (BPA Report DOE/BP-00004464-1).

Fulton, L. A. 1968. Spawning areas and abundance of Chinook salmon, *Oncorhynchus tshawytscha*, in the Columbia River Basin--Past and present. U.S. Fish. Wildl. Serv. Spec. Sci. Rep.--Fish. 571, 26 p.

Gerking, S.D. 1994. Feeding Ecology of Fish. Academic Press Inc., San Diego, CA. 416 p.

Giger, R.D. 1972. Ecology and management of coastal cutthroat trout in Oregon. Fishery Research Report No. 6. Oregon State Game Commission. 61 p.

Gilbert, C. H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bull. U.S. Fish Comm. 32:57-70.

Godfrey, H., K. A. Henry, and S. Machidori. 1975. Distribution and abundance of coho salmon in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 31, 80 p.

Good, J.W. 1987. Mitigating estuarine development impacts in the Pacific Northwest: from concept to practice. Northwest Environmental Journal. Volume 3, Number 1.

Gray, G.A. and D.W. Rondorf. 1986. Predation on juvenile salmonids in Columbia Basin reservoirs. Pages 178-185 in G.E. hall and M.J. Van Den Avle eds. Reservoir Fisheries Management Strategies for the 80's. Southern Division American Fisheries Society, Bethesda, Maryland.

Gregory, R. S. 1988. Effects of Turbidity on benthic foraging and predation risk in juvenile Chinook salmon. Pages 64-73 *in* C. A. Simenstad, editor. Effects of Dredging on Anadromous Pacific Coast Fishes. Washington Sea Grant Program, Washington State University, Seattle.

Gregory, R.S. 1993. Effect of turbidity on the predator avoidance behavior of juvenile Chinook salmon (Oncorhynchus tshawytcha). Canadian J. Fish. Aquatic Sciences 50:241-246.

Gregory, R. S., and C. D. Levings. 1998. ▪Turbidity Reduces Predation on Migrating Juvenile Pacific Salmon.• Transactions of the American Fisheries Society 127: 275-285.

Gucinski, H., M. J. Furniss, R. R. Ziemer, and M. H. Brookes, editors. 2001. Forest roads: A synthesis of scientific information. General Technical Report PNW-GTR-509. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 103 p.

Gustafson, R. G., T. C. Wainwright, G. A. Winans, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-33, 282 p.

Harrison, C.S. 1984. Terns Family Laridae Pages 146-160 in D. Haley, D. ed. Seabirds of eastern North Pacific and Arctic waters. Pacific Search Press. Seattle. 214 p.

Harrison, P. 1983. Seabirds: an Identification Guide. Houghton Mifflin Company. Boston. 448 pp.

Healey, M. C. 1983. Coastwide distribution and ocean migration patterns of stream- and ocean type Chinook salmon, *Oncorhynchus tshawytscha*. Canadian Field-Naturalist 97:427-433.

Healey, M. C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size selective fisheries. Can. Spec. Publ. Fish. Aquat. Sci. 89:39-52.

Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393 *In:* Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. Vancouver, British Columbia: University of British Columbia Press.

Hebdon, J. L., M. Elmer, and P. Kline 1999. Snake River sockeye salmon captive broodstock program research element. Annual Progress Report January 1, 1999■December 31, 1999. Report to Bonneville Power Administration, Contract No. 00000167-00001, Project No. 199107200, 56 electronic pages (BPA Report DOE/BP-00000167-1).

Heiser, D.W. and E.L. Finn Jr. 1970. Observations of juvenile chum and pink salmon in marina and bulkheaded areas. Washington Department of Fisheries Management and Research Division. 28p.

Helfman, G.S. 1981. The advantage to fishes of hovering in shade. Copeia. 1981(2):392-400.

Herke, W.H. and B.D. Rogers. 1993. Maintenance of the estuarine environment. Pages 263-286 in C.C. Kohler and W.A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Hicks, B.J., J.D. Hall, P.A. Bisson and J.R. Sedell. 1991. Responses of salmonids to habitat changes. American Fisheries Society Special Publication 19:483-518.

Hobson, E. S. 1979. Interactions between piscivorous fishes and their prey. Pages 231-242 *in* R. H. Stroud and H. Clepper, editors. Predator-Prey Systems in Fisheries Management. Sport Fishing Institute, Washington, D.C.

Hogan, D.L. and B.R. Ward. 1997. Watershed geomorphology and fish habitat. Chapter 2 *In:* Slaney, P.A. and Zaldokas, D. (eds.) 1997. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. British Columbia Ministry of Environment, Lands and Parks. Vancouver, BC.

Hollender, B.A. and R. F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:643-649.

Hoss, D.E. and G.W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. American Fisheries Society Symposium 14:147-158.

House, R. 1996. An evaluation of stream restoration structures in a coastal Oregon stream, 1981-1993. N. Am. J. Fish. Mgmt. 16:272-281.

Howick, G. L. and W.J. O♣Brien. 1983. Piscivorous feeding behavior of largemouth bass: an experimental analysis. Trans. Am. Fish. Soc. 112:508-516.

Hubble, J. and S. Crampton. 2000. Methow basin spring Chinook spawner ground survey report for 1999. Fisheries Resource Management Program. Yakama Nation. Prepared for Douglas County PUD. 17 pp + tables.

IDFG (Idaho Department of Fish and Game). 1994. Documents submitted to the ESA Administrative Record for west coast steelhead by E. Leitzinger, 18 October 1994. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Irving J. S. and T. Bjornn. 1991. A forecast of abundance of Snake River fall Chinook salmon. Prepared for U.S. Fish and Wildlife Service. Unpubl. MS. 55 p. Available from Idaho Cooperative Fishery Research Unit. Univ. of Idaho, Moscow, ID.

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

Johnson, L., S.Y. Sol, G.M. Ylitalo, T. Hom, B. French, O.P. Olson, and T.K. Collier. 1999. Reproductive injury in English sole (*Pleuronectes vetulus*) from the Hylebos Waterway, Commencement Bay, Washington. Journal of Aquatic Ecosystem Stress and Recovery. 6:289-310.

