BIOLOGICAL ASSESSMENT

FY 2007–2011 MAINTENANCE DREDGING

TURNING BASIN AND NAVIGATION CHANNEL

UPPER DUWAMISH WATERWAY

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ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers Seattle District
DMMO	Corps Dredged Material Management Office
DMMP	Dredged Material Management Plan
DNR	Washington State Department of Natural Resources
DO	dissolved oxygen
DPS	Distinct Population Segment
Ecology	Washington State Department of Ecology
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FMPs	Fishery Management Plans
FY	Fiscal Years
LDWG	Lower Duwamish Waterway Group
MLLW	Mean Lower Low Water
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Unit
OHWL	Ordinary High Water Line
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCEs	Primary Constituent Elements
PHS	Priority Habitats and Species
ppt	parts per trillion
PSDDA	Puget Sound Dredged Disposal Analysis
PSR	Pacific Sound Resources
RM	River Mile
Services	National Marine Fisheries Service and U.S. Fish and Wildlife Service
SMS	Safety Management System
TSS	Total suspended solids
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife
YOY	Young of the Year
PSMFC	Pacific States Fishery Management Council

1. INTRODUCTION

This Biological Assessment (BA) addresses the effects of U.S. Army Corps of Engineers (Corps) fiscal years (FY) 2007–2011 routine federal maintenance dredging of a portion of the Duwamish Federal Navigation Waterway, Seattle Harbor, Washington, on species that are protected under the Endangered Species Act (ESA) of 1973. The Corps is proposing to conduct maintenance dredging of the Waterway on a 1- to 3- year frequency to remove shoaling river sediment from the area extending from the Turning Basin (River Mile RM 5.5) downstream approximately 2,100 feet. The Waterway will be dredged with a mechanical dredge, and dredged materials will be barged down the Waterway and disposed of at the Elliott Bay Puget Sound Dredged Disposal Analysis (PSDDA) site near the center of Elliott Bay.

Listed species potentially occurring in the Duwamish Waterway include Puget Sound Chinook salmon (threatened), Coastal/Puget Sound bull trout (threatened) and bald eagles (threatened). The Waterway is also designated critical habitat for Chinook salmon and bull trout.

Several other listed species and species proposed for listing could also occur in Elliott Bay and Puget Sound, but are not expected to occur in the Waterway due to the lack of appropriate habitat. These species include the marbled murrelet (threatened), Steller sea lion (threatened), humpback whale (endangered), leatherback sea turtle (endangered), and the southern resident killer whale population (endangered).

All dredged material will be disposed of at the Elliott Bay PSDDA site. In March 2005, the Corps completed informal consultation with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (jointly termed the Services) on dredged material disposal at PSDDA sites (Corps 2005a). The Corps received concurrence from the Services that transport to and disposal of dredged material at the Elliott Bay PSDDA site was not likely to adversely affect listed species (NMSF 2005, USFWS 2005). Consequently, potential effects of transport to and dredged material disposal at the Elliott Bay PSDDA site will not be revisited in this BA. Therefore, this BA evaluates only the actual maintenance dredging of the Upper Duwamish Waterway in FY 2007 through FY 2011 with a maximum frequency of once per year. Species considered in this BA are only those listed species with potential to occur in the Waterway (Chinook salmon, bull trout and bald eagle).

This BA will serve as the consultation document addressing the dredging activities during formal Section 7 consultation with NMFS and informal consultation with USFWS per the requirements of the Endangered Species Act. It also evaluates potential effects of maintenance dredging on Essential Fish Habitat under Public Law 104-267 of the Sustainable Fisheries Act of 1996, which amended the Magnuson-Stevens Act. The Corps is pursuing formal consultation with NMFS because recent information collected from the Duwamish Waterway indicates that juvenile Chinook salmon may be present in the Waterway during the dredging window (as early as mid-January). The Corps shall continue informal consultation with USFWS for dredging activities because bull trout have not been observed in the Waterway during the proposed dredging window.

The Corps is proposing to conduct each maintenance dredge event of the Duwamish Waterway between October 1 and February 15. However, the period of time during which the Corps can accomplish dredging activities in the Waterway is defined by fish migration patterns and by the usual and accustomed fishing activities of the Muckleshoot Indian Tribe. Tribal fisheries in the Waterway generally take place through the end of December. The Corps is coordinating with the Muckleshoot Indian Tribe regarding options that might allow the Corps to begin dredging prior to the end of December.

There is a potential that between FY 2008 and 2011, dredged material from the Upper Duwamish Waterway could be used beneficially rather than being disposed of at the Elliott Bay PSDDA site. If a beneficial use is proposed, the Corps will reinstate consultation with the Services for beneficial use activities.

1.1. Authority

The Seattle Harbor Federal Navigation Project and maintenance dredging is authorized by the Rivers and Harbors Acts of March 2, 1925 and July 3, 1930. Federal maintenance dredging is required within the lower 5.5 miles of the Duwamish River (also known as the Duwamish Waterway) on a 1- to 3-year frequency to remove annually shoaling river sediment. The area typically dredged is a settling basin that extends from the natural bend in the river at River Mile (RM) 5.5 (known as the Turning Basin and Channel) downriver approximately 2,100 feet. The authorized depth in the channel and Turning Basin is –15 feet Mean Lower Low Water (MLLW) with a 2-foot allowable over depth to –17 feet MLLW. The authorized dimension for the channel bottom width is 150 feet. The authorized dimensions for the Turning Basin are 250 feet wide by 500 feet long (total area of approximately 8 acres). This BA addresses proposed dredging activities from FY 2007 through FY 2011 in the Turning Basin and the portion of the authorized project from stations 254+00 to 275+56. The Corps is authorized to remove up to 200,000 cubic yards of dredged material from this site during each dredge cycle.

2. CONSULTATION HISTORY

In September 2000, the Corps prepared a BA to evaluate the effects of maintenance dredging, from FY 2000 to FY 2005, in the Upper Duwamish Waterway (Corps 2000a). NMFS concurred with effect determinations (not likely to adversely affect listed species) related to this maintenance dredging activity through FY 2005 (NMFS 2001). USFWS concurred with the effect determinations (not likely to adversely affect listed species) made in that BA, but limited their concurrence to the FY 2002 maintenance dredge (for dredging between October 16, 2001 and February 14, 2002) (USFWS 2001).

In July 2003, the Corps prepared a BA to evaluate potential effects of FY 2004–2005 maintenance dredging activities to species under the jurisdiction of the USFWS. The USFWS concurred with the not likely to adversely affect findings of that BA (USFWS 2003).

In 2005, USFWS and NMFS concurred (NMFS 2005, USFWS 2005) with effect determinations related to transport to and disposal of dredged material at the PSDDA open water site in Elliott Bay (not likely to adversely affect listed species), as presented in programmatic biological evaluation prepared for the continued disposal of dredged materials at PSDDA Dispersive and

Non-Dispersive Disposal Sites (Corps 2005a). NMFS also concurred that the transport to and disposal of dredged material at PSDDA sites would not affect Pacific salmon or coastal pelagic Essential Fish Habitat (EFH), and would not substantially affect groundfish EFH (NMFS 2005).

In August 2005, the Corps met with NMFS, USFWS, Washington Department of Fish and Wildlife (WDFW), and Muckleshoot Indian Tribe fisheries biologists and harvest managers to discuss the FY 2007–2011 Duwamish Waterway maintenance dredging. During that meeting, NMFS expressed concern regarding the timing of the dredging activity. Recent information (discussed below) indicates that outmigrating juvenile Chinook salmon have been found in the Duwamish Waterway earlier than previously thought. The existing in-water work window for the Duwamish is October 1 through February 15. This recent data indicated that juvenile Chinook salmon could be present in the Waterway as early as mid-January. NMFS informed the Corps that the dredging would need to be concluded by January 15 in future years to avoid impacts on juvenile Chinook salmon. During this meeting, the Corps explained that there were additional challenges as to the time they could start dredging because of potential interference with the Tribes usual and accustomed fishing activities. Federal agencies share in the Trust responsibility to the Muckleshoot Indian Tribe. In order to avoid interfering with the Muckleshoot fishery, the Corps restricts its dredging in the Duwamish until after the Tribal fishery has concluded, which is generally mid- to late December. Thus, although the in-water work window begins October 1, the Corps usually waits to begin in-water work until late December or early January. Because dredging this area generally takes 4 to 6 weeks to complete, the Corps anticipates that dredging activities could be occurring in the Duwamish as late as mid-February. Therefore, the Corps is pursuing formal consultation with NMFS to allow in water work through February 15.

3. DESCRIPTION OF PROJECT AREA AND ACTION AREA

3.1. Historic Conditions

The lower Green/Duwamish River estuary was historically an area of very low gradient with a sinuous, meandering main channel. Most of the coarser sediment had been deposited in the middle river, and the lower river had a primarily sand and mud substrate. Most of the lower reach of the river was affected by tidal influence, whether freshwater tidal or brackish tidal. Historically, the river had several distributary channels spread over the broad delta floodplain. Large woody debris was carried into the lower river and estuary from the upper watershed during floods (Perkins 1993, Corps 1997a, 1997b).

The Duwamish estuary was once a vast tidally influenced mosaic of swamp and marsh wetlands. The soils in this area were likely fine materials from alluvium mixed with organic materials from the vast amounts of plant material produced in the estuarine marshes. These soils are generally very deep, poorly drained, and subject to being compacted and destabilized when disturbed (Perkins 1993, Corps 1997a, 1997b).

At one time, the Duwamish delta comprised more than 4,000 acres of tidal and intertidal habitat (Bloomberg et al. 1988). There was likely a large and sustainable salmon and clam fishery in the

Duwamish River and Elliott Bay available to Native Americans before Euro American settlement.

Dredging of the mouth of the estuary and construction of Harbor Island by the City and Port of Seattle began in the early 1900s. Congress subsequently authorized and funded a navigation project to assume maintenance of the existing channel and a deepening, widening, and straightening of the estuary portion of the Duwamish River to facilitate the commercial navigation and industrial development that characterizes the lower river today. The consequence on the environment of these actions has been a substantial degradation of the entire ecosystem of the lower Duwamish River and estuary through a combination of channelization and the destruction of the intertidal habitats in the estuary.

3.2. Current Conditions

Over the last 100 years, the braided flows of the lower river have been extensively channelized and reduced to a single permanent channel (the Duwamish Waterway) through dredging and construction of levees. Dredging has resulted in the replacement of 9.3 miles of meandering tidal channel habitat with the 5.5 miles of channel habitat that exists today (Bloomberg et al. 1988).

A natural rock weir located approximately one mile above the Turning Basin retards saltwater intrusion into upriver areas, except during high tides and low stream flows, while freshwater inflows greater than 1,000 cubic feet per second (cfs) hold the saltwater wedge to areas downstream of RM 7.8 regardless of tidal height (Stoner 1967). A general increase in the distance of saltwater intrusions inland has been documented and is largely attributed to the loss of freshwater flows (from the diversion of the White, Black, and Cedar rivers) coupled with the regular deepening and channelization that comes with navigation dredging (Corps 1997a).

Nearly all intertidal wetlands and shallow subtidal aquatic habitats in the vicinity of Elliott Bay and the lower Duwamish River have been eliminated as a result of urban and industrial development; only about 1 percent of the estimated 4,000 acres of tidal and intertidal habitat remains today. In addition to patches of remnant native marsh, a series of 10 small intertidal marsh restoration projects have been constructed downstream of the Turning Basin since 1995. The existing shoreline banks are thin bands of mud- and sandflats along the toe of riprap. There are two pocket beaches at the head of the West and Main Slips along the shoreline of the Pacific Sound Resources (PSR) Superfund site that contain limited shallow subtidal aquatic habitats.

The lower end of the river (downstream of the Turning Basin) is the heavily industrialized portion known as the Duwamish Waterway (Figure 1). The shoreline along the Duwamish Waterway is developed for industrial and commercial operations and the upland areas are heavily industrialized. The Duwamish River segment of the larger Green/Duwamish River (RM 11 to 0) similarly contains dense industrial, commercial and residential development. The main navigation channel is a major shipping route for containerized and bulk cargo and is consequently subject to high volumes of marine traffic.

