APPENDIX B

Biological Evaluation

*L*ower *D*uwamish *W*aterway *G*roup

Port of Seattle / City of Seattle / King County / The Boeing Company

DRAFT BIOLOGICAL EVALUATION

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

DRAFT

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June 22, 2015

Project No. LY15160310

EXECUTIVE SUMMARY

The Lower Duwamish Waterway Group will conduct a Pilot Study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW) in Seattle, Washington. The study will evaluate whether enhanced natural recovery (ENR) material amended with activated carbon (AC) can be successfully applied to reduce bioavailability in remediated contaminated sediment in the LDW. The study will compare the effectiveness of reducing polychlorinated biphenyl (PCB) bioavailability in ENR material amended with AC (ENR+AC) to that of ENR material alone in three areas in the LDW, referred to as the intertidal, subtidal, and scour pilot plots.

This biological evaluation assessed potential effects of the Pilot Study on existing environmental conditions in the LDW, listed species that use the LDW, and the critical habitats of the listed species in the LDW.

The Pilot Study is not expected to substantially alter existing environmental conditions within the LDW. Potential impacts on existing environmental conditions in the Action Area defined for this biological evaluation are the following:

- Placement of ENR and ENR+AC materials may result in temporary and localized increases in turbidity in the water column.
- Physical and conventional sediment characteristics (e.g., grain size and total organic carbon) within the three pilot plot areas covering a total of approximately 3 acres may be altered in the short term relative to those of the surrounding sediments. In the long term, the physical and conventional sediment characteristics are expected to return to current conditions by means of natural riverine processes.
- Placement of ENR and ENR+AC on 3 acres of sediments that are contaminated with PCBs will reduce the exposure of aquatic organisms to PCBs within those areas.
- The ENR and ENR+AC materials placed during the Pilot Study will be approximately 6 to 9 inches thick and are not expected to substantially alter the bathymetry in the pilot plots.
- Placement of ENR and ENR+AC materials will bury 3 acres of benthic habitat; however, two of the pilot plot areas are subtidal, located in areas unlikely to provide preferred foraging habitat for juvenile salmonids. Therefore, the temporary reduction in foraging opportunities for juvenile salmonids is expected to be limited to 1 acre in the intertidal plot.
- The Pilot Study will have no effect on access and refugia; flow, water current patterns, saltwater-freshwater mixing; marine macroalgae and macrophytes; forage fish; or ambient noise.

The Pilot Study **may affect, but is not likely to adversely affect** Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and Puget Sound steelhead trout. The Pilot Study **will not jeopardize the continued existence of** Dolly Varden trout. The Pilot Study will have **no effect** on three listed species of rockfish.

The Pilot Study **may affect, but is not likely to adversely affect** some of the primary constituent elements (PCEs) of the critical habitats for Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and Puget Sound steelhead trout but will have **no effect** on the other PCEs for the critical habitats of those species.

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ABBREVIATIONS AND ACRONYMS

AADT	average annual daily traffic
AC	activated carbon
AOC	Administrative Order on Consent
BE	biological evaluation
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
dB	decibel
dBA	A-weighted noise level as decibels in air
dBrms	decibels root mean square
dBpeak	peak decibels
DPS	distinct population segment
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery with activated carbon
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FMO	foraging, migrating, and overwintering
FS	feasibility study
KCIA	King County International Airport
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
µm	micrometer
MLLW	mean lower low water
NOAA-Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	primary constituent element
PHS	Priority Habitat and Species (program)
PMU	primary monitoring unit

ABBREVIATIONS AND ACRONYMS (Continued)

RI	remedial investigation
RM	river mile
TMDL	total maximum daily load
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WQI	water quality improvement
WSDOT	Washington State Department of Transportation

DRAFT BIOLOGICAL EVALUATION
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

An amendment to the Administrative Order on Consent (AOC) for Remedial Investigation/ Feasibility Study for the Lower Duwamish Waterway (EPA Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055 and Ecology Docket No. 00TCPNR-1895, issued on December 20, 2000) was issued in July 2014. Under this amendment, the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) require that a Pilot Study of enhanced natural recovery (ENR) material amended with activated carbon (AC) be conducted in the LDW, in King County, Washington (Figure 1). The Lower Duwamish Waterway Group (LDWG) will conduct this Pilot Study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the LDW. The study will determine whether ENR material amended with AC (ENR+AC) can be successfully used to reduce bioavailability in remediated contaminated sediment in the LDW. The Pilot Study will compare the effectiveness of reducing PCB bioavailability in ENR+AC to that of ENR without the addition of activated carbon.

Section 7 of the Endangered Species Act (ESA) states that actions of federal agencies should be “not likely to jeopardize the continued existence of any (listed) species or result in the destruction or adverse modification of habitat of such species.” Because of the federal nexus (EPA), the Pilot Study qualifies as an action by a federal agency and must comply with Section 7 of the ESA. Under ESA Section 7(c), the EPA, as the lead federal agency for the Pilot Study, is required to produce a biological evaluation (BE) describing the potential effects of the action on listed species and their critical habitats. To assist in the evaluation of the potential effects of the Pilot Study on listed species, this BE has been prepared on behalf of the LDWG for EPA’s use in the consultation process.

2.0 PROJECT LOCATION

Three plot areas for the Pilot Study, designated as the intertidal, subtidal, and scour plots, will be located in the LDW in Seattle and Tukwila, King County, Washington (Figures 1 and 2; Table 1).

3.0 PROJECT DESCRIPTION

This section provides a description of the Pilot Study, including the active placement of the ENR and ENR+AC materials, as well as pre- and post-implementation monitoring of the pilot plots.

The Pilot Study will evaluate the effectiveness of ENR+AC compared to ENR alone as a remedial sediment cleanup action in three areas of the LDW in which sediments are contaminated with polychlorinated biphenyls (PCBs); they are designated as the intertidal, subtidal, and scour plots. In each plot, two adjacent, half-acre areas will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with AC has been placed. The ENR material in the subtidal plot will consist of clean sand; the ENR material in the intertidal and scour plots will consist of a gravely sand mixture (1-1/2-inch minus with on the order of 50 percent sand). In all three plots, the ENR+AC material will also contain granular AC at a concentration of 1 to 3 percent. The proposed AC concentration is sufficient to sequester PCBs (and to reduce bioavailability) but is not expected to adversely affect benthic biota.

3.1 CONSTRUCTION ELEMENTS

It is anticipated that a barge-mounted fixed-arm excavator with a clamshell bucket will be used for submerged placement of the ENR and ENR+AC materials. The submerged release of the ENR and ENR+AC materials a few feet above the substrate will minimize the loss of AC as the ENR+AC material descends through the water column and will also minimize turbidity plumes that may result as fine particles in the ENR and ENR+AC materials become suspended in the water column and descend to the bottom substrate. The ENR+AC materials will be preblended to meet the target concentration of AC and presoaked prior to placement. Presoaking of the ENR+AC material will help to minimize the loss of AC as the ENR+AC materials descends through the water column during placement. The target thickness of the ENR and ENR+AC materials is at least 6 inches, with an average of approximately 9 inches placed over the existing substrate.

Precision navigation, as well as offset and staggered placement, will be used to ensure precise placement of the ENR and ENR+AC materials at each of the pilot plots.

Equipment that will used by the contractor includes, but is not limited to barges (with and without spuds), excavators, tugs, small work boats, and anchors. The disturbance of existing sediments will be limited to disturbance from anchors or barge spuds. The construction of the project does not require dredging of any sediment; however, in the event that material is overplaced within a plot above the placement thickness to such a degree that it may impact navigation, some placed material will be moved using the clamshell bucket and relocated to the perimeter of the appropriate subplot.

3.2 CONSTRUCTION TIMING

The completion of in-water construction activities for the Pilot Study will require 2 to 4 weeks. All in-water work associated with the placement of ENR and ENR+AC materials will be conducted during the authorized 2016–2017 in-water work window of October 1 through February 15 (Corps, 2012) for the LDW, when listed salmonid species are least likely to be present in the LDW. Construction will occur after the end of the Muckleshoot Indian Tribe's netfishery season. Construction is expected to begin in December 2016.

3.3 PRE- AND POST-IMPLEMENTATION MONITORING

Pre- and post-implementation monitoring of the three pilot plots will be conducted to assess baseline conditions prior to project activities and to periodically evaluate conditions of the three pilot plots after placement of the ENR and ENR+AC materials.

The following presents an overview of the monitoring activities during the Pilot Study:

- Collection of surficial sediment samples for chemical, physical, and benthic taxonomic analyses (benthic taxonomic analyses will be conducted only during Year 3).
- Analysis of PCBs in pore water using passive samplers.
- Use of sediment profile imaging to assess benthic recolonization.

Reports summarizing the results of the monitoring events will be provided to the EPA and Ecology.

3.4 CONSERVATION MEASURES AND BEST MANAGEMENT PRACTICES

A number of conservation measures and best management practices (BMPs) will be implemented to minimize and avoid impacts on listed species and the environment during in-water work activities:

- Restriction of all in-water work activities to the authorized in-water work window for the LDW, when listed salmonid species are least likely to be present in the Action Area;
- Use of submerged placement of the ENR and ENR+AC materials will minimize the loss of AC as the ENR+AC descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed;
- Prewetting of the ENR+AC material prior to placement to minimize loss of AC during placement of the ENR+AC materials; and

- Implementation of a water quality monitoring plan during the ENR and ENR+AC material placement to assess turbidity downcurrent of the pilot plots. The water quality monitoring results will be provided to Ecology and EPA.

The following BMPs will be implemented:

- All mechanized equipment will be maintained in proper operating condition, with equipment inspections occurring prior to each workday. Equipment found to be leaking petroleum products or hydraulic fluid will be removed from the site for maintenance.
- Drip pads or pans will be placed under mechanized equipment to contain any potential leaks of petroleum products or hydraulic fluids.
- To the extent possible, vegetable-based hydraulic fluids will be used.
- A spill kit will be kept on work vessels to contain any potential petroleum spills that might occur.
- Ecology and the U.S. Coast Guard will be contacted immediately in the event of a spill.
- Any project-related debris or wastes will be placed in appropriate containers for off-site disposal. No project-related debris or wastes will be allowed to enter the water.
- Barges and work vessels will not be allowed to run aground on the substrate. Work barges will be held on station with spuds or anchors.

4.0 ACTION AREA

The Action Area is the defined geographic area that may be directly or indirectly affected by the Pilot Study. For the purpose of establishing baseline conditions from which to evaluate the potential effects of the project, the project activities as well as the physical site conditions such as substrate composition and bathymetry were reviewed.

In-water and above-water Action Areas can be defined based on project activities that would result in noise, soil, or sediment disturbance and changes in water quality or air quality. The in-water and above-water Action Areas for the Pilot Study are described in Sections 4.1 and 4.2, respectively.

4.1 IN-WATER ACTION AREA

The in-water Action Area for the Pilot Study is defined primarily by the area of placement and potential impacts on water quality caused by increased turbidity during the placement of ENR and ENR+AC materials. Although there may be some underwater noise associated with the movement of tugs and barges, as well as that resulting from the placement of the ENR materials, the quality and level of underwater noise associated with these activities is not expected to be greater than the existing background conditions within the LDW.

Defining the extent of the in-water Action Area was based on water quality monitoring data associated with recent backfilling projects in the LDW, such as those for Terminal 117 (T-117) and the Boeing Company's Plant 2 project. Water quality monitoring was required to assess exceedances of the turbidity standards for each of these projects during the placement of backfill. The monitoring data indicate that any turbidity plumes associated with these operations was not likely to extend more than 500 feet downcurrent of the operations. Based on those data, the proposed in-water Action Area is defined as an area 500 feet downcurrent of each of the pilot plots (Figures 3, 4, and 5). The Action Area around each of the pilot plots will extend 500 feet both north and south of the plots to reflect the directions of the water currents during ebbing and flowing tides (Figures 3, 4 and 5).

4.2 ABOVE-WATER ACTION AREA

The U.S. Fish and Wildlife Service (USFWS) indicates that a number of listed terrestrial species occur in King County (Section 5.0); however, these species are very unlikely to occur within the project area. Therefore, no above-water Action Area has been designated.

5.0 LISTED SPECIES AND CRITICAL HABITAT

This section discusses species listed under the ESA that may occur in the Action Area, including specific life-history stages that may occur in the Action Area. The presence of critical habitat within the Action Area is also addressed. The National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries) (http://www.nmfs.noaa.gov/pr/species/esa/listed.htm#fish) and USFWS (http://www.fws.gov/wafwo/speciesmap/KING.html) were consulted for lists of ESA-listed species occurring in the Action Area (Attachment A). Additionally, the Washington Department of Fish and Wildlife's (WDFW) Priority Habitat and Species (PHS) program (http://wdfw.wa.gov/mapping/phs/) was contacted for a list of sensitive species and habitats within the site vicinity (Attachment A). The species that could potentially occur in the Action Area are listed in Table 2.

NOAA-Fisheries indicates the following listed species as occurring or potentially occurring in Puget Sound:

- Southern resident killer whale (*Orcinus orca*);
- Leatherback sea turtle (*Dermochelys coriacea*);
- Humpback whale (*Megaptera novaeangliae*);
- Pacific eulachon (*Thaleichthys pacificus*); and
- Southern distinct population segment (DPS) of green sturgeon (*Acipenser medirostris*).

Although these species occur or may occur in Puget Sound, it is highly unlikely that any of these species occur in the Action Area. The Pilot Study will likely have no effect on the southern resident killer whale, leatherback sea turtle, humpback whale, Pacific eulachon, or the southern DPS of green sturgeon.

The USFWS has determined that several listed species, other than those listed in Table 2, occur in King County:

- Canada lynx (*Lynx canadensis*);
- Gray wolf (*Canis lupus*);
- Grizzly bear (*Ursus arctos*);
- Marbled murrelet (*Brachyramphus marmoratus*); and
- Northern spotted owl (*Strix occidentalis caurina*).

With the exception of the grizzly bear, for which critical habitat has been proposed but has not yet been designated, designated critical habitat for the remaining species does not occur in the Action Area. It is extremely unlikely that these species occur in the Action Area. Of the above-listed species, only the marbled murrelet has the potential of occurring in the Action Area. Marbled murrelet monitoring conducted in Puget Sound during 2013 as part of the Northwest Forest Plan monitoring program reported a population density within Stratum 3 of Conservation Zone 1 (Puget Sound south of Whidbey Island and portions of Hood Canal) of less than one bird per square kilometer (Falxa et al., 2014). The primary monitoring unit (PMU) closest to the LDW is located on the western shore of Puget Sound between the south end of Bainbridge Island and the Kitsap Peninsula. Monitoring data for this PMU also indicated a murrelet density of less than one bird per square kilometer (Falxa et al., 2014). Under the Northwest Forest Plan, no murrelet monitoring is conducted within the LDW, and no other sources reporting the occurrence of marbled murrelet within the LDW were found; however, it is expected that marbled murrelets rarely occur in the LDW. Therefore, it was determined that the Pilot Study would have no effect on these species.

5.1 Life-History Stages of Listed Species Occurring in Action Area

Brief life histories of each of the listed species addressed in this BE are provided in Attachment B. This section presents information on the life-history stages of species that may occur in the Action Area.

5.1.1 Chinook Salmon

The Green/Duwamish River system supports summer/fall run Chinook salmon (*Oncorhynchus tshawytscha*), which is a historically native stock (WDFW, 2014). The adult escapement numbers for Green/Duwamish River Chinook from 1994 through 2014 are provided in Table 3. Broodstock from the original Soos Creek hatchery Chinook program came from native Green River adults captured on the river or diverted into Soos Creek in the early 1900s. Eggs from out-of-basin hatcheries have occasionally been imported to supplement egg takes at Soos Creek, but the hatchery stock has remained, to a very large extent, a local Soos Creek stock. There is a significant amount of genetic interchange between wild and hatchery-origin Chinook that return to the hatchery and spawn each year, as well as between stray hatchery adults and wild fish that intermingle on spawning grounds (WDFW, 2014).

Most Chinook spawning generally occurs in the mainstem Green River from river mile (RM) 25 to RM 61 and in the lower 6 miles of Newaukum and Soos creeks (WDFW, 2010). The run timing of the different freshwater phases of Chinook salmon in the Green/Duwamish River is indicated in Figure 6.

5.1.2 Steelhead Trout

Both summer and winter steelhead trout (*Oncorhynchus mykiss*) use the Green/Duwamish River. The summer steelhead stock is a non-native stock. Smolts originating from the Skamania hatchery (lower Columbia River Basin) were first released into the Green River in 1965. Before the introduction of hatchery-origin steelhead, there was no evidence that summer steelhead were present in this system. This stock is presumed to have arisen from uncaught hatchery-origin adults that spawn, with limited success, in the system. The stock status was listed as depressed in 2002 (WDFW, 2002).

The winter steelhead stock is a native stock with wild production. The hatchery winter steelhead program on the Green River uses fish originating from the Chambers Creek hatchery. Adult broodstock is trapped at the Palmer Rearing Ponds on the Green River and at out-of-basin hatcheries. Because hatchery-origin adults return to the river and spawn earlier than the native stock, it is believed that there has been very little genetic introgression between the hatchery-original fish and wild stocks. The stock status was listed as healthy in 2010 (WDFW, 2010).

The run timing of the different freshwater phases of both summer and winter steelhead in the Green/Duwamish River is indicated in Figure 6. The adult escapement numbers for Green/Duwamish River winter steelhead from 1994 through 2014 are provided in Table 3.

5.1.3 Coastal/Puget Sound Bull Trout and Dolly Varden

This section discusses both the Coastal/Puget Sound bull trout (*Salvelinus confluentus*) and the Dolly Varden trout (*S. malma*). The USFWS announced in January 2001 that it proposed to protect the Dolly Varden trout in the Coastal/Puget Sound region of Washington under the "similarity of appearance" provision of the ESA, because the Dolly Varden so closely resembles the bull trout.

Information on the presence, abundance, distribution, and life history of bull trout in the Green River basin is extremely limited. There is no information on the timing or distribution of spawning, if any, in the Green River. Howard Hanson Dam has been a complete barrier to the upstream passage of salmonids since its construction in 1961. The City of Tacoma's municipal water diversion has also been a barrier to anadromous fish since 1911. Anecdotal reports of bull trout harvested in the Green River may refer to fish that have strayed into the Green River but were produced in a different basin. There is no confirmation or quantitative measure of bull trout natural production or juvenile rearing in the Green River basin (WDFW, 2004).

Isolated observations of adult bull trout have been reported in the lower Duwamish, including one adult captured at RM 5 in 1994 and two adult bull trout/Dolly Varden (species unconfirmed) at RM 2.1 and 4.0 in the early 1980s. Eight adults were captured near Turning Basin 3 during two sampling events in August and September 2000. It is unknown whether these fish were of Green/Duwamish River origin, non-Green/Duwamish River fish temporarily in the Duwamish River, or strays attempting to recolonize the basin (SEA, 2004).

Although bull trout do not spawn in the Duwamish-Green River watershed, they may be attracted to the Duwamish River during periods of juvenile salmonid outmigration. The Action Area provides foraging, migrating, and overwintering (FMO) habitat for anadromous bull trout originating from other core areas, such as the Puyallup, Snohomish-Skykomish, and Skagit rivers. Non-core FMO habitat provides important foraging and overwintering opportunities and is essential to maintaining connectivity between the Puget Sound Management Unit's core areas and populations (USFWS, 2011).

It is expected that bull trout use the Action Area infrequently and in relatively low numbers. Available data suggest that bull trout presence in the Duwamish Waterway generally coincides with the outmigration of juvenile salmonids. Anadromous bull trout generally return to their core areas and natal waters by mid-fall, and bull trout presence in the Duwamish Waterway has never been documented during the previous in-water work window (November 1 to February 15) for maintenance dredging operations conducted by the U.S. Army Corps of Engineers (USFWS, 2011).

5.1.4 Puget Sound Rockfish

Three species of Puget Sound rockfish have been listed under the ESA (Table 2): bocaccio (*Sebastes paucispinis*), canary (*S. pinniger*), and yelloweye (*S. ruberrimus*). These species of rockfish are typically associated with deep water (at least 50 meters) marine habitats (NOAA-Fisheries, 2009a, 2009b, 2009c). A survey of nonsalmonid fishes in the Green/Duwamish River system did not report any rockfish species (SEA, 2004); however, the brown rockfish (*S. auriculatus*) and an unidentified rockfish species (*Sebastes* spp.) were reported to occur rarely in the LDW (Windward, 2010).

5.2 Critical Habitat within the Action Area

This section discusses the occurrence of critical habitat for salmonids and the primary constituent elements (PCEs) of species-specific critical habitats within the Action Area.

The Action Area contains critical habitats for the Puget Sound Chinook salmon and the Coastal/Puget Sound bull trout. The PCEs for each of these species are listed below, although not all of the PCEs listed occur within the Action Area.

The PCEs of critical habitat for Puget Sound Chinook salmon are the following:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, logjams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Of these PCEs for Puget Sound Chinook salmon, only the attributes described in PCE 4 occur in the Action Area. There are no freshwater or marine habitats within the Action Area.

The PCEs of critical habitat for Coastal/Puget Sound bull trout are the following:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
2. Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including, but not limited, to permanent, partial, intermittent, or seasonal barriers.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks, and substrates to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 to 15 degrees Celsius (°C), or 36 to 59 degrees Fahrenheit (°F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.
6. Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 millimeter (0.03 inch) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.
7. A natural hydrograph, including peak, high, low, and base flows within historical and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Few or no non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.

Of the PCEs listed above for Coastal/Puget Sound bull trout, only the attributes described in PCE 6 would not apply in the Action Area.

Critical habitat for Puget Sound steelhead trout has not yet been designated, although critical habitat for this distinct population segment was proposed on January 14, 2013 (50 CFR 2726 2796).

Critical habitat was designated for the yelloweye rockfish, the canary rockfish, and the bocaccio in the Puget Sound/Georgia Basin in November 2014; however critical habitat for these species does not extend into the Action Area (NOAA-Fisheries, 2014).

6.0 ENVIRONMENTAL BASELINE

This section provides a brief description of the general habitat and environmental conditions within the project area and Action Area. It also provides descriptions of habitat elements, significant to the species being addressed, that could be affected by the Pilot Study or that would affect the use of the Action Area by listed species. The information provided in this section has been summarized primarily from the *Final Lower Duwamish Waterway Remedial Investigation Report* (Windward, 2010) and the *Final Feasibility Study, Lower Duwamish Waterway* (AECOM, 2012). The remedial investigation (RI) and feasibility study (FS) reports present extensive information on the history of development within the LDW, water current conditions, habitat, flora and fauna, and chemicals detected in surface water, sediment, and tissue samples collected throughout the LDW since the early 1990s. For more detailed information about the LDW in the vicinity of the Pilot Study sites, the RI and FS may be viewed online at http://www.ldwg.org/.

6.1 GENERAL

In the early years of the twentieth century, the last 6 miles of the Duwamish River were straightened and channelized into a commercial corridor for ship traffic, officially designated as the LDW and the East and West Waterways (located near the river mouth). A federally authorized navigation channel runs down the center of the LDW; it is 200 feet wide in the downstream reaches and 150 feet wide in the upstream reaches, where it terminates in the Upper Turning Basin at RM 4.6 to RM 4.65. This channel is maintained at depths between -30 feet mean lower low water (MLLW) in the downstream reaches and -15 feet MLLW in the upstream reach.