Johnson, O.W., W.S. Grant, R.G. Cope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-32, 280 p.

Kahler, T., M. Grassley and D. Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shore zone development on ESA listed salmonids in lakes. Final Report to the City of Bellevue, Washington. 74 p.

Kauffman, J.B., R.L. Beshta, N. Otting and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries, 22(5)12-23.

Keevin, T.M.. 1998. A review of natural resource agency recommendations for mitigating the impacts of underwater blasting. Rev. Fish. Sci. 6(4):281-313.

Kershner, J.L., H.L. Forsgren and W.R. Meehan. 1991. American Fisheries Society Special Publication 19:599-606.

Kesner, W. D., and R. A. Barnhart. 1972. Characteristics of the fall-run steelhead trout *(Salmo gairdneri gairdneri*) of the Klamath River system with emphasis on the half-pounder. California Fish and Game 58(3):204-220.

Kirn, R.A., R.D. Ledgerwood and A.L. Jensen. 1986. Diet of subyearling Chinook salmon (*Oncorhynchus tshawytscha*) in the Columbia River estuary and changes effected by the 1980 eruption of Mount St. Helens. Northwest Science 60:191-195.

Kline, P. A., and C. Willard. 2001. Snake River sockeye salmon captive broodstock program hatchery element. Annual Progress Report January 1, 2000 - December 31, 2000. Report to Bonneville Power Administration, Contract No. 00000167, Project No. 199107200, 42 electronic pages. (BPA Report DOE/BP-00000167-2)

Knudsen, F.R., C.B. Schreck, S.M. Knapp, P.S. Enger, and O. Sand. 1997. Infrasound produces flight and avoidance responses in Pacific juvenile salmonids. Journal of Fish Biology, 51:824-829.

Kohler, A., R. Griswold, and D. Taki, Snake River sockeye salmon habitat and limnological research. Project No. 9107-100, 97 electronic pages, (BPA Report DOE/BP-00004343-3). (Available online at: https://www.bpa.gov/efw/Pages/default.aspx)

Kondolf, G.M., R. Kattlemann, M. Embury, and D.C. Erman. 1996. Status of riparian habitat. Pages 1009-1029 in Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, assessments and scientific basis for management options. University of California, Davis, Centers for Water and Wildland Resources.

Kostow, K. 2003. The biological implications of non-anadromous *Oncorhynchus mykiss* in Columbia basin steelhead ESUs. Report to NOAA Fisheries and ODFW. Draft report to NMFS. Jan. 13, 2003. 90 p.

Krohn, W.B., R.B. Allen, J.R. Moring and A.E. Hutchinson. 1995. Double-crested cormorants in New England; population and management histories. Pages 99-109 in The Double-crested Cormorant: biology, conservation and management (D.N. Nettleship and D.C. Duffy, eds.) Colonial Waterbirds 18 (Special Publication 1).

Larkin, P.A. 1979. Predator-prey relations in fishes: an overview of the theory. Pages 13-22 in R.H. Stroud and H. Clepper, editors. Predator-prey systems in fisheries management. Sport Fishing Institute, Washington D.C.

Larson, K.W., and C.E. Moehl. 1990. Entrainment of Anadromous Fish by Hopper Dredge at the Mouth of the Columbia River. in Effects of Dredging on Anadromous Pacific Coast Fishes, edited by C.A. Simenstad. Washington Sea Grant program, University of Washington, Seattle. 160 p.

Laufle, J. C., G. B. Pauley, and M. F. Shepard. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest): coho salmon. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.48), 18 p.

Lawson, P. W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries (Bethesda) 18(8):6-10.

Lloyd, D. S. 1987. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management 7:34-45.

Lloyd, D. S., J. P. Koenings, and J. D. LaPerriere. 1987. ■Effects of Turbidity in Fresh Waters of Alaska.• North American Journal of Fisheries Management 7: 18-33.

Lockwood, J.C. 1990. Seagrass as a consideration in the site selection and construction of marinas. Environmental Management for Marinas Conference, September 5-7, 1990, Washington D.C. Technical Reprint Series, International Marina Institute, Wickford, Rhode Island.

Longmuir, C., and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile and Dredge Ltd., New Westminster, British.Columbia. 9 pp.

Mallet, J. 1974. Inventory of salmon and steelhead resources, habitats, use and demands. Job Performance Report. Proj. F-58-R-1. Idaho Dept. of Fish and Game. Boise. Idaho.

Mason, J. C. and D. W. Chapman. 1965. Significance of early emergence, environmental rearing capacity, and behavioral ecology of juvenile coho salmon in stream channels. Journal of the Fisheries Resarch Board of Canada 22:173-190.

Matthews, G.M. and R.S. Waples. 1991. Status review for Snake River spring and summer Chinook salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-F/NWC-200, 75 p.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S.

Department of Commerce, NOAA Technical Memoradum NMFS-NWFSC-42, Seattle, Washington, 156 p.

McEwan, D., and T. A. Jackson. 1996. Steelhead restoration and management plan for California. California Dep. Fish Game, 234 p. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814.)

McGraw, K.A. and D.A. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. Pages 113-131 in Effects of dredging on anadromous Pacific coast fishes. C. A. Simenstad, editor. Washington Sea Grant. Seattle, WA

McLeay, D. J., G. L. Ennis, I. K. Birtwell, and G. F. Hartman. 1984. ■Effects On Arctic Grayling (Thymallus arcticus) of Prolonged Exposure to Yukon Placer Mining Sediment: A Laboratory Study.• Canadian Technical Report of Fisheries and Aquatic Sciences 1241.

McLeay, D. J., I. K. Birtwell, G. F. Hartman, and G. L. Ennis. 1987. ■Responses of Arctic Grayling (Thymallus arcticus) To Acute and Prolonged Exposure to Yukon Placer Mining Sediment.• Canadian Journal of Fisheries and Aquatic Sciences 44: 658-673.

McMichael, G.A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13:229-233

McMichael, G. A. L. Fritts, and T. N. Pearsons, 1998. Electrofishing Injury to Stream Salmonids; Injury Assessment at the Sample, Reach, and Stream Scales. North American Journal of Fisheries Management 18:894-904.