In 2001, the U.S. Environmental Protection Agency (EPA) placed the Lower Duwamish Waterway on its National Priorities List, also known as the Superfund. That listing launched more formal processes to assess risks and identify necessary and alternative cleanup actions for contaminated sediment. The Lower Duwamish Waterway Group (LDWG), a local public-private partnership composed of the City of Seattle, King County, the Port of Seattle, and the Boeing Company was formed to help create better habitat conditions. In 2003, LDWG proposed and EPA approved seven early action sites for sediment cleanup. Cleanups are already completed at some sites while work continues at others. By 2008, the early cleanups should be finished and work will continue to address contaminated sediment still in the Waterway.

3.3. Project Location and Description

The dredging activities proposed for FY 2007 through FY 2011 are a component of the Seattle Harbor Federal Navigation Project, providing maintenance of the navigation channel in the upper Duwamish Waterway (lower Duwamish River) (Figure 1). The channel width in the Waterway is 150 feet, widening at the Turning Basin to approximately 250 feet (Figure 2). Dredging is typically accomplished using a clamshell dredge or other mechanical equipment and the dredged materials are loaded on bottom-dump barges. The typical volume of dredge material removed during maintenance dredging is approximately 100,000 cubic yards. For the FY 2007 to FY 2011 maintenance dredging cycle, the Corps is proposing to dispose of the dredged material at the Elliott Bay PSDDA site. As noted above, this BA assumes that all material dredged between FY 2007 and FY 2011 will be disposed of at the Elliott Bay PSDDA site, and that Corps would reinitiate consultation if alternative beneficial uses become available.

Without routine maintenance dredging, shoaling would lead to a shallower channel that would reduce the ability of large ships to enter and leave safely. In addition, not conducting maintenance dredging in the Turning Basin (which acts as a settling basin for sediments moving downstream) would result in a buildup of sediment in the Turning Basin, which would eventually exceed the holding capacity of the basin. Once the capacity of the Turning Basin is exceeded, the sediment would continue to move downstream and settle in areas below the Turning Basin, where in some areas there is known sediment contamination. Eventually, as sediment accrued in these downstream areas, dredging could be required in areas below the Turning Basin to maintain navigation.

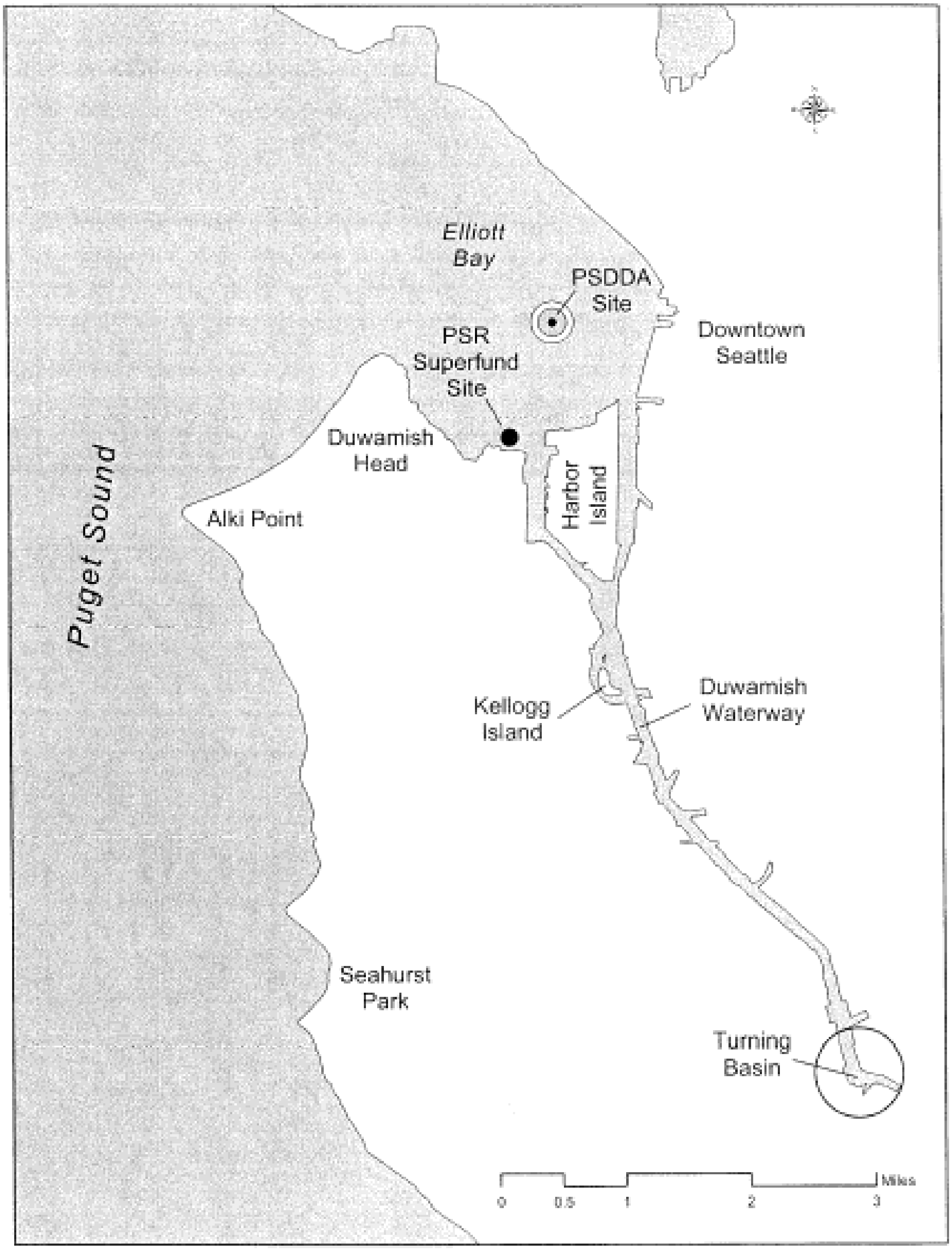

Figure 1. Location of the Turning Basin (Upper Duwamish Waterway Maintenance Dredging Site)

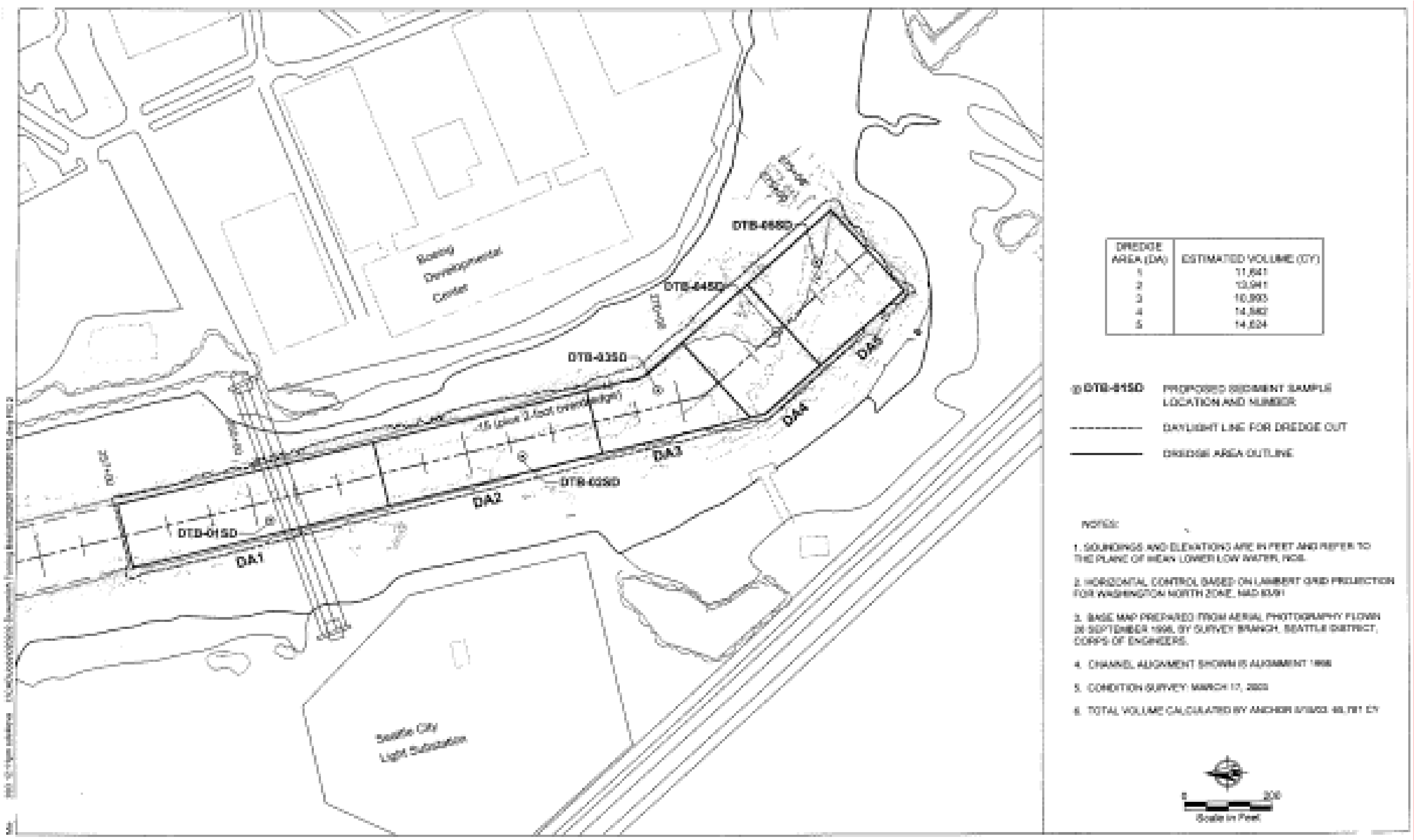

Figure 2. Proposed dredging area at the Turning Basin

3.4. Definition of Action Area

For this action, potential impacts would include physical removal of sediment from the project area, activity at the dredge site, and sediment resuspension to the water column. Because the dredge area is tidally influenced, sediment resuspended in the water column could move up or down river. The action area (i.e., the area affected directly or indirectly by the dredging project) is defined as the Duwamish Waterway between the natural rock weir 1 mile above the Turning Basin and the confluence of waterway with Elliott Bay (Figure 1). Conveyance of dredged material from the dredge site through Elliott Bay to the disposal site was evaluated as part of a separate Section 7 consultation and is not repeated in this BA.

4. DESCRIPTION OF PROPOSED ACTIONS

The Corps is planning routine maintenance dredging of the Upper Duwamish Waterway from FY 2007 through FY 2011. Dredging operations during this period would be scheduled between October 1 and February 15 each year that dredging is conducted and will require approximately 4 to 6 weeks to complete. Dredging is typically accomplished using clamshell dredge or similar mechanical equipment, and dredged materials are loaded on to bottom dump barges for transport to the disposal site.

Clamshell dredges and similar mechanical excavators have “clamshell” shaped buckets consisting of hinged jaws with an open top. A clamshell dredge, mounted to a floating barge, lowers a crane with cables to the bottom. The weight of the clamshell penetrates the sediment and as the bucket is pulled up, the clamshell closes, “biting” and retrieving the sediment within to the surface where it is loaded onto the barges. A mechanical excavator also works from a barge but the jaws are operated hydraulically from an arm. The barge platforms from which both types of dredges are operated are positioned via a system of anchors and wires or spuds, with or without the aid of tug boats.

It is assumed in this BA that dredged material from all maintenance dredging of the Waterway between FY 2007 and FY 2011 would be disposed of at the Elliott Bay PSDDA site. If some other beneficial use is identified, the Corps will reinitiate Section 7 consultation with the Services.

The width of the navigable channel portion is 150 feet, widening at the Turning Basin to approximately 250 feet (Figure 2). The 150-foot-wide portion of the channel to be dredged is centered within the river, thus all intertidal areas along both banks are retained during and after dredging (Figure 2). Authorized dredge depth is –15 feet MLLW, with an allowable over-depth of 2 feet below the required dredge depth (i.e., to –17 feet MLLW). Side slopes along the edge of the dredged portion in the center of the channel will be approximately 2:1 (Horizontal: Vertical) after dredging.

The Turning Basin was last dredged between January 15 and February 16, 2004, between stations 257+00 and 275+56. Dredging removed 75,770 cubic yards of dredged material, which was used beneficially to cap the PSR Superfund site in Elliott Bay. This FY 2004 maintenance dredging resulted in removal of approximately 2,368 cubic yards of dredged material per day.