The proposed Pilot Study areas are located in the LDW, which was added to the National Priorities List as a Superfund site on September 13, 2001. The LDW Superfund site encompasses 441 acres, is about 5 miles long and approximately 400 feet wide (with many variations in width where slips and Kellogg Island occur), and consists of the downstream portion of the Duwamish River, excluding the East and West Waterways, which are part of the Harbor Island Superfund site.

Outside the navigation channel, the benches along the channel consist of sloped subtidal embankments created by the navigation channel deepening, shallow subtidal and intertidal areas (including five slips along the eastern shoreline, three embayments along the western shoreline), and an island, Kellogg Island, at the downstream end on the western side of the navigation channel. In addition, a comparatively deep area (up to -45 feet MLLW) is present outside the navigation channel between RM 0.0 and RM 0.4.

The Upper Turning Basin serves as a trap for most of the bed load sediment carried downstream by the Green/Duwamish River. The Upper Turning Basin and portions of the navigation channel just downstream of the Upper Turning Basin are dredged periodically to remove accumulated sediment, reduce sediment transport into the lower reaches of the LDW, and maintain appropriate navigation depths.

The LDW flows through an industrial and mixed-use residential area in Tukwila, unincorporated King County, and the southern portion of Seattle. The LDW corridor is one of Seattle's primary industrial areas. Two Seattle neighborhoods, South Park and Georgetown, are also adjacent to the LDW to the west and east, respectively. These neighborhoods support a mixture of residential, recreational, commercial, and industrial uses.

The LDW is used for vessel traffic, primarily bulk carriers, tugs, barges, small container ships, and, to a lesser extent, recreational vessels. The LDW supports considerable commercial navigation but is also used for various recreational activities such as boating, kayaking, fishing, and beach recreation. The LDW, which connects Puget Sound to the Green River, is also an important migratory pathway for salmon.

The LDW is frequently used by Native American tribes as a resource and for cultural purposes. The Muckleshoot Indian Tribe and the Suquamish Tribe, which are federally recognized tribes, are natural resource trustees for the Duwamish River. The Muckleshoot Indian Tribe currently conducts seasonal commercial, ceremonial, and subsistence netfishing operations in the LDW. The Suquamish Tribe actively manages resources north (downstream) of the Spokane Street bridge, located just north of the LDW Superfund site.

The slips on the east side of the LDW, originally old meander remnants, do not retain their natural character, having armored shorelines that have been filled to steep bank slopes. The shorelines of the slips are dominated by berthing areas and overwater structures. Approximately 3.7 miles of exposed bank are currently present in the LDW, of the approximate 18 miles of combined shoreline and dock face. Very little of this exposed bank is in the location of the original natural meandering riverbank.

Habitats along the LDW have been modified extensively since the late 1800s as the result of hydraulic changes, channel dredging, filling of surrounding floodplains, and construction of overwater and bank stabilization structures. The only evidence of the river's original, winding course is present in the remnants of some of the natural meanders along the LDW (several of which are now used as slips) and the area around Kellogg Island. Remnants of habitat also remain in the LDW, and portions of intertidal habitat are the focus of recent restoration efforts, some of which have already been completed.

The dominant natural habitat types in the LDW are intertidal mudflats, tidal marshes, and subtidal areas. About 98 percent of the approximately 1,270 acres of tidal marsh and 1,450 acres of mudflats and shallows, as well as all of the approximately 1,230 acres of tidal wetland historically present in the Duwamish estuary, have either been filled or dredged. Areas of remnant tidal marshes account for only 5 acres of the LDW, while mudflats account for only 54 acres.

Intertidal habitats are dispersed in relatively small patches downstream of RM 3.0, with the exception of the area around Kellogg Island, which represents the largest contiguous area of intertidal habitat remaining in the LDW. In these intertidal habitat areas, fish and wildlife can be exposed to contaminants either through direct contact with sediment or through consumption of prey. However, these areas also provide wildlife habitat in an otherwise industrial waterway.

Kellogg Island is currently designated as a wildlife refuge. Habitat associated with the island encompasses high and low marshes, intertidal mudflats, and filled uplands. A mixture of introduced and native plant and tree species has colonized this 17.3-acre island.

Approximately 208 direct discharge points are located along the LDW shoreline, of which 203 are public or private outfalls, and 5 are ditches, creeks, or streams. In addition, 7 major seeps and 22 abandoned outfalls have been identified during shoreline surveys.

Historical or current commercial and industrial operations include cargo handling and storage, marine construction, boat manufacturing, marina operation, paper and metals fabrication, food processing, and airplane manufacturing. Contaminants may have entered the LDW via several transport mechanisms, including spillage during product shipping and handling, direct disposal or discharge, contaminated groundwater discharge, surface water runoff, stormwater discharge, or contaminated soil erosion (EPA, 2001).

6.2 WATER QUALITY

This section describes existing conditions at each of the pilot plot areas and expected effects of the Pilot Study related to water quality and stormwater discharge to the LDW.

6.2.1 Existing Conditions

A search of Washington State's Water Quality Assessment [303(d) & 305(b) Integrated Report] (Ecology, 2012) for each of the pilot plot areas identified no water quality chemistry specific to these areas; however, the LDW has been listed as not meeting the state water quality criteria for ammonia nitrogen (Category 4A), bacteria (Category 5), bis(2-ethylhexyl) phthalate (Category 2), and dissolved oxygen (Category 5).

Ecology's water quality assessment list divides water body impairments into a number of categories. The category listings for each of the four constituents not meeting their respective state water quality criteria are defined as follows:

- Category 2 – Waters of concern: waters where there is some evidence of a water quality problem but not enough to require production of a water quality improvement (WQI) project (including total maximum daily load [TMDL]) at this time. There are several reasons why a water body would be placed in this category. A water body might have pollution levels that are not quite high enough to violate the water quality standards, or there may not have been enough violations to categorize it as impaired according to Ecology's listing policy. There might be data showing water quality violations, but the data were not collected using proper scientific methods. In all of these situations, these are waters that we want to continue to test.
- Category 4a – Water bodies that have an approved TMDL in place that is being actively implemented.
- Category 5 – Polluted waters that require a TMDL or other WQI project.

According to Washington State's Water Quality Assessment [303(d) & 305(b) Integrated Report] (Ecology, 2012), an area just below the Turning Basin in the LDW is listed as Category 5 for dissolved oxygen and bacteria.

Windward (2010) summarized surface water chemistry data for the LDW, reporting detectable concentrations of most metals, polycyclic aromatic hydrocarbons (PAHs), phthalate esters, phenol, total PCBs, and some pesticides but no exceedances of state or federal ambient water quality criteria for the protection of aquatic life for any of the chemicals.

6.2.2 Effects of the Action

The ENR and ENR+AC materials will consist of clean sand or clean gravelly sand (depending on the plot location) without and with activated carbon, respectively. Placement of both the ENR and ENR+AC materials may result in temporary and localized increases in turbidity as fine materials in the ENR and ENR+AC materials become suspended in the water column as the materials descend through the water column and settle on the substrate.

Turbidity (total suspended solids) may be increased on a temporary and localized basis during placement of the ENR and ENR+AC materials, but any increased turbidity would be very limited in extent and duration. Furthermore, concentrations of total suspended solids sufficient to cause adverse effects on the species of concern are not expected to occur (see Section 7.0). Therefore, the temporary increases in turbidity during placement of the ENR and ENR+AC materials are expected to be insignificant and are not expected to result in long-term degradation of the existing water quality conditions within the Action Area or to adversely affect listed species.

6.3 Shoreline and Bathymetry, Sediment and Substrates, and Habitat Diversity

This section describes existing conditions at each of the pilot plot areas and expected effects of the Pilot Study related to shoreline conditions, bathymetry, sediment and substrates, and habitat diversity within the Action Area

6.3.1 Existing Conditions

6.3.1.1 Shoreline and Bathymetry

The depths of the Pilot Study plots are provided in Table 1.

The scour plot will be located at RM 0.1 near the south end of Harbor Island on the eastern shoreline of the LDW and adjacent to an industrial pier (Figure 5). The eastern shoreline of the LDW near the scour plot is heavily industrialized, with no riparian vegetation adjacent to the scour plot. West of the scour plot and across the channel is a marina consisting of riprapped banks above which are landscaped areas consisting of some trees and grass. The areas west of the scour plot are primarily commercial.

The subtidal plot will be located at RM 1.2 toward the middle of the LDW in an area heavily industrialized on both the eastern and western shorelines (Figure 4). The western shoreline is dominated by industrial piers, and the eastern shoreline consists of a combination of industrial piers and riprapped banks, with some vegetation located on top of the banks.

The intertidal plot will be located at RM 3.9 in an industrialized area of the LDW on an intertidal bench on the eastern shoreline of the LDW (Figure 3). Wooden and steel bulkheads are located on the eastern bank above the bench, with some riparian vegetation located on top of the bank. The western shoreline is also industrialized and is similar to the eastern shoreline, with armored or bullheaded banks on top of which is riparian vegetation.

6.3.1.2 Sediment and Substrate

The Pilot Study will evaluate the effectiveness of ENR+AC compared to ENR alone in remediating contaminated sediments in the LDW. The contaminants of primary concern in the pilot plot areas are PCBs. The PCB concentrations in surface (0 to 10 centimeters) sediments in each of the pilot plot areas are summarized in Table 4. A more detailed presentation of sediment chemistry and remedial action levels for the three pilot plot areas is provided in the Final Plot Selection Memo (LDWG, 2015).

The ENR and ENR+AC materials will consist of various combinations of clean sand, gravel, and AC. Placement of the ENR and ENR+AC materials may change the sediment characteristics in the pilot plot areas. As an example, sediment in the intertidal plot consists primarily of fine, cohesive material (Table 1). The ENR and ENR+AC materials will alter the sediment characteristics over the three 1-acre pilot plots by covering the finer, cohesive sediments with coarser material.

It is expected that placement of the ENR and ENR+AC materials may alter the sediment physical and conventional characteristics (e.g., grain size and total organic carbon) in the areas being treated compared to those in the surrounding sediments. Because placement of the new material will not change the local depositional environment, it is expected that over time the physical characteristics of the sediments will return to those that existed prior to implementation of the Pilot Study due to the natural estuarine process and sedimentation. Placement of ENR and ENR/AC ENR+AC on 3 acres of sediments that are contaminated with PCBs will reduce the exposure of aquatic organisms to PCBs within those areas.

6.3.1.3 Habitat Diversity

Habitat diversity and complexity in the three pilot plots is limited, with the surrounding habitat at each plot lacking such features as side-channel habitat, floodplain connectivity, large woody debris, and sinuosity. The scour and subtidal plots are located in heavily industrialized areas of the LDW with both shorelines dominated by overwater structures and armored banks with little or no riparian vegetation. Although located in an industrialized area, the intertidal plot offers the greatest habitat diversity of the three pilot plot areas for juvenile salmonids, with shallow-water benches potentially providing foraging habitat and riparian vegetation providing shade, a source of terrestrial insects, and allochthonous organic material.

6.3.2 Effects of the Action

This section discusses the potential effects of the Pilot Study related to shoreline conditions, bathymetry, sediment and substrates, and habitat diversity within the Action Area.

6.3.2.1 Shoreline and Bathymetry

Installation of the intertidal plot may temporarily affect approximately 1 acre of intertidal shoreline, covering the existing sediments with clean sand and gravel with and without AC. The ENR material will not change the shoreline slope but could change the physical nature of the existing sediment, as well as the depth (less than 1 foot of elevation change) of the pilot plot during tidal inundation. Alteration of the bathymetry will be negligible and will affect only a small fraction of the total intertidal habitat within the LDW; the habitat will continue to be intertidal.

Placement of ENR and ENR+AC materials in the subtidal and scour plots may temporarily and slightly affect the bathymetry (less than 1 foot of elevation change) of the 2 acres making up the two plots. Alteration of the bathymetry will be negligible and will affect only a small fraction of the total subtidal habitat within the LDW; the habitat will continue to be subtidal.

6.3.2.2 Sediment and Substrate

Placement of ENR and ENR+AC may alter the physical characteristics of the sediment, such as grain size, over a total area of 3 acres within the LDW; however, this alteration will be temporary and minor in comparison to the total area of intertidal and subtidal habitats within the LDW. The mean percentage of fines for each of the pilot plot areas is provided in Table 1. The fines fraction of sediments consists of silts and clays and is defined as sediment particles with a diameter less than 63 micrometers (µm). The mean percentage of fines at the three pilot plots range from 32.9 to 63.8 percent. The fines fraction of the ENR and ENR+AC materials is expected to be less than 2 percent. The 3 acres of intertidal and subtidal habitats that will be affected by the Pilot Study represent only 0.68 percent of the 441 acres within the LDW Superfund site (AECOM, 2012). Sedimentation in the LDW will, over time, deposit sediments over the ENR and ENR+AC materials in the pilot plot areas, likely resulting in surficial sediments in the pilot plot areas that are identical to the surficial sediments in adjacent areas. The modeled net sedimentation rate for each of the pilot plots and the empirical net sedimentation rate for the intertidal plot are presented in Table 1. The alteration of the sediment physical characteristics is expected to be negligible because of the relatively small areas being treated and will affect only a small fraction of the total intertidal and subtidal habitats within the LDW.

6.3.2.3 Habitat Diversity

The Pilot Study is expected to have no effect on habitat diversity within the Action Area, because the Pilot Study will neither diminish nor increase the existing habitat diversity in the Action Area.

6.4 ACCESS AND REFUGIA

This section describes existing conditions and expected effects of the Pilot Study related to access by and refugia for listed species.

6.4.1 Existing Conditions

No fish passage barriers or other obstacles occur in the Action Area that would limit access by listed species or other aquatic species. The Action Area provides shallow-water habitat for migrating juvenile salmonids, as well as other fishes and aquatic biota. Refugia within the Action Area are limited to the existing nearshore structures or recently constructed habitat restoration projects. Refugia such as large woody debris, overhanging vegetation, and side-channel habitats are very limited to nonexistent within the Action Area.

6.4.2 Effects of the Action

The Pilot Study will be implemented during the authorized in-water work window when very few listed salmonid species are expected to occur in the Action Area. Construction activities may temporarily discourage listed species from approaching the construction areas during active construction, causing them to alter their course around the construction area, but the activities will not prevent their access to the Action Area. The Pilot Study will have no effect on access or refugia within the Action Area.

6.5 FLOW, CURRENT PATTERNS, SALTWATER–FRESHWATER MIXING

This section describes existing conditions and expected effects of the Pilot Study related to water flow, water current patterns, and saltwater-freshwater mixing within the LDW.

6.5.1 Existing Conditions

Water circulation within the LDW, a well-stratified estuary, is driven by tidal actions and river flow; the relative influence of each is highly dependent on seasonal river discharge volumes. Fresh water moving downstream overlies the tidally influenced salt water entering the system. Typical of tidally influenced estuaries, the LDW has a relatively sharp interface between the freshwater outflow at the surface and the saltwater inflow at depth (Windward, 2010).

The tidally influenced water (or salt wedge) area of the LDW typically extends from Harbor Island to near the head of the navigation channel. When freshwater inflow is greater than 28.3 cubic meters per second (1,000 cubic feet per second), the saltwater wedge does not extend upstream beyond the East Marginal Way South bridge (RM 6.3) regardless of the tide height (Windward, 2010). During high tide stages and periods of low freshwater inflow, the saltwater wedge has been documented as extending as far upstream as the Foster Bridge (RM 8.7). At the mouth of the

LDW at the northern end of Harbor Island, a salinity of 25 parts per thousand is typical for the entire water column; salinity decreases toward the upriver portion of the estuary. The thickness of the freshwater layer increases throughout the LDW as the river flow rate increases (Windward, 2010).

Dye studies indicate that downward vertical mixing over the length of the saltwater wedge is almost nonexistent (Windward, 2010). Studies in the LDW have described how the upstream location or "toe" of the saltwater wedge, typically located between Slip 4 and the head of the navigation channel, is determined by both tidal elevation and freshwater inflow. Fluctuations in tidal elevation also influence flow in the upper freshwater layer, which varies over the tidal cycle (Windward, 2010).

The U.S. Geological Survey measured the average net upstream transport of salt water below the Spokane Street bridge and reported it as approximately 5.4 cubic meters per second (190 cubic feet per second). This average net upstream flow was about 12 percent of the average downstream flow measured at the Tukwila gaging station. During seasonal low-flow conditions, saltwater inputs from the West Waterway of the LDW were more than one-third of the total discharge from the LDW (Windward, 2010).

6.5.2 Effects of the Action

The project is not expected to affect flow, current, or saltwater-freshwater mixing in the Action Area.

6.6 Marine Macroalgae and Macrophytes

This section describes existing conditions relevant to macroalgae (e.g., laminarians) and macrophytes (e.g., eelgrass) and expected effects of the Pilot Study in the Action Area.

6.6.1 Existing Conditions

There have been no surveys conducted in the Action Area to quantify macroalgal or macrophyte communities; however, extensive trawling and anecdotal observations suggest that neither macroalgal nor macrophyte communities would likely occur within the Action Area because of the characteristics of each of the pilot plot areas. The subtidal plot is within the navigation channel, in deep water where light penetration for submerged aquatic plant growth is limited (approximately -30 feet MLLW). The scour plot is within a scour area where tugs/barges frequently operate and where establishment of submerged aquatic vegetation is unlikely due to sediment disturbance. The intertidal plot is located RM 3.9, which is farther upstream, and hence is less likely to support brackish/marine submerged aquatic vegetation.

6.6.2 Effects of the Action

The Pilot Study is expected to have no effect on macroalgal or macrophytes communities, because it is highly unlikely that such communities exist in the Action Area.

6.7 BENTHIC FAUNA

This section describes existing conditions relevant to benthic fauna in the LDW and expected effects of the Pilot Study.

6.7.1 Existing Conditions

Numerous studies have investigated the use of the LDW by benthic invertebrates. The benthic invertebrate communities observed in the LDW consisted of 670 taxa, representing 178 families in 13 phyla. Typical of estuarine environments, the benthic invertebrate community was dominated by annelid worms, mollusks, and crustaceans. Crustaceans were the most diverse of these three groups in the LDW, including more than 250 taxa. Mollusks included various bivalves and snails. The most abundant large epibenthic invertebrates included slender crabs, crangon shrimp, and coonstripe shrimp. Dungeness crabs were also common, although their distribution was generally limited to the portions of the LDW with higher salinity (Windward, 2010).

Benthic invertebrates in the LDW form two distinct communities: the infaunal community and the epibenthic community. The infaunal community is typified by burrowing polychaetes and bivalves. At most sampling locations, the infaunal community was dominated by surface detrital/surface-deposit feeding organisms. The epibenthic community (invertebrates living on top of the sediment) consisted mainly of larger crustaceans (crabs and shrimps) and mussels and was dominated by surface detrital and surface filter-feeding organisms (Windward, 2010).

6.7.2 Effects of the Action

This section discusses the potential effects of the Pilot Study on the benthic faunal community of the Action Area.

6.7.2.1 Burial of Benthic Habitat and Temporary Decrease in Benthic Diversity

The Pilot Study will result in the placement of ENR and ENR+AC materials on a total of 3 acres of intertidal and subtidal habitats. The burial of sediments with contaminant concentrations greater than the Sediment Management Standards could have a net beneficial effect on benthic habitat. Post-implementation monitoring of the pilot plot areas will assess whether benthic recolonization differs between the ENR and ENR+AC materials.

It is expected that ENR and ENR+AC materials placed in the pilot plots will be rapidly recolonized by benthic fauna from adjacent areas. The placement of ENR and ENR+AC materials will temporarily reduce the populations of the benthic and epibenthic invertebrate community by the burial and smothering of the benthic substrate in the pilot plot areas. Invertebrate prey for juvenile salmonids and bottom fish will, thus, be temporarily reduced in the 3 acres covered by the pilot plots, although the potential impact on juvenile salmonids is likely to be greater at the intertidal plot because of its location in the shallow nearshore area, a preferred foraging habitat for juvenile salmonids (see Section 7.1.2.1). The concentration of total organic carbon will initially be slightly lower in surficial sediments in the pilot plot areas after placement of the ENR and ENR+AC materials. Thus, the amount of food (in the form of organic matter) available for benthic invertebrates in the pilot plot areas will be slightly reduced temporarily.

While benthic and epibenthic prey species will be temporarily displaced, benthic invertebrate abundance is expected to recover within 1 to 2 years after the placement activities are completed, with community diversity typically taking longer to recover. Adjacent undisturbed intertidal and subtidal habitats will continue to provide an established source of benthic and epibenthic invertebrates to colonize the ENR and ENR+AC materials. Because new benthic invertebrate communities are expected to recolonize the pilot plot areas, no long-term loss of biological productivity or prey base for juvenile salmonids or bottom fish is expected.

Discussions of recolonization of disturbed sediments and the secondary effect of AC on benthic communities are provided below.

Recolonization of Disturbed Sediments

Recolonization of disturbed sediments by benthic biota occurs via four mechanisms: vertical migration of buried assemblages from the underlying natural bottom, horizontal migration from the surrounding ambient bottom, larval recruitment from the plankton, and active and passive dispersion of adult organisms (Scott et al., 1987). The recolonization of disturbed sediments occurs in successional development of colonizing species. The early successional stage of colonization begins with relatively short-lived, shallow burrowing organisms. The second component of the recovery process, which may begin concurrently with the initial colonization, is the progressive development of subsurface bioturbation associated with the reestablishment of the long-lived species. The time scale of this process may be on the order of 1 to 2 years or more (Scott et al., 1987).

Guerra-García et al. (2003), studying benthic recovery after a small-scale (28,255 square feet) dredging project in a chemically polluted, enclosed harbor in North Africa, reported that the macrobenthic community recovered to near predredging conditions within 6 months. Merkel and

Associates (2009), studying benthic recolonization of dredged areas within the San Diego Harbor, reported that the benthic community recovered in 14 to 28 months. Kotta et al. (2009), studying the impacts of large-scale dredging (approximately 2 million cubic yards) on the recovery of benthic communities in the Gulf of Finland in the Baltic Sea, reported that dredging had weak but consistent effects on benthic invertebrate assemblages, and recovery of the communities took place within 1 year after dredging.

Secondary Effects of Activated Carbon on Benthic Communities

Beyond the primary goal of the Pilot Study to reduce contaminant availability and uptake into the tissues of benthic organisms, there may be both beneficial and adverse secondary effects of AC on benthic organisms. There have been a number of field and laboratory studies evaluating the potential secondary effects of AC on individual benthic organisms and benthic communities. Janssen and Buckingham (2013) and Kuprianchyk et al. (2015) provide comprehensive reviews of biological responses to AC and are summarized below.