McPhail, J.D., and C. C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Bull. Fish. Res. Board Can. 173:381.

Mesing, C.L. and A.M. Wicker. 1986. Home range, spawning migrations, and homing of radio-tagged Florida largemouth bass in two central Florida lakes. Trans. Am. Fish. Soc. 115:286-295.

Metcalfe, N. B., S. K. Valdimarsson and N. H. C. Fraser. 1997. Habitat profitability and choice in a sit-and-wait predator: juvenile salmon prefer slower currents on darker nights. Journal of Animal Ecology 66:866-875.

Miller, R. J., and E. L. Brannon. 1982. The origin and development of life-history patterns in Pacific salmon. *In* E. L. Brannon and E. O. Salo (eds), Proceedings of the Salmon and Trout Migratory Behavior Symposium., p. 296-309. Univ. Wash. Press, Seattle, WA.

Mitsch, W. J. 1996. Ecological engineering: A new paradigm for engineers and ecologists. Pages 111-128 *in* P. C. Schulze, editor. Engineering within ecological constraints. National Academy of Engineering, National Academy Press, Washington, D.C.

Mitsch, W.J. and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time and self-design. Ecological Applications 6(1)77-83.

Morton, J.W. 1977. Ecological effects of dredging and dredge spoil disposal: a literature review. U.S. Fish and Wildlife Service Technical Paper No. 94. 33 p.

Mosey, T. R. and L. J. Murphy. 2002. Spring and summer spawning ground surveys on the Wenatchee River basin, 2001. Washington Dept. of Fish and Wildlife Rept. to Chelan County PUD. 35 pp + appendices.

Mueller, G. 1980. Effects of recreational river traffic on nest defense by longear sunfish. Trans. Am. Fish. Soc. 109: 248-251.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Myers, J. M., C. Busack, D. Rawding, and A. Marshall. 2002. Identifying historical populations of Chinook and chum salmon and steelhead within the lower Columbia River and upper Willamette River evolutionary significant units. Draft report to the co-managers from the Willamette/Lower Columbia River Technical Recovery Team. (10 May 2002).

Naiman, R.J., H. DeCamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. Ecological Applications, 3(2):209-212.

National Research Council. 1996. *Upstream: Salmon and Society in the Pacific Northwest*. National Academy Press, Washington, D.C.

Neave, F. 1961. Pacific salmon: Ocean stocks and fishery developments. Proc. 9th Pac. Sci. Congr. 1957(10):59-62.

Nedwell, J., and B. Edwards. 2002. Measurements of underwater noise in the Arun River during piling at County Wharf, Littlehampton. Report by Subacoustech, Ltd to David Wilson Homes, Ltd.

Nelson, W. 1997. Restoration strategies for the Umpqua basin. Pages 125-128 in J.D. Hall, P.A. Bisson, and R.E. Gresswell, editors. Sea-run cutthroat trout: biology, management, and future conservation. Oregon Chapter, American Fisheries Society, Corvallis.

Newcombe, C. P., and D. D. MacDonald. 1991. "Effects of Suspended Sediments on Aquatic Ecosystems." North American Journal of Fisheries Management 11: 72-82.

Nickelson T. and P. Lawson. 1998. Population viability of coho salmon *Oncorhynchus kisutch* in Oregon coastal basins: Application of a habitat-based life cycle model. Can. J. Fish. Aquat. Sci. 55: 2383-2392.

NMFS (National Marine Fisheries Service). 1987. Endangered and threatened species; winter run Chinook salmon. Federal Register [Docket No. 27 Febuary 1986] 52(39):6041-6048.

NMFS (National Marine Fisheries Service). 1990. STATUS REVIEW: Listing Endangered and Threatened Species; Notice of Status Review for Sockeye Salmon (*Oncorhynchus nerka*). Federal Register [April 9, 1990] 55(68):13181-13182.

NMFS (National Marine Fisheries Service). 1991a. PROPOSED RULE: Endangered and Threatened Species; Proposed Endangered Status for Snake River Sockeye Salmon. Federal Register [Docket 910379-107, April 5, 1991] 56(66):14055-14067.

NMFS (National Marine Fisheries Service). 1991b. FINAL RULE: Endangered and Threatened Species; Endangered Status for Snake River Sockeye Salmon. Federal Register [Docket 910379-1256, November 20, 1991] 56(224):58619-58624.

NMFS (National Marine Fisheries Service). 1993. Endangered and threatened species; Illinois River winter steelhead in Oregon. Federal Register [Docket 930517-3117, 20 May 1993] 58(96): 29390-29392.

NMFS (National Marine Fisheries Service). 1995a. Proposed recovery plan for Snake River Salmon. 364 p. + app. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

NMFS (National Marine Fisheries Service). 1995b. Federal Register Vol. 60, No. 74, [I.D. 040795A] Endangered and Threatened Wildlife and Plants; Notice of Availability of a Proposed Recovery Plan for Review and Comment; Public Hearings. April 18, 1995. p. 19388.

NMFS (National Marine Fisheries Service). 1996a. Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. National Marine Fisheries Service, Environmental and Technical Services Division, Habitat Conservation Branch, Portland, Oregon (August 1996).

NMFS (National Marine Fisheries Service). 1996b. Supplemental report of the Biological Review Team on central California coast coho salmon. Memorandum from M. Schiewe to W. Stelle, dated 17 October, 1996, 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Portland, OR 97232.)

NMFS (National Marine Fisheries Service). 1996c. Status review update for coho salmon from Washington, Oregon, and California. Draft document prepared by the West Coast Coho salmon Biological Review Team, 20 December 1996, 47 p. plus tables, figures and appendices.

NMFS (National Marine Fisheries Service). 1997. Status review update for coho salmon from the Oregon and Northern California coasts. West Coast coho salmon Biological Review Team, 28 Mar. 1997. 70 p. + appendices.