The volume of sediment to be dredged is based on the results of annual condition surveys conducted prior to the dredging. It is not possible to exactly predict the volume of material that would need to be dredged between FY2007 and FY 2011. Shoaling rates and depths depend on seasonal rainfalls driving river flows and sedimentation rates. Typically, each maintenance dredging of the Upper Duwamish Waterway results in the removal of approximately 100,000 cubic yards of material between stations 254+00 and 275+56.

Maintenance dredging of the Upper Duwamish Waterway may be repeated on a 1- to 3-year frequency between FY 2007 and FY 2011 (the channel has typically required dredging every other year since FY 1987).

While the specifics of daily total loads, total days worked, and the exact daily schedule are generally decided by the contractor at the time of dredging, the Corps anticipates that the FY 2007 through 2011 dredging activities will be conducted in a manner similar to the 2004 dredging.

4.1. Sediment Sampling

The Corps sampled sediments within the area to be dredged in the Upper Duwamish Waterway (Figure 2) according to DMMP protocols on June 26, 2003. The portion of the channel to be dredged is considered a "low–moderate ranked" area for contaminants. The PSDDA agencies (Corps, Environmental Protection Agency, Washington Department of Ecology, Washington Department of Natural Resources) concluded that all the material to be dredged was suitable for disposal at the Elliott Bay open water PSSDA site. As the sediment characterizations from the June 26, 2003 sampling have a "recency frequency" or sampling frequency of 5 to 7 years, additional sediment testing will be required again in 2008, 2009, or 2010.

If sediment sampling in 2008 to 2010 meets PSSDA standards, the dredged sediment would also be disposed of at the Elliott Bay PSDDA site, unless a beneficial use for the material became available. If samples from any individual dredge area were found unsuitable for unconfined open water disposal at the PSSDA site, sediment from that dredging area would not be dredged under this proposed action.

Disposal activities will be conducted in accordance with established criteria for the PSSDA sites. As noted earlier, effects of the transport and disposal actions were analyzed in a previous Biological Assessment prepared by the Corps (Corps 2005a).

5. SPECIES AND HABITAT INFORMATION

This section describes the listed species considered in this BA and the habitat indicators important for their survival and recovery. Estuarine habitats are emphasized, because of the potential effects of the proposed dredging action on that type of habitat. This evaluation is loosely based on the types of guidelines developed by NMFS to facilitate and standardize the determination of effects of projects/actions on listed anadromous salmonids (i.e., the NMFS

Matrix of Pathways and Indicators 1996 [NMFS 1996]). However, as this tool was developed for freshwater environments, it is not directly applicable to estuarine waters.

Therefore, the following discussion is organized around a set of modified indicator-based categories of habitat function developed from review of scientific literature and best professional judgment. This evaluation is thus generally qualitative in nature and is divided into three main pathways that address water quality, physical habitat quality, and biologic habitat quality. These indicator categories form the matrix of pathways that were used to establish the baseline condition in the project area and to then determine the potential effects of the proposed dredging actions on these baseline conditions.

5.1. Listed Species

Based on available information on the distribution of listed, proposed, and candidate species known to occur in the project area (Duwamish Waterway), the following species are included in this BA.

Table 1. Species Included in BA

Common Name	Scientific Name	Federal Listing Status (Date)	Critical Habitat Designated?
Bald Eagle	*Haliaeetus leucocephalus*	Threatened (July 12, 1999) Delisting proposed (July 6, 1999)	No
Bull Trout	*Salvelinus confluentus*	Threatened (November 1, 1999)	Yes (September 26, 2005)
Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened (March 24, 1999)	Yes (September 2, 2005)

5.1.1. Critical Habitat

Critical habitat for 19 species of salmonids (including Puget Sound Chinook salmon) was designated by NMFS in September 2005 (70 FR 52630). Critical habitat for bull trout was designated by USFWS in September 2005 (70 FR 56211). Critical Habitat has not been designated for bald eagle.

Section 3(5)(A)(i) of the ESA and 50 CFR 424.12, regulate which areas are designated as critical habitat for listed species. For each listed species, the Services consider certain biological and physical features, termed primary constituent elements (PCEs), which are composed of those physical and biological components deemed essential for the conservation and recovery of the species, including space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical geographical and ecological distribution of a species. The Duwamish River (including the project action area) is designated as critical habitat for Puget Sound Chinook salmon ESU and Puget Sound / Coast bull trout DPS.

The lateral extent of critical habitat for each stream reach has been defined somewhat differently by NMFS and USFWS for salmon and bull trout, respectively. For salmon, NMFS defines the lateral extent as the width of the stream channel based on Ordinary High Water Line (OHWL) as defined by the Corps in 33 CFR 329.11. In areas where the OHWL has not been defined, the bankfull elevation defines the lateral extent of critical habitat for salmon.

For bull trout, the USFWS defines the lateral extent of critical habitat for a stream reach as the bankfull width. In areas where the bankfull width cannot be determined, the OHWL determines the lateral extent of critical habitat.

Adjacent floodplains are not included as critical habitat for either species, however it is recognized that the quality of aquatic habitat within stream channels is intrinsically related to the character of the floodplains and associated riparian zones, and that human activities that occur outside the river channels can have demonstrable effects on physical and biological features of the aquatic environment.

The lateral extent of critical habitat in nearshore marine areas is defined slightly by the two Services. NMFS defines critical habitat in nearshore marine areas for Chinook salmon by the area inundated by extreme high tide to -30 meters Mean Lower Low Water (MLLW) (with the exception of certain specific areas). USFWS defines the extent of critical habitat in nearshore marine areas for bull trout to extend from Mean Higher High Water (MHHW) to –10 meters MLLW). Although the action area for the project is tidally influenced, it would more appropriately be defined as estuarine because it is 5.5 miles from Elliott Bay.

5.2. Species Present

The following section describes listed and non-listed species potentially present in the action area (in the lower Duwamish River). Species potentially occurring at the Elliott Bay PSDDA site were described in the BE prepared for the evaluation of continued use of the PSDDA sites (Corps 2005a) and are not considered in this BA.

5.2.1. Invertebrates

A number of studies have characterized the benthic community on the mudflats and remaining remnant marshes in the Duwamish River estuary. Many of these studies have been undertaken in conjunction with the Elliott Bay/Duwamish Restoration Program and have been conducted by the USFWS and the University of Washington Wetland Ecosystem Team (Low and Myers 2002). These studies illustrate the importance of estuarine marsh and mudflat habitats in providing food for juvenile salmonids. Juvenile salmonids prey preferentially on certain species of small crustaceans including amphipods (e.g., *Corophium* spp., *Anisogammarus* sp., *Eogammarus* sp.), some species of harpacticoid copepods (e.g., *Harpacticus uniremis, Tisbe* sp.), cumaceans, opossum shrimp (order Mysidacea), and midges (chironomid larvae).

5.2.2. Anadromous Salmonids

Multiple migratory runs of both native and hatchery reared salmonid stocks occur seasonally in Elliott Bay and the Duwamish River (Warner and Fritz 1995). The use of Elliott Bay by salmonids is believed to be predominantly as a migration corridor. However, some rearing and foraging by juvenile salmonids is likely, particularly in the limited shoreline areas with some structural diversity. Returning adult salmon congregate at the mouth of the Duwamish prior to upstream migration, and juvenile salmonids may use the nearshore reaches to transition into marine waters. In-migrating adult salmon use deeper areas of Elliott Bay prior to moving into the Duwamish River.

The Green/Duwamish River system supports a diversity of salmonid species compared to other rivers of this size in the Puget Sound region. There are nine stocks of anadromous salmonids that have been documented in the Green/Duwamish River: bull trout [*Salvelinus confluentus*], summer/fall Chinook salmon, fall run coho salmon, fall run chum salmon, cutthroat trout, sockeye salmon, summer/winter steelhead, and native char (Dolly Varden [*Salvelinus malma*]). Pink salmon are present in the system, but typically not in large numbers. Chinook salmon, chum salmon, coho salmon, and steelhead utilize Elliott Bay to access upstream freshwater spawning habitat associated with the Duwamish and Green rivers. Chinook salmon and chum salmon utilize Elliott Bay and the Duwamish estuary more extensively than other anadromous species (Weitkamp and Schadt 1982; Meyer et al. 1981), especially when congregating at the mouth of the Duwamish River during their adult return.

The principal juvenile salmonid out-migration season for steelhead, coastal cutthroat trout, and coho salmon occurs from mid-April through mid-June; chum salmon generally out-migrate slightly earlier, between mid-March and early May (Grette and Salo 1986, Corps 1998; Figure 3). Chinook salmon begin to out-migrate earlier, in mid-January.

In the last 50 years, no juvenile bull trout have been reported in the Green River basin, although adult bull trout have sporadically been captured in the Duwamish River estuary and lower Green River (Matsuda et al. 1968, Grette and Salo 1986, Warner and Fritz 1995). Recently, sub-adult bull trout were captured in Newakum Creek in 2000 and at the Turning Basin in August and September 2000, September 2002, and May 2003 (J. Chan USFWS unpublished data, Jim Shannon, Taylor and Associates, unpublished data).

Although past studies have shown Green River Chinook salmon fry emerge from the gravel in late February through April, with peak migration not occurring until mid April (Dunstan et al. 1955, Hilgert and Jeanes 1999, Jeanes and Hilgert 2000), surveys conducted from 2001–2003 by Nelson et al. (2004) observed juvenile Chinook salmon in the Duwamish estuary as early as January and February (Figure 3). These findings were confirmed by a recent study by the Corps that investigated species distribution (presence), life stage/size, relative abundance and habitat use of salmonids present during the typical maintenance dredging period of December 2004 through March 2005 (Corps 2005b). The results of this study confirmed that juvenile salmonids, including juvenile and sub-adult Chinook salmon, can be present within the portion of the

Waterway that is dredged by the Corps and can be present during the typical period of time (January through mid-February) when the Corps conducts dredging in order to avoid interfering with the Muckleshoot Tribe's usual and accustomed fishing activities.

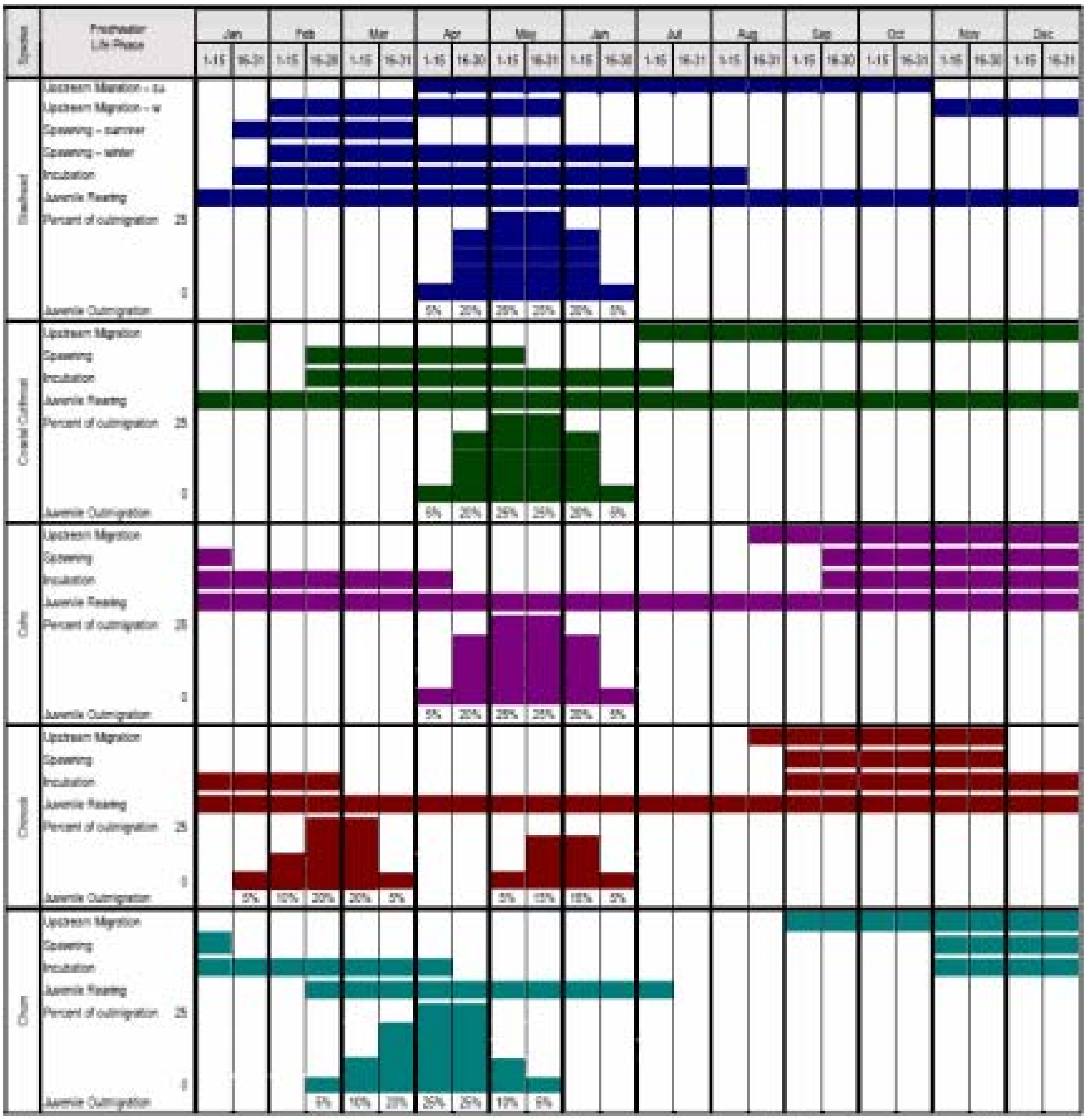

Figure 3. Generalized timing of five species of salmonids that use the Green/Duwamish River (from Nelson et al. 2004)

As federally threatened species, the occurrence and potential effects of the proposed dredging activities on bull trout and Chinook salmon are addressed in detail in Section 10.