Laboratory studies evaluating the potential effects of AC exposure on individual benthic organisms have included survival, growth, lipid content, and behavior endpoints in over 90 tests with 20 different species. For nearly all of the species tested (98 percent of tests reviewed), either survival increased with AC treatment or there was no decrease in survival in sediments amended with AC in the range of 1 to 30 percent. This includes studies with mysids, amphipods (*Ampelisca abdita*, *Corophium volutator*, and *Leptocheirus plumulosus*), polychaetes (*Neanthes arenaceodentata* and *Nereis* spp.), molluscs (*Macoma* spp.), and echinoderms. Decreased survival was observed only in studies with the amphipods *Gammarus pulex* (freshwater) and *Leptocheirus plumulosus* (marine). Decreased *L. plumulosus* survival was limited to exposures with carbon particles smaller than 38 µm and at relatively high concentrations (approximately 30 percent AC) (Kennedy et al., 2008). Effects in *G. pulex* were observed in clean sediments supplemented with 3 to 15 percent AC. However, additional studies showed improved *G. pulex* survival in PAH-contaminated sediments treated with 5 to 30 percent AC, indicating that the potential adverse effects observed in unpolluted sediments may be offset by the benefits of AC treatment of contaminated sediments.

Sublethal effects observed in laboratory studies appear to be species specific and were generally associated with higher AC doses and finer AC particle sizes. No effects on growth were observed in tests with amphipods (*L. plumulosus* and *G. pulex*), some polychaetes (*Nereis* spp.), clams (*Macoma* spp. [marine] and *Corbicula fluminea* [freshwater]), mussels (*Mytilus edulis*), snails (*Nassarius nitidus* [marine]), and brittle stars. For estuarine and marine species, adverse effects on growth and lipid content were limited to tests with the polychaete *N. arenaceodentata*. Decreases in both growth and lipid content in exposures to AC-amended sediments were equivocal and appeared to be sediment specific. One study (Janssen et al., 2011, 2012) showed both beneficial and adverse effects in different sediment treatments, with up to 20 percent AC (Janssen et al., 2012). Another study demonstrated growth inhibition with powdered AC at concentrations of 3.4 percent and higher (Millward et al., 2005). Data on the sublethal behavioral effects of AC amendments on estuarine and marine species are limited. One study conducted with *Corophium* spp. showed inconsistent results for avoidance, with effects observed in exposures to 4, 7, and 15 percent powdered AC but no effects in exposures to 25 percent powdered AC (Jonker et al., 2009).

Benthic community impacts have been evaluated after field applications of AC. No changes in benthic taxa richness, composition, or diversity were observed with applications of granulated AC (2 to 4 percent AC) in freshwater and estuarine wetland sediments (Beckingham and Ghosh, 2011; Cho et al., 2009, 2012) or powdered AC (3 to 5 percent AC) in both freshwater wetland and marine sediments (Conder et al., 2015; Menzie et al., 2014). In applications of powdered AC in Upper Canal Creek, Maryland, Menzie et al. (2014) also found no changes in vegetative cover and nutrient uptake by wetland plants, relative to control plots. In situ toxicity tests in conjunction with benthic community monitoring in sediments treated with 3 to 5 percent powdered AC resulted in no significant toxicity for polychaetes or clams (Conder et al., 2015). During in situ freshwater sediment tests with powdered AC mixed into clean sediments, Kupryianchyk et al. (2012) found no effects on community diversity and abundance or on short-term or long-term recruitment. There was a significant decrease in the abundance of oligochaete worms and Pisidiidae clams (freshwater); however, this appeared to be related to AC dose. Similarly, field trials in Trondheim Harbor, Norway, marine sediments showed decreased abundance in AC plots that was related to higher concentrations of powdered AC (up to 40 percent AC) (Cornelissen et al., 2011).

Overall, the laboratory and field studies indicate that secondary effects on benthic organisms and communities are limited. Whereas selected species may show some effects, they are generally associated with fine AC particle sizes and higher AC concentrations.

The AC that will be used during the Pilot Study will consist of larger particle-size granular AC at concentrations of 1 to 3 percent so that the potential effects on benthic organisms that may be associated with powdered AC and high doses is expected to be avoided. The temporary decreases in benthic and epibenthic prey within the pilot plot areas, resulting from both ENR and ENR+AC, are expected to cause an insignificant and discountable effect on local fish populations in the Action Area and are not expected have long-term adverse effects on listed fish species within the Action Area.

6.8 FORAGE FISH

This section describes existing conditions relevant to forage fish in the LDW and expected effects of the Pilot Study.

6.8.1 Existing Conditions

Pacific sand lances (*Ammodytes hexapterus*) and longfin smelts (*Spirinchus thaleichthys*), though known to be abundant in the LDW, were encountered infrequently in recent beach seine and trawling efforts, as were Pacific herring (*Clupea harengus pallasi*) and surf smelts (*Hypomesus pretiosus pretiosus*). Though these species were not encountered frequently during recent sampling, they are occasionally found in large numbers in the LDW (Windward, 2010).

The Action Area does not provide suitable substrate for Pacific sand lance or surf smelt spawning, and no eelgrass or macroalgal beds are located in the project area to provide spawning habitat for Pacific herring. The Action Area does not provide suitable spawning habitat for any of these species (WDFW, 2005; Pentilla, D., WDFW, email dated October 28, 2002).

6.8.2 Effects of the Action

The Pilot Study will not affect forage fish or their spawning habitats.

6.9 AMBIENT NOISE

This section describes existing conditions relevant to existing underwater and above-water noise in the LDW and expected effects of the Pilot Study.

6.9.1 Existing Underwater Noise Conditions

The best available data indicate that the broadband background underwater sound level in Puget Sound in the nearshore areas (i.e., within 1 kilometer of the shoreline with frequent human activities and shipping or ferry lanes) is approximately 135 decibels – root mean square (dBrms) (WSDOT, 2014). Underwater background sound levels measured in the LDW during impact pile driving for the South Park Bridge Test Pile Project in 2010 were reported to range between 134 and 136 dBrms (WSDOT, 2011), noise levels consistent with the background underwater sound level of 135 dBrms in Puget Sound.

Ambient underwater noise levels in Puget Sound with no construction activity have been reported to range between 131 decibels – peak (dBpeak) and 136 dBpeak. With construction activity (excluding pile driving), the ambient underwater noise levels can range between 133 and 140 dBpeak (WSDOT, 2014). Noise levels produced by human or mechanical sources include those attributable to large tankers and naval ship engines (up to 198 decibels [dB]) and 180+ dB for depth sounders (WSDOT, 2014). Commercial sonar devices operate in a frequency range of 15 to 200 kilohertz and in an acoustical range of 150 to 215 dB (WSDOT, 2014).

6.9.2 Existing Above-Water Noise Conditions

The pilot plots are located in industrialized areas of the LDW. Ambient noise in the LDW is generated from multiple sources including manufacturing, commercial shipping, car and truck traffic, and commercial flight operations (King County International Airport [KCIA] and the approach for Seattle-Tacoma International Airport). KCIA is located approximately 1,500 feet east of the intertidal plot area. Three bridges cross the LDW: the Spokane Street bridge located immediately north of the scour plot area, the First Avenue South bridge located south of the subtidal plot area, and the South Park Bridge located north of the intertidal plot area. A noise survey published in 2004 reported that the estimated annual operations (i.e., take offs and landings) at KCIA in 2008 would be 322,951, or about 885 per day (BDC, 2004). Of the predicted 885 flights per day, 737 would occur during daylight hours, and the remaining 148 flights would occur at night. Additionally, the LDW is located within the approach path for Seattle-Tacoma International Airport, which had a total of 347,046 operations in 2007, or about 951 per day (Port of Seattle, 2008). Other sources of background noise in the vicinity of the project area are the following:

- Local road noise from sources such as East Marginal Way South, which is located east of the LDW with an average annual daily traffic (AADT) volume of 15,900 vehicles (SDOT, 2008);
- A railroad located east of the LDW pilot plot areas and paralleling East Marginal Way South;
- Bridges crossing the LDW, such as the South Park Bridge, which historically had an AADT volume of 18,100 vehicles (SDOT, 2008); and
- Commercial marine traffic within the LDW immediately adjacent to the pilot plots in the LDW.

Parsons Brinckerhoff, Inc. (2004) conducted a noise study in the South Park area as part of the environmental impact statement for the South Park Bridge Project. According to the study, automobile and truck traffic constituted a considerable portion of the noise in the study area, and aviation noise contributed to the overall noise environment in the area. The study monitored noise levels at eight locations, with 10- and 15-minute noise measurements collected at seven of the locations during one or more periods during daylight hours, and noise levels were monitored for a 24-hour period at the eighth location. The highest sound level reported (Parsons Brinckerhoff, 2004) at seven of the stations was 71 dBA (A-weighted noise level in air [WSDOT, 2011]), which was reported at a station located approximately 750 feet from the LDW, and the lowest sound level of 61 dBA was reported at a station located about 1,000 feet from the LDW. The sound level at a station located approximately 40 feet from the LDW was reported to be 62 dBA.

Parsons Brinckerhoff, Inc. (2004) reported sound levels at the eighth station, located approximately 500 feet from the LDW, for every hour over a 24-hour period. The sound levels during the day (0700 to 2200) ranged from a low of approximately 45 dBA to a high of approximately 72 dBA, and those at night (2200 to 0700) ranged from a low of approximately 40 dBA to a high of 80 dBA.

6.9.3 Effects of the Action

Considering the location of the pilot plot areas and the type of construction activities associated with the placement of the ENR+AC materials, noise associated with Pilot Study activities will likely be indistinguishable from the multiple sources of background noise in the industrialized areas of the pilot plots. There will be no pile driving and the clamshell bucket used to deposit the ENR+AC materials will be operated from the barge. Therefore, the Pilot Study is unlikely to affect either existing under-water or existing above-water noise levels.

7.0 EFFECTS OF THE ACTION ON LISTED SPECIES AND THEIR CRITICAL HABITATS

This section discusses long-term and short-term direct and indirect effects on listed species and their critical habitats attributable to project activities and concludes with an effects determination. It discusses only attributes of listed species that are relevant to the Action Area and likely to be affected by the project. Attachment C addresses essential fish habitat, describing habitat for federally managed commercial fish species, potential project impacts, and any proposed conservation measures.

7.1 PUGET SOUND CHINOOK SALMON

This section discusses short-term and long-term direct and indirect effects on Puget Sound Chinook salmon attributable to project activities.

7.1.1 Direct Effects

The long-term and short-term direct effects of the Pilot Study on Puget Sound Chinook salmon are described below.

7.1.1.1 Long-Term Effects

The Pilot Study is expected to result in a net long-term, beneficial direct effect on Puget Sound Chinook salmon by reducing exposure to PCB-contaminated sediments over a total area of 3 acres.

The Pilot Study is expected to have no direct, long-term adverse effects on Puget Sound Chinook salmon.

7.1.1.2 Short-Term Effects

The primary short-term direct effects of the Pilot Study will be temporary and localized water quality impairment (e.g., increased turbidity).

Increased turbidity could affect juvenile salmonids in the immediate project vicinity by decreasing visibility, which could affect behaviors such as foraging and homing, territoriality, and predator avoidance responses. Duration, timing, and particle size and shape have been shown to influence the potential effect of increased turbidity on juvenile Pacific salmon, but there is little specific information on thresholds of physical, physiological, or behavioral tolerances for particular species. It is unknown what threshold of turbidity might exist that serves as a cue to fish to avoid light-reducing turbidity. The primary determinant of risk level for a particular species is likely to lie in the spatial and temporal overlap between the area of increased turbidity, degree of increased turbidity, occurrence of the fish, and options available to fish for carrying out the critical function of their particular life-history stage (Nightingale and Simenstad, 2001).

The available evidence indicates that concentrations of total suspended solids sufficient to cause such effects would be limited in extent during the ENR and ENR+AC materials placement. LeGore and Des Voigne (1973) conducted 96-hour bioassays on juvenile coho salmon (*Oncorhynchus kisutch*) using resuspended estuarine sediments. Acute effects were not observed at suspended sediment concentrations up to 5 percent (28,800 milligrams per liter dry weight). Salo et al. (1979) reported a maximum of only 94 milligrams per liter of sediment in solution in the immediate vicinity of a working dredge in Hood Canal, a turbidity concentration that is extremely unlikely to occur during the ENR and ERN/AC materials placement. Palermo et al. (1986) reported that up to 1.2 percent of sediments dredged by clamshell became suspended in the water column. It is expected that any turbidity associated with the ENR and ENR+AC materials placement would be low because the materials will be cleaned and washed prior to placement on the bed.

However, to reduce potential adverse effects of turbidity on juvenile salmonids, even of limited duration, a number of conservation measures and BMPs will be implemented to help minimize turbidity (see Section 3.4), and project activities will be timed to occur during the approved in-water work window specifically to avoid juvenile outmigration periods. This timing will dramatically reduce the temporal overlap between possible localized increases in turbidity during project implementation and the presence of juvenile salmonids within the Action Area, thereby reducing the potential exposure of juveniles to harmful levels of turbidity to a negligible level. Any increased turbidity is expected to be localized and of short-term duration.

7.1.2 Indirect Effects

The long-term and short-term indirect effects of the Pilot Study on Puget Sound Chinook salmon are described below.

7.1.2.1 Long-Term Effects

The primary long-term indirect adverse effect of the Pilot Study on Puget Sound Chinook salmon will be the long-term (1 to 2 years), temporary disturbance of approximately 3 acres of benthic habitat. Of the three pilot plot areas, the intertidal plot area is likely the preferred foraging habitat potentially used most by juvenile Chinook salmon as foraging habitat. Although the scour and subtidal plots may be used by foraging juvenile salmon, their depths may preclude their use as preferred foraging habitats, as discussed below.

Of all the salmonid species using the Duwamish/Green River system, juvenile Chinook are among the most dependent on the nearshore environment. Although most juvenile Chinook spend only about 2 weeks in the heavily industrialized Duwamish estuary, depending on their life-history trajectory, some may spend months in the Duwamish estuary. Although the peak juvenile outmigration occurs in spring (March–June), juveniles commonly arrive earlier and may be present in the nearshore environment throughout the year if conditions are favorable (King County and WSCC, 2000). Ruggerone et al. (2006) conducted studies in the Duwamish River and estuary during 2005 to collect data on occurrence patterns of juvenile Chinook salmon in habitats of the lower Duwamish River and estuary to identify reaches and habitat types where restoration projects might be most effective. The results of the study indicated that natural subyearling Chinook salmon were considerably more abundant in the nearshore compared with the midchannel habitats of the Duwamish estuary during late January and February.

As discussed in Section 6.7.2, placement of the ENR and ENR+AC materials will temporarily impact benthic habitat by burying benthic and some epibenthic fauna within the pilot plot areas. After placement, the newly exposed sediment surface of the ENR and ENR+AC materials will have a depauperate benthic community, thereby reducing the prey abundance for foraging fish, particularly during the first outmigration period for salmonid fry. Of the three pilot plot areas, a reduction in foraging opportunities for juvenile Chinook salmon likely applies only to the intertidal plot area because of its location in a shallow intertidal area. Although benthic communities in the other two pilot plot areas will be buried, these locations are much less likely to provide preferred foraging habitat for juvenile Chinook salmon. It is unknown how long this condition will persist; however, the benthic community is expected to reestablish itself in the pilot plot areas within 1 to 2 years. During the recolonization period, foraging opportunities for Chinook salmon will be reduced in the pilot plot areas, although this is expected to be less of an issue in the scour and subtidal plot areas and more pronounced in the intertidal plot area. Fish will be forced to forage in adjacent areas of the LDW. The temporary disturbance of benthic habitat in the LDW will be over a relatively small area, with recovery time for the benthic community expected to occur within 1 to 2 years after project completion.

7.1.2.2 Short-Term Effects

No short-term indirect effects on Puget Sound Chinook salmon are expected as a result of the Pilot Study.

7.1.3 Effects Determination

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **may affect** Puget Sound Chinook salmon for the following reasons:

- Suitable Chinook migration and rearing habitats are present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work.
- Foraging opportunities will be temporarily reduced over an area of 1 acre in the intertidal plot area.

The Pilot Study is **not likely to adversely affect** Puget Sound Chinook salmon for the following reasons:

- In-water work activities are being timed to occur when Puget Sound Chinook salmon are least likely to occur in the Action Area.
- Reduced bioavailability of PCBs over 3 acres of PCB-contaminated sediment will be a beneficial effect.
- Water quality disturbances due to increased turbidity will be temporary and localized and will not persist after project completion.
- Temporary disruption of benthic habitat may reduce foraging habitat for juvenile Chinook salmon over an area of 1 acre in the intertidal plot area for up to 2 years.

7.1.4 Effects on Critical Habitat

The PCEs determined essential to the conservation of Puget Sound Chinook salmon are presented in Section 5.2. Of the listed PCEs, only PCE 4 occurs in the Action Area.

The Pilot Study will have no effect on the PCEs that do not occur in the Action Area.

A **may affect** determination is warranted for Puget Sound Chinook salmon critical habitat because the Pilot Study:

- Will occur within designated critical habitat for Puget Sound Chinook salmon;
- May result in reduced water quality in the Action Area due to localized and temporary increases in turbidity; and
- May temporarily reduce foraging habitat within the Action Area.

A **not likely to adversely affect** determination is warranted for Puget Sound Chinook salmon critical habitat because the Pilot Study:

- Will improve habitat conditions in the LDW by reducing exposure to contaminated sediments;
- May cause only temporary and localized increases in turbidity;
- Will result in a long-term (up to 2 years) temporary reduction in foraging habitat on only 1 acre of intertidal habitat; and
- Will be of only short duration, resulting in no long-term adverse impacts on Puget Sound Chinook salmon critical habitat.

7.2 Coastal/Puget Sound Bull Trout and Dolly Varden

This section discusses potential long- and short-term direct and indirect effects of the Pilot Study on Coastal/Puget Sound bull trout and Dolly Varden. When discussing potential project effects on Coastal/Puget Sound bull trout, it is assumed that Dolly Varden would be affected in a similar fashion; therefore, potential effects on Dolly Varden are not discussed separately. Potential project effects on bull trout may be somewhat similar to those described for Puget Sound Chinook salmon but certainly not identical.

7.2.1 Direct Effects

The long-term and short-term temporary direct effects of the Pilot Study on Coastal/Puget Sound bull trout are described below.

7.2.1.1 Long-Term Effects

The Pilot Study is expected to result in a net long-term, beneficial direct effect on Coastal/Puget Sound bull trout by reducing exposure to PCB-contaminated sediments over a total area of 3 acres.

The Pilot Study is expected to have no direct, long-term adverse effects on Coastal/Puget Sound bull trout.

7.2.1.2 Short-Term Effects

The primary short-term direct effects of the Pilot Study will be temporary and localized water quality impairment (e.g., increased turbidity).

As discussed in Section 7.1.1.2, increased turbidity could affect adult and subadult bull trout in the immediate project vicinity by decreasing visibility, which could affect behaviors such as foraging and homing, territoriality, and predator avoidance responses.

However, to reduce potential adverse effects of turbidity on Coastal/Puget Sound bull trout, even of limited duration, a number of conservation measures and BMPs will be implement to help minimize turbidity (see Section 3.4), and project activities will be timed to occur during the approved in-water work window specifically to avoid juvenile outmigration periods, when bull trout would also be most likely to occur in the Action Area. As piscivores, adult and subadult bull trout may enter rivers to prey upon outmigrating salmon smolts. This timing is expected to reduce the temporal overlap between possible localized increases in turbidity during project implementation and the presence of Coastal/Puget Sound bull trout within the Action Area, thereby reducing the potential exposure of bull trout to harmful levels of turbidity to a negligible level. Any increased turbidity is expected to be localized and of short-term duration.

7.2.2 Indirect Effects

The long-term and short-term indirect effects of the Pilot Study on Coastal/Puget Sound bull trout are described below.

7.2.2.1 Long-Term Effects

No long-term indirect effects on Coastal/Puget bull trout are expected as a result of the Pilot Study.

7.2.2.2 Short-Term Effects

Bull trout/Dolly Varden that may enter the Action Area are likely to be adults or subadults and primarily piscivorous. The temporary disturbance of approximately 3 acres of benthic habitat, with the 1-acre intertidal plot the only area that is likely used by juvenile salmon as foraging habitat, is unlikely to reduce the density of juvenile salmon available to foraging bull trout/Dolly Varden in the LDW. Therefore, no short-term indirect effects on Coastal/Puget Sound bull trout or Dolly Varden are expected as a result of the Pilot Project.

7.2.3 Effects Determination

This section presents the effects determinations for Coastal/Puget Sound bull trout and Dolly Varden. Individual effects determinations have to be made because the Coastal/Puget Sound bull trout is listed as threatened under the ESA, whereas, the Dolly Varden is proposed for listing.

7.2.3.1 Coastal/Puget Sound Bull Trout

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **may affect** Coastal/Puget Sound bull trout for the following reasons:

- Suitable bull trout migration and foraging habitats are present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work.

The Pilot Study is **not likely to adversely affect** Coastal/Puget bull trout for the following reasons:

- In-water work activities are being timed to occur when Coastal/Puget bull trout are least likely to occur in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres.
- Water quality disturbances due to increased turbidity will be temporary and localized and will not persist after project completion.

7.2.3.2 Dolly Varden

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **will not jeopardize the continued existence** of Dolly Varden for the following reasons:

- Suitable Dolly Varden foraging habitat is present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work but will not persist beyond project completion.
- In-water work activities are being timed to occur when Dolly Varden are least likely to occur in the Action Area.

7.2.4 Effects on Critical Habitat

This section presents the effects determination for Coastal/Puget Sound bull trout critical habitat. Critical habitat has not been designated for Dolly Varden; therefore, no effects determination is required for Dolly Varden.

The PCEs determined essential to the conservation of Coastal/Puget Sound bull trout are presented in Section 5.2. Of the PCEs listed for Coastal/Puget Sound bull trout in Section 5.2, only the attributes of PCEs 6 and 9 would not apply in the Action Area:

- **PCE 6.** Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 millimeter (0.03 inch) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.

Many of the attributes of the various PCEs for bull trout critical habitat are not well represented in or are absent from the Action Area:

- An abundant food base of riparian origin;
- Complex river, stream, lake, and reservoir aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure; and
- A natural hydrograph, including peak, high, low, and base flows within historical and seasonal ranges.

Although PCE 9 would apply in the Action Area, the proposed project will have **no effect** on the attributes of PCE 9 because the proposed project will not introduce nonnative predatory species or competitive species.

The Pilot Study may result in the following conditions:

- Localized and temporary increases in turbidity caused by in-water work; and
- Temporary disruption of foraging habitat used by bull trout prey species.

A **may affect** determination is warranted for Coastal/Puget Sound bull trout critical habitat because the Pilot Study:

- Will occur within designated critical habitat for Coastal/Puget Sound bull trout; and

- May temporarily affect foraging behavior within the Action Area and may result in reduced water quality in the Action Area due to localized and temporary increases in turbidity.

A **not likely to adversely affect** determination is warranted for Coastal/Puget Sound bull trout critical habitat because the Pilot Study:

- Will reduce bioavailability of PCBs over 3 acres of PCB-contaminated sediments after placement of the ENR and ENR+AC materials; and
- Will be of only short duration, resulting in no long-term adverse impacts on Coastal/Puget bull trout critical habitat.

7.3 PUGET SOUND STEELHEAD TROUT

This section discusses potential long- and short-term direct and indirect effects of the Pilot Study on Puget Sound steelhead trout. The project-related effects on Puget Sound steelhead trout are expected to be nearly identical to those described in Section 7.1 for Puget Sound Chinook salmon.

7.3.1 Effects Determination

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **may affect** Puget Sound steelhead trout for the following reasons:

- Suitable steelhead migration and rearing habitats are present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work.
- Foraging opportunities will be temporarily reduced over a 1-acre area in the intertidal plot area.