NMFS (National Marine Fisheries Service). 1998a. Conclusions regarding the updated status of Puget Sound, Lower Columbia River, Upper Willamette River, and Upper Columbia River spring-run ESUs of West Coast Chinook Salmon. Memorandum to U. Varanasi (Northwest Fisheries Science Center, NMFS), W. Stelle (NWFSC, NMFS), and W. Hogarth (Southwest Fisheries Science Center, NMFS) from M. Schiewe (Northwest Fisheries Science Center, NMFS), 12 February 1999. 62 p.

NMFS (National Marine Fisheries Service). 1998b. Endangered and threatened species: Proposed threatened status and designated critical habitat for Hood Canal summer-run chum salmon and Columbia River chum salmon. Federal Register [Docket 980219043-8043-01, No. 011498B. 10 March 1998] 63(46):11774-11795.NMFS 1998

NMFS (National Marine Fisheries Service). 1998c. PROPOSED RULE: Endangered and threatened species: Proposed threatened status and designated critical habitat for Ozette Lake, Washington sockeye salmon. Federal Register [Docket 980219043-8043-01, March 10, 1998] 63(46):11750-11771.

NMFS (National Marine Fisheries Service). 1998d. Status review update for deferred and candidate ESUs of west coast steelhead (Lower Columbia River, Upper Willamette River, Oregon Coast, Klamath Mountains Province, Northern California, Central Valley, and Middle Columbia River ESUs). Pre-decisional ESA document, National Marine Fisheries Service.

NMFS (National Marine Fisheries Service). 1998e. Factors contributing to the decline of Chinook salmon: an addendum to the 1996 West Coast steelhead factors for decline report. Protected Resource Division, National Marine Fisheries Service, Portland, OR. 70 p.

NMFS (National Marine Fisheries Service). 1999a. Status review update for deferred ESUs of West Coast Chinook salmon (*Oncorhynchus tshawytscha*) from Washington, Oregon, California, and Idaho. Memorandum to U. Varanasi (Northwest Fisheries Science Center, NMFS) and M. Tillman (Southwest Fisheries Science Center, NMFS) from M. Schiewe (Northwest Fisheries Science Center, NMFS), 16 July 1999. 116 p.

NMFS (National Marine Fisheries Service). 1999b. Endangered and threatened species: Threatened status for two ESUs of chum salmon in Washington and Oregon. [Docket 980219042-9069-02, No. 011498B. 25 March 1999] 64(57):14508-14517.NMFS 1999

NMFS (National Marine Fisheries Service). 1999c. Status review update for sockeye salmon from Ozette Lake and Baker River, Washington. Memo from Memorandum thru U. Varanasi (Northwest Fisheries Science Center, NMFS), to W. Stelle (NWFSC, NMFS), and W. Hogarth (Southwest Fisheries Science Center, NMFS) from M. H. Schiewe (Northwest Fisheries Science Center, NMFS), 17 December 1998. 40 p. + cover letter.

NMFS (National Marine Fisheries Service). 1999d. FINAL RULE: Endangered and Threatened Species; Threatened Status for Ozette Lake Sockeye Salmon in Washington. Federal Register [Docket 980219043■9068■02, March 25, 1999] 64(57):14528-14536.

NMFS (National Marine Fisheries Service). 1999e. Updated Review of the Status of the Upper Willamette River and Middle Columbia River ESUs of Steelhead. Memorandum for W. Stelle and W. Hogarth from M. Schiewe. January 12, 1999, 49 p.

NMFS (National Marine Fisheries Service). 1999f. The Habitat Approach: Implementation of section 7 of the Endangered Species Act for actions affecting the habitat of Pacific Anadromous Salmonids. Northwest Region Habitat Conservation and Protected Resources Divisions, Portland, Oregon. 12 p. (August 26, 1999)

NMFS (National Marine Fisheries Service). 2000a Biological Opinion on Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. NMFS, Hydro Division, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act. Protected Resources Division, NMFS, Portland, Oregon. (June 2000)

NMFS (National Marine Fisheries Service). 2001a. Status review update for Lower Columbia River Coho Salmon. West Coast coho salmon Biological Review Team, May 2001. 67 p.

NMFS (National Marine Fisheries Service). 2001b. Guidelines for salmonid passage at stream crossings. NMFS, Southwest Region, Habitat Conservation Division, Long Beach, California. 33 p. (September 2001)

NMFS (National Marine Fisheries Service). 2002a. Memorandum for Frank L. Cassidy, Jr. (Northwest Power Planning Council) from Bob Lohn (NMFS), April 2002.

NMFS (National Marine Fisheries Service). 2002b. Biological Opinion on the Collection, Rearing, and Release of Salmonids Associated with Artificial Propagation Programs in the Middle Columbia River Steelhead Evolutionarily Significant Unit (ESU). NMFS, Protected Resources Division, Portland, Oregon. (February 14, 2002)

NOAA Fisheries. 2001. Programmatic Biological Opinion ■ 15 Categories of Activities Requiring Department of the Army Permits. NMFS, Habitat Conservation Division, Portland, Oregon. (March 21, 2001)

NOAA Fisheries. 2003. Programmatic Biological Opinion on the Federal Highway Administrations♣ Programmatic Consultation for Statewide Drilling, Surveying, and Hydraulic Engineering Activities in Oregon. (February 6, 2003).

Nordstrom, K.F. 1989. Erosion control strategies for bay and estuarine beaches. Coastal Management 17:25-35.

NRC (National Research Council). 1992. Restoration or aquatic ecosystems. National Academy Press, Washington, D.C. 552 p.

NRC (National Research Council). 1996. Upstream●Salmon and Society in the Pacific Northwest. National Academy Press, Washington, D.C. 452 p.

ODAS (Oregon Department of Administrative Services). 1999. Oregon economic and revenue forecast. Vol. XIX. No. 2. Office of Economic analysis, Salem.

ODFW (Oregon Department of Fish and Wildlife). 1991. Grand Ronde River subbasin salmon and steelhead plan. Prepared for Northwest Power Planning Council. 129 pp.

ODFW (Oregon Department of Fish and Wildlife). 1995. Oregon coho salmon biological status assessment and staff conclusions for listing under the Oregon Endangered Species Act. Oregon Department of Fish and Wildlife, Portland, Oregon February 22, 1995. 59 p. (Attachment to II-B-I to the Draft OCSRI Plan dated 8/20/96.