5.2.3. Birds

Bald eagles are occasionally seen over Elliott Bay and are frequently observed perching or foraging along the lower Duwamish River. The closest documented eagle nest occurs 2.6 miles from the dredging site at Lakeridge Park, almost due east of the site. As a federally threatened species, the occurrence and potential effects of the proposed dredging activities on bald eagles are addressed in detail in Section 10. Potential effects of dredged material transport to and disposal at the Elliott Bay PSDDA site has already been evaluated in an earlier BA (Corps 2005a) with the USFWS concurring that the action was not likely to adversely affect bald eagles (USFWS 2005).

The marbled murrelet is a permanent, though not common resident of southern Puget Sound in the vicinity of the lower Duwamish River. In the Pacific Northwest, it forages almost exclusively in the nearshore marine environment (mainly within a few miles of shore), but nests in old growth forests as much as 50 miles from marine waters. Marbled murrelet nests do not occur within the action area, but murrelets may forage within the waters of Elliott Bay, particularly during the winter. Murrelets would not be expected to feed or roost near the Turning Basin. Potential effects of dredged material transport and disposal at the Elliott Bay PSDDA site have already been evaluated in an earlier BA (Corps 2005a) with the USFWS concurring that the action was not likely to adversely affect marbled murrelets or designated critical habitat for this species (USFWS 2005).

The shorelines of Elliott Bay provide habitat to a number of terrestrial and water dependent birds that may serve as prey for bald eagles. These species include loons, grebes, cormorants, scaups, mergansers, coots, and gulls. The majority of these birds utilize these areas during their respective over wintering periods. These over wintering waterfowl species are generally found in the central Puget Sound region from early November through late April, with the highest concentrations during December through February. The remaining waterfowl are present year-round. Most of the year-round and over wintering species are classified as “divers” and actively pursue pelagic and benthic organisms up to 10 meters below the water surface.

Abundant waterfowl species occur within the lower Duwamish River and provide an avian prey base for bald eagles. Common species include greater scaups, ring-necked ducks, scoters, American wigeons, Canada geese, mallards, common goldeneye, mergansers, and bufflehead. Other common species include western grebes, double-crested cormorants, American coots, pigeon guillemots, and several gull species. Shorebirds observed in the vicinity of the Duwamish Waterway have included sandpipers, dunlins, and snipe. These waders are generally present in the tidal mudflats and marshes or along sandy shorelines.

Several other bird species expected to inhabit the action area are either Federal Species of Concern or are listed by Washington State as Monitor, Candidate, or Sensitive species. The peregrine falcon (Federal Species of Concern and State Sensitive), osprey (State Monitor), great blue heron (State Monitor), and purple martin (State Candidate) all occur fairly frequently within the action area.

Since 1994, a pair of peregrine falcons has been nesting in downtown Seattle atop the east side of the Washington Mutual Tower. While this pair has not been active at the Washington Mutual site in 2003, the female may be nesting about four blocks away at One Union Square and the male may be nesting with other females in West Seattle. Peregrine falcons were also reported using a nest box under the West Seattle Bridge just south of Harbor Island in 1999 (Priority Habitat and Species database search September 2005). Peregrine falcons would be expected to hunt waterfowl over Elliott Bay and to hunt waterfowl and pigeons over the lower Duwamish and shoreline industrial facilities.

Osprey are frequently seen foraging for fish over Elliott Bay and the lower Duwamish River and appear to be fairly tolerant of human disturbance when choosing nesting locations. Since 1999, osprey nests have been documented on utility poles or other artificial structures in at least two locations within one mile of the proposed dredging: on the east side of the Turning Basin, and at the intersection of Highway 99 and 112th St. Seven additional nests are located within 5 miles of the action area at: Martin Luther King Jr. Way and S. Director St., at the end of 48th Ave, on Highway 181 on the north side of south Longacres, on a cell phone tower near the southeast corner of Lake Washington, at Terminal 115, at Terminal 105 (Crowley Marine facility), and at Terminal 18 on Harbor Island (Priority Habitat and Species database search September 2005).

Similarly, great blue herons are also frequently seen wading within the lower Duwamish River and its remaining intertidal habitats. Bald eagles are known to disrupt rookeries while attempting to prey upon young herons. Two heron rookeries have been documented within the action area: approximately 4 miles downstream of the Turning Basin on the forested slope west of Terminal 105 (nests unoccupied in 2000), and the Black River rookery approximately 4 miles southeast has been active since 1985. There is also an unoccupied nest 4 miles downstream of the Turning Basin (Priority Habitat and Species database search September 2005).

A purple martin nest was noted in 1979 within the Bon Marché parking garage in downtown Seattle, approximately 7 miles east of the proposed disposal sites (Priority Habitat and Species database search June 5, 2003). In recent years, private individuals have erected nest boxes around Puget Sound and the lower Duwamish River; these boxes have successfully attracted nesting purple martins. As of June 2003, 10 pairs were nesting in Jack Block Park on the west side of Harbor Island, one pair is nesting at Kellogg Island, and one to two pairs are nesting at Terminal 105. There are currently no nest boxes erected further upstream (i.e., toward the Turning Basin dredging site) than the Terminal 105 site (Kevin Lee, personal communication, June 9, 2003).

The horned grebe and red-necked grebe (State Monitor species); the western grebe, Brandt's cormorant, merlin, and common murre (State Candidate species); and the common loon (State Sensitive species) are also likely to forage over or utilize surface waters near the mouth of the Duwamish River.

5.2.4. Marine Mammals and Turtles

Harbor seals and Dall's porpoise are known to frequently forage in Elliott Bay, and are both State Monitor Species (Calambokidas 1991). Harbor seals are also common within the lower Duwamish River where they hunt for fish. Pacific harbor porpoises can occur within Elliott Bay, and southern resident killer whales have been observed infrequently. Killer whales are listed as endangered (70CFR 69903) and harbor porpoises are a State Candidate Species (Calambokidas 1991). California gray whales, Pacific harbor porpoise, and California sea lions are also common inhabitants of the Elliott Bay. Harbor porpoise and harbor seals are year-round residents. California sea lions may utilize waters of Elliott Bay in the winter to feed on migrating salmon and steelhead (Pfeifer 1991). Both harbor seals and California sea lions have been seen hauled out on floats and navigation buoys near the mouth of the Duwamish River. The leatherback sea turtle, a species federally listed as endangered, are extremely rare within Puget Sound and would not be expected to occur in Elliott Bay or the action area.

Federally listed marine mammals and turtles would not be expected to occur in the Duwamish waterway and are not considered in this BA.

Potential effects of dredged material transport to and disposal at the Elliott Bay PSDDA site for listed marine mammals and turtles have already been evaluated in an earlier BA (Corps 2005a) with the NMFS concurring that the action was not likely to adversely affect those species (NMFS 2005).

5.2.5. Benthic and Epibenthic Prey Availability

Benthic and epibenthic invertebrate prey assemblages have been documented in the lower Duwamish River since 1994 as part of the Duwamish River Coastal America restoration program and subsequent restoration efforts undertaken by USFWS and the Elliott Bay/Duwamish Restoration Program. These restoration efforts have been designed to recreate intertidal marsh vegetation along the lower Duwamish, and in so doing provide habitat for juvenile salmonids to forage on benthic and epibenthic invertebrates. These studies have documented a diverse assemblage of invertebrates, with variable invertebrate biodiversity (density and number of species) depending on the age and structure of the habitat (Cordell et al. 1994, 1996, 1997). While the intertidal marshes surrounding the Turning Basin have been studied and documented over the past 10 years, benthic assemblages within the deeper subtidal dredged waterway are not well documented, although are expected to be of much lower biodiversity than those of the adjacent intertidal marshes. Because of their occurrence at deeper depths, the assemblages within the center of the channel are of lower functional value to juvenile salmonids.

5.2.6. Forage Fish Availability

Forage fish larvae are ubiquitous in Puget Sound and are a common component of the nearshore plankton. As such, it is difficult to determine the source of this prey item within any given estuary. Very little research has been done to determine if larvae using any given estuary originate in nearby spawning grounds. Intertidal spawning habitat was historically more abundant, however, armoring and other shoreline modifications have limited the amount of available spawning areas.

Forage fish include Pacific herring, surf smelt, and sand lance. Larvae and juveniles prey on epibenthic invertebrates and crustaceans and are themselves important prey items for larger juvenile salmon and bull trout. Sand lance is particularly important for juvenile Chinook salmon and bull trout.

None of these forage fish species spawn within the lower Duwamish River, likely due to the modified shoreline and lack of intertidal gravel and sandy beaches (WDFW PHS database search September 2005)

Pacific herring spawn within Quartermaster Harbor between Vashon and Maury Island and within Port Orchard and Port Madison bays along western and northern Whidbey Island, respectively (WDFW PHS database search September 2005, D. Pentilla Washington State Pacific Herring Fact Sheet undated).

Surf smelt spawning is known to occur in Elliott Bay on the northern shore near Alki Point, along Williams Point just north of Fauntleroy Cove, and along the Seahurst Park shoreline and Secoma Beach (WDFW PHS database search September 2005, D. Pentilla Washington State Surf Smelt Fact Sheet undated).

Documented Pacific sand lance spawning beaches occur in the same areas identified for surf smelt (D. Pentilla, Washington State Sand Lance Fact Sheet) within Puget Sound.

Fish sampling conducted by USFWS in 2001 captured small numbers (fewer than 10 individuals) of Pacific sand lance at both the Turning Basin and the Hamm Creek estuary restoration sites (Low and Myers 2002). Few forage fish species were found during beach and purse seining at the Turning Basin in the winter of 2004–2005. An average of 0.96 Pacific herring per hectare, 8.65 surf smelt per hectare and no sand lance were caught in beach seines between December 3, 2004 and March 3, 2005. An average of 85.85 Pacific herring, 22.06 surf smelt and 0.57 sand lance per hectare were caught in purse seines between December 4, 2004 and February 20, 2005 (Corps 2005b).

5.2.7. Intertidal Vegetation

The area of wetlands and more natural shorelines along the Duwamish estuary and Elliott Bay has increased modestly over the last few years through restoration efforts and as mitigation for redevelopment projects. A series of 10 small intertidal marsh restorations have been constructed downstream of the Turning Basin since 1995 and represent nearly the only areas of native intertidal marsh within the lower Duwamish River. However, these areas of habitat are isolated (for terrestrial species) by intensive development between patches. The marshes are dominated by Lyngby's sedge (*Carex lyngbyei*), hard-stem bulrush (*Scirpus acutus*), and common cattail (*Typha latifolia*) with generally vegetated upland buffers that have also been planted as part of the restoration efforts. Agencies and nonprofit groups including, but not limited to, the Port of Seattle, King County Department of Natural Resources (DNR), the City of Seattle, the Corps, USFWS, and People for Puget Sound are actively monitoring and maintaining many of these areas.