The Pilot Study is **not likely to adversely affect** Puget Sound steelhead trout for the following reasons:

- In-water work activities are being timed to occur when Puget Sound steelhead trout are least likely to occur in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres.
- Water quality disturbances due to increased turbidity will be temporary and localized and will not persist after project completion.

- Temporary disruption of benthic habitat may reduce foraging habitat for juvenile steelhead trout over a small area of 1 acre in the intertidal plot area for a period of up to 2 years.

7.3.2 Effects on Critical Habitat

Critical habitat has only been proposed for Puget Sound steelhead trout.

The project will not destroy or adversely modify proposed Puget Sound steelhead critical habitat because:

- Anticipated habitat impacts within this proposed critical habitat area will affect non-suitable habitat and will not affect any PCEs.
- The conservation role of the habitat for the species will not be altered by the proposed project.

If Puget Sound steelhead critical habitat is designated prior to completion of this project, a provisional effect determination for critical habitat is the following:

- The project **may affect but is not likely to adversely affect** Puget Sound steelhead critical habitat.

A **may affect** determination is warranted for Puget Sound steelhead trout proposed critical habitat because the Pilot Study:

- Will occur within designated critical habitat for Puget Sound steelhead trout;
- May result in reduced water quality in the Action Area due to localized and temporary increases in turbidity; and
- May temporarily reduce foraging habitat within the Action Area.

A **not likely to adversely affect** determination is warranted for Puget Sound steelhead trout proposed critical habitat because the Pilot Study:

- Will improve habitat conditions in the LDW by reducing exposure to contaminated sediments;
- May cause only temporary and localized increases in turbidity;
- Will result in a temporary (up to 2 years) reduction in foraging habitat on only 3 acres of intertidal and subtidal habitat; and
- Will be of only short duration, resulting in no long-term adverse impacts on Puget Sound steelhead critical habitat.

7.4 ROCKFISH

Although it is possible that juveniles of the three listed species of rockfish could occur in the Action Area, their presence is highly unlikely. Therefore, no short-term or long-term direct or indirect effects on bocaccio, canary rockfish, or yelloweye rockfish are expected to occur as a result of the Pilot Study.

7.4.1 Effects Determination

The effects determination for the Pilot Study is that it will have **no effect** on bocaccio, canary rockfish, or yelloweye rockfish, because these species likely do not occur in the Action Area.

7.4.2 Effects on Critical Habitat

Although critical habitat has been designated for the three listed species of rockfish, the critical habitat does not extend into the Action Area; therefore, the Pilot Study will have **no effect** on rockfish critical habitat.

8.0 INTERRELATED/INTERDEPENDENT ACTIONS AND CUMULATIVE EFFECTS

Interdependent actions are those from actions with no independent utility apart from the Pilot Study. Interrelated actions include those that are part of a larger action and depend on the larger action for justification. Cumulative effects are those from state or private activities not involving activities of other federal agencies that are reasonably certain to occur within the area of the federal action subject to consultation (Code of Federal Regulations, Title 50, Section 402.02, Definitions).

The Pilot Study is not expected to result in any interdependent or interrelated actions.

Federal actions unrelated to the Pilot Study are not considered in this section because they require separate consultation pursuant to ESA Section 7.

There are no other state or private activities that are reasonably certain to occur within the Action Area as a result of the Pilot Study. Therefore, no cumulative effects are expected as a result of the Pilot Study.

9.0 SUMMARY

The Pilot Study has very low potential to affect listed species or their critical habitat, as discussed in Section 7.0. The determinations of effects for the Pilot Study for each listed species and their critical habitats that may occur in the Action Area are summarized in Table 5.

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TABLES

TABLE 1

PILOT PLOT LOCATONS, DEPTHS, SEDIMENTATION RATES, AND PERCENTAGE OF FINES

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Plot Type	Locations[1]				Elevation in Footprint (feet MLLW)[2]	Modeled Net Sedimentation Rate (cm/yr)[3]	Empirical Net Sedimentation Rate (cm/yr)[3]	Mean Percent Fines[4] (<63 µm)
	River Mile	Township	Range	Section				
Scour	0.1	24	4E	18	-33 to -7	0.5	ND	63.8
Subtidal	1.2	24	4E	19	-36 to -31	1.7	ND	32.9
Intertidal	3.9	24	4E	33	-5 to +9	2.2	0.9 to 2.6	46.2

Notes:
1. Source: WDNR, 2015
2. Source: Windward, 2003
3. Source: AECOM, 2014
4. AECOM, 2012

Abbreviations:
cm/yr = centimeters per year
µm = micrometer
MLLW = mean lower low water
ND = not determined

TABLE 2

ESA-LISTED SPECIES POTENTIALLY OCCURRING IN THE ACTION AREA

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Species	Listing Status (Date)	Critical Habitat
Fish		
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened (03/24/99)	Designated
Coastal/Puget Sound bull trout (*Salvelinus confluentus*)	Threatened (06/10/98)	Designated
Dolly Varden (*Salvelinus malma*)	Proposed – Threatened (01/09/01	Not Designated
Puget Sound steelhead trout (*Oncorhynchus mykiss*)	Threatened (05/7/07)	Proposed
Bocaccio (*Sebastes paucispinis*)	Endangered (04/27/10)	Designated (not in Action Area)
Canary rockfish (*Sebastes pinniger*)	Threatened (04/27/10)	Designated (not in Action Area)
Yelloweye rockfish (*Sebastes ruberrimus*)	Threatened (04/27/10)	Designated (not in Action Area)

Abbreviation:
ESA = Endangered Species Act

TABLE 3

TOTAL ESCAPEMENT FOR GREEN/DUWAMISH RIVER CHINOOK AND WINTER STEELHEAD[1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Year	Total Escapement	
	Chinook Salmon	**Winter Steelhead Trout**
1994	4,078	1,782
1995	7,939	2,198
1996	6,026	2,500
1997	9,967	1,882
1998	7,312	2,284
1999	11,025	5,480
2000	6,170	1,694
2001	7,975	1,402
2002	13,950	1,068
2003	5,864	1,615
2004	7,947	2,359
2005	2,523	1,298
2006	5,790	1,955
2007	4301	1,452
2008	5,971	833
2009	688	304
2010	2,092	423
2011	993	855
2012	3,090	392
2013	2,041	656
2014	NR	997

Note:
1. Source: WDFW, 2014

Abbreviation:
NR = not reported

TABLE 4

SURFICIAL (0 TO 10 CENTIMETERS) SEDIMENT PCB CONCENTRATIONS IN PILOT PLOT AREAS[1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Analyte	Scour Plot							
	North 0.5 Acre				South 0.5 Acre			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
Total PCBs (µg/kg DW)	172.0	440.0	265.0	120.0	213.0	260.0	240.0	24.0
Total PCBs (mg/kg OC)	6.8	26.0	14.0	9.1	7.6	23.0	12.0	7.3
% TOC	1.40	3.50	2.30	0.54	0.97	3.40	2.40	1.00
	Subtidal Plot							
	West 0.5 Acre				East 0.5 Acre			
Total PCBs (µg/kg DW)	202.0	1,530.0	621.0	616.0	450.0	2,900.0	1,518.0	1021.0
Total PCBs (mg/kg OC)	10.0	841.0	33.0	33.0	68.0	180.0	110.0	51.0
% TOC	1.60	2.20	1.90	0.22	0.66	1.60	1.30	0.45
	Intertidal Plot							
	North 0.5 Acre				South 0.5 Acre			
Total PCBs (µg/kg DW)	230.0	3,300.0	1,000.0	983.0	127.0	1,060.0	438.0	274.0
Total PCBs (mg/kg OC)	16.0	150.0	55.0	43.0	7.2	57.0	28.0	15.0
% TOC	1.40	2.20	1.70	0.34	1.30	1.70	1.50	0.33

Note:
1. Source: LDWG, 2015

Abbreviations:
µg/kg DW = micrograms per kilogram of dry weight sediment
mg/kg OC = millgrams per kilogram of organic carbon
PCB = polychlorinated biphenyl
Std. Dev. = standard deviation
TOC = total organic carbon

TABLE 5

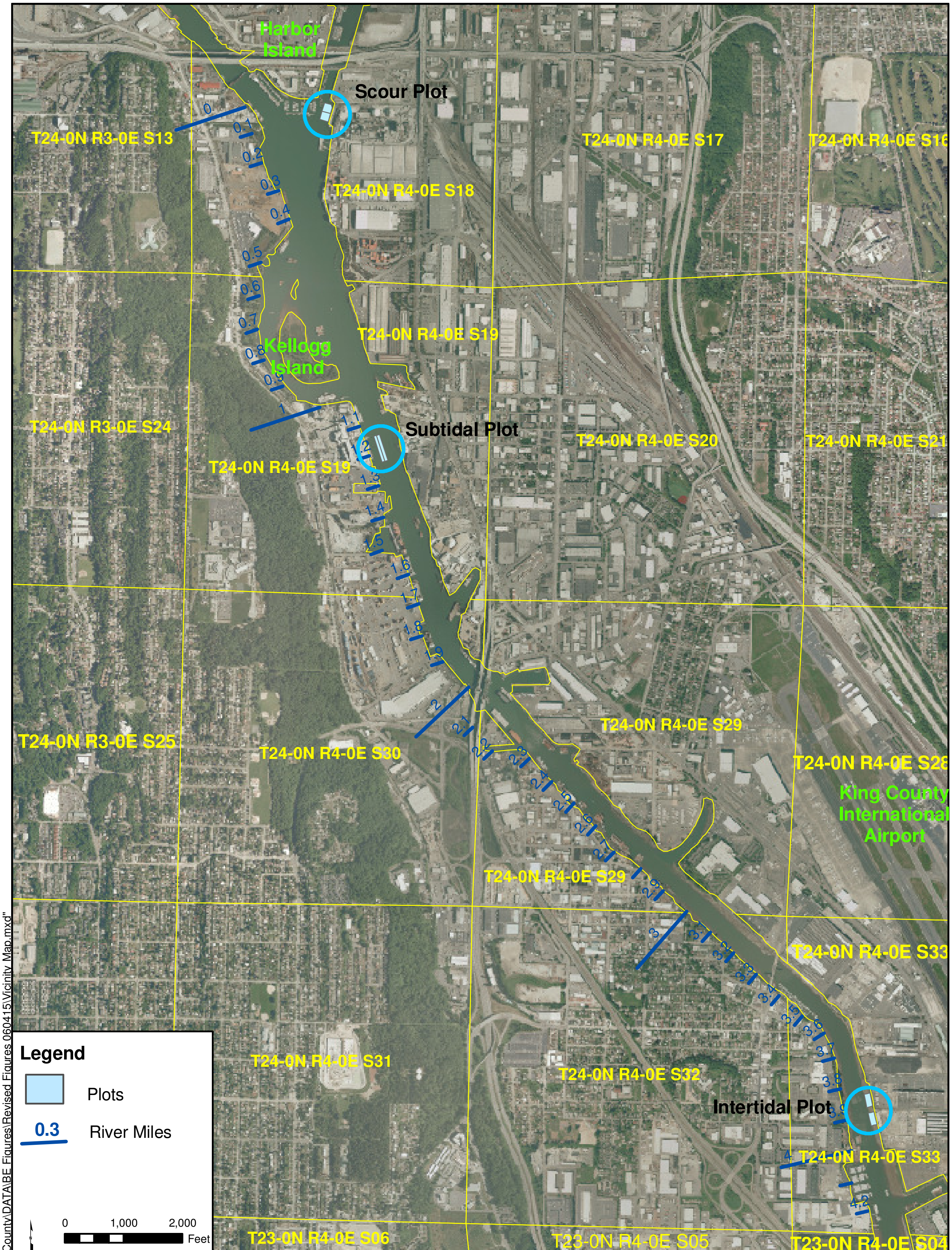
SUMMARY OF EFFECTS DETERMINATIONS FOR LISTED SPECIES AND THEIR CRITICAL HABITATS IN THE ACTION AREA

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Species/Critical Habitat PCEs	No Effect	May Affect, Not Likely to Adversely Affect	Will Not Jeopardize Continued Existence
Puget Sound Chinook salmon		X	
Critical habitat PCE 4		X	
Critical habitat PCEs 1, 2, 3, 5, and 6	X		
Coastal/Puget Sound bull trout		X	
Critical habitat PCEs 1, 2, 3, 4, 5, 7, and 8		X	
Critical habitat PCEs 6 and 9	X		
Dolly Varden (proposed)			X
Puget Sound steelhead trout		X	
Critical habitat (proposed)		X	
Rockfishes (bocaccio, canary, and yelloweye)	X		
Critical habitat	X		

Abbreviation:
PCE = primary constituent element

FIGURES



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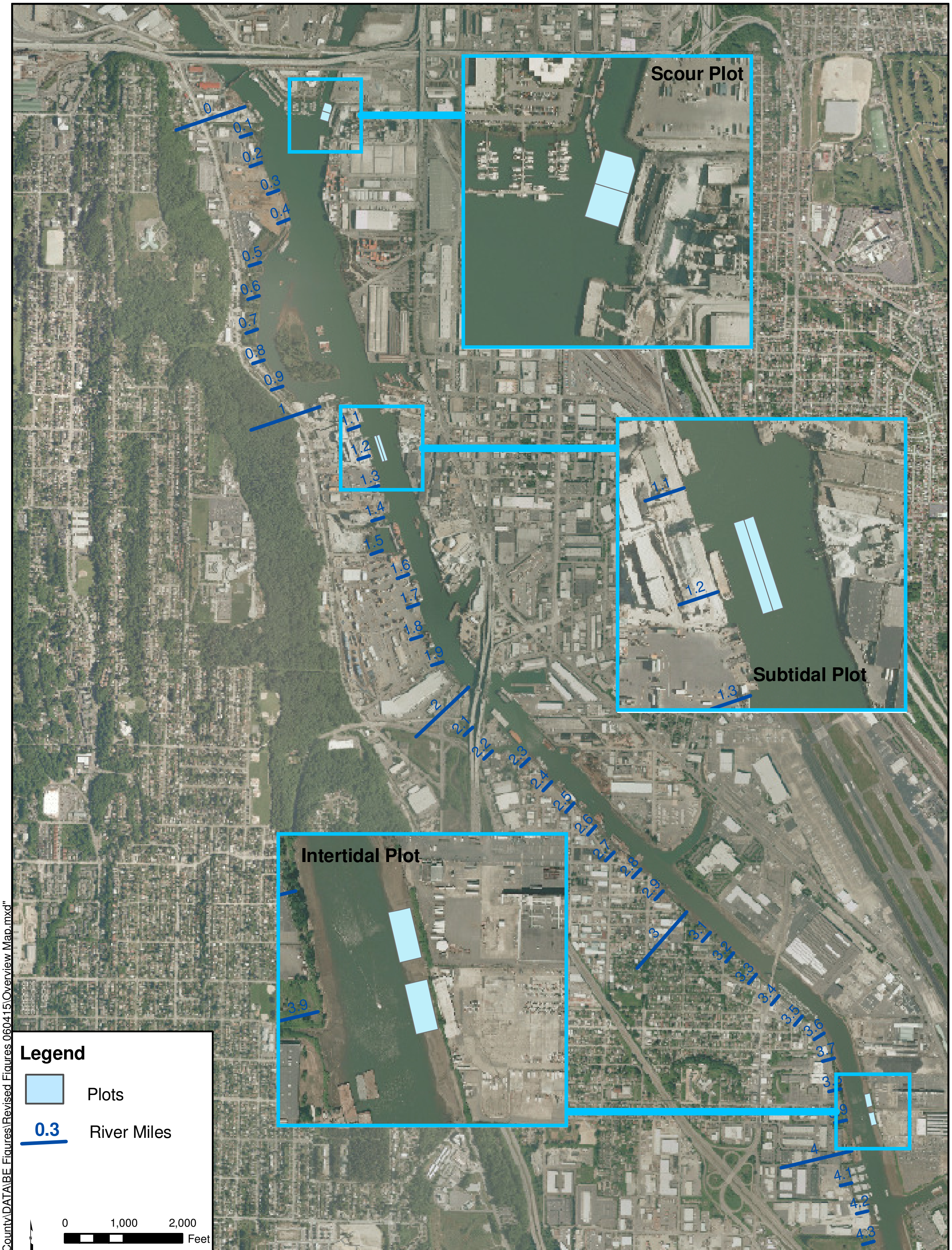
Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	ENR/AC Pilot Study Biological Evaluation DRAFT	Figure 1 Vicinity Map



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Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	ENR/AC Pilot Study Biological Evaluation DRAFT	Figure 2 Overview Map of Pilot Plot Areas

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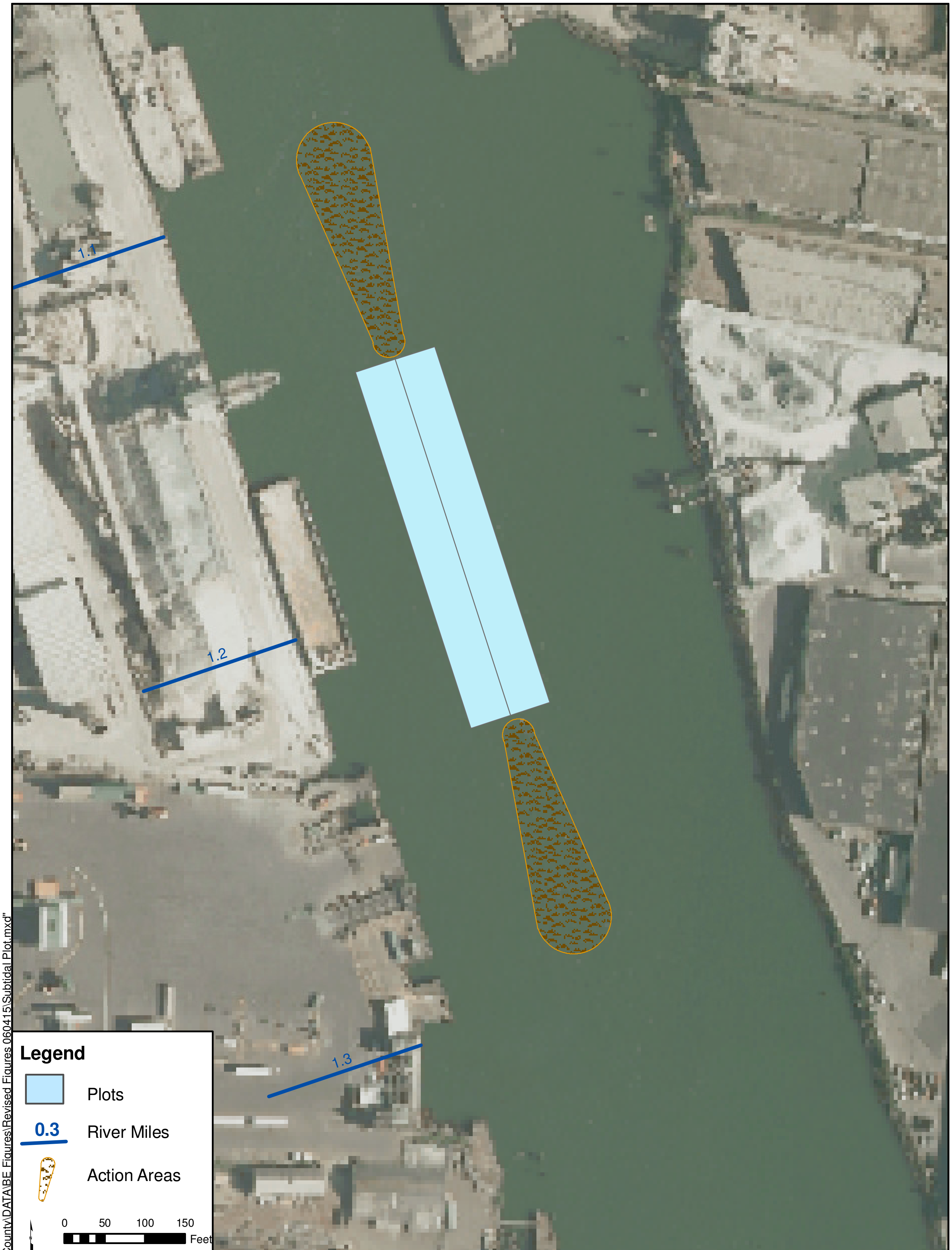
Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 3
Intertidal Plot — Action Area



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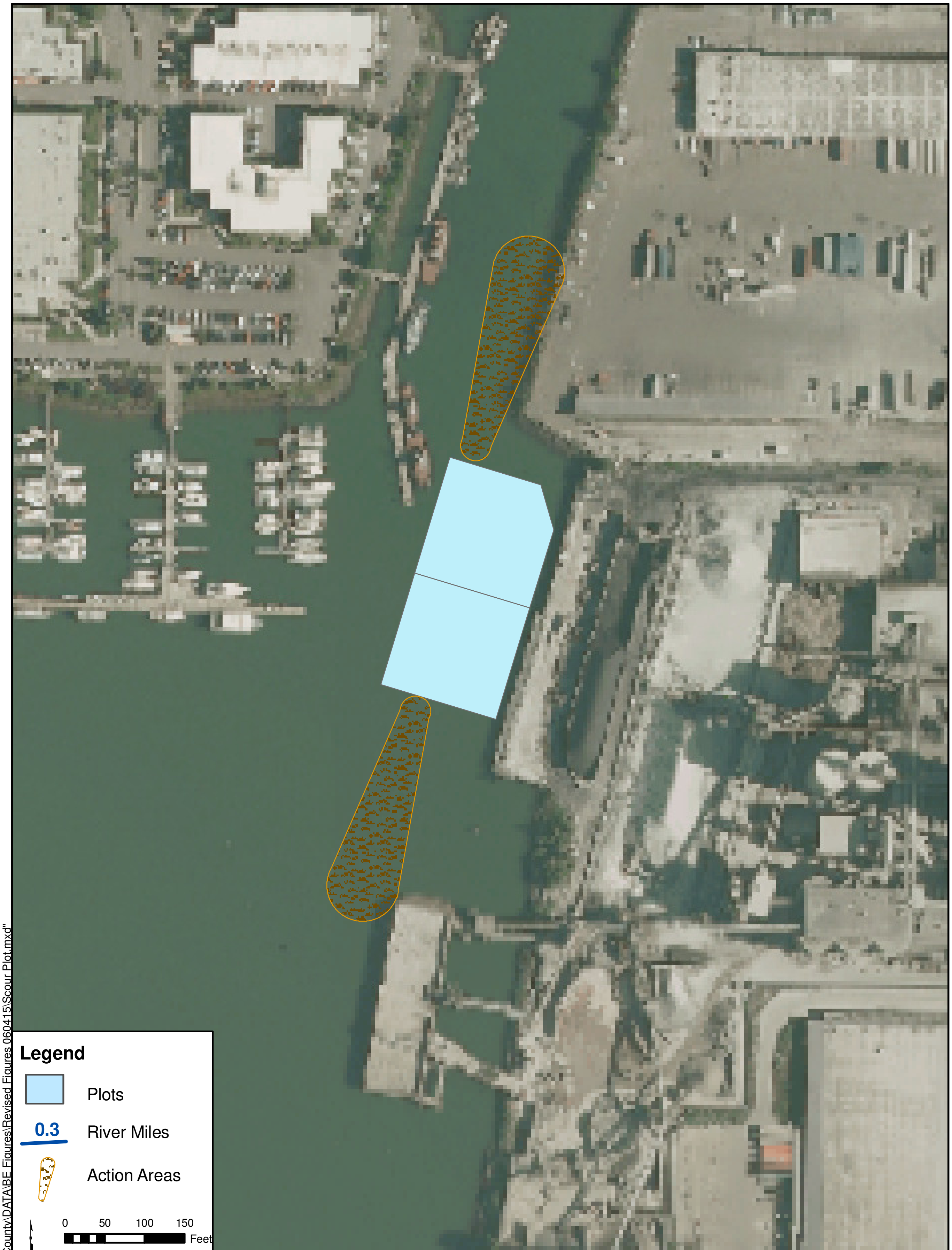
Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 4
Subtidal Plot — Action Area