ODOT (Oregon Department of Transportation). 1999. Routine road maintenance: Water quality and habitat guide, best management practices. Oregon Department of Transportation, Salem, Oregon. 21 p.

ONRC (Oregon Natural Resources Council), Siskiyou Regional Education Project, Federation of Fly Fishers, Kalmiopsis Audubon Society, Siskiyou Audubon Society, Klamath/Siskiyou Coalition, Headwaters, The Wilderness Society, North Coast Environmental Center, Oregon Chapter of The Sierra Club, and The National Wildlife Federation. 1992. Petition for a rule to list the Illinois River winter steelhead as threatened or endangered under the Endangered Species Act and to designate critical habitat. Unpubl. manuscr., 16 p. (Document submitted to USDOC NOAA NMFS Northwest Region, Seattle, Washington, May 1992).

Oregon Plan. 1997. Oregon Plan for Salmon and Watersheds (consisting of the Oregon Coastal Salmon Restoration Initiative, March 10, 1997 and as amended with the steelhead Supplement, December 1997). Governor♣s Natural Resources Office, State of Oregon, Salem.

Oregon Trout, Native Fish Society, Oregon Council of Trout Unlimited. 2000. Petition to list lower Columbia River coho salmon (*Oncorhynchus kisutch*) as endangered pursuant to the Endangered Species Act of 1973 as amended. Petition to Secretary of Commerce, Washington D.C., July 2000, 22 p.

Pacific Estuarine Research Laboratory. 1990. A manual for assessing restored and natural coastal wetlands with examples from southern California. California Sea Grant Report No. T-CSGCP-021. La Jolla, California.

Pacific Fisherman. 1928. Record chum caught off Quadra. Pac. Fisherman 1928(Oct.):13.

Palmisano, J.F. 1997. Oregon♣s Umpqua sea-run cutthroat trout: review of natural and human-caused factors of decline. Pages 103-118 *In:* J.D. Hall, P.A. Bisson, and R.E. Gresswell, editors. Sea-run cutthroat trout: biology, management, and future conservation. Oregon Chapter, American Fisheries Society, Corvallis.

Parente, W.D. and J.G. Smith. 1981. Columbia River Backwater Study Phase II. U.S. Dept of Interior. Fisheries Assistance Office. Vancouver, Washington. 87 pp.

Pearcy, W.G. 1992. Ocean ecology of north Pacific salmonids. University of Washington Press. 179 pp.

Pentec Environmental. 2003. Mukilteo Public Access Dock Pile Driving ▪ Air Bubble Curtain and Acoustic Monitoring, Mukilteo, Washington. 18 p. + Figs. and Appendices .

Peters, D.S. and F. A. Cross. 1992. What is coastal fish habitat? Pages 17-22 in R.H. Stroud, editor Stemming the tide of coastal fish habitat loss. Proceedings of a symposium on conservation of coastal fish habitat. National Coalition for Marine Conservation, Inc., Savannah, Georgia.

Peters, R.J., B.R. Missildine, and D.L. Low. 1998. Seasonal Fish Densities near River Banks Stabilized with Various Stabilization Methods. First Year Report of the Flood Technical Assistance Project. U.S. Fish and Wildlife Service.

Petersen, J.M. and D.M. Gadomski. 1994. Light-Mediated Predation by Northern Squawfish on Juvenile Chinook Salmon. Journal of Fish Biology 45 (supplement A), 227-242.

Peterson, C.H., H.C. Summerson, and S.R. Fegley. 1987. Ecological consequences of mechanical harvesting of clams. Fishery Bulletin 85(2):281-298.

Pflug, D.E. and G.B. Pauley. 1984. Biology of Smallmouth Bass (*Micropterus dolomieui*) in Lake Sammamish, Washington. Northwest Science 58(2):119-130.

PFMC (Pacific Fishery Management Council), 1998a. Final Environmental Assessment/Regulatory Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan. October 1998.

PFMC (Pacific Fishery Management Council), 1998b. The Coastal Pelagic Species Fishery Management Plan: Amendment 8. Portland, Oregon.

PFMC (Pacific Fishery Management Council). 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Portland, Oregon.

Phillips, R.C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: a community profile. U.S. Fish and Wildlife Service. FWS/OBS-84/24. 85 pp.

Phillips, S.H. 1990. A guide to the construction of freshwater artificial reefs. Sportfishing Institute. Washington D.C. 24 pp.

Piper, K. L., J. C. Hoag, H. H. Allen, G. Durham, J. C. Fischenich, and R. O. Anderson. 2001. Bioengineering as a tool for restoring ecological integrity to the Carson River. ERDC TN-WRAP-01-05, U.S. Army Engineer Research and Development Center, Visksburg, Mississippi.

Pitcher, T. J. 1986. Functions of shoaling in teleosts. *In* T.J. Fisher (ed.). The Behavior of Teleost Fishes. Johns Hopkins University Press, Baltimore, Maryland, pp. 294-337.

Poe, T.P, H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of Predaceous Fishes on Out-Migrating Juvenile Salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405-420.

Poston, T. 2001. Treated wood issues associated with overwater structures in marine and freshwater environments. Prepared for the Washington Departments of Fish and Wildlife, Ecology, and Transportation. Olympia, Washington.

Raibley, P.T., K.S. Irons, T.M. O♣Hara, and K.D. Blodgett. 1997. Winter habitats used by largemouth bass in the Illinois River, a large river-floodplain ecosystem. N. Am. J. Fish. Mgmt. 17:401-412.

Randall, R. G., M. C. Healey, and J. B. Dempson. 1987. Variability in length of freshwater residence of salmon, trout, and char. *In* M.J. Dodswell *et al.* (editors), Common Strategies of Anadromous and Catadromous Fishes. American Fisheries Society Symposia, Bethesda, MD. 1:27-41.

Rawding, D. 2001b. Simsam (Steelhead). Unpublished data and documentation sent from Dan Rawding (WDFW) to Paul McElhany on 5/16/2001 as Excel file and Word document, via e-mail.