These restored areas have been shown to receive substantial utilization by juvenile salmon including juvenile Chinook salmon, and to provide important benthic and epibenthic prey resources (e.g., Cordell et al. 1997). The restoration of these habitats is part of an overall trend toward improvement in the estuary that began with improvements in source control and water quality in the 1970s and continues today.

5.2.8. Riparian Vegetation

There are virtually no functional riparian communities along the lower Duwamish River, with the exception of Kellogg Island, located approximately 3 miles downstream of the Turning Basin. Scattered patches and individual trees are all that remains of the once diverse riparian forests and tidal swamps that fringed the lower Duwamish River (Bloomberg et al. 1988). Currently, dominant riparian species include black cottonwood (*Populus balsamifera*), Pacific willow (*Salix lucida*), Hooker's willow (*Salix hookeriana*), and red alder (*Alnus rubra*) trees, with understory shrubs dominated by invasive Himalayan blackberry (*Rubus discolor*) and evergreen blackberry (*Rubus laciniatus*) growing out of the riprapped shorelines.

5.3. Baseline or Existing Environmental Conditions

The discussion below presents a synopsis of baseline indicators relevant to an analysis of effects from maintenance dredging operations. Because these indicators (water quality, physical habitat quality, and biological habitat quality) can directly affect fish populations (such as bull trout and salmon), they can also affect higher order consumers that feed on fish, such as bald eagles.

As a result of its commercial importance and highly degraded condition, the Waterway has been the subject of numerous studies by various governmental and private entities. These studies have included water and sediment chemistry, physical habitat conditions, benthic community analyses, fish and marine invertebrate data, tissue chemistry, and toxicity bioassays. Due to the highly urbanized and degraded condition of the action area (i.e., a heavily industrialized waterway with a history of channelization, dredging, and intertidal filling) all of the baseline indicators can be considered "at risk" or "not properly functioning."

5.3.1. Water Quality

Water Contamination

The Washington State Department of Ecology (Ecology) is responsible for setting water quality standards based on water use and water quality criteria.

The waters of the Duwamish River (RM 11 to 0) are designated Class B waters (good). Water quality within the lower Duwamish River can influence water quality conditions in the Duwamish River estuary. Pollutants within the Duwamish River are derived primarily from industrial point and non-point sources, storm water runoff, discharges from vessels, and resuspension of contaminated bottom sediments.

Overall, water quality in the estuary was probably poorest in the early 1960s. Since then, enforcement of the Clean Water Act and subsequent State water quality standards and implementation of the National Pollutant Discharge Elimination System (NPDES) have spurred substantial improvement in water quality conditions in the Duwamish estuary.

Diversion of wastewater effluent discharges from the river to Puget Sound has significantly reduced the biological oxygen demand in the estuary. Of the parameters for which historic data are available, all contaminants have been controlled to the point where few exceedances of state chronic water quality criteria, or thresholds for effects on salmonids, have been reported in recent years. Since the mid-1980s, there have been no reports of direct mortality of salmon or other fish in the estuary; problems previously associated with delayed Chinook salmon upstream migrations due to low dissolved oxygen barriers likewise have not been reported since the diversion of the Renton Treatment Plant outfall.

Elliott Bay and the Duwamish Waterway remain on Ecology's 303(d) list of threatened and impaired waters. The enforcement of total maximum daily load limitations for a number of parameters is expected to result in additional improvements in water quality. The trend for water quality in the action area is one of overall improvement.

Turbidity and Suspended Sediment

Water quality sampling data from the U.S. Geological Survey (USGS) gauge located at the Foster Golf Links golf course in Tukwila Washington (Station No. 12113390) were reviewed for the 1995–2004 period. This data indicates that the Duwamish River reaches its maximum suspended sediment levels generally between December and March. Average suspended sediment levels recorded during the window of the proposed dredging (October 1 through February 15) have been 72 mg/L, including the highest readings of 787 mg/L on February 9, 1996, 361 mg/L on February 12, 1996, and 196 mg/L recorded on January 3, 1997. Lowest readings during the proposed dredging period have been 4 mg/L in December 2000.

The Duwamish is also characterized by occasional high levels of suspended sediment occurring during the late spring and even well into the driest portions of the year (274 mg/L on March 19, 1997, 264 mg/L on August 7, 1997, and 101 mg/L on March 22, 1998), which are likely due to intense precipitation from seasonal storm events.

Dissolved Oxygen

Dissolved oxygen levels in the lower Duwamish do not always meet State criteria. These excursions occur in mid- and late summer (Herrera Environmental Consultants 2005). The proposed maintenance dredging would occur in the winter months (October 1 through February 15) when dissolved oxygen ranges from 9.6 to 12.1 mg/l (USGS data for 1999 to 2004 collected at Station 12113390 at Foster Golf Links golf course in Tukwila, WA). The state dissolved oxygen criterion for Class B freshwater is 6.5 mg/l (WAC 173-201A).

Temperature

In the lower Duwamish, the relative temperatures of the freshwater inflow and the saltwater intruded from Elliott Bay primarily influence water temperature (Warner and Fritz 1995). This saltwater intrusion profoundly influences water temperature at various depths in the Turning Basin (Muckleshoot Indian Tribe Fisheries Department, unpublished data). For example, in January, water temperatures measured at 1-meter depths (46.8° F) can be 10° F warmer than water at a depth of 8 meters (36.5° F). In May, temperatures measured at 1 meter were 9° F warmer (63.9° F) than at a depth of 4 meters (52.9° F). In September, temperatures are more uniform with difference in the 5° F range (61.9 to 56.8° F). The range of temperatures overdepth is also influenced by the tidal stage. The variation in water temperature with depth provides adult and juvenile salmonids some refuge from the higher temperatures. However, in the late summer and early fall, the general range of temperatures offers no refuge from temperatures considered outside the preferred range for salmonid species.

Lack of large vegetation in the riparian zone has also been cited as a significant cause of elevated temperature. Due to heavy industrialization, there is a near complete lack of riparian trees along the shoreline of the lower Duwamish River. Thus, the contribution of vegetation as an effective buffer against increasing water temperature from direct sun exposure is probably minimal for the action area and the lower Duwamish River on the whole.

5.3.2. Physical Habitat Quality

The sediments dredged between Stations 257+00 and 275+56 were tested in June 2003 according to PSDDA protocol. Analysis of the sediments from the dredge site indicated that the sediments were suitable for disposal at the PSDDA site. Sediments on the site were given a low-medium ranking by the DMMP.

Sediments in the dredge area are primarily coarse. In sections DA4 and DA5 (Figure 2), where the majority of dredging will occur, the sediment is made up primarily of sand, with sand comprising 89.5 and 90.5 percent in each of these areas, respectively. Fines (which include silt and clay) comprise 8.7 percent in section DS4 and 6.4 percent in section DS5. Similar sediment grain size characteristics are expected for dredging in FY 2007–FY2011.

All sediment tested met Washington State Sediment Management Standards (SMS), with the exception of one constituent in one sample (hexachlorobenzene in a sample collected in DA4). However, the PSDDA agencies agreed that this apparent “hit” was likely caused by low organic carbon in the sample, and did not believe that this undetected chemical is present at any level of concern.

The sediment characterizations from the June 2003 sampling have a “recency frequency” of 5 to 7 years; additional sediment testing prior to dredging will be required again in 2008, 2009 or 2010.

Sediment sampling within the portion of the Duwamish River below the proposed dredging area (i.e., below station 254+00) has identified several contaminates of concern, including oil and grease, sulfides, pesticides, polychlorinated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs) (Corps 1995, 2000d). Urban and industrial development in the lower Green/Duwamish River has resulted in numerous sources of contamination, including industrial discharges, combined sewer overflows, stormwater runoff, and shipping-related sources (i.e., accidental spills, treated pilings) (TetraTech 1998).

Shoreline and Estuarine Habitat Conditions

The shorelines of Elliott Bay and the lower Duwamish River (as well as the adjacent shorelines of Puget Sound) are almost exclusively armored (rip rapped). The existing shoreline banks are thin bands of mud- and sand-flats along the toe of the riprap. Common shoreline features also include constructed bulkheads and piers, principally for large commercial and industrial marine users. Similarly, nearly all intertidal wetlands and shallow subtidal aquatic habitats in the vicinity of Elliott Bay and the lower Duwamish River have been eliminated as a result of urban and industrial development with the exception of an area of intertidal sedge (*Carex* spp.) marsh located along the west bank of the river at the Turning Basin.

In the reach that includes the Turning Basin, the waterway is much wider, and shallower, and the water is consistently brackish as the freshwater collides with the marine saltwater wedge. Warner and Fritz (1995) found the highest catches of juvenile Chinook salmon near the upper end of this reach over shallow, gently sloping, intertidal mudflats. This reach also contains intertidal areas composed of sand, gravel and cobble substrates, but these authors found fewer fish there. Compared to the reach downstream and the Elliott Bay shoreline, this reach has the greatest percentage of semi-natural shoreline fringed by intertidal mudflats and a narrow salt marsh fringe (Nelson et al. 2004).

Disturbance/Noise

Due to the highly industrialized nature of Elliott Bay and the lower Duwamish River, this area is subject to frequent boat/ship traffic and the associated noise and disturbance typical of the commercial and industrial facilities along the shoreline. In addition to recreational vessels of all types and sizes, these areas are subject to extensive use by tugboats and barges. Consequently, existing noise and disturbance levels are typical of highly industrialized areas.

6. EFFECTS OF MAINTENANCE DREDGING ACTIVITIES ON SPECIES AND HABITATS

The effects of the transport to and the disposal of the dredged material at the PSSDA open water disposal site in Elliott Bay has been previously analyzed for potential effects to listed species (Corps 2005a). Both USFWS and NMFS have concurred that continued use of the PSDDA sites is not likely to adversely affect listed species (NMFS 2005, USFWS 2005).

Consequently, this analysis focuses only on the short- and long-term, direct and indirect effects of routine maintenance dredging of the Turning Basin on federally listed endangered or threatened species and critical habitat. The proposed dredging would occur between FY 2007 and FY 2011. The dredging activities are proposed to occur between October 1 and February 15 of that year.

Evaluation of possible impacts of the proposed activity were based on predicting changes from the baseline condition of the indicator-based categories of habitat function described in Section 5.3. This evaluation is generally qualitative in nature and is divided into effects on the water quality, physical habitat quality, and species present (Sections 6.1, 6.2, and 6.3). Specific effect determinations for bull trout, bald eagle and Chinook salmon and potential effects to designated critical habitat for Chinook salmon and bull trout are described in Section 10. Potential effects of maintenance dredging in the Upper Duwamish Waterway on EFH are evaluated in Section 11.

6.1. Effects on Water Quality

6.1.1. Water Contamination

Maintenance dredging in the Turning Basin and channel will result in the release of some sediment to the water column as the bucket contacts the bottom, closes, and is raised through the water column to load dredged material into the barges. Dredging results in pulsed and localized increases in suspended solids to the water column. Ecology sets limitations on the amount of sediment that is allowed to be re-suspended during dredging operations (and other in-water activities). Ecology's Section 401 requirements are discussed below.

The sediments to be dredged meet PSDDA and State Sediment Safety Management standards (SMS). Although there will be a short-term resuspension of sediments into the water column, release of contaminants (present in very low concentrations, if at all) to the water column is expected to be insignificant and discountable and is not expected to adversely degrade the existing water quality condition within the action area or have adverse effects on listed species or their prey.

It is also important to note that if maintenance dredging of the Turning Basin (which acts as a settling basin for sediments moving downstream) were not conducted, it is likely that eventually the sediment that would have accumulated in the Turning Basin would continue downstream and settle in areas with known sediment contamination. As sediment accreted in these downstream areas, dredging could be required downstream of the Turning Basin to maintain navigation. If the Corps or other entity were required to dredge sediments in areas downstream of Station

254+00 from the Turning Basin (rather than in the Turning Basin), the sediments (that would have been dredged from the Turning Basin) could settle and mix with previously contaminated sediments downstream, and dredging in those areas could potentially release contaminants from existing sediments below the Turning Basin.

6.1.2. Turbidity (Total Suspended Solids)

The principal water quality impact of dredging is that of increased total suspended solids (TSS) concentrations in waters near the dredging sites. As noted above, sediments may be resuspended into the water column by lowering of the clamshell or other mechanical bucket, impacting the bottom with the bucket, closing the bucket, and raising the bucket through the water column and onto the haul barge. This method of dredging has been documented to produce a downstream plume, which in certain circumstances, could extend up to 300 m at the surface and 500 m near the bottom (Gordon 1973; Cronin et al. 1976; Sustar et al. 1976; Williamson and Nelson 1977; Yagi et al. 1977; Nakai 1978; Onuschuk 1982, as cited in LaSalle 1988).