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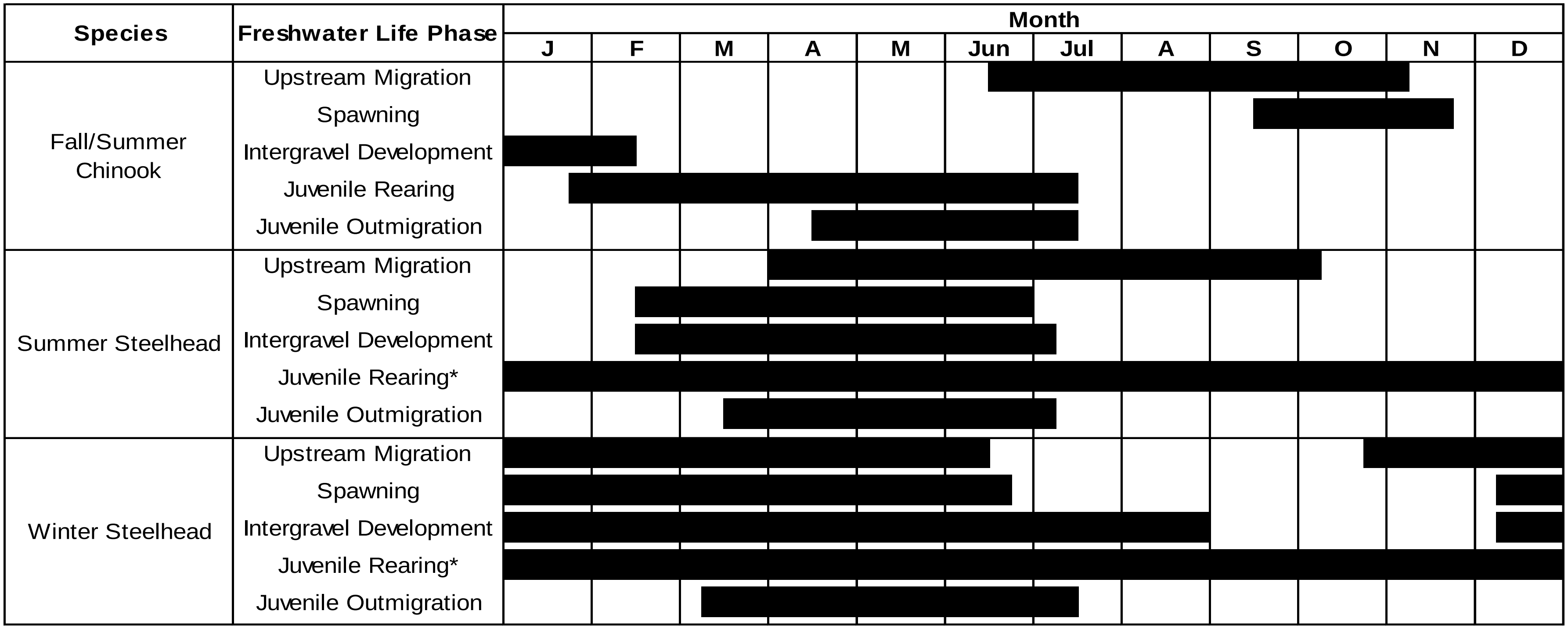
Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 5
Scour Plot — Action Area



* Normally extends over a 2-year period

(Source: Ecology, 1980)

P:\King County

SALMON RUN TIMING IN THE GREEN/DUWAMISH RIVER BASIN		
Enhanced Natural Recovery/Activated Carbon Lower Duwamish Waterway		
By: RES	Date 06/04/15	Project No. LY15160310
Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company		Figure 6 DRAFT

ATTACHMENT A

Species Lists from NOAA-Fisheries, USFWS, and WDFW PHS Program

Federally ESA listed fish species for Washington State

Family	Species	DPS / ESU	Status	As of	Critical Habitat Designated [1]	4(d) Protective Regulations [1]	Puget Sound	Washington Coast	Lower Columbia River	Middle Columbia River	Upper Columbia River	Snake River Basin
Acipeneridae	***Green Sturgeon***	Northern DPS	Species of concern	15-Apr-04	-	-	X	X	X			
		Southern DPS	***Threatened***	***6-Apr-05***	***X***	***I***	***X***	***X***	***X***			
Cluperidae	Pacific Herring	Cherry Point subpopulation	Not warranted	1-Jun-05	-	-	X	X				
		Georgia Basin DPS	Not warranted	1-Jun-05	-	-	X	X				
Gadidae	Pacific Cod	Pacific Cod DPS	Not warranted	24-Nov-00	-	-	X	X				
	Pacific Hake	Georgia Basin DPS	Species of concern	24-Nov-00	-	-	X	X				
	Walleye Pollack	Lower Boreal Pacific DPS	Not warranted	24-Nov-00	-	-	X	X				
Osmeridae	***Eulachon***	***Southern DPS***	***Threatened***	***17-May-10***	***I***	***I***	***X***	***X***	***X***			
Petromyzontidae	Pacific Lamprey	-	Not warranted	27-Dec-04	-	-	X	X	X	X	X	X
	River Lamprey	-	Not warranted	27-Dec-04	-	-	X	X	X	X	X	X
	Western Brook Lamprey	-	Not warranted	27-Dec-04	-	-	X	X	X	X	X	X
Salmonidae	***Bull Trout***	***Columbia River DPS***	***Threatened***	***10-Jul-98***	***X***	***X***			***X***	***X***	***X***	***X***
		Puget Sound / Coastal DPS	***Threatened***	***1-Dec-99***	***X***	***X***	***X***	***X***				
	Cutthroat Trout (Coastal)	Puget Sound / Strait of Georgia DPS	Not warranted	5-Apr-99	-	-	X					
		Olympic Peninsula DPS	Not warranted	5-Apr-99	-	-		X				
		SW Washington / Lower Columbia River DPS	Not warranted	25-Feb-10	-	-		X	X			
	Cutthroat Trout (Westslope)	-	Not warranted	14-Apr-00	-	-					X	X
	Chinook Salmon	***Lower Columbia River ESU***	***Threatened***	***24-Mar-99***	***X***	***X***			***X***			
		Middle Columbia River Spring-run ESU	Not warranted	9-Mar-98	-	-				X		
		Puget Sound ESU	***Threatened***	***24-Mar-99***	***X***	***X***	***X***					
		Snake River Fall-run ESU	***Threatened***	***22-Apr-92***	***X***	***X***						***X***
		Snake River Spring/Summer-run ESU	***Threatened***	***22-Apr-92***	***X***	***X***						***X***
		Upper Columbia River Spring-run ESU	***Endangered***	***22-Apr-99***	***X***	***X***					***X***	
		Upper Columbia River Summer/Fall-run ESU	Not warranted	9-Mar-98	-	-					X	
		Washington Coast ESU	Not warranted	9-Mar-98	-	-		X				
	Chum Salmon	***Columbia River ESU***	***Threatened***	***25-Mar-99***	***X***	***X***			***X***	***X***		
		Hood Canal Summer-run ESU	***Threatened***	***25-Mar-99***	***X***	***X***	***X***					
		Pacific Coast ESU	Not warranted	10-Mar-98	-	-		X				
		Puget Sound / Strait of Georgia ESU	Not warranted	10-Mar-98	-	-	X					
	Coho Salmon	***Lower Columbia River ESU***	***Threatened***	***28-Jun-05***	***I***	***X***			***X***			
		Olympic Peninsula ESU	Not warranted	25-Jul-95	-	-		X				
		Puget Sound / Strait of Georgia ESU	Species of concern	15-Apr-04	-	-	X	X				
		Southwest Washington ESU	Undetermined	-	-	-		X	X			
	Kokanee	Lake Sammamish DPS	Candidate	6-May-08	-	-	X					
	Pink Salmon	Even-year ESU	Not warranted	4-Oct-95	-	-	X					
		Odd-year ESU	Not warranted	4-Oct-95	-	-	X					
	Sockeye Salmon	Baker River ESU	Not warranted	25-Mar-99	-	-	X					
		Lake Pleasant ESU	Not warranted	10-Mar-98	-	-		X				
		Lake Wenatchee ESU	Not warranted	10-Mar-98	-	-					X	
		Okanogan River ESU	Not warranted	10-Mar-98	-	-					X	
		Ozette Lake ESU	***Threatened***	***25-Mar-99***	***X***	***X***		***X***				
		Quinault Lake ESU	Not warranted	10-Mar-98	-	-		X				
		Snake River ESU	***Endangered***	***20-Nov-91***	***X***	***X***						***X***
	Steelhead	***Lower Columbia River DPS***	***Threatened***	***19-Mar-98***	***X***	***X***			***X***			
		Middle Columbia River DPS	***Threatened***	***19-Mar-98***	***X***	***X***				***X***	***X***	
		Olympic Peninsula DPS	Not warranted	9-Aug-96	-	-		X				
		Puget Sound DPS	***Threatened***	***11-Jun-07***	***I***	***X***	***X***					
		Snake River Basin DPS	***Threatened***	***18-Aug-97***	***X***	***X***						***X***
		Southwest Washington DPS	Not warranted	9-Aug-96	-	-		X	X			
		Upper Columbia River DPS	***Threatened***	***24-Aug-09***	***X***	***X***					***X***	
Scorpaenidae	Black Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Blue Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Bocaccio	***Georgia Basin DPS***	***Endangered***	***27-Jul-10***	***I***	***I***	***X***					
	Brown Rockfish	Puget Sound population	Not warranted	3-Apr-01	-	-	X	X				
	Canary Rockfish	***Georgia Basin DPS***	***Threatened***	***27-Jul-10***	***I***	***I***	***X***					
	China Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Copper Rockfish	Puget Sound population	Not warranted	3-Apr-01	-	-	X	X				
	Greenstripe Rockfish	Puget Sound DPS	Not warranted	23-Apr-09	-	-	X					
	Quillback Rockfish	Puget Sound population	Not warranted	3-Apr-01	-	-	X	X				
	Redstripe Rockfish	Puget Sound DPS	Not warranted	23-Apr-09	-	-	X					
	Tiger Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Widow Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Yelloweye Rockfish	***Georgia Basin DPS***	***Threatened***	***27-Jul-10***	***I***	***I***	***X***					
	Yellowtail Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				

1 "-" - No designation; "I" - Designation in progress; "X" - Designation finalized

Endangered and Threatened Marine Species under NMFS' Jurisdiction

Approximately 2,215 species are listed as endangered or threatened under the ESA. Of these species, about 645 are foreign species, found only in areas outside of the U.S. and our waters.

We have jurisdiction over 125 endangered and threatened marine species, including 38 foreign species. We work with U.S. Fish and Wildlife Service (USFWS) to manage ESA-listed species. Generally, we manage marine species, while USFWS manages land and freshwater species.

- Marine Mammals
- Sea Turtles
- Fish (Marine and Anadromous)
- Marine Invertebrates and Plants


ESA Fact Sheet

» How does the ESA define "species"?

Marine Mammals (27 listed "species")

Manatees and sea otters are also listed under the ESA, but fall under the jurisdiction of the U.S. Fish and Wildlife Service.

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
Cetaceans				
dolphin, Chinese River / baiji (*Lipotes vexillifer*)	1989	E (F)	n/a	n/a
dolphin, Indus River (*Platanista minor*)	1991	E (F)	n/a	n/a
porpoise, Gulf of California harbor / vaquita (*Phocoena sinus*)	1985	E (F)	n/a	n/a
whale, beluga (1 listed DPS) (*Delphinapterus leucas*)				
• Cook Inlet	2008	E	final	in process
whale, blue (*Balaenoptera musculus*)	1970	E	n/a	final
whale, bowhead (*Balaena mysticetus*)	1970	E	n/a	n/a
whale, false killer (1 listed DPS) (*Pseudorca crassidens*)				
• Main Hawaiian Islands Insular	2012	E	no	no
whale, fin (*Balaenoptera physalus*)	1970	E	n/a	final
whale, gray (1 listed DPS) (*Eschrichtius robustus*)				
• Western North Pacific	1970	E (F)	n/a	n/a
whale, humpback (*Megaptera novaeangliae*)	1970	E	n/a	final
whale, killer (1 listed DPS) (*Orcinus orca*)				
• Southern Resident	2005	E	final	final
whale, North Atlantic right (*Eubalaena glacialis*)	2008	E	final	final
original listing as "northern right whale" -	1970	E		
whale, North Pacific right (*Eubalaena japonica*)	2008	E	final	final
original listing as "northern right whale" -	1970	E		
whale, sei (*Balaenoptera borealis*)	1970	E	n/a	final

whale, Southern right (*Eubalaena australis*)	1970	E (F)	n/a	n/a
whale, sperm (*Physeter macrocephalus*)	1970	E	n/a	final
Pinnipeds				
sea lion, Steller (1 listed DPS) (*Eumetopias jubatus*)				
• Western *original listing -*	1997 1990	E T	final	final
seal, bearded (1 listed DPS) (*Erignathus barbatus*)				
• Okhotsk	2012	T (F)	no	no
seal, Guadalupe fur (*Arctocephalus townsendi*)	1985	T	n/a	n/a
seal, Hawaiian monk (*Neomonachus schauinslandi*)	1976	E	final	final
seal, ringed (5 listed subspecies) (*Phoca hispida*)				
• Arctic (*Phoca hispida hispida*)	2012	T	no	no
• Baltic (*Phoca hispida botnica*)	2012	T (F)	no	no
• Okhotsk (*Phoca hispida ochotensis*)	2012	T (F)	no	no
• Ladoga (*Phoca hispida ladogensis*)	2012	E (F)	no	no
• Saimaa (*Phoca hispida saimensis*)	1993	E (F)	n/a	n/a
seal, Mediterranean monk (*Monachus monachus*)	1970	E (F)	n/a	n/a
seal, spotted (1 listed DPS) (*Phoca largha*)				
• Southern	2010	T (F)	n/a	n/a

Sea Turtles (16 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
green turtle (2 listed populations^) (*Chelonia mydas*)				
• Florida & Mexico's Pacific coast breeding colonies	1978	E	final	final
• all other areas » Hawaii population under review for delisting	1978	T	final	final
hawksbill turtle (*Eretmochelys imbricata*)	1970	E	final	final
Kemp's ridley turtle (*Lepidochelys kempii*)	1970	E	n/a	final
leatherback turtle (*Dermochelys coriacea*)	1970	E	final	final
loggerhead turtle (9 listed DPSs) (*Caretta caretta*) » *original listing - 1978*			*no*	*final*
• Mediterranean Sea	2011	E (F)	n/a	n/a

• North Indian Ocean	2011	E (F)	n/a	n/a
• North Pacific Ocean	2011	E	no	final
• Northeast Atlantic Ocean	2011	E (F)	n/a	n/a
• Northwest Atlantic Ocean	2011	T	final	final
• South Atlantic Ocean	2011	T (F)	n/a	n/a
• South Pacific Ocean	2011	E (F)	n/a	n/a
• Southeast Indo-Pacific Ocean	2011	T (F)	n/a	n/a
• Southwest Indian Ocean	2011	T (F)	n/a	n/a
olive ridley turtle (2 listed populations^) (*Lepidochelys olivacea*)				
• Mexico's Pacific coast breeding colonies	1978	E	n/a	final
• all other areas	1978	T	n/a	final

^ These populations were listed before the 1978 ESA amendments that restricted population listings to "distinct population segments of vertebrate species."

Fish (Marine & Anadromous) (57 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; XN = "nonessential experimental population"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
bocaccio (1 listed DPS) (*Sebastes paucispinis*)				
• Puget Sound/ Georgia Basin	2010	E	no	no
eulachon, Pacific / smelt (1 listed DPS) (*Thaleichthys pacificus*)				
• Southern DPS	2010	T	final	no
rockfish, canary (1 listed DPS) (*Sebastes pinniger*)				
• Puget Sound/ Georgia Basin	2010	T	no	no
rockfish, yelloweye (1 listed DPS) (*Sebastes ruberrimus*)				
• Puget Sound/ Georgia Basin	2010	T	no	no
salmon, Atlantic (1 listed DPS) (*Salmo salar*)				
• Gulf of Maine *original listing -*	2009 (expanded) 2000	E	final	final
salmon, Chinook (9 listed ESUs & 1 XN) (*Oncorhynchus tshawytscha*)				
• California coastal	1999**	T	final	in process
• Central Valley spring-run	1999**	T	final	final
• Central Valley spring-run in the San Joaquin River, CA	2013	XN	n/a	-
• Lower Columbia River	1999**	T	final	final
• Upper Columbia River spring-run	1999**	E	final	final
• Puget Sound	1999**	T	final	final
• Sacramento River winter-run	1994**	E	final	final
• Snake River fall-run	1992**	T	final	in process
• Snake River spring/ summer-run	1992**	T	final	in process
• Upper Willamette River	1999**	T	final	final
salmon, chum (2 listed ESUs) (*Oncorhynchus keta*)				
• Columbia River	1999**	T	final	final

• Hood Canal summer-run	1999**	T	final	final
salmon, coho (4 listed ESUs) (*Oncorhynchus kisutch*)				
• Central California coast	2005**	E	final	final
original listing -	1996**	T		
• Lower Columbia River	2005**	T	proposed	final
• Oregon coast	2008	T	final	in process
• Southern Oregon & Northern California coasts (SONCC)	1997**	T	final	final
salmon, sockeye (2 listed ESUs) (*Oncorhynchus nerka*)				
• Ozette Lake	1999**	T	final	final
• Snake River	1991**	E	final	draft
sawfish, dwarf (*Pristis clavata*)	2014	E	no	no
sawfish, green (*Pristis zijsron*)	2014	E	no	no
sawfish, largetooth (*Pristis pristis*) (formerly *P. perotteti*, *P. pristis*, and *P. microdon*)	2014	E	no	no
sawfish, narrow (*Anoxypristis cuspidata*)	2014	E	no	no
sawfish, smalltooth (2 listed DPSs) (*Pristis pectinata*)				
• U.S. portion of range	2003	E	final	final
• Non-U.S. portion of range	2014	E	no	no
shark, scalloped hammerhead (4 listed DPSs) (*Sphyrna lewini*)				
• Central & Southwest Atlantic	2014	T	no	no
• Eastern Atlantic	2014	E (F)	no	no
• Eastern Pacific	2014	E	no	no
• Indo-West Pacific	2014	T	no	no
sturgeon, Adriatic (*Acipenser naccarii*)	2014	E (F)	n/a	no
sturgeon, Atlantic (5 listed DPSs) (*Acipenser oxyrinchus oxyrinchus*)				
• Gulf of Maine	2012	T	no	no
• New York Bight	2012	E	no	no
• Chesapeake Bay	2012	E	no	no
• Carolina	2012	E	no	no
• South Atlantic	2012	E	no	no
sturgeon, Chinese (*Acipenser sinensis*)	2014	E (F)	n/a	no
sturgeon, European (*Acipenser sturio*)	2014	E (F)	n/a	no
sturgeon, green (1 listed DPS) (*Acipenser medirostris*)				
• Southern DPS	2006	T	final	in process
sturgeon, Gulf (*Acipenser oxyrinchus desotoi*)	1991	T	final	final
sturgeon, Kaluga (*Huso dauricus*)	2014	E (F)	n/a	no
sturgeon, Sakhalin (*Acipenser mikadoi*)	2014	E (F)	n/a	no
sturgeon, shortnose (*Acipenser brevirostrum*)	1967	E	n/a	final
	1979	E (F)	n/a	n/a

totoaba (*Totoaba macdonaldi*)				
trout, steelhead (11 listed DPSs & 1 XN) (*Oncorhynchus mykiss*)				
• Puget Sound	2007	T	in process	no
• Central California coast	1997**	T	final	in process
• Snake River Basin	1997**	T	final	in process
• Upper Columbia River *original listing -* *change in status -* *court reinstated status -*	2009+ 1997** 2006** 2007+	T E T E	final	final
+ reinstated to endangered status per U.S. District Court decision in June 2007, reclassified to threatened [pdf] per U.S. District Court order in June 2009				
• Southern California	1997**	E	final	final
• Middle Columbia River	1999**	T	final	final
• Middle Columbia River	2013	XN	n/a	
• Lower Columbia River	1998**	T	final	final
• Upper Willamette River	1999**	T	final	final
• Northern California	2000**	T	final	in process
• South-Central California coast	1997**	T	final	final
• California Central Valley	1998**	T	final	final

** All Pacific salmonid listings were revisited in 2005 and 2006. Only the salmonids whose status changed as a result of the review will show the revised date; for all others, only the original listing date is shown. For more information on the listing history, please click on the link for each ESU/DPS.

Marine Invertebrates (24 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
Abalone				
abalone, black (*Haliotis cracherodii*)	2009	E	final	no
abalone, white (*Haliotis sorenseni*)	2001	E	not prudent [pdf]	final
Corals				
coral, [no common name] (*Acropora globiceps*)	2014	T	no	no
coral, [no common name] (*Acropora jacquelineae*)	2014	T	no	no
coral, [no common name] (*Acropora lokani*)	2014	T (F)	n/a	no
coral, [no common name] (*Acropora pharaonis*)	2014	T (F)	n/a	no
coral, [no common name] (*Acropora retusa*)	2014	T	no	no
coral, [no common name] (*Acropora rudis*)	2014	T (F)	no	no
coral, [no common name] (*Acropora speciosa*)	2014	T	no	no
coral, [no common name] (*Acropora tenella*)	2014	T (F)	n/a	no
coral, [no common name] (*Acropora spinosa*)	2014	T (F)	n/a	no
coral, [no common name] (*Euphyllia paradivisa*)	2014	T	no	no
	2014	T	no	no

coral, [no common name] (*Isopora crateriformis*)				
coral, [no common name] (*Montipora australiensis*)	2014	T (F)	n/a	no
coral, [no common name] (*Pavona diffluens*)	2014	T (F)	no	no
coral, [no common name] (*Porites napopora*)	2014	T (F)	n/a	no
coral, [no common name] (*Seriatopora aculeata*)	2014	T	no	no
coral, boulder star (*Orbicella franksi*)	2014	T	no	no
coral, elkhorn (*Acropora palmata*)	2006	T	final	draft
coral, lobed star (*Orbicella annularis*)	2014	T	no	no
coral, mountainous star (*Orbicella faveolata*)	2014	T	no	no
coral, pillar (*Dendrogyra cylindrus*)	2014	T	no	no
coral, rough cactus (*Mycetophyllia ferox*)	2014	T	no	no
coral, staghorn (*Acropora cervicornis*)	2006	T	final	draft

Marine Plants (1 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
Johnson's seagrass (*Halophila johnsonii*)	1999	T	final	final

* NOTE: Critical habitat cannot be designated in foreign waters; critical habitat is also not required for species listed prior to the 1978 ESA amendments that added critical habitat provisions. Recovery plans for sea turtles are developed and implemented by NMFS and USFWS; the plans have been written separately for turtles in the Atlantic and Pacific oceans (and East Pacific for the green turtle) rather than for each listed species. Bowhead whales are exempt from recovery planning.