Ray, D.K. and W.O. Woodroof. 1986. Approaches for restoring and recreating wetlands in California♣s coastal zone. Pages 392-402 in J.A. Kusler, M.L. Quammen and G. Brooks, eds. Proceedings of the national wetlands symposium: mitigation of impacts and losses. Association of State Wetland Managers. Berne, NY.

Redding, J. M., C. B. Schreck, and F. H. Everest. 1987. Physiological Effects on Coho Salmon and Steelhead of Exposure to Suspended Solids. Transactions of the American Fisheries Society 116: 737-744.

Reeves, G.H., J.D. Hall, T.D. Roelofs, T.L. Hickman, and C.O. Baker. 1991. Rehabilitating and modifying stream habitats. American Fisheries Society Special Publication 19:519-558.

Reyff, J.A. 2003. Underwater sound levels associated with seismic retrofit construction of the Richmond-San Rafael Bridge. Document in support of Biological Assessment for the Richmond-San Rafael Bridge Seismic Safety Project. January, 31, 2003. 18 pp.

Reyff, J.A and P. Donovan. 2003. Benicia-Martinez Bridge Bubble Curtain Test - Underwater Sound Measurement Data. Memo to Caltrans dated January 31, 2003. 3 pp.

Ricker, W. E. 1938. ■Residual• and kokanee salmon in Cultus Lake. J. Fish. Res. Board Can. 4(3):192-218.

Rieman, B.E. and R.C. Beamesderfer. 1991. Estimated Loss of Juvenile Salmonids to Predation by Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:448-458.

Risser, P.G. (Chair, State of the Environment Science Panel) *Oregon State of the Environment Report 2000*, Oregon Progress Board, Salem, Oregon, 214 pp. (September 2000).

Roelofs, T. D. 1983. Current status of California summer steelhead (*Salmo gairdneri*) stocks and habitat, and recommendations for their management. Submitted to USDA Forest Service, Region 5, 77 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Rogers, P.H. and M. Cox. 1988. Underwater sound as a biological stimulus. pp. 131-149 *in*: Sensory biology of aquatic animals. Atema, J, R.R. Fay, A.N. Popper and W.N. Tavolga (eds.). Springer-Verlag. New York.

Roper, B.B., J.J. Dose and J.E. Williams. 1997. Stream restoration: Is fisheries biology enough? Fisheries 22(5):6-11.

Rosgen, D. L. undated. The cross-vane, w-weir, and j-hook vane structures . . . their description, design and application for stream stabilization and river restoration. Wildland Hydrology, Pagosa Springs, Colorado. (https://www.wildlandhydrology.com/)

Rumrill, S.S. and C.E. Cornu. 1995. South Slough coastal watershed restoration a case study in integrated ecosystem restoration. Restoration and Management Notes 13:1 pages 53-57.

Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta*). Pages 231-309 *In:* Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. Vancouver, British Columbia: University of British Columbia Press.

Sand, O., P.S. Enger, H.E. Karlsen, F. Knudsen, T. Kvernstuen. 2000. Avoidance responses to infrasound in downstream migrating European silver eels, Anguilla anguilla. Environmental Biology of Fishes, 57:327-336.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). Pages 395-445 *In:* Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. Vancouver, British Columbia: University of British Columbia Press.

Scannell, P.O. 1988. Effects of Elevated Sediment Levels from Placer Mining on Survival and Behavior of Immature Arctic Grayling. Alaska Cooperative Fishery Unit, University of Alaska. Unit Contribution 27.

Servizi, J.A. 1988. Sublethal effects of dredged sediments on juvenile salmon. Pages 57-63 *In:* C. A. Simenstad (ed.) Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Servizi, J. A., and Martens, D. W. 1991. Effects of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 49:1389-1395.

Sharber, N. G. and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N. G., S. W. Carothers, J. P. Sharber, J. C. DeVos, Jr. and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Sigler, J. W. 1988. Effects of chronic turbidity on anadromous salmonids: recent studies and assessment techniques perspective. Pages 26-37 *in* C. A. Simenstad, editor. Effects of Dredging on Anadromous Pacific Coast Fishes. Washington Sea Grant Program, Washington State University, Seattle.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. ■Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon.• Transactions of the American Fisheries Society 113: 142-150. 1984.

Simenstad, C. A. 1994. pages 11-19 in Wyllie-Echeverria, S., A.M. Olson and M.J. Hershman (eds), Seagrass science and policy in the Pacific Northwest: proceedings of a seminar series (SMA 94-1) EPA 910/R-94-004. 63 pp.

Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function. Pages 343-364 in Estuarine Comparisons. Academic Press, Inc.

Simenstad, C.A., C.D. Tanner, F. Weinmann, and M. Rylko. 1991. The estuarine habitat assessment protocol. Puget Sound Notes. No. 25 June 1991.

Simenstad, C.A., J.R. Cordell, W.G. Hood, B.E. Feist, and R.M. Thom. 1997. Ecological status of a created estuarine slough in the Chehalis River estuary: assessment of created and natural estuarine sloughs, January-December 1995. FRI-UW-9621, Fisheries Research Institute, University of Washington, Seattle, Washington. 47 pp.

Simenstad, C.A. and R.M. Thom. 1996. Functional equivalency trajectories of the restored Gog-Le-Hi-Te estuarine wetland. Ecological Applications, 6(1)38-56.

Slaney, P.A. and A.D. Martin. 1997. Planning fish habitat rehabilitation: linking to habitat protection. Chapter One *In:* Slaney, P.A. and Zaldokas, D. (eds.) 1997. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. British Columbia Ministry of Environment, Lands and Parks. Vancouver, BC.

Snyder, D. L. 1992 Impacts of Electrofishing on fish. Contribution number 50 of the Larval Fish Laboratory, Colorado State University, Fort Collins.

Snyder, J. O. 1925. The half-pounder of Eel River, a steelhead trout. Calif. Fish Game 11(2): 49-55.