The plumes from clamshell dredging and other mechanical bucket operations are relatively localized and pulsed. The characteristics of the plume (persistence downstream, depth of plume, concentration of TSS) are dependent on several factors including the type of dredge used, the rate at which sediments are dredged, the percent fines in the sediment, stratification of the water, tidal dynamics and currents.

The effects of turbidity on anadromous fish can be classified as behavioral, sublethal, or lethal, depending on the level of turbidity (Newcombe and MacDonald 1991).

Behavioral effects are described as any effect that results in a change of activity usually associated with an organism in an undisturbed environment. These effects include affects to avoidance responses, territoriality, feeding and homing behavior (Sigler et al. 1984, cited in LaSalle 1988). Suspended sediments in the 30–60 Nephelometric Turbidity Unit (NTU) range resulted in a breakdown of the dominance hierarchies of coho salmon, accompanied by more frequent gill-flaring activity and territorial defense cessation; a return to lower turbidities (0–20 NTU) allowed reestablishment of social organization (Berg and Northcote 1985, cited in LaSalle 1988). Such behavioral modifications may denote impairment of the fitness (sublethal effects) of salmonids populations exposed to short-term, low-level suspended sediments.

Sublethal effects relate to tissue injury or alteration of the physiology of an organism. Effects are chronic in nature and while not leading to immediate death, may result in mortality over time. These may include effects such as gill trauma, or impacts to osmoregulation, blood chemistry, and reproduction and growth. For example, when yearling coho salmon and steelhead were exposed to high concentrations of suspended sediments (2000–3000 g/L), both species showed a decrease in feeding rates, an increase of plasma cortisol levels and blood hematocrits, and a reduced tolerance to infection (Redding et al. 1987, cited in Sigler 1988). Similarly, Chinook salmon in the Columbia River estuary showed a decrease in feeding on amphipods (typically a primary dietary constituent) in the months after the 1980 eruption of Mount St. Helens (Kim et al. 1986, cited in Sigler 1988). This was likely a result of both turbidity (affecting feeding) and siltation (affecting amphipod communities). Such physiological stresses are sublethal but reduce the performance capability of the fish.

Although suspended sediment can adversely affect the visual abilities of estuarine fishes, it should similarly affect a reduction in their vulnerability to predation (Gradall and Swenson 1982; Guthrie 1986; Ritchie 1972; cited in Gregory 1988). Therefore, it is not surprising that there is a decrease in foraging at very low levels of turbidity, and moderate increases in turbidity are not necessarily detrimental to the survival of young salmonids (Gregory 1988).

Lethal effects kill individual fish and can cause overall population reductions, or damage the capacity of the system to produce future populations. Suspended sediment levels high enough to cause lethal effects generally are not attained in the natural estuarine environment or during dredging operations (Cordone and Kelley 1961, cited in Gregory 1988; LaSalle 1988) and are not expected to be present during the dredging project.

Results of suspended sediment impacts on gill tissue of juvenile salmonids have been varied, with some studies reporting damage to gill tissue and others reporting no difference in gill tissue when fish exposed to sediment are compared to their control groups (Servizi and Martens 1987; Noggle 1978; Redding and Schreck 1987; McLeay et al. 1987, cited in Servizi 1988). Injury to gill tissue can provide an entry for infectious organisms. This, compounded with the suspended sediment effect of reduced leucocrit (white blood cells), can lead to reduced tolerance of infection (McLeay et al. 1987, cited in Servizi 1988).

In addition to affecting salmonid physiology and behavior, deposited sediments may affect salmonids by altering the physical structure of the stream environment. Although not relevant to this project as the operation is well below salmonid spawning areas, sediments pose a direct threat to salmonid embryos through deposition in interstitial spaces, thereby reducing oxygen-rich flows and pathways for wastewater removal, as well as potentially entombing emerging fry.

Broader systemic effects of sedimentation in streams can include the loss of habitat complexity and abundance, loss of refugia, and alterations to hyporheic flow (Sedell et al. 1990; Poole and Berman 2001).

It is apparent that salmonids have the ability to cope with some level of turbidity at certain life stages (Gregory and Northcote 1993). Evidence of this is illustrated by the presence of juvenile salmonids in turbid estuaries prior to leaving for the ocean and in local streams characterized by high natural levels of glacial silt, and therefore high turbidity and low visibility (Gregory and Northcote 1993). However, salmonid populations not normally exposed to high levels of natural turbidity or exposed to anthropogenic sediment sources may be deleteriously affected by levels of turbidity considered to be relatively low (18–70 NTU) (Gregory 1992).

During the period in which the Upper Duwamish Waterway is to be dredged, ambient TSS at the site can be quite high, depending primarily on the intensity and duration of rainfall events in the watershed. It is often that these same rainfall events trigger the downstream migration of juvenile Chinook salmon. USGS data reviewed as part of this analysis (see Section 5.3) indicate that the Duwamish River reaches its maximum suspended sediment levels generally between December and March. The average suspended sediment concentration recorded during the window of the proposed dredging (October 1 through February 14) was 72 mg/L. This would indicate that juvenile Chinook salmon in the Green/Duwamish River system are adapted to tolerating at least moderate levels of suspended solids during their outmigration.

To insure that potential effects of elevated TSS from dredging are minimized, Ecology regulates water quality through a project specific Water Quality Certification and short-term Modification to the Water Quality Standards authorizations, if necessary to accommodate "essential" activities. The dredging for FY 2007–2011 will require a Department of Ecology Water Quality Certification with accompanying conditions to reduce impacts to water quality during dredging. It is anticipated that a Modification to the Water Quality Standards will also be granted. The modification for the 2004–2005 maintenance dredging specified the following criteria to accommodate temporary impacts on water quality: a mixing zone of 300 feet radially and 600 feet down current from the dredging operation, waived Class A turbidity standards, and no reduction in dissolved oxygen below 4.0 mg/l. The 2004–2005 Ecology Water Quality Certification also stipulated corrective measures if water quality parameters exceed established standards during dredging operations. These corrective measures emphasize the following: 1) modifying the dredging activity or equipment; 2) reducing the dredging rate; or 3) stopping dredging operations. These corrective measures applied until dredging operations demonstrated compliance with water quality standards. It is anticipated that Ecology would grant similar 401 Certification specifications and modification to water quality standards for upcoming maintenance dredging activities in the Duwamish. Compliance with Ecology's Water Quality Certification standards is expected to minimize water quality impacts during dredging to localized, short-term events.

In addition to the above measures, Ecology may require compliance monitoring of water quality during dredging to verify that turbidity and dissolved oxygen conditions are met. If not met, corrective actions (as noted above) would be required to immediately bring turbidity from dredging activities into compliance with permit requirements.

The following describes monitoring and corrective actions taken as part of the recent dredging of the Lower Snohomish River maintenance dredging as an example of how these measures minimize potential effects to water quality.

Water quality monitoring of maintenance dredging operations in the Snohomish River was conducted in January 2005 to evaluate compliance with turbidity criteria. The results from this monitoring revealed that exceedance conditions (greater than 5 NTUs above background) occurred only once during the 5 days that the clamshell dredge was monitored (Corps 2005c). In the instance where background levels were exceeded by more than 5 NTUs, the contractor slowed the dredging rate and turbidity levels dropped to acceptable levels within one hour. The Corps conducted additional monitoring to evaluate the effect of very strong ebb tides on the plume. Sampling found that turbidity downstream of the dredge exceeded 5 NTUs above background in mid-depth and bottom samples, but not surface samples. Because of this, the Corps and contractor established a modified dredging schedule to not dredge during maximum ebb conditions. Sampling after dredging ceased indicated that turbidity returned to within 5 NTUs of background (the threshold) within 30 minutes.

The Corps is proposing to monitor water turbidity and dissolved oxygen during the initial 5 days of the dredging operation (the same conditions as the Snohomish River maintenance dredging permit) as a conservation measure to minimize the potential for dredging to affect listed species (i.e., no more that 5 NTUs above background when ambient turbidity is less than 50 NTUs, and no more than 10 NTUs above background when ambient is above 50 NTUs at a distance of 600 feet downcurrent of the dredge) (see Section 7).

The majority of emigrating juvenile salmonids will not be exposed to elevated turbidity from dredging due to the proposed timing of dredging between October 1 and February 15 (because they emigrate later in the year; see Figure 3) and because they migrate in the nearshore areas rather than the main channel.

However, some early emigrating Chinook salmon (during late January and early February) could potentially be exposed to the dredge plume if juveniles migrate downstream while the dredge is active. Assuming that some exposure to areas with elevated turbidity from dredging is "unavoidable" once the juveniles start their migration in late January, the Corps is proposing several additional conservation measures that will be initiated to minimize the potential for juvenile Chinook salmon to be exposed to water with turbidity at levels that may affect them (see Sections 7 and 10).

6.1.3. Dissolved Oxygen

Dissolved oxygen (DO) concentrations tend to decline in the vicinity of dredging operations when the suspension of anoxic sediments creates high chemical oxygen demand. Temporary decreases in DO associated with increased suspended sediments are possible in the immediate dredging plume area. However, DO in the Duwamish River during the winter months (when dredging would occur) would not be expected to be a limiting factor due to the cooler conditions and consequent higher DO concentrations expected in these waters (based on USGS data cited in Section 5.3, mean concentrations of DO between October and February are 9.4–12.1 mg/l). Further, it is not likely that sediments to be dredged are strongly anoxic because the bulk of the sediment to be dredged is expected to have a very low percentage of fine sediments (areas DA 4 and DA 5 contain 8.7 and 6.4 percent fines, respectively).

In the short term, temporary effects of decreases in DO could include avoidance of the dredging area by mobile aquatic organisms and reduced foraging during and immediately after dredging as fish avoid areas of temporarily depressed dissolved oxygen. The majority of juvenile salmonids will not be exposed to reduced dissolved oxygen conditions due to the timing of dredging between October 1 and February 15. However, some early out-migrating Chinook salmon juveniles (late January and February) could potentially be exposed to effects of the dredge plume if dredging were to extend beyond January 15.

Ecology's Water Quality Certification is expected to contain conditions to reduce impacts to water quality during dredging. This includes conditions for corrective measures to be taken in the event that the dredging results in reduced dissolved oxygen to levels that may affect aquatic organisms. These corrective measures emphasize the following: 1) modifying the dredging activity or equipment; 2) reducing the dredging rate; or 3) stopping dredging operations. As a conservation measure, the Corps is also proposing to monitor DO during the initial dredging period to insure compliance with the Water Quality Certification and short-term Modification to the Water Quality Standards authorizations, which will minimize the potential for DO in the water to degraded to a level that might adversely affect salmon or other aquatic organisms.

6.1.4. Temperature

The proposed maintenance dredging is not expected to significantly alter the depth or extent of the salt wedge within the lower Duwamish River. The resulting configuration of the bottom will not significantly change currents or flow pathways within the navigation channel. Dredging will remove areas of shoaled sediments and will return the Turning Basin portion of the navigation channel to its authorized depth. The dredging will similarly have no effect on the distribution or density of riparian vegetation fringing the river. Therefore, the proposed dredging is not expected to result in a change to water temperature in the action area or to affect listed species that may be sensitive to changes in water temperature.

6.2. Effects on Physical Habitat Quality

6.2.1. Sediment Contamination

The regular testing of sediments within the proposed dredging area (Figure 2) ensures that any contaminated sediments are identified prior to dredging. This testing minimizes the potential resuspension or transport of contaminated sediments to other areas by preventing contaminated sediments from being disturbed during dredging. Sediment characterization in 2003 indicated that all dredging areas between stations 257+00 and 275+56 were suitable for both beneficial use and open water disposal. Therefore, the proposed dredging is not expected have an adverse effect on aquatic organisms including listed species.

6.2.2. Shoreline and Estuarine Habitat Conditions

Maintenance dredging will not result in any deepening and/or widening of the project channel at the Turning Basin; dredging will only be conducted to maintain the authorized depths of the navigation channel (–15 feet plus up to 2 feet overdepth). The dredging is unlikely to degrade the migratory pathway or foraging habitat of juvenile salmonids because they generally follow the shoreline and would not be expected to utilize the 150-foot wide center of the navigation waterway (where the dredging is concentrated). Therefore, the proposed dredging is not expected to degrade the character or distribution of shoreline or estuarine habitat or to negatively affect the ability of listed species to utilize those habitats.