Endangered and Threatened Species Under NMFS' Jurisdiction:

- All Endangered and Threatened Species under NMFS Jurisdiction
  - » Marine Mammals
  - » Sea Turtles
  - » Fish (Marine & Anadromous)
  - » Marine Invertebrates & Plants

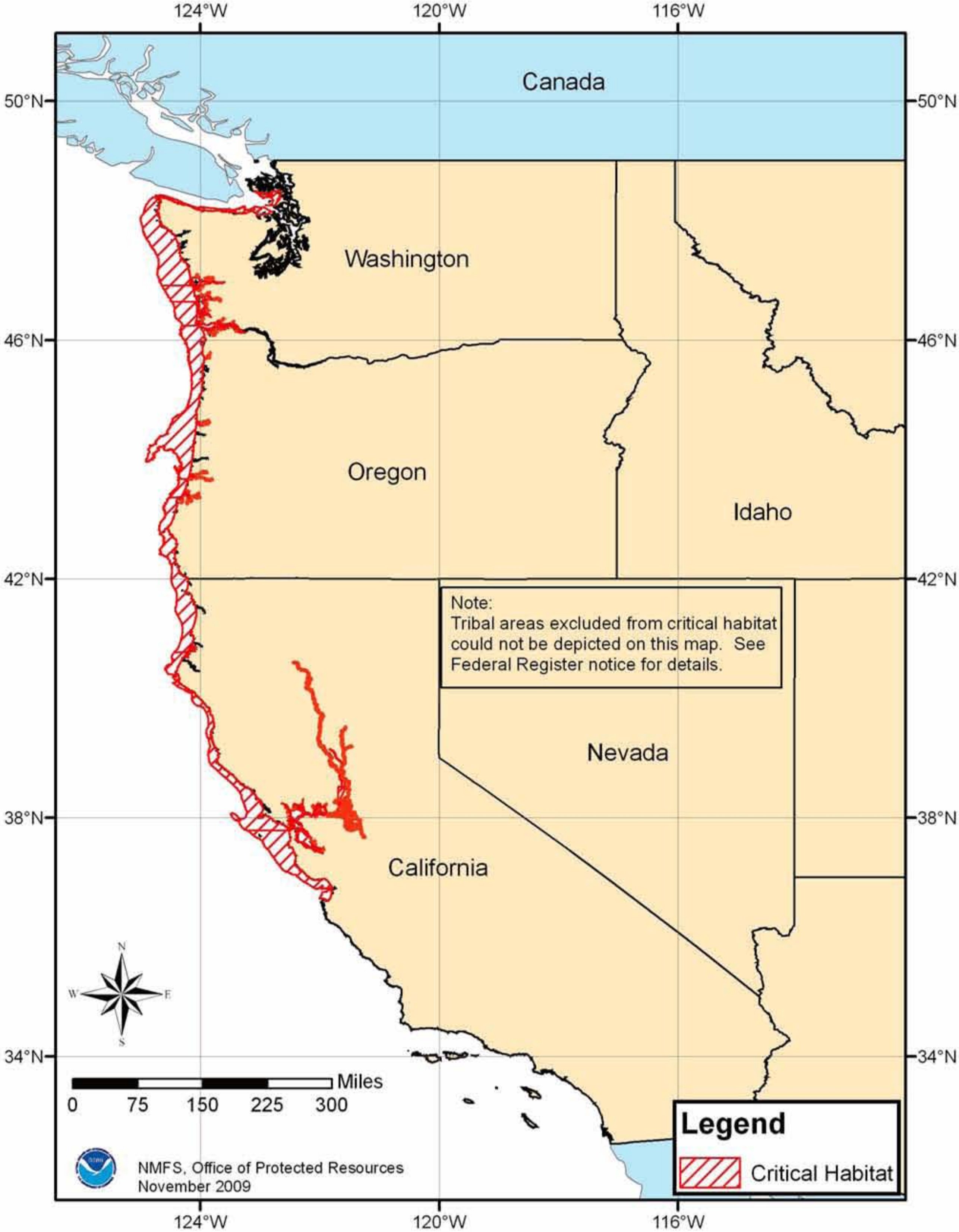
Additional Species:

- Species Petitioned for Listing under the ESA (awaiting 90-day findings)
- Candidates for ESA Listing
- Species Proposed for ESA Listing
- Species with "Not Warranted" 12-month findings (we reviewed the status, but determined that listing was not warranted)
- Delisted Species

Updated: January 21, 2015

http://www.n fs.noaa.gov/pr/pdfs/cr t ca hab tat/greenst rgeon.pdf
Accessed 02/21/15

Green Sturgeon Critical Habitat



http://www.fws.gov/wafwo/ spec[illegible]es[illegible] ap/[illegible] .ht[illegible]
Accessed 02/21/15

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CRITICAL HABITAT; CANDIDATE SPECIES; AND SPECIES OF CONCERN IN KING COUNTY AS PREPARED BY THE U.S. FISH AND WILDLIFE SERVICE WASHINGTON FISH AND WILDLIFE OFFICE

(Revised September 3, 2013)

LISTED

Bull trout *(Salvelinus confluentus)*
Canada lynx *(Lynx canadensis)*
Gray wolf *(Canis lupus)*
Grizzly bear *(Ursus arctos = U. a. horribilis)*
Marbled murrelet *(Brachyramphus marmoratus)*
Northern spotted owl *(Strix occidentalis caurina)*

Major concerns that should be addressed in your Biological Assessment of project impacts to listed animal species include:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project activities and implementation (e.g., increased noise levels, increased human activity and/or access, loss or degradation of habitat) that may result in disturbance to listed species and/or their avoidance of the project area.

Castilleja levisecta (golden paintbrush) [historic]

Major concerns that should be addressed in your Biological Assessment of project impacts to listed plant species include:

1. Distribution of taxon in project vicinity.

2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.

1. Changes in hydrology where taxon is found.

DESIGNATED

Critical habitat for bull trout
Critical habitat for the marbled murrelet
Critical habitat for the northern spotted owl

PROPOSED

North American wolverine *(Gulo gulo luteus)* – contiguous U.S. DPS
Oregon spotted frog *(Rana pretiosa)* [historical]

CANDIDATE

Fisher *(Martes pennanti)* – West Coast DPS
Yellow-billed cuckoo *(Coccyzus americanus)*
Pinus albicaulis (whitebark pine)

SPECIES OF CONCERN

Bald eagle *(Haliaeetus leucocephalus)*
Beller's ground beetle *(Agonum belleri)*
Cascades frog *(Rana cascadae)*
Hatch's click beetle *(Eanus hatchi)*
Larch Mountain salamander *(Plethodon larselli)*
Long-eared myotis *(Myotis evotis)*
Long-legged myotis *(Myotis volans)*
Northern goshawk *(Accipiter gentilis)*
Northern sea otter *(Enhydra lutris kenyoni)*
Northwestern pond turtle *(Emys (= Clemmys) marmorata marmorata)*
Olive-sided flycatcher *(Contopus cooperi)*
Pacific lamprey *(Lampetra tridentata)*
Pacific Townsend's big-eared bat *(Corynorhinus townsendii townsendii)*
Peregrine falcon *(Falco peregrinus)*
River lamprey *(Lampetra ayresi)*
Tailed frog *(Ascaphus truei)*
Valley silverspot *(Speyeria zerene bremeri)*
Western toad *(Bufo boreas)*
Aster curtus (white-top aster)
Botrychium pedunculosum (stalked moonwort)
Cimicifuga elata (tall bugbane)

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE PRIORITY HABITATS AND SPECIES REPORT

SOURCE DATASET: PHSPlusPublic
REPORT DATE: 02/21/2015 4.13

Query ID: P150221161315

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Alcids (possibly others)	SEATTLE W. SBirdCat 175022	Breeding Area Breeding area http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Catalog of Washington Seabirds Points
Bald eagle Haliaeetus leucocephalus	WEST MARGINAL WAY WS_OccurPoint 63325 March 22, 2002	Breeding Area Nest http://wdfw.wa. http://wdfw.wa.	1/4 mile (Quarter	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Bald eagle Haliaeetus leucocephalus	Not Given BaldEagle_Bf	Breeding Area Management buffer http://wdfw.wa.	NA	Fed Spp Concern Sensitive PHS Listed	N AS MAPPED	WDFW Wildlife Program Polygons
Bald eagle Haliaeetus leucocephalus	Not Given BaldEagle_Bf	Breeding Area Management buffer http://wdfw.wa.	NA	Fed Spp Concern Sensitive PHS Listed	N AS MAPPED	WDFW Wildlife Program Polygons
Biodiversity Areas And	CHEASTY GREENSPACE - PHSREGION 915024	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	WEST DUWAMISH PHSREGION 915023	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	CAMP LONG-LONGFELLOW PHSREGION 915030	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Biodiversity Areas And	DEARBORN PARK-MAPLE PHSREGION 915033	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	EAST DUWAMISH PHSREGION 915041	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	SEAHURST-INGLESEA PHSREGION 902290	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Bull Trout Salvelinus malma	Duwamish River SASI 8132	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Bull Trout Salvelinus malma	SASI 8132	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Bull Trout Salvelinus malma	Duwamish Waterway SASI 8132	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
California sea lion Zalophus californianus	PHSREGION 904461	Haulout Haulout N/A	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Chinook Oncorhynchus tshawytscha	Duwamish River SASI 1160	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Chinook Oncorhynchus tshawytscha	SASI 1160	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chinook Oncorhynchus tshawytscha	Duwamish Waterway SASI 1160	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish River SASI 2143	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish River SASI 2154	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	SASI 2143	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	SASI 2154	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish Waterway SASI 2143	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish Waterway SASI 2154	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Coho Oncorhynchus kisutch	Duwamish River FISHDIST 40726	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	Duwamish River FISHDIST 40727	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	FISHDIST 41160	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	FISHDIST 41509	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	FISHDIST 42624	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	FISHDIST 42625	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	FISHDIST 42698	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Coho Oncorhynchus kisutch	Duwamish Waterway FISHDIST 43626	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Coho Oncorhynchus kisutch	FISHDIST 43875	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	Duwamish River SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Coho Oncorhynchus kisutch	Duwamish Waterway SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Dolly Varden/ Bull Trout Salvelinus malma	Duwamish River FISHDIST 40728	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Dolly Varden/ Bull Trout Salvelinus malma	Duwamish Waterway FISHDIST 43627	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
ESTUARINE INTERTIDAL	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
ESTUARINE INTERTIDAL	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
ESTUARINE INTERTIDAL	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
Esturine Zone	PHSREGION 904754	Aquatic Habitat N/A http://wdfw.wa.	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Fall Chinook Oncorhynchus tshawytscha	Duwamish River FISHDIST 40722	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chinook Oncorhynchus tshawytscha	Duwamish River FISHDIST 40723	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chinook Oncorhynchus tshawytscha	Duwamish Waterway FISHDIST 43624	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	Duwamish River FISHDIST 40724	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	Duwamish River FISHDIST 40725	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	 FISHDIST 41158	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	Duwamish Waterway FISHDIST 43625	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Great blue heron Ardea herodias	WEST SEATTLE WS_OccurPolygon 157 April 15, 2006	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	Standard buffer	N/A Monitored PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Great blue heron Ardea herodias	WEST SEATTLE WS_OccurPolygon 158 March 24, 2003	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	Standard buffer	N/A Monitored PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Osprey Pandion haliaetus	TERMINAL 105 WS_OccurPoint 69771 June 17, 2005	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	TERMINAL 18 SEATTLE WS_OccurPoint 69872 April 16, 2003	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	BOEING S SEATTLE WS_OccurPoint 69874 July 02, 2002	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	TERMINAL 115 WS_OccurPoint 69915 April 16, 2003	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	INTERURBAN WS_OccurPoint 69917 April 16, 2003	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
Peregrine falcon Falco peregrinus	WEST SEATTLE BRIDGE WS_OccurPoint 60096 July 09, 2011	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Peregrine falcon Falco peregrinus	WEST SEATTLE BRIDGE WS_OccurPoint 60097 June 10, 2009	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Peregrine falcon Falco peregrinus	1ST AVENUE S. BRIDGE - WS_OccurPoint 106072 June 13, 2009	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	GPS	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Peregrine falcon Falco peregrinus	WEST SEATTLE BRIDGE WS_OccurPoint 112561 June 10, 2012	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	GPS	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Pink Salmon Odd Year Oncorhynchus gorbuscha	Duwamish River FISHDIST 40729	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

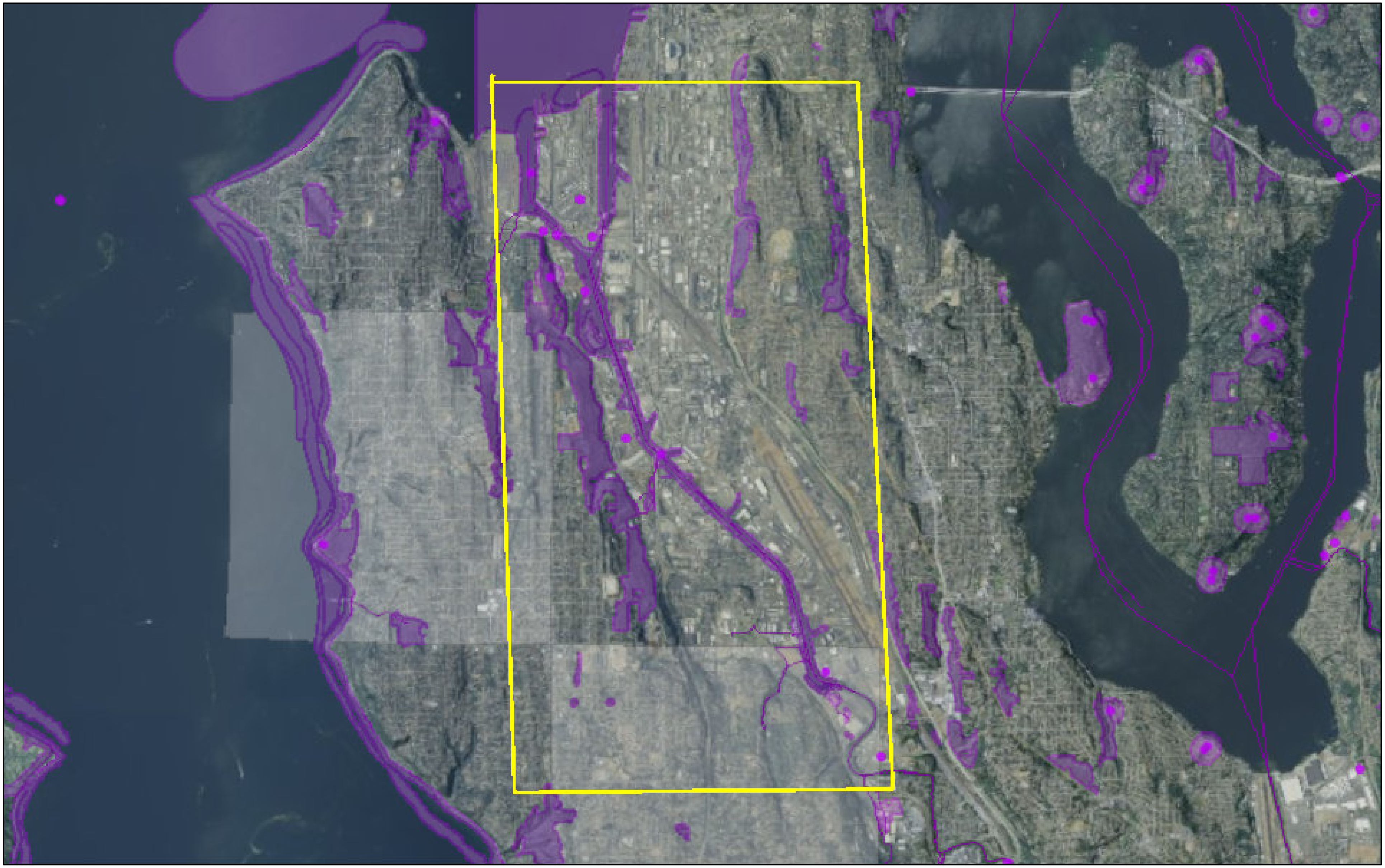
Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Pink Salmon Odd Year Oncorhynchus gorbuscha	Duwamish Waterway FISHDIST 43628	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Purple martin Progne subis	KELLOGG ISLAND WS_OccurPolygon 3831 August 04, 2004	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	GPS	N/A Candidate PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Purple martin Progne subis	TERMINAL 105 PARK WS_OccurPolygon 3832 August 04, 2004	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	GPS	N/A Candidate PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Purple martin Progne subis	JACK BLOCK PARK WS_OccurPolygon 3834 August 08, 2004	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	GPS	N/A Candidate PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Resident Coastal Cutthroat Oncorhynchus clarki	Duwamish River FISHDIST 40721	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Resident Coastal Cutthroat Oncorhynchus clarki	FISHDIST 41156	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Resident Coastal Cutthroat Oncorhynchus clarki	FISHDIST 41575	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Resident Coastal Cutthroat Oncorhynchus clarki	Duwamish Waterway FISHDIST 43623	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Resident Coastal Cutthroat Oncorhynchus clarki	FISHDIST 43872	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Sockeye Oncorhynchus nerka	Duwamish River FISHDIST 40730	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Sockeye Oncorhynchus nerka	Duwamish Waterway FISHDIST 43629	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Steelhead Oncorhynchus mykiss	Duwamish River SASI 6168	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	Duwamish River SASI 6175	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	SASI 6168	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	SASI 6175	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	Duwamish Waterway SASI 6168	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Steelhead Oncorhynchus mykiss	Duwamish Waterway SASI 6175	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Summer Steelhead Oncorhynchus mykiss	Duwamish River FISHDIST 40731	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Summer Steelhead Oncorhynchus mykiss	Duwamish Waterway FISHDIST 43630	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Western (Pacific) Pond Turtle Actinemys marmorata	WS_OccurPoint 18745 January 01, 2001	Occurrence Biotic detection http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A Endangered PHS LISTED	Y QTR-TWP	WA Dept. of Fish and Wildlife Points
Western (Pacific) Pond Turtle Actinemys marmorata	WS_OccurPoint 10065 July 01, 1988	Occurrence Biotic detection http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A Endangered PHS LISTED	Y QTR-TWP	WA Dept. of Fish and Wildlife Points
Wetlands	GREEN RIVER WETLANDS PHSREGION 902525	Aquatic Habitat N/A http://www.ecy.wa.	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Wetlands	REGION 4 SALTWATER PHSREGION 903606	Aquatic Habitat N/A http://www.ecy.wa.	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Winter Steelhead Oncorhynchus mykiss	Duwamish River FISHDIST 40732	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Winter Steelhead Oncorhynchus mykiss	FISHDIST 41162	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Winter Steelhead Oncorhynchus mykiss	Duwamish Waterway FISHDIST 43631	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

WDFW Test Map



February 21, 2015

	PHS Report Clip Area		AS MAPPED		TOWNSHIP
●	PT		SECTION		
—	LN		QTR-TWP		

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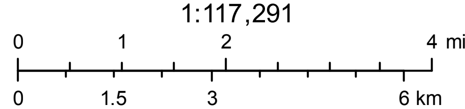

WDFW

ATTACHMENT B

Species' Life Histories

SPECIES' LIFE HISTORIES

June 22, 2015

Project No. LY15160310

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SPECIES' LIFE HISTORIES

1.0 INTRODUCTION

This document provides brief descriptions of the life histories of species listed under the Endangered Species Act (ESA), and those proposed for listing, that may occur in the action area of the proposed project. The species discussed herein include:

- Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*);
- Puget Sound steelhead trout (*O. mykiss*);
- Coastal/Puget Sound bull trout (*Salvelinus confluentus*) and Dolly Varden (*S. malma*);
- Bocaccio (*Sebastes paucispinis*);
- Yelloweye rockfish (*S. ruberrimus*); and
- Canary rockfish (*S. pinniger*).

2.0 CHINOOK SALMON

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for Puget Sound Chinook salmon.

2.1 SPECIES DESCRIPTION

The Chinook salmon is the largest of the Pacific salmon. Also known as "king" salmon, adult Chinook salmon migrate from a marine environment into freshwater streams and rivers of their birth where they spawn and die. Among Chinook salmon, two distinct races have evolved:

1. A "stream-type" Chinook is found most commonly in headwater streams. Stream-type Chinook salmon have a longer freshwater residency and perform extensive offshore migrations before returning to their natal streams in the spring or summer months.
2. An "ocean-type" Chinook is commonly found in coastal streams in North America. Ocean-type Chinook typically migrate to sea within the first 3 months of emergence, but they may spend up to a year in fresh water prior to emigration. They also spend their ocean life in coastal waters. Ocean-type Chinook salmon return to their natal streams or rivers as spring, winter, fall, summer, and late-fall runs, but summer and fall runs predominate (Healey, 1991).

The difference between these life history types is physical, with both genetic and morphological foundations (USACE, 2000).

2.2 HABITAT

Adult female Chinook will prepare a spawning bed, called a redd, in a stream area with suitable gravel composition, water depth, and velocity. Redds will vary widely in size and in location within the stream or river. The adult female Chinook may deposit eggs in four to five “nesting pockets” within a single redd. After laying eggs in a redd, adult Chinook will guard the redd from 4 to 25 days before dying. Chinook salmon eggs will hatch, depending upon water temperatures, between 90 to 150 days after deposition. Streamflow, gravel quality, and silt load all significantly influence the survival of developing Chinook salmon eggs. Juvenile Chinook may spend from 3 months to 2 years in fresh water after emergence and before migrating to estuarine areas as smolts, and then into the ocean to feed and mature. Juvenile ocean-type Chinook tend to utilize estuaries and coastal areas more extensively for juvenile rearing. Juvenile Chinook salmon feed primarily on aquatic insect larvae and terrestrial insects, typically in the nearshore areas. Puget Sound Chinook salmon hatch and rear in streams and rivers flowing into Puget Sound and the Dungeness River and its tributaries (USACE, 2000).

2.3 DISTRIBUTION

The Puget Sound Chinook Evolutionarily Significant Unit (ESU) is listed as threatened under the ESA. The range for the Puget Sound Chinook salmon ESU includes all marine, estuarine, and river reaches accessible to listed Chinook salmon in Puget Sound. Puget Sound marine areas include South Sound, Hood Canal, and North Sound to the international boundary at the outer extent of the Strait of Georgia, Haro Strait, and the Strait of Juan De Fuca to a straight line extending north from the west end of Freshwater Bay, inclusive. Excluded are areas above Tolt Dam (Washington), Lansburg Diversion (Washington), Alder Dam (Washington), and Elwha Dam (Washington) or above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) (USACE, 2000).