Sogard, S.M. and K.W. Able. 1991. A comparison of eelgrass, sea lettuce macroalgae and marsh creeks as habitats for epibenthic fishes and decapods. Estuarine, Coastal and Shelf Science. 33, 501-519.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc., Corvallis, Oregon, to National Marine Fisheries Service, Habitat Conservation Division, Portland, Oregon (Project TR-4501-96-6057).

Stadler, J.H. 2002. Personal observation of fish-kill occurring during pile driving activity at the Winslow Ferry Terminal, Winslow, WA. October 7, 2002. Fish Biologist, DOC/NOAA/National Marine Fisheries Service/HCD, Lacey, Washington.

Stehr, C.M., D.W. Brown, T. Hom, B.F. Anulacion, W.L. Reichert, and T.K. Collier. 2000. Exposure of juvenile Chinook and chum salmon to chemical contaminants in the Hylebos Waterway of Commencement Bay, Tacoma, Washington. Journal of Aquatic Ecosystem Stress and Recovery. 7:215-227.

Steinke, T.J. 1986. Hydrologic manipulation and restoring wetland values: Pine Creek, Fairfield, Connecticut. Pages 377-383 in J.A. Kusler, M.L. Quammen and G. Brooks, eds. Proceedings of the national wetlands symposium: mitigation of impacts and losses. Association of State Wetland Managers. Berne, NY.

Stickney, R.R. 1973. Effects of hydraulic dredging on estuarine animlas studies. World Dredging Mar. Const.: 34-37.

Stotz, T. and J. Colby. 2001. January 2001 dive report for Mukilteo wingwall replacement project. Washington State Ferries Memorandum. 5 pp. + appendices.

Thayer, G.W., W.J. Kenworthy and M.S. Fonseca. 1984. The ecology of eelgrass meadows of the Atlantic coast: a community profile. U.S. Fish and Wildlife Service FWS/OBS-84/02. 147 pp.

Thompson, K. G., E. P. Bergersen, R. B. Nehring and D. C. Bowden. 1997. Long-term effects of electrofishing on growth and body condition of brown and rainbow trout. North American Journal of Fisheries Management 17:154-159.

Tutty, B. D. 1976. Assessment of techniques used to quantify salmon smolt entrainment by a hydraulic suction hopper dredge in the Fraser River estuary. Fish. And Mar. serv. Environment Canada. Tech. Rept. Ser. No. PAC/T-76-16.

USACE (U.S. Army Corps of Engineers), U.S. Environmental Protection Agency, Oregon Department of Environmental Quality, and Washington Department of Natural Resources. 1998. Dredged Material Evaluation Framework: Lower Columbia River Management Area.

USEPA (U.S. Environmental Protection Agency). 1993. Guidance specifying management measures for sources of nonpoint pollution in coastal waters. 840-B-92-002. EPA, Office of Water, Washington, D.C.

USEPA (U.S. Environmental Protection Agency). 1998. Rock barbs enhance fish habitat and water quality in Oregon's Tillamook Bay Watershed: Demonstrating practical tools for watershed management through the National Estuary Program. Coastlines Information

About Estuaries and Near Coastal Waters, Volume 8, Number 2. U.S. Environmental Protection Agency, Office of Water. EPA842-F-98-003L. (Spring 1998)

Waknitz, F. W., G. M. Matthews, T. Wainwright, and G. A. Winans. 1995. Status review for Mid-Columbia River summer Chinook salmon. NOAA Tech. Mem. NMFS-NWFSC-22, 80 p.

Walters, D.A., W.E. Lynch, Jr., and D.L. Johnson. 1991. How depth and interstice size of artificial structures influence fish attraction. N. Am. J. Fish. Mgmt. 11:319-329.

Wanjala, B.S., J.C. Tash, W.J. Matter and C.D. Ziebell. 1986. Food and habitat use by different sizes of largemouth bass (*Micropterus salmoides*) in Alamo Lake, Arizona. Journal of Freshwater Ecology Vol. 3(3):359-368.

Waples, R. S. 1991. Pacific salmon, Oncorhynchus spp., and the definition of “species” under the Endangered Species Act. Marine Fisheries Review 53(3):11-22.

Waples, R.S., R.P. Jones, Jr., B.R. Beckman, and G.A. Swan. 1991a. Status review for Snake River fall Chinook salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-201. 73 p.

Waples, R.S., O.W. Johnson, and R.P. Jones, Jr. 1991b. Status review for Snake River sockeye salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-195. 23 p.

Waples, R.S., P.B. Aebersold and G.A. Winans. 1997. Population genetic structure and life history variability in *Oncorhynchus nerka* from the Snake River Basin. Final Report of Research. Bonneville Power Administration, Portland, Oregon 104 p.

Ward, D.L. (ed). 1992. Effects of waterway development on anadromous and resident fish in Portland Harbor. Final Report of Research. Oregon Dept. of Fish and Wildlife. 48 pp.

Ward, D.L. and A.A. Nigro. 1992. Differences in Fish Assemblages Among Habitats Found in the Lower Willamette River, Oregon: Application of and Problems With Multivariate Analysis. Fisheries Research 13:119-132.

Ward, D.L., A.A. Nigro, R.A. Farr, and C.J. Knutsen. 1994. Influence of Waterway Development on Migrational Characteristics of Juvenile Salmonids in the Lower Willamette River, Oregon. North American Journal of Fisheries Management 14:362-371.

Ward, D.L., C.J. Knutsen, and R.A. Farr. 1991. Status and biology of black crappie and white crappie in the lower Willamette River near Portland, Oregon. Oregon Department of Fish and Wildlife Fish Division Information Reports Number 91-3. Portland, Oregon. 17 pp.

Warren, C. E. 1971. Biology and water pollution control. W. B. Saunders Co., Philadelphia, Pennsylvania. 434 p.