6.2.3. Disturbance/Noise

Maintenance dredging at the Turning Basin will temporarily increase ambient noise levels as the dredge is working. Lights operating on the dredge will temporarily increase ambient lighting levels at night in the immediate vicinity of the dredge, but are not expected to adversely affect neighboring properties or adjacent habitats due to the short duration of their presence. Noise and activity during dredging operations could temporally disturb some species from the adjacent shoreline areas and from the immediate area of the working dredge, but this effect is expected to be temporary. Once the dredge ceases to operate, there will be no long-term effects from the temporary increase in noise.

Temporary increases in noise and disturbance during dredging are expected to be insignificant and discountable and are not expected to significantly degrade existing conditions within the action area or to have adverse effects on listed species.

6.3. Effects on Species Present

6.3.1. Fish

A clamshell or other mechanical bucket dredge would be used for the proposed project. Due to the characteristics of this equipment, it is generally accepted that they do not have the potential to entrain fish. The bucket cannot trap or contain a mobile organism during its descent because it is totally open.

Temporary increases in noise, turbidity, and activity during the dredging is expected to signal any adult fish in the vicinity to avoid the area during dredging activities. Because dredging is confined to the center of the waterway, adults, if present, could readily avoid the disturbed portion of the water column by moving toward the shoreline and either holding or transiting around the area being dredged. The proposed dredging is not likely to adversely affect adult salmonids if their upstream migration overlaps the dredging period.

The majority of outmigrating juvenile salmonids would not be present in the Turning Basin when dredging is occurring because of the proposed timing of the dredging. However, some early emigrating Chinook salmon (during late January and early February) could potentially be in the area of dredging should the dredge be operating after January 15 (presence of other salmonid species during the October 1 to February 15 period would not be expected because they emigrate later in the year; see Figure 3).

Bull trout have never been observed in the Turning Basin in winter.

Even though most juvenile Chinook salmon migrate along the shoreline, some early outmigrating Chinook salmon (during late January and early February) could potentially be exposed to the dredge plume if juveniles migrate downstream in the dredge channel while the dredge is active. Exposure to TSS in the dredge plume or short-term avoidance of the plume would potentially result in some disorientation of juvenile Chinook salmon, but they normally should be expected to avoid the heaviest part of the plume. Assuming that some contact with the plume areas during dredging is “unavoidable”, the Corps is proposing conservation measures that will be initiated to minimize the potential for juveniles salmon to be exposed to TSS at levels that may affect them (see Section 7 and Section 10).

6.3.2. Birds

Resident populations of osprey, peregrine falcon, great blue heron, purple martin, and the variety of songbirds, shorebirds, and waterfowl that utilize the lower Duwamish River are believed to be acclimated to the levels of human disturbance, noise, and the existing, degraded habitats of the action area. Resident individuals wintering along the shore or within the restored areas of salt marsh may avoid the center of the waterway during dredging, but this effect is expected to be temporary. Resident birds are expected to immediately return to their usual foraging areas and behaviors after the dredging stops and thus the proposed action is not expected to reduce the foraging prey base for bald eagles (see Section 5.2). Seagulls and other more aggressive birds that regularly utilize the lower Duwamish River, such as crows and possibly osprey, may be attracted to the dredging area.

The proposed dredging is thus expected to have insignificant and discountable effects on resident birds in the action area and is not expected have adverse effects on listed bald eagles.

6.3.3. Marine Mammals and Turtles

With the exception of incidental upstream foraging by harbor seals, marine mammals and turtles are not expected to occur in the Duwamish Waterway. If harbor seals did move upstream as far as the Turning Basin, they would be expected to avoid active dredging. Consequently, the proposed dredging is not expected to have any effects on marine mammals or turtles and is not expected have adverse effects on listed species.

6.3.4. Benthic and Epibenthic Prey Availability

Dredging will temporarily reduce the populations of the subtidal benthic and epibenthic invertebrate community through removal of benthic substrate and smothering of adjacent benthic invertebrates as suspended sediments settle out of the water column. Invertebrate prey for juvenile salmonids and bottom fish will thus be temporarily reduced in the center of the waterway. Total organic carbon could be slightly lower in the newly exposed sediments after dredging. Thus, the amount of food (in the form of organic matter) available for subtidal benthic invertebrates immediately adjacent to the edges of the dredged channel would be slightly reduced on a temporary basis.

While benthic and epibenthic prey species will be temporarily displaced, populations are expected to recover shortly (within 2 years) after dredging activities are completed. Because dredging will occur in the center of the waterway, adjacent undisturbed intertidal habitat along the channel edges will continue to provide an established source of benthic and epibenthic invertebrates to colonize the newly exposed subtidal substrate. Since new invertebrate communities will recolonize the dredging area, no long-term loss of biological productivity or prey base for juvenile salmonids or bottom fish is expected.

Temporary decreases in benthic and epibenthic prey within the dredged area are not expected to cause a significant or countable effect on local fish populations in the action area and is not expected to have adverse effects on listed fish species.

6.3.5. Forage Fish Availability

Dredging activities would not effect the spawning of Pacific herring, surf smelt, or sand lance because there is no appropriate spawning habitat within the vicinity of the dredging activities.

Small numbers of forage fish do occur in the Duwamish Waterway. Temporary effects on forage fish are possible during dredging activities. Forage fish such as Pacific herring, sand lance, and surf smelt are expected to avoid the dredging area, resulting in a temporary loss of forage fish from the immediate area during the dredging period. Although sand lance borrow, they would not be expected to burrow in the area to be dredged because of its depth.

Although there will be temporary disturbance to small groups of forage fish, coupled with temporary decreases in water quality surrounding the dredge, these are expected to be insignificant and discountable effects on local forage fish in the action area and these effects are not expected to have adverse effects on listed fish species through food web interactions.

6.3.6. Intertidal Vegetation

No direct impacts to intertidal vegetation would occur as a result of dredging the Turning Basin and channel. Dredging activities are concentrated in the center of the waterway and would not impact the intertidal marsh restorations at the Turning Basin or channel.

By maintaining the navigable depth of the Waterway at the Turning Basin, the proposed dredging will help prevent barges from stranding in this area (as they have in the past). Vessel stranding and salvage has the potential to cause catastrophic disturbance to the developing marsh.

The proposed dredging is thus not expected to degrade the character or distribution of intertidal vegetation, or to negatively affect the ability of listed species to utilize intertidal marshes in the vicinity of the proposed dredging.

6.3.7. Riparian Vegetation

Because dredging activities are concentrated in the center of the waterway, the proposed dredging will not impact the scattered patches of trees and shrubs which fringe portions of the lower Duwamish River. The proposed dredging is thus not expected to degrade the character or distribution of riparian vegetation, or to negatively affect the ability of listed species to benefit from the scattered areas of riparian vegetation within the action area.

7. CONSERVATION MEASURES FOR MAINTENANCE DREDGING ACTIVITIES

The following identifies conservation measures proposed by the Corps to avoid and minimize potential effects of the Upper Duwamish Waterway maintenance dredging activities to listed avian and aquatic species. Because of the possibility of the movement of outmigrating juvenile Chinook salmon through the Turning Basin during dredging activities, additional conservation measures (9–12) have been developed to identify when juvenile Chinook salmon start occurring in the Turning Basin (before January 15) and what actions would occur when significant numbers of juvenile Chinook salmon begin migrating through the Turning Basin (after January 15).

Conservation measures 1–8, Tier 1, would be implemented before and/or during all active dredging periods:

(1) Maintenance dredging will be conducted based on the results of site-specific hydrographic condition surveys conducted each year.

(2) Maintain and/or obtain current suitability determinations of channel and Turning Basin sediments by testing sediments, following PSDDA protocols for sediment disposal and beneficial use.

(3) Dredging will be performed with a mechanical dredge and will be carried out in a manner that minimizes spillage of excess sediments from the bucket and minimizes entrainment of fish.

(4) Barges used to transport the dredged material to the disposal or transfer sites will not be filled beyond their capacity to completely contain the dredged material.

(5) Dredging will be carried out in compliance with permits issued by the responsible regulatory agencies. These permits may include additional conditions to protect water quality, as specified in the 401 Water Quality Certification from Ecology. These conditions will likely include water quality monitoring during the first five days of active dredging, including monitoring at compliance points upstream and downstream of the dredging as well as monitoring on a transect across the channel to determine the lateral extent of turbidity.

(6) Coordinate with the Muckleshoot Indian Tribe before and during every dredging event to establish other opportune times to dredge earlier in the dredging window to complete dredging by January 15 if possible.

(7) Coordinate with WRIA 9, per the Salmon Habitat Recovery Plan and other local restoration/stewardship groups to identify individual and long-term opportunities for beneficial use of dredged material.

(8) Conclude dredging by February 15 of each year.

Conservation measures 9–12, Tier 2, will be implemented during dredging operations after January 15:

(9) Weather and USGS river flow conditions will be monitored on a daily basis to identify potential for freshet.

(10) Exploratory beach seining will be conducted to determine start of out migration of young-of-the-year (YOY) juvenile Chinook salmon (one day per week, outgoing tide minimum); monitoring would occur until the first freshet; monitoring would take place at the Site 1/North Wind's Weir mudflat and marsh located approximately one mile upstream of the Turning Basin on the left bank of the river.

(11) The day/night dredging protocol will be initiated after juvenile Chinook salmon outmigration has begun. The protocol will be initiated when beach seine surveys indicate that YOY Chinook salmon are present in the project area in appreciable numbers (greater than 100 per hectare [10 per beach seine set]). Age 1+ Chinook would not be counted for this protocol because they are of hatchery origin.

The protocol would require the dredge to confine nighttime dredging to the middle portions of the navigation channel and Turning Basin, which acts to increase the distance between the active dredging operation and the nearshore areas occupied by YOY Chinook salmon. During the daytime, when Chinook salmon appear to be less abundant in the navigation channel and Turning Basin, the outer margins of the navigation channel and Turning Basin would be dredged.

(12) After juvenile outmigration has begun, the day/night dredging protocol will be initiated. The protocol will be initiated after the first freshet after January 15 or after fish are detected during the seining operations. The center of the navigation channel will be dredged at night, and the outer margins of the navigation channel will be dredged during the daytime to minimize the proximity of dredging to the nearshore mudflats.

8. INTERRELATED AND INTERDEPENDENT EFFECTS

The disposal of the dredged material generated by the dredging operations is an interrelated and interdependent effect of the proposed dredging. The effects of transport to and disposal of disposal of the dredged material at the Elliott Bay PSSDA open water disposal site has been analyzed in detail in a previous BE (Corps 2005a). Both USFWS and NMFS have concurred with the "not likely to adversely affect" determinations presented in that BE (USFWS 2005, NMFS 2005). Other interrelated and interdependent effects of the proposed dredging include the continuation of deep-draft ships utilizing the Duwamish Waterway up to the Turning Basin. The proposed dredging safeguards navigation within the Waterway by removing potentially hazardous areas of shoaling and maintaining the authorized depth of the navigation channel. These effects are not expected to increase due to the proposed dredging; rather, they are a continuation of the current type and intensity of use in the Waterway. As noted earlier, failure to continue maintenance dredging at the Turning Basin may result in a requirement to dredge areas downstream of the Turning Basin, which may include areas that are previously contaminated (see Section 6.1).

9. CUMULATIVE EFFECTS

Numerous projects could occur in or near the Duwamish Waterway between FY 2007 and FY 2011 including sediment cleanup, navigational dredging, habitat restoration, or in-water infrastructure construction or repair. Other projects that may affect in-water habitat would be required to obtain federal permits and thus would undergo separate Section 7 review.

The Corps is not aware of any other non-federal projects that may take place in the Duwamish Waterway that would result in a cumulative effect to salmon, bull trout or eagles.