Chinook salmon in the Puget Sound ESU spawn from Dakota Creek north of the Nooksack River in the north, through south Puget Sound, into Hood Canal, and out the Strait of Juan de Fuca to the Elwha River. These spawning distributions are relatively well known compared to information on the location of juvenile rearing areas and historical spawning distributions in most basins (Ruckelshaus et al., 2006).

Ruckelshaus et al. (2006) determined that the following 22 historical populations currently contain Chinook salmon:

1. North Fork Nooksack River
2. South Fork Nooksack River
3. Lower Skagit River
4. Upper Skagit River

5. Cascade River
6. Lower Sauk River
7. Upper Sauk River
8. Suiattle River
9. North Fork Stillaguamish River
10. South Fork Stillaguamish River
11. Skykomish River
12. Snoqualmie River
13. Sammamish River
14. Cedar River
15. Green/Duwamish River
16. White River
17. Puyallup River
18. Nisqually River
19. Skokomish River
20. Mid-Hood Canal Rivers
21. Dungeness River
22. Elwha River

2.4 POPULATION TRENDS

Overall, the natural spawning escapement estimates for Puget Sound Chinook salmon populations are improved relative to those at the time of the previous status review of Puget Sound Chinook salmon conducted with data through 1997. The differences between population escapement estimates based on status assessments using data from 1997 and the present assessment using data through 2002 could be due to (1) revised pre-1997 data, (2) differences in which fish are counted as part of a population, (3) new information on the fraction of natural spawners that are hatchery fish, or (4) true differences reflected in new data on natural spawners obtained over the most recent 5 years. The median across populations of the most recent 5-year geometric mean of natural escapement for the same 22 populations through 1997 was N = 438 (compared to N = 771 through 2002), and the range was 1 to 5,400. As was the case at the time of the previous status review, it is not possible to determine the status of the natural-origin, natural spawners in half the populations of Chinook salmon in Puget Sound. The most dramatic change in recent natural escapement estimates from the previous status assessment was in the Green River—the recent natural-origin escapement estimate is lower than the previous one by almost 5,000 spawners. This apparent drop in natural escapement is probably due primarily to new information about the fraction of hatchery fish that are spawning naturally (Good et al., 2005).

Throughout the ESU, the estimates of trends in natural spawning escapements for Puget Sound Chinook salmon populations are similar to the previous status review of Puget Sound Chinook salmon conducted with data through 1997. Some populations exhibit improvement in trends relative to the last status assessment, and others show more significant declines. The median across populations of the long-term trend in natural spawners was a 1.1% decline per year through 1997, compared to a median estimate indicating a flat trend through 2002. Twelve populations had declining long-term trends through 1997, and ten populations had declining long-term trends through 2002. Short-term trends were generally more positive in recent years—the median trend across 22 populations through 1997 was a 4% decline per year, and the median trend through 2002 was a 1.1% increase per year. Fourteen populations showed declining short-term trends at the time of the previous status reviews, and only four populations exhibited declining short-term trends in recent years. There is a lack information on the fraction of naturally spawning, hatchery-origin fish for 10 of the 22 populations of Chinook salmon in Puget Sound, so the understanding of the trend in natural-origin spawners among populations across the ESU is incomplete (Good et al., 2005).

2.5 THREATS

Habitat throughout the ESU has been blocked or degraded. In general, forest practices impacted upper tributaries, and agriculture or urbanization impacted lower tributaries and mainstem rivers. Diking for flood control, draining and filling of freshwater and estuarine wetlands, and sedimentation due to forest practices and urban development are problematic throughout the ESU. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in several basins. A variety of critical habitat issues exist for streams in the range of this ESU, including changes in flow regime, sedimentation, high temperatures, streambed instability, estuarine loss, loss of large woody debris, loss of pool habitat, and blockage or passage problems associated with dams or other structures (Good et al., 2005).

The Puget Sound Salmon Stock Review Group of the Pacific Fishery Management Council (PFMC, 1997) provided an extensive review of habitat conditions for several stocks in this ESU. It concluded that reductions in habitat capacity and quality have contributed to escapement problems for Puget Sound Chinook salmon, citing evidence of direct losses of tributary and mainstem habitat due to dams, and of slough and side-channel habitat due to diking, dredging, and hydromodification. It also cited reductions in habitat quality due to land management activities. Eleven out of 29 stocks in this ESU are classified as being sustained, in part, through artificial propagation. Nearly 2 billion fish have been released into Puget Sound tributaries since the 1950s (Good et al., 2005). The vast majority of these fish were derived from local returning fall-run adults. Returns to hatcheries have accounted for 57% of total spawning escapement, although the hatchery contribution to spawner escapement is probably much higher than that due to hatchery-derived strays on the spawning grounds. Almost all releases into this ESU have come from stocks within this ESU, with the majority of within-ESU transfers coming from the Green River hatchery or hatchery broodstocks derived from Green River stock (Good et al., 2005). The electrophoretic similarity between Green River fall-run Chinook salmon and several other fall-run stocks in Puget Sound suggests that there may have been a significant effect from some hatchery transplants.

Overall, the pervasive use of Green River stock throughout much of the extensive hatchery network that exists in this ESU may reduce the genetic diversity and fitness of naturally spawning populations (Good et al., 2005).

Harvest impacts on Puget Sound Chinook salmon stocks were quite high. Ocean exploitation rates on natural stocks averaged 56 to 59%; total exploitation rates averaged 68 to 83% (1982 to 1989 brood years). Total exploitation rates on some stocks have exceeded 90% (Good et al., 2005).

Previous assessments of stocks within this ESU identified several stocks as being at risk or of concern (Good et al., 2005).

2.6 CONSERVATION EFFORTS

On January 19, 2007, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Services (NOAA-Fisheries) adopted the final ESA-recovery plan for Puget Sound Chinook salmon. Under the ESA, a recovery plan must have quantitative recovery criteria and goals, identify threats to survival, site-specific management strategies and actions necessary to address the threats, cost estimates of the actions, and a schedule for implementation. A monitoring and adaptive management program is also included in the recovery plan. In addition to the general requirements, this plan was directed by the recovery criteria developed by the group of scientists appointed by NOAA-Fisheries and the Puget Sound Technical Recovery Team.

3.0 PUGET SOUND STEELHEAD TROUT

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for Puget Sound steelhead trout.

3.1 SPECIES DESCRIPTION

The life history of steelhead trout is one of the most complex of any of the salmonid species. The species exhibits both anadromous forms (steelhead) and resident forms (usually referred to as rainbow or redband trout). They reside in the marine environment for 2 to 3 years before returning to their natal stream to spawn as 4- or 5-year-old fish. Unlike Pacific salmon, steelhead trout are iteroparous or capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and those that do are usually females (USACE, 2000).

Biologically, steelhead can be divided into two reproductive ecotypes, based on their state of sexual maturity at the time of river entry. These two ecotypes are termed “stream-maturing” and “ocean-maturing.” Stream-maturing steelhead enter fresh water in a sexually immature condition and require from several months to a year to mature and spawn. These fish are often referred to as "summer-run" steelhead. Ocean-maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. These fish are commonly referred to as "winter-run" steelhead. In the Columbia River Basin essentially all steelhead that return to streams east of the Cascade Mountains are stream-maturing. Ocean-maturing fish are the predominate ecotype in coastal streams and lower Columbia River tributaries (USACE, 2000).

3.2 HABITAT

Native steelhead in California generally spawn earlier than those to the north with spawning beginning in December. Washington populations begin spawning in February or March. Native steelhead spawning in Oregon and Idaho is not well-documented. In the Clackamas River in Oregon, winter-run steelhead spawning begins in April and continues into June. In the Washougal River, Washington, summer-run steelhead spawn from March into June whereas summer-run fish in the Kalama River, Washington, spawn from January through April. Among inland steelhead, Columbia River populations from tributaries upstream of the Yakima River spawn later than most downstream populations.

Depending on water temperature, fertilized steelhead eggs may incubate in redds for 1.5 to 4 months before hatching as "alevins." Following yolk sac absorption, young juveniles or "fry" emerge from the gravel and begin active feeding. Juveniles rear in fresh water for 1 to 4 years, then migrate to the ocean as smolts. Downstream migration of wild steelhead smolts in the lower Columbia River begins in April, peaks in mid-May and is essentially complete by the end of June (FPC, 1993, 1995, 1997). Previous studies of the timing and duration of steelhead downstream migration indicate that they typically move quickly through the lower Columbia River estuary with an average daily movement of about 21 kilometers (km) (Dawley et al., 1979 and 1980).

3.2.1 Winter-Run Steelhead

In general, winter-run, or ocean-maturing steelhead return as adults to the tributaries of Puget Sound from December to April (WDF et al., 1973). Spawning occurs from January to mid June, with peak spawning occurring from mid-April through May. Prior to spawning, maturing adults hold in pools or in side channels to avoid high winter flows.

Steelhead tend to spawn in moderate to high-gradient sections of streams. In contrast to semelparous Pacific salmon, steelhead females do not guard their redds or nests, but return to the ocean following spawning (Burgner et al., 1992). Spawned-out females that return to the sea are referred to as "kelts" (NOAA-Fisheries, 2005).

3.2.2 Summer-Run Steelhead

The life history of summer-run steelhead is highly adapted to specific environmental conditions. Because these conditions are not common in Puget Sound, the relative incidence and size of summer-run steelhead populations is substantially less than that for winter-run steelhead. Summer-run steelhead have also not been widely monitored; in part, because of their small population size and the difficulties in monitoring fish in their headwater holding areas. Sufficient information exists for only 4 of the 16 Puget Sound summer-run steelhead populations identified in the 2002 Salmon Steelhead Inventory (SaSI) to determine the population status (WDFW, 2002).

3.2.3 Juvenile Life History

The majority of steelhead juveniles reside in fresh water for 2 years prior to emigrating to marine habitats, with limited numbers emigrating as 1- or 3-year old smolts. Smoltification and seaward migration occur principally from April to mid-May (WDF et al., 1973). Two-year-old naturally produced smolts are usually 140 to 160 millimeters (mm) in length (Wydoski and Whitney, 1979; Burgner et al., 1992). The inshore migration pattern of steelhead in Puget Sound is not well understood; it is generally thought that steelhead smolts move quickly offshore (Hartt and Dell, 1986).

3.2.4 Ocean Migration

Steelhead oceanic migration patterns are poorly understood. Evidence from tagging and genetic studies indicates that Puget Sound steelhead travel to the central North Pacific Ocean (French et al., 1975; Hartt and Dell, 1986; Burgner et al., 1992). Puget Sound steelhead feed in the ocean for 1 to 3 years before returning to their natal stream to spawn. Typically, Puget Sound steelhead spend 2 years in the ocean, although, notably, Deer Creek summer-run steelhead spend only a single year in the ocean before spawning (NOAA-Fisheries, 2005).

3.3 DISTRIBUTION

Steelhead are found in most accessible larger tributaries to Puget Sound and the eastern Strait of Juan de Fuca. A survey of the Puget Sound District in 1929 and 1930, which did not include Hood Canal, identified steelhead in every major basin except the Deschutes River. The propensity for steelhead to spawn in side channels and tributaries during winter and spring months when flows are high and visibility is low would likely have resulted in an underreporting of steelhead sightings. Additionally, by the late 1920s steelhead abundance had already undergone significant declines and many marginal or ephemeral populations may have already disappeared (Hard et al., 2007).

3.4 POPULATION TRENDS

Declining trends in abundance have occurred despite widespread reductions in direct harvest of natural steelhead in this ESU since the mid-1990s. Natural run sizes (sum of harvest and escapement) for most populations show even more marked declining trends than indicated by escapements, indicating the substantially reduced harvest rates for natural fish since the early 1990s have not resulted in a rebound in steelhead production in Puget Sound. For many of the Puget Sound populations, the decline in adult recruits per spawner has been precipitous. Populations of summer-run steelhead occur throughout the Puget Sound ESU but are concentrated in the northern Puget Sound area, are generally small, and are characterized as isolated populations adapted to streams with distinct attributes (Hard et al., 2007).

3.5 THREATS

Habitat utilization by steelhead has been most affected by reductions in habitat quality and by fragmentation. A number of large dams in Puget Sound basins have affected steelhead. In addition to eliminating accessibility to habitat, dams affect habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and the movement of large woody debris. Many of the lower reaches of rivers and their tributaries in Puget Sound have been dramatically altered by urban development. Urbanization and suburbanization have resulted in the loss of historical land cover in exchange for large areas of imperious surface (buildings, roads, parking lots, etc.) (Hard et al., 2007).

The loss of wetland and riparian habitat has dramatically changed the hydrology of many urban streams, with increases in flood frequency and peak flow during storm events and decreases in groundwater-driven summer flows. Flood events result in gravel scour, bank erosion, and sediment deposition. Land development for agricultural purposes has also altered the historical land cover; however, because much of this development took place in river floodplains, there has been a direct impact on river morphology. River braiding and sinuosity have been reduced through the construction of dikes, hardening of banks with riprap, and channelizing the mainstem. Constriction of rivers, especially during high-flow events, increases likelihood of gravel scour and dislocation of rearing juveniles (Hard et al., 2007).

This ESU is likely to be at elevated risk due to the reduced complexity of spatial structure of its steelhead populations and, consequently, diminishing connectivity among them. The declines in natural abundance for most populations, coupled with large numbers of anthropogenic barriers such as impassable culverts, sharply reduce opportunities for natural adfluvial movement and migration between steelhead aggregations in different watersheds. Resident *O. mykiss* below migration barriers in watersheds throughout the ESU may provide short-term buffers against demographic stochasticity in many of these populations. Resident *O. mykiss* were considered to be a relatively minor component of these anadromous populations based on field surveys of juvenile fish in fresh water (Hard et al., 2007).

Reduced harvest levels and recent changes in management of natural steelhead, the recent onset of recovery efforts in Puget Sound and Hood Canal for Chinook salmon and summer run chum salmon (*O. keta*) prompted by the listing of those ESUs, and reduced off-site plantings of hatchery steelhead were all considered as recent actions that could positively affect Puget Sound steelhead. However, the continued releases of out-of-ESU hatchery summer run and winter run steelhead throughout the region, reductions in steelhead escapement goals to help support harvest opportunities in several systems, evidence for diminishing marine survival rates, a recent increase in the Pacific Decadal Oscillation Index reflecting a general change in climate in the region toward warmer and drier conditions, increases in pinniped populations in Puget Sound, degradation of water quality in Hood Canal and southern Puget Sound, and continued land development and urbanization with associated impacts on freshwater habitat are all likely to increase risk to this ESU (Hard et al., 2007).

3.6 CONSERVATION EFFORTS

Reduced harvest levels and recent changes in management of natural steelhead, the recent onset of recovery efforts in Puget Sound and Hood Canal for Chinook salmon and summer run chum salmon prompted by the listing of those ESUs, and reduced off-site plantings of hatchery steelhead are recent actions that could positively affect Puget Sound steelhead (Hard et al., 2007).

4.0 COASTAL/PUGET SOUND BULL TROUT AND DOLLY VARDEN

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for Coastal/Puget Sound bull trout and Dolly Varden. Dolly Varden have been proposed as threatened under the ESA by the U.S. Fish and Wildlife Service because of the similarity of appearance to bull trout. It is assumed that Dolly Varden share many of the same life history characteristics of bull trout.

4.1 SPECIES DESCRIPTION

Bull trout are native to western North America and are widespread throughout tributaries of the Columbia River Basin, including the headwaters in Montana and Canada. Bull trout are generally nonanadromous and live in a variety of habitats including small streams, large rivers, and lakes or reservoirs. However, Coastal/Puget Sound bull trout are anadromous, migrating and maturing in Puget Sound or the Pacific Ocean. They may spend the first 2 to 4 years in small natal streams and then migrate through the larger rivers, lakes, and reservoirs to Puget Sound and the Pacific Ocean (USACE, 2000).

Bull trout exhibit resident and migratory life history strategies through much of the current range (Rieman and McIntyre, 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear from 1 to 4 years before migrating to either a lake (adfluvial), river (fluvial), or in certain coastal areas, to salt water (anadromous), where maturity is reached in one of the three habitats (Fraley and Shephard, 1989; Goetz, 1989). Resident and migratory forms may be found together and it is suspected that bull trout give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre, 1993).

In some stocks of bull trout, maturing adults may begin migrating to spawning grounds in the spring or early summer. Female bull trout may deposit up to 5,000 or 10,000 eggs in redds they build, depending on their size. The embryos incubate during the fall, winter, and spring, and the surviving fry emerge from the redds in April and May. The rate of embryo development is dependent upon temperature. After they emerge, the young bull trout disperse upstream and downstream to find suitable areas to feed. Feeding areas for Coastal/Puget Sound bull trout include estuaries and nearshore marine waters. Young fish feed primarily on aquatic invertebrates in the streams during their first 2 or 3 years but become more piscivorous as they get larger (USACE, 2000).

The bull trout has been eliminated from some of its native range and seriously reduced in abundance in most of the remaining drainages. Excessive exploitation, habitat degradation, and introductions of exotic species are probably the major causes of the declines (USACE, 2000).

4.2 HABITAT

Bull trout have more specific habitat requirements compared to other salmonids (Rieman and McIntyre, 1993). Habitat components that appear to influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrates, and migratory corridors (Oliver, 1979; Pratt, 1984, 1992; Fraley and Shephard, 1989; Goetz, 1989; Hoelscher and Bjornn, 1989; Sedell and Everest, 1991; Rieman and McIntyre, 1993, 1995; Rich, 1996; Watson and Hillman, 1997). Bull trout typically spawn from August to November during periods of decreasing water temperatures. However, migratory bull trout frequently begin spawning migrations as early as April. Bull trout require spawning substrate consisting of loose, clean gravel relatively free of fine sediments (Fraley and Shephard, 1989). Depending on water temperature, incubation is normally 100 to 145 days (Pratt, 1992) and, after hatching, juveniles remain in the substrate. Time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May depending upon water temperatures and increasing streamflows (Pratt, 1992; Ratliff and Howell, 1992). Bull trout are opportunistic feeders with food habits primarily a function of size and life history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro zooplankton, and small fish (Boag, 1987; Goetz, 1989; Donald and Alger, 1993). Adult migratory bull trout are primarily piscivorous, known to feed on various fish species (Fraley and Shephard, 1989; Donald and Alger, 1993).

4.3 DISTRIBUTION

The Coastal/Puget Sound bull trout distinct population segment (DPS) is listed as threatened under the ESA. The Coastal/Puget Sound bull trout population segment encompasses all Pacific Coast drainages within Washington, including Puget Sound. This population segment is discrete because the Pacific Ocean and the crest of the Cascade Mountain Range geographically segregate it from subpopulations. The population segment is significant to the species as a whole because it is thought to contain the only anadromous forms of bull trout in the conterminous United States, thus, occurring in a unique ecological setting. No bull trout exist in coastal drainages south of the Columbia River (USACE, 2000).

4.4 POPULATION TRENDS

A 1998 Washington Department of Fish and Wildlife (WDFW) study found 80 bull trout/Dolly Varden populations in Washington: 14 (18%) were healthy, two (3%) were in poor condition, six (8%) were critical, and the status of 58 (72%) of the stocks were unknown. Bull trout are estimated to have occupied about 60% of the Columbia River Basin, and presently occur in 45% of the estimated historical range (Quigley and Arbelbide, 1997).

Although specific data on population abundance, trends, and spatial distribution is scarce, ample information exists to indicate that the bull trout are threatened. Population abundance and distribution has declined within many individual river basins, and habitat is severely fragmented in many instances (SSDC, 2007).

4.5 THREATS

Bull trout display a high degree of sensitivity to environmental disturbance and have been significantly impacted by habitat degradation similar to other listed and sensitive species. In addition to migratory barriers, such as dams or diversion structures which isolate populations, bull trout are threatened by poor water quality, sedimentation, harvest, and the introduction of nonnative species. Although several populations lie completely or partially within national parks or wilderness areas, these local populations are threatened by the presence of introduced brook trout or from habitat degradation outside of the park boundaries. Based on biological and genetic information, the U.S. Fish and Wildlife Service (USFWS) has delineated two management units in the Coastal/Puget Sound population segment. Olympic Peninsula bull trout populations are thought to differ from those in the Puget Sound management unit, which originate in watersheds on the western slopes of the Cascade Mountains. Although the two units are connected by marine waters, there is currently no evidence that bull trout from Puget Sound migrate to the Strait of Juan de Fuca or Hood Canal (SSDC, 2007).

Land and water management activities that degrade bull trout habitat and continue to threaten all of the bull trout population segments include dams, forest management practices, livestock grazing, agriculture, and roads and mining (Beschta et al., 1987; Chamberlain et al., 1991; Furniss et al., 1991; Meehan, 1991; Nehlsen et al., 1991; Sedell and Everest, 1991; Craig and Wissmar, 1993; MBTSG, 1998). Fish barriers, timber harvesting, agricultural practices, and urban development are thought to be major factors affecting “native char” in the Coastal/Puget Sound DPS (64 Federal Register 58909-58933).

4.6 CONSERVATION EFFORTS

The USFWS has subdivided the Coastal/Puget Sound bull trout DPS into two separate management units: the Puget Sound and the Olympic Peninsula (USFWS, 2004a,b). Individual draft recovery plans have been prepared for each of these management units. Volume I of the Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout covers the Puget Sound Management Unit, addressing bull trout populations in all watersheds within the Puget Sound Basin north of the Columbia River in Washington and the marine nearshore areas of Puget Sound. It also includes the Chilliwack River and associated tributaries flowing in British Columbia, Canada. Volume II covers the Olympic Peninsula Management Unit, including all watersheds within the Olympic Peninsula and the nearshore marine waters of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal.

The USFWS revised the draft recovery plan for the United States population of bull trout (USFWS, 2014). According to the USFWS (2014), specific recovery actions in Puget Sound may include removing or modifying structures such as riprap, dikes, and tide gates; restoring tidal flow to coastal wetlands; contaminant remediation; or restoring eelgrass or kelp beds. Active, ongoing partnerships such as the Puget Sound Partnership and Puget Sound Nearshore Ecosystem Restoration Project are already contributing to bull trout recovery through restoration projects.

Generally, salmon recovery actions also function to improve habitat for bull trout; often spawning and rearing habitat for salmon and steelhead is concurrently used as foraging, migrating, and overwintering (FMO) habitat by bull trout. Moreover, restoration of chinook and steelhead runs in Olympic Peninsula and Puget Sound core areas (e.g., the Elwha basin restoration in the Elwha core area, ongoing projects in Lewis and Skokomish core areas) also benefits bull trout by providing juvenile salmonids as forage fish (USFWS, 2014).

5.0 PUGET SOUND ROCKFISH SPECIES PROPOSED FOR LISTING UNDER THE ENDANGERED SPECIES ACT

On April 27, 2010, NOAA-Fisheries listed three species of Puget Sound rockfish under the ESA. The three species are:

- The Georgia DPS of bocaccio (*Sebastes paucispinis*), listed as endangered;
- The Georgia Basin DPS of the yelloweye rockfish (*S. ruberrimis*), listed as threatened; and
- The Georgia Basin DPS of the canary rockfish (*S. pinniger*), listed as threatened.

The following sections will present brief descriptions of the species' biology, their habitats, distribution, population trends, threats, and conservation efforts.

5.1 BOCACCIO

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the bocaccio.