Warrington, P. D. 1999a. Impacts of recreational boating on the aquatic environment. https://www.nalms.org/

Warrington, P.D1999b. Impacts of outboard motors on the aquatic environment. https://www.nalms.org/

WDFW, WDOT, WDOE, and USACE (Washington Department of Fish and Wildlife, Washington Department of Transportation, Washington Department of Ecology, and the U.S. Army Corps of Engineers). 2000. Integrated streambank protection guidelines. Various pagination (Draft). Olympia, Washington. Various pagination. (October 30, 2000) (https://wdfw.wa.gov/sites/default/files/publications/00046/wdfw00046.pdf

WDNR (Washington Department of Natural Resources). 2000. Changing Our Waterways: Trends in Washington♣s Water Systems. 133pp

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon and California. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

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

Whitman, R.P., T.P. Quinn and E.L. Brannon. 1982. Influence of suspended volcanic ash on homing behavior of adult Chinook salmon. Trans. Am. Fish. Soc. 113:142-150.

Williams, R. N, L. D. Calvin, C. C. Coutant, M. W. Erho, Jr., J. A. Lichatowich, W. J. Liss, W. E. McConnaha, P. R. Mundy, J. A. Stanford, R. R. Whitney, D. L. Bottom, and C. A Frissell. 1996. Return to the river: Restoration of salmonid fishes in the Columbia River ecosystem. Council Document 2000-12. Northwest Power Planning Council, Portland, Oregon.

Williamson, A. K., Munn, M. D., Ryker, S. J., Wagner, R. J., Ebbert, J. C., and A. M. Vanderpool. 1998. Water Quality in the Central Columbia Plateau, Washington and Idaho, 1992-95. U.S. Geological Survey Circular 1144.

Winans, G. A., P. B. Aebersold, and R. S. Waples. 1996. Allozyme variability of *Oncorhynchus nerka* in the Pacific Northwest, with special consideration to populations of Redfish Lake, Idaho. Trans. Am. Fish. Soc. 125:645-663.

Winfield, T.P. 1986. Off the rack buying or taylor-made fits: what♣s best for Pacific Coast coastal wetlands. Pages 410-413 in J.A. Kusler, M.L. Quammen and G. Brooks, eds. Proceedings of the national wetlands symposium: mitigation of impacts and losses. Association of State Wetland Managers. Berne, NY.

Withler, R. E. 1988. Genetic consequences of fertilizing Chinook salmon (*Oncorhynchus tshawytscha*) eggs with pooled milt. Aquaculture 68: 15-25.

Wood, C. C. 1995. Life history variation and population structure in sockeye salmon. *In* J. L. Nielsen (editor), Evolution and the aquatic ecosystem: defining unique units in population conservation. Am. Fish. Soc. Symp. 17:195-216.

Würsig, B., C.R. Greene, Jr., and T.A. Jefferson. 2000. Development of an air bubble curtain to reduce underwater noise from percussive piling. Marine Environmental Research 49: 19-93.

Wyllie-Echeverria, S. and R.C. Phillips. 1994. Pages 1-4 in Wyllie-Echeverria, S., A.M. Olson and M.J. Hershman (eds), Seagrass science and policy in the Pacific Northwest: proceedings of a seminar series (SMA 94-1) EPA 910/R-94-004. 63 pp.

Zedler, J.B. 1996. Ecological issues in wetland mitigation: an introduction to the forum. Ecological Applications, 6(1)33-37.

Zhou, S. and M. Chilcote. 2003. Stock assessment and population viability of Clackamas River coho salmon. Oregon Department of Fish and Wildlife Fish Division Information Report; Portland, Oregon. 35 p.

Zieman, J.C. 1976. The ecological effects of physical damage from motor boats on turtle grass beds in southern Florida. Aquatic Botany 2:127-139.

Appendix A

PROJECT NOTIFICATION FORM

INSTRUCTIONS

Before issuing a permit under the Programmatic Consultation for Statewide Drilling, Surveying, and Hydraulic Engineering Activities in Oregon Funded by the Federal Highway Administration, issued on December 6, 2004, the FWHA must submit a complete Project Notification Form, or its equivalent, with the following information to NOAA Fisheries at odot.drilling.nwr@noaa.gov.

47. Date

48. Project Identification

49. Applicant

50. Location (County and 5th field HUC)

51. Project Description

52. FHWA contact

53. Project

54. Type of activity

55. Proposed start and end dates

56. Is the project area within the present or historic range of ESA-listed salmon or steelhead or a designated critical habitat, or otherwise likely to adversely affect likely to an ESA-listed salmon or steelhead or a designated critical habitat?
YES NO

57. Was the project individually reviewed to ensure that all adverse effects to ESA-listed salmon and steelhead and their designated critical

habitats are within the range of effects considered in the Opinion? YES NO

58. Which terms and conditions will be attached to the permit?

Terms and Conditions	Required for Permit		Attached to notice
Project completion report	YES	NO	
Restoration report	YES	NO	
Monitoring	YES	NO	
Construction	YES	NO	
Planning Conditions			
Pollution and erosion control plan	YES	NO	YES NO
Work area isolation plan	YES	NO	YES NO
Site restoration plan	YES	NO	YES NO

59. Requests for written approval attached to this notification? Check all that apply, attach a written explanation to support the request.

Exploration or construction near an occupied redd
Exploration or construction within 300 feet of native submerged aquatic vegetation
Timing of in-water work
Work area isolation
Transfer of ESA-listed fish
Fish passage during construction
Vehicle and material staging
Soil disturbance and compaction for temporary access road or drill pad

Appendix B

Salvage Reporting Form

INSTRUCTIONS

The applicant must submit a complete a Salvage Reporting Form, or its equivalent, with the following information to NOAA Fisheries at odot.drilling.nwr@noaa.gov within 10 days of completing a capture and release as part of a permit issued under the Programmatic Consultation for Statewide Drilling, Surveying, and Hydraulic Engineering Activities in Oregon Funded by the Federal Highway Administration, issued on December 6, 2004.

60. Date

61. FHWA Action ID

62. Applicant

63. Location of fish salvage operation (County and 5^{th} field HUC)

64. Project Name

65. FHWA contact

66. Date of fish salvage operation

67. Supervisory Fish Biologist

    Name
    Address
    Telephone number

9. Describe methods used to isolate the work area, remove fish, minimize adverse effects on fish, and evaluate their effectiveness.

10. Describe the stream conditions before and following placement and removal of barriers.

11. Describe the number of fish handled, condition at release, number injured, number killed by species.