5.1.1 Species Description

Bocaccio are large Pacific Coast rockfish that reach up to 3 feet (1 meter [m]) in length with a distinctively long jaw extending to at least the eye socket. Their body ranges in color from olive to burnt orange or brown as adults. Young bocaccio are light bronze in color and have small brown spots on their sides (NOAA-Fisheries, 2009a).

Rockfish are unusual among the bony fish in that fertilization and embryo development is internal, and female rockfish give birth to live larval young. Larvae are found in surface waters, and may be distributed over a wide area extending several hundred miles offshore. Fecundity in female bocaccio ranges from 20,000 to over 2 million eggs, considerably more than many other rockfish species. Larvae and small juvenile rockfish may remain in open waters for several months, being passively dispersed by ocean currents (NOAA-Fisheries, 2009a).

Larval rockfish feed on diatoms, dinoflagellates, tintinnids, and cladocerans, and juveniles consume copepods and euphausiids of all life stages. Adults eat demersal invertebrates and small fishes, including other species of rockfish, associated with kelp beds, rocky reefs, pinnacles, and sharp dropoffs. Approximately 50% of adult bocaccio mature in 4 to 6 years. Bocaccio are difficult to age but are suspected to live as long as 50 years (NOAA-Fisheries, 2009a).

5.1.2 Habitat

Bocaccio are most common at depths between 160 and 820 feet (50 to 250 m), but may be found as deep as 1,560 feet (475 m). Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops. Juveniles and subadults may be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures, such as piers and oil platforms (NOAA-Fisheries, 2009a).

5.1.3 Distribution

Bocaccio range from Punta Blanca, Baja California, to the Gulf of Alaska off the Krozoff and Kodiak Islands. They are most common between Oregon and northern Baja California. In Puget Sound, most bocaccio are found south of the Tacoma Narrows (NOAA-Fisheries, 2009a).

5.1.4 Population Trends

Recreational catch and effort data spanning 12 years from the mid-1970s to mid-1990s suggests possible declines in abundance in Washington. Additional data over this period show the number of angler trips increased substantially and the average number of rockfish caught per trip declined. Taken together, these data suggest declines in the population over time. Currently there are no survey data being taken for this species, but few of these fish are caught by fishermen and none have been caught by Washington state biological surveys in 20 years, suggesting very low population abundance. They are thought to be at an abundance that is less than 10% of their unfished abundance. A 2005 stock assessment by NOAA-Fisheries suggests bocaccio may have higher populations than was thought to be the case (NOAA-Fisheries, 2009a).

Bocaccio were infrequently recorded in the recreational catch data reported by Buckley (1967, 1968, and 1970) and Bargmann (1977) for Puget Sound Proper from the mid-1960s into the early 1970s. However, bocaccio were reported up to 8 to 9% of the catch in the late-1970s from the Washington State Sport Catch Reports (WDF, 1975-86). The majority of the catch (66%) during 1975 to 1986 was from punch card area 13 (south of the Tacoma Narrows) (as reported in the Washington Sport Catch Reports); Point Defiance and the Tacoma Narrows were historically reported as local areas of high bocaccio abundance in punch card area 13. Bocaccio appear to have declined in frequency, relative to other species, from the 1970s to the 1980s to the 1990s. From 1975 to 1979, bocaccio were reported as an average of 4.63% of the catch (sample size unknown; reference Washington State Sport Catch Reports). During 1980 to 1989, they were

0.24% of the 8,430 rockfish identified (Palsson et al., 2008). From 1996 to 2007, bocaccio have not been observed out of the 2,238 rockfish identified in the dockside surveys of the recreational catches (Palsson et al., 2008). In a sample this large, the probability of observing at least one bocaccio would be 99.5%, assuming it was at the same frequency (0.24%) as in the 1980s. Also (as expected as a result of their habitat preferences), bocaccio have not been observed in the WDFW fisheries independent trawl surveys (Palsson et al., 2008).

5.1.5 Threats

Bocaccio are fished directly and are often caught as bycatch in other fisheries, including those for salmon. Adverse environmental factors led to recruitment failures in the early to mid-1990s (NOAA-Fisheries, 2009a).

5.1.6 Conservation Efforts

Various state restrictions on fishing have been put in place over the years. Current regulations in the State of Washington, where the species is most at risk, limit the daily rockfish catch to three rockfish total (of any species). Because this species is so slow-growing, late to mature, and long-lived, recovery from the above threats will take many years, even if the threats are no longer affecting the species (NOAA-Fisheries, 2009a).

5.2 YELLOWEYE ROCKFISH

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the yelloweye rockfish.

5.2.1 Species Description

Yelloweye rockfish are very large rockfish that reach up to 3.5 feet (~1 m) in length and 39 pounds (18 kilograms [kg]) in weight. They are orange-red to orange-yellow in color and may have black on their fin tips. Their eyes are bright yellow. Adults usually have a light to white stripe on the lateral line; juveniles have two light stripes, one on the lateral line and a shorter one below the lateral line (NOAA-Fisheries, 2009b).

Rockfish are unusual among the bony fish in that fertilization and embryo development is internal and female rockfish give birth to live larval young. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore. Fecundity in female yelloweye rockfish ranges from 1.2 to 2.7 million eggs, considerably more than many other rockfish species. Larvae and small juvenile rockfish may remain in open waters for several months being passively dispersed by ocean currents (NOAA-Fisheries, 2009b).

Larval rockfish feed on diatoms, dinoflagellates, tintinnids, and cladocerans, and juveniles consume copepods and euphausiids of all life stages. Adults eat demersal invertebrates and small fishes, including other species of rockfish, associated with kelp beds, rocky reefs, pinnacles, and sharp dropoffs. Approximately 50% of adult yelloweye rockfish are mature by 16 inches (41 centimeters [cm]) total length (about 6 years of age). Yelloweye rockfish are among the longest lived of rockfishes, living up to 118 years (NOAA-Fisheries, 2009b).

5.2.2 Habitat

Juveniles and subadults tend to be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures such as piers and oil platforms. Adults generally move into deeper water as they increase in size and age, but usually exhibit strong site fidelity to rocky bottoms and outcrops. Yelloweye rockfish occur in waters 80- to 1,560-feet (25- to 475-m) deep, but are most commonly found between 300 to 590 feet (91 to 180 m) (NOAA-Fisheries, 2009b).

5.2.3 Distribution

Yelloweye rockfish range from northern Baja California to the Aleutian Islands, Alaska, but are most common from central California northward to the Gulf of Alaska (NOAA-Fisheries, 2009b).

5.2.4 Population Trends

Recreational catch and effort data spanning 12 years from the mid-1970s to mid-1990s suggests possible declines in abundance. While catch data are generally constant over time, the number of angler trips increased substantially, and there was a decline in the average number of rockfish caught per trip. Taken together, these data suggest declines in the population over time. Currently there are no survey data being taken for this species, but few of these fish are caught by fishermen, suggesting low population abundance (NOAA-Fisheries, 2009b).

Yelloweye rockfish occur more consistently in the recreational catch than bocaccio but at lower frequency than canary rockfish and are still infrequently observed (typically 1 to 2% in Puget Sound Proper and 2 to 5% in north Puget Sound). The frequency of yelloweye rockfish in Puget Sound Proper appears to have increased from a frequency of 0.34% (sample size 8,430) in 1980 to 1989 to a frequency of 2.7% (sample size 550) in 1996 to 2001. There were 3 recent years (1999 to 2001) when yelloweye rockfish were not reported in the recreation catch; however, the sample sizes were low these years and zeros are expected for an infrequent species when sample sizes are low (NOAA-Fisheries, 2008).

In north Puget Sound, in contrast, the frequency of yelloweye rockfish decreased between the 1980s and 1990s in the catch surveys. From 1980 to 1989, they were reported at a frequency of 1.9% (sample size 3,910), and from 1996 to 2001, they were reported at a frequency of 0.65% (sample size 1,718). Since 2002, fishing for yelloweye rockfish is prohibited in Puget Sound and thus no frequency data are available since 2002 from the recreational fishery (NOAA-Fisheries, 2008).

The early stock data do not report sample size (number of individuals identified), thus the uncertainty in the early estimates cannot be calculated. Species misidentification should not be a problem for yelloweye rockfish, but their frequency may be affected by nonrandom reporting in the 1960s and early 1970s. Buckley and Bargmann (1965 to 1973) suggest that only a few (2 to 3) common species were being recorded in some punch card areas (NOAA-Fisheries, 2008).

As expected, yelloweye rockfish have been observed infrequently in the WDFW fisheries independent trawl surveys in Puget Sound Proper, and in north Puget Sound, yelloweye rockfish were not observed in the WDFW trawl survey in 1987 1989 1991, or 2001, but were caught in 2004 (0.65% of the catch). In the Reef Environmental Education Foundation (REEF) scuba survey data, yelloweye rockfish have been sighted consistently throughout the Puget Sound (north and south) since 2001 at an average frequency of 0.5% of dives in the south reporting a sighting of yelloweye rockfish and 2% of dives in the north reporting a sighting. There is no evidence of a decline in the probability of sightings during dives (NOAA-Fisheries, 2008).

In the Strait of Georgia, yelloweye rockfish are common in the recent recreational catches; the proportion of yelloweye rockfish in the 2006 and 2005 recreational catch (Department of Fisheries and Oceans Canada catch data) was 17.1% and 7.5%, respectively. The high frequency of yelloweye rockfish in the recreational catch may reflect targeting for this species, as yelloweye rockfish are a small proportion of the rockfish observed in the few fisheries independent surveys that are available. A genetic tagging study in 2003 (Yamanaka et al., 2004), where data were collected from tissue taken from hooks, 1% of samples were yelloweye rockfish. In a 2003 pilot camera study designed to estimate rockfish biomass (Yamanaka et al., 2006), 439 rockfish were observed, of which one (0.2%) was a yelloweye rockfish. Another survey in 2004 in the southern Strait of Georgia identified 105 rockfish species, of which 5 (4.8%) were yelloweye rockfish (NOAA-Fisheries, 2008).

There appears to be limited information on population trends yelloweye rockfish in the Strait of Georgia. Data from the recreational creel survey conducted by Department of Fisheries and Oceans Canada is of limited value because the species composition information and groundfish-targeted effort is lacking; salmon-targeted and groundfish-targeted trips are reported together.

Submersible surveys were conducted in 1984 and 2003 in the Strait of Georgia (Yamanaka et al. 2004). Between the two surveys, there was a decline in the mean number of yelloweye rockfish per transect (8.57 to 4.65), but the difference was not statistically significant. Trend data are also available from the commercial long-line fishery (Yamanaka et al., 2004), which show generally declining trends in catch-per-unit-effort (CPUE) from the late 1980s through the 1990s, but interpretation is difficult given the effects of market forces and management regulations on commercial fisheries (NOAA-Fisheries, 2008).

5.2.5 Threats

Yelloweye rockfish are targeted by recreational and commercial fisheries and are often caught as bycatch in other fisheries, including those for salmon. Adverse environmental factors led to recruitment failures in the early- to mid-1990s (NOAA-Fisheries, 2009b).

5.2.6 Conservation Efforts

Various state restrictions on fishing have been put in place over the years, leading to the current ban on retention of yelloweye rockfish in Washington in 2003. Because this species is slow-growing, late to mature, and long-lived, recovery from these threats will take many years, even if the threats are no longer affecting the species (NOAA-Fisheries, 2009b).

5.3 CANARY ROCKFISH

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the canary rockfish.

5.3.1 Species Description

Canary rockfish are large rockfish that reach up to 2.5 feet (77 cm) in length and 10 pounds (4 kg) in weight. Adults have bright yellow to orange mottling over gray, three orange stripes across the head, and orange fins. Animals less than 14 inches long have dark markings on the posterior part of the spiny dorsal fin and gray along the lateral line (NOAA-Fisheries, 2009c).

Rockfish are unusual among the bony fish in that fertilization and embryo development is internal and female rockfish give birth to live larval young. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore. Fecundity in female canary rockfish ranges from 260,000 to 1.9 million eggs, considerably more than many other rockfish species. Larvae and small juvenile rockfish may remain in open waters for several months, being passively dispersed by ocean currents (NOAA-Fisheries, 2009c).

Larval rockfish feed on diatoms, dinoflagellates, tintinnids, and cladocerans, and juveniles consume copepods and euphausiids of all life stages. Adults eat demersal invertebrates and small fishes, including other species of rockfish, associated with kelp beds, rocky reefs, pinnacles, and sharp dropoffs. Approximately 50% of adult canary rockfish are mature at 14 inches (36 cm) total length (about 5 to 6 years of age). Canary rockfish can live to be 75 years old (NOAA-Fisheries, 2009c).

5.3.2 Habitat

Canary rockfish primarily inhabit waters 160- to 820-feet (50- to 250-m) deep but may be found to 1,400 feet (425 m). Juveniles and subadults tend to be more common than adults in shallow water and are associated with rocky reefs, kelp canopies, and artificial structures, such as piers and oil platforms. Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops where they hover in loose groups just above the bottom (NOAA-Fisheries, 2009c).

5.3.3 Distribution

Canary rockfish range between Punta Colnett, Baja California, and the Western Gulf of Alaska. Within this range, canary rockfish are most common off the coast of central Oregon (NOAA-Fisheries, 2009c).

5.3.4 Population Trends

Recreational catch and effort data spanning 12 years from the mid-1970s to mid-1990s suggests possible declines in abundance. While catch data are generally constant over this time period, the number of angler trips increased substantially, and the average number of canary rockfish caught per trip declined. Taken together, these data suggest declines in the population over time. Currently there are no survey data being taken for this species, but few of these fish are currently caught by fishermen, suggesting low population abundance. Canary rockfish used to be one of the three principal species caught in Puget Sound in the 1960s (NOAA-Fisheries, 2009c).

Canary rockfish occur more consistently in the recreational catch than bocaccio and yelloweye rockfish, but are still infrequently observed (typically 1 to 2% in Puget Sound Proper and 2 to 5% in north Puget Sound). Like bocaccio, canary rockfish appear to have become less frequent in the catch data since 1965 (NOAA-Fisheries, 2008). From 1980 to 1989, they were reported at a frequency of 1.1% (sample size 8,430) and 1.4% (sample size 3,910) in south and north Puget Sound, respectively. From 1996 to 2001, they were reported at a frequency of 0.73% (sample size 550) and 0.56% (sample size 1,718) in south and north Puget Sound, respectively (NOAA-Fisheries, 2008). The early stock data do not report sample size (number of individuals identified), thus the uncertainty in the early estimates cannot be calculated. Species misidentification should not be a problem for canary rockfish, but their reported frequency may be affected by nonrandom reporting of species in the catch in the 1960s and early 1970s. The data from Buckley and Bargmann (1967 to 1977) suggest that only a few (2 to 3) common species were being recorded in some punch card areas (NOAA-Fisheries, 2008).

Since 2002, fishing for canary rockfish in Puget Sound is prohibited and thus no frequency data are available from the recreational fishery since then. Canary rockfish have not been observed in the WDFW fisheries independent trawl surveys (Palsson et al., 2008). In REEF scuba survey data (REEF, 2008), canary rockfish were not observed in the first 3 years of the survey 1998 to 2000, when the number of dives was 100 to 130 per year. Since 2001, however, the number of dives per year has increased substantially, to 400 to 1,000 dives per year, and canary rockfish have been reported consistently since 2001 in 0.5 to 3.6% of dives with no evidence of a temporal decline in sightings (REEF, 2008). Canary rockfish have been documented in the Strait of Georgia, but the overwhelming research focus is on the large stocks that are commercially harvested off the west coast of Vancouver Island and in Queen Charlotte Strait (NOAA-Fisheries, 2008). The prevalence of this species in recreational fishing in the Strait of Georgia indicates that they are probably well-distributed but rare (1% of total rockfish catch) in enclosed waters and inlets (DFO, 2008). However, wide interannual variations in some recreational catch data suggests that catch estimates may be unreliable due to poor species identification and changing bag limits (NOAA-Fisheries, 2008). Recent long-line surveys throughout the Strait of Georgia collected 100 canary rockfish individuals from two shallow sets. All were adults (mean size 529 cm) in post-spawning condition (Lochead and Yamanaka, 2007). They have also been documented in Georgia Strait jig surveys (Yamanaka et al., 2006).

5.3.5 Threats

Canary rockfish are targeted by recreational and commercial fishers and are often caught as bycatch in other fisheries, including those for salmon. Adverse environmental factors led to recruitment failures in the early to mid-1990s (NOAA-Fisheries, 2009c).

5.3.6 Conservation Efforts

Various state restrictions on fishing have been put in place over the years, including banning retention of canary rockfish in all Washington marine waters in 2004. Because this species is slow-growing, late to mature, and long-lived, recovery from these threats will take many years, even if the threats are no longer affecting the species (NOAA-Fisheries, 2009c).

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ATTACHMENT C

Essential Fish Habitat Assessment (Magnuson-Stevens Fishery Conservation and Management Act)

ESSENTIAL FISH HABITAT ASSESSMENT

1.0 ACTION AGENCY

U.S. Environmental Protection Agency, Region 10, Seattle, Washington

2.0 LOCATION

Lower Duwamish Waterway, Seattle, King County, Washington (Township 24 North, Range 4 East, and Sections 18, 19, and 33).

3.0 PROJECT NAME

Enhanced Natural Recovery/Activated Carbon Pilot Study – Lower Duwamish Waterway

4.0 ESSENTIAL FISH HABITAT BACKGROUND

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires federal agencies to consult with the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries) on activities that may adversely affect essential fish habitat (EFH). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include "aquatic areas and their associated physical, chemical, and biological properties that are used by fish." They may include aquatic areas historically used by fish. "Substrate" includes "sediment, hard bottom, structures underlying the waters, and associated biological communities" (NMFS, 1999).

The MSA requires consultation for all actions that may adversely affect EFH and does not distinguish between actions within and outside of EFH. Any reasonable attempt to encourage the conservation of EFH must take into account actions that occur outside of EFH, such as upstream and upslope activities that may have an adverse effect on EFH. Therefore, EFH consultation with NOAA-Fisheries is required by federal agencies undertaking, permitting, or funding activities that may adversely affect EFH, regardless of its location.

This assessment evaluates the impacts of the Pilot Study to determine whether it "may adversely affect" designated EFH for federally managed fisheries species in the proposed Action Area (see Section 4.1 of BE). The assessment also describes conservation measures to avoid, minimize, or otherwise offset potential adverse effects of the Pilot Study on designated EFH.

5.0 IDENTIFICATION OF EFH

The Pacific Fishery Management Council (PFMC) has designated EFH for federally managed fisheries within the waters of Washington, Oregon, and California. The designated EFH for groundfish (PFMC, 1998a; Casillas et al., 1998) and coastal pelagic species (PFMC, 1998b) encompasses all waters from the mean high water line and upriver extent of salt water to the boundary of the United States exclusive economic zones (370.4 kilometers [km]) (PFMC, 1998a, 1998b). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, California, and Idaho, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally impassable barriers (e.g., natural waterfalls in existence for several hundred years) (PFMC, 1999). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception, to the Canadian border (PFMC, 1999).

Groundfish, coastal pelagic, and salmonid fish species that have designated EFH in Puget Sound are listed in Table 1. Coastal pelagic species and pink salmon (*Oncorhynchus gorbuscha*) likely do not occur in the action area; however, some of the groundfish species may occur in the action area. Chinook (*O. tshawytscha*) and coho (*O. kisutch*) occur in the action area. Refer to the relevant EFH designations (Casillas et al., 1998; PFMC, 1998a, 1998b; PFMC, 1999) for life-history stages of these species that may occur in the action area. Assessment of the impacts on these species' EFH from the Pilot Study is based on this information.

6.0 DETAILED DESCRIPTION OF THE PROPOSED PROJECT

The Pilot Study includes the following project elements:

- A sediment remedial action that consists of placing enhanced natural recovery (ENR) material without and with activated carbon (ENR+AC) at three pilot plots (i.e., intertidal, subtidal, and scour) located in the Lower Duwamish Waterway. The total area of coverage will be 3 acres.
- Three years of post-implementation monitoring to assess the effectiveness of ENR and ENR+AC in reducing the bioavailability of polychlorinated biphenyls (PCBs) in contaminated sediments at the three pilot plot areas.

For a more detailed project description, please refer to Section 3.0 of the biological evaluation.

7.0 POTENTIAL ADVERSE EFFECTS OF PROPOSED PROJECT

The EFH designation for the Pacific salmon fishery includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except above the impassible barriers identified by PFMC (1999). In estuarine and marine areas, proposed designated EFH for salmon extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California north of Point Conception (PFMC, 1999).

The Pacific salmon management unit includes Chinook, coho, and pink salmon. All three of these species use Puget Sound for adult migration, juvenile outmigration, and rearing where suitable habitat is present. Resident coho and Chinook remain within Puget Sound throughout their entire life histories.

The EFH designation for groundfish and coastal pelagics is defined as those waters and substrate necessary to ensure the production needed to support a long-term sustainable fishery. The marine extent of groundfish and coastal pelagic EFH includes those waters from the nearshore and tidal submerged environment within Washington, Oregon, and California state territorial waters out to the exclusive economic zone (370.4 km [231.5 miles]) offshore between Canada and the Mexican border.

The West Coast groundfish management unit includes 83 species that typically live on or near the bottom of the ocean. Species groups include skates and sharks, rockfishes (55 species), flatfishes (12 species) and groundfish. Some groundfish, such as lingcod (*Ophiodon elongatus*), cabezon (*Scorpaenichthys marmoratus*), and species of rockfish (*Sebastes* spp.) could potentially occur in the action area.

Coastal pelagics are schooling fishes, not associated with the ocean bottom, that migrate in coastal waters. West Coast pelagics include the Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*). These fishes are primarily associated with the open-ocean and coastal areas (PFMC, 1998a) and are not likely to occur in the action area.

The Pacific sand lance (*Ammodytes hexapterus*) and the surf smelt (*Hypomesus pretiosus pretiosus*) are an important forage fish for Chinook and coho salmon. Loss of prey is considered an adverse effect on EFH. Both species have been reported to occur in the action area (Windward, 2010).

EFH for groundfish and Pacific salmon is present in the action area. The Pilot Study may result in a minor, localized reduction in foraging habitat until the area is recolonized by benthic macroinvertebrates. The existing shoreline is of marginal value, at best, as a foraging area for Pacific salmon and groundfish. There may also be some minor, temporary, and localized water quality impacts due to increased turbidity during placement of the ENR and ENR+AC materials. No permanent adverse effects on EFH for groundfish or Pacific salmonids or their prey species will result from the Pilot Study.

8.0 CONSERVATION MEASURES

Implementing the conservation measures specified in Section 3.4 of the biological evaluation will avoid and minimize any potential effects of the Pilot Study on EFH.

9.0 CONCLUSION

The Pilot Study will result in a minor, localized, and temporary (1 to 2 years) effect on approximately 3 acres of potential intertidal and subtidal foraging habitat for juvenile salmonids at the three pilot plot areas. There may also be some minor temporary and localized water quality impacts due to increased turbidity during placement of the ENR and ENR+AC materials. It is expected that the Pilot Study will result in an overall net benefit to EFH for Pacific salmonids and groundfish using the action area by reducing the bioavailability of PCBs in contaminated sediments at the three pilot plot areas. No permanent adverse effects on EFH for groundfish, Pacific salmonids, or their prey species will result from the Pilot Study.

10.0 REFERENCES

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