10. DETERMINATION OF EFFECT FOR LISTED SPECIES AND CRITICAL HABITAT

Table 2. Summary of Effect Determinations

Common Name	Scientific Name	Effect on Listed Species	Effect on Designated Critical Habitat
Bald Eagle	*Haliaeetus leucocephalus*	May affect, but is not likely to adversely affect	No critical habitat designated
Bull Trout	*Salvelinus confluentus*	May affect, but is not likely to adversely affect	Not likely to adversely affect
Chinook salmon	*Oncorhynchus tshawytscha*	May affect, likely to adversely affect	Not likely to adversely affect

10.1. Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) was initially listed as endangered under the Endangered Species Act in 1978 throughout the lower 48 states, except Minnesota, Michigan, Wisconsin, Washington, and Oregon, where it was listed as threatened. In 1995, the USFWS reclassified the bald eagle from endangered to threatened throughout the lower 48 states due to the steady increase in their populations (32 FR 4001). On July 6, 1999, the USFWS announced a proposal to delist the bald eagle under the Endangered Species Act in 1978 (60 FR 36010). However, formal delisting of the species has not yet occurred.

10.1.1. Description of Species

The bald eagle is found along the shores of saltwater and freshwater lakes and rivers. In Washington, breeding territories are located in predominantly coniferous, uneven-aged stands with old-growth components. Territory size and configuration are influenced by a variety of habitat characteristics, including availability and location of perch trees for foraging, quality of foraging habitat and distance of nests from waters supporting adequate food supplies. Habitat models for nesting bald eagles in Maine show that the eagles select areas with 1) suitable forest structure, 2) low human disturbance, and 3) highly diverse or accessible prey (Steenof 1978).

Although bald eagles may range over great distances, they usually return to nest within 100 miles of where they were raised. They typically mate for life. Their nest tree is usually the dominant tree in the canopy and they are often built within a mile of the water body used for foraging.

Bald eagles typically build nests in mature old-growth trees, which are generally used in successive years. In Washington, courtship and nest-building activities generally begin in January and February. Egg laying begins in March or early April, with eaglets hatching in mid-April or early May. Eaglets usually fledge in mid-July and often remain in the vicinity of the nest for another month (Steenof 1978).

Bald eagles are adaptable, feeding on whatever is most expedient. Eagles often depend on dead or weakened prey, and their diet may vary locally and seasonally. Various carrion, including spawned salmon taken from gravel bars along wide, braided river stretches, serve as important food items during fall and winter. Waterfowl often are taken as well. Anadromous and warm-water fishes, small mammals, carrion, and seabirds are consumed during the breeding season (Steenof 1978). In winter, northern birds migrate south and gather in large numbers near open water areas where fish or other prey are plentiful.

10.1.2. Occurrence in Project Area

Nesting and wintering populations in almost all recovery areas in Washington, including the West Cascade Mountains recovery zone, have reached levels that may allow delisting. In the state of Washington just over 100 nesting pairs of eagles were documented in 1978. Since that time, the nesting population has increased to approximately 650 pairs (WDFW 2001). Several hundred additional bald eagles occupy rivers and streams associated with the Skagit River system each winter between approximately October 31 and March 31 to feed on the carcasses of salmon that have returned to spawn. Wintering populations in Washington are thought to be stable or increasing. However, habitat loss, degradation, and major disturbance factors continue to be serious problems that must be guarded against to assure population gains are not diminished.

Adult, sub-adult, and juvenile bald eagles are commonly sighted flying over or perched along the lower Duwamish River and are known to forage within and around Elliott Bay and the Duwamish Waterway where they are year-round residents. Due to the industrialized nature of the lower Waterway and the lack of significant trees for nesting, there are no documented nests within the vicinity of the proposed dredging. Similarly, wintering bald eagles do not generally concentrate along the lower Duwamish River or Elliott Bay.

The nearest bald eagle nest to the dredging operation is located 2.6 miles east from of the dredging site at Lakeridge Park (Priority Habitat and Species database search September 2005). Three bald eagle nests have been documented in Seward Park, approximately 4 miles northeast of the Turning Basin, and one nest is located on the southern end of Mercer Island, approximately 3.7 miles east of the Turning Basin. One bald eagle nest has also been documented in Seahurst Park, approximately 4.25 miles southwest of the Turning Basin (WDFW PHS database search September 2005).

10.1.3. Analysis of Effects

Species

Potential effects of the proposed maintenance dredging on bald eagles include disturbance from the dredging activities and increased turbidity around the Turning Basin during dredging that may inhibit foraging or result in temporarily reduced food availability. Noise (running heavy equipment) and temporary increases in turbidity during dredging will likely cause prey fish and waterfowl to avoid the immediate area of the dredging operations. Consequently, resident or wintering bald eagles are expected to temporarily avoid the immediate area and forage elsewhere until dredging operations are completed.

Because the action area represents a small portion of the foraging habitat locally available for bald eagles along the shoreline of central Puget Sound, any such interference with bald eagle foraging activity is expected to be insignificant and discountable, ending when the dredging activities are completed. Similarly, because resident and wintering bald eagle populations in this area are likely acclimated to frequent boat and barge traffic on both the lower Duwamish River and Elliott Bay, no long-term effects on habitat suitability or bald eagle foraging behavior are expected. Noise and activity levels during the dredging activities are expected to be within the range of recurrent ambient levels within these industrialized areas.

Although dredging activities could take place during early portion of the nesting season (January through February 15), survival and reproductive success of bald eagles at the Lakeridge Park nest would be unaffected.

Long-term degradation of bald eagle habitat is also not expected. Effects of dredging to bald eagle prey availability would be negligible and discountable.

No significant cumulative, interrelated or interdependent effects on the bald eagle are expected from the proposed dredging activities when considered in conjunction with other projects or actions.

Critical Habitat

No critical habitat has been designated for bald eagle.

10.1.4. Take Analysis

Although foraging activities of bald eagles may be temporarily disturbed during dredging operations, this disturbance is not expected to significantly disrupt normal behavior patterns or increase the likelihood of injury or “take” of any bald eagles. Therefore, the potential for incidental take in any form (including harassment) is considered negligible.

10.1.5. Conservation Measures

No specific conservation measures are warranted, because the potential for adverse effects on the bald eagle from short-term dredging operations is negligible. Conservation measures described in Section 7 for bull trout and salmon are expected to also benefit bald eagles by limiting effects on salmon.

10.1.6. Effect Determination

Proposed maintenance dredging activities will not result in any long-term degradation of habitat or other significant adverse effects on bald eagles. Short-term effects such as noise disturbance and reduced prey availability will not occur or will be very small in magnitude, as discussed above. Temporary disturbance to foraging activities are expected to be insignificant and discountable. The survival or reproductive success of bald eagles in the project vicinity would not be affected. Therefore, the proposed maintenance dredging activities may affect, but are not likely to adversely affect the bald eagle.

10.2. Bull Trout – Coastal/Puget Sound Distinct Population Segment

10.2.1. Description of Species

Bull trout (*Salvelinus confluentus*) are native char that are part of the salmonid family. Bull trout were historically found throughout the Pacific Northwest, from Northern California to the upper Yukon and Mackenzie drainages in Canada. Inland populations were found in Idaho, Montana, Utah, and Nevada. Bull trout may be extirpated in California and have declined in numbers in much of their range, especially along its southern limits (McPhail and Baxter 1996). Bull trout have probably been extirpated from parts of their former range in Washington, such as Lake Chelan and the Okanogan River. Bull trout was listed as a threatened species on November 1, 1999 (FR 64 58910) and critical habitat was designated for the species on September 26, 2005 (70 FR 56 211).

Bull trout have more specific habitat requirements as compared to other salmonids, generally restricting their spawning and juvenile rearing to high quality habitats. Particularly important requirements are water temperature, cover, channel form and stability, valley form, spawning and rearing substrates, and migratory corridors. Bull trout prefer deep pools of cold rivers, lakes, and reservoirs, often seeking out the coldest water in a watershed (USFWS 1999a). Streams with abundant cover (e.g., cut banks, root wads, and other woody debris) and clean gravel and cobble beds provide the best habitat. Their preferred summer water temperature is generally less than 55° F, while temperatures less than 40° F are tolerated. Spawning during fall usually starts when water temperatures drop to the mid- to low-40s. Cold, clear water is required for successful reproduction (USFWS 1999).

Juvenile bull trout, particularly young of year, also have very specific habitat requirements. Small bull trout are primarily bottom dwellers, occupying positions above, on, or below the stream bottom. Good hiding cover is also important to all life stages of all forms of bull trout. Fry and juveniles can be found in pools or runs in close proximity with cover provided by boulders, cobble, large woody debris, and undercut banks. Age 1+ and older juveniles utilize deeper, faster water than underyearlings, often in pools with shelter-providing large organic debris or clean cobble substrate. In large rivers, the highest abundance of juveniles can be found near rocks, along the stream margin, or in side channels (Pratt 1984, 1992; Goetz 1994).

10.2.2. Distribution of Bull Trout in Puget Sound

The current distribution of bull trout within Puget Sound marine waters is not completely known but has been documented from the Canadian border to at least Commencement Bay to the south. Bull trout migrate and are captured throughout the inner bays of northeast Puget Sound from Possession Sound, Port Susan, Skagit Bay, Padilla Bay, and west to Whidbey Island (F. Goetz, Corps, unpublished data). One bull trout tagged in the Nooksack River was later recovered in the Lower Fraser River (N. Currence, Nooksack Tribe, pers. comm. 2003). It is thought that bull trout primarily use the shallower nearshore waters along the eastern shore of Puget Sound, and occasionally use or cross deeper waters to access locations along the west side of Puget Sound. It is unknown if individuals from Puget Sound populations migrate as far west as the Straits of Juan de Fuca and to what extent they may migrate up the coast of British Columbia.

Bull trout may also use the estuaries and reaches of river systems that have not historically or currently supported spawning populations of bull trout, such as the Samish and Duwamish rivers. Bull trout are believed to be foraging on juvenile salmonid downstream migrants or other fish species while occupying these areas.

10.2.3. Distribution and Ecology of Juveniles

Current information suggests that bull trout first enter tidally influenced waters in Puget Sound as age-2 fish. The size of juvenile fish at marine entry may range from 110 to 200 mm (Yates 1988; Tanner et al. 2002; Kraemer 2003; Jeanes, R2 Resource Consultants, Mindy Rowse, NOAA, E. Beamer, Skagit Systems Cooperative, unpublished data). The seasonal timing of entry extends from mid-February to early September. The Skagit River provides the only long-term monitoring point for juvenile bull trout downstream migration timing. The WDFW operates a scoop trap and screw trap near Mt. Vernon, Washington, which lies within the range of tidal influence. Since 1990, the WDFW has captured over 2000 juvenile bull trout at the trap. A cumulative frequency analysis of their catch data shows that 98 percent of all the fish were captured between April 1 and July 31 with approximately 0.2 percent captured in February, 1 percent in March, and 0.6 percent in August and September (Dave Seiler, WDFW, unpublished data).

Upon entry, the juvenile fish may elect to rear in the tidally influenced delta within intertidal marsh, distributary channels, or along mainstem habitat areas; or they may pass through into nearshore marine areas. Larger juveniles may elect to migrate substantial distances through the nearshore marine environment from the natal river basin to adjacent areas. The longest documented migration of a larger juvenile or small sub-adult bull trout was from one of the rivers in the western Olympic Peninsula (Quinault, Hoh, or Queets rivers) to the Willapa River. A single fish approximately 200–250 mm was captured at RM 29 in the Willapa River in May 2002 (J. Chan, USFWS, pers. comm.), this fish would have migrated a minimum of 60 to 100 miles from a known spawning river to get to the Willapa River.

10.2.4. Habitat Use

Migratory (fluvial, adfluvial, and anadromous) bull trout habitat use of off-channel areas in floodplain areas (freshwater and tidally influenced) has been little studied in larger mainstem rivers. Prior to 2002, reports of bull trout use of floodplain areas in western Washington were not available. Recent review of gray literature and personal contacts shows there is increasing information available showing that sub-adult and adult bull trout use lower elevation floodplains in freshwater and tidally influenced areas.

In the Puget Sound basin, other observations of bull trout use of freshwater floodplain areas have been recorded in: 1) the lower end of South Fork of the Nooksack River, in Black Slough in a beaver dam complex (N. Currence, Nooksack Tribe, pers. comm.); 2) the North Fork Stillaguamish River, in a slough at the mouth of McGovern Creek (C. Kraemer, WDFW, pers. comm.); 3) the Skagit River, in Manser Slough near Parker Creek at RM 40 (E. Conner, Seattle Public Utilities, pers. comm.); 4) the Upper Skagit, at Park and Nehalem Sloughs near Nehalem, caught by smolt trapping (C. Kraemer, WDFW, pers. comm.).

In tidally influenced floodplain areas of Puget Sound, subadult bull trout have been observed or captured in restored and natural tidal channels (three and two locations, respectively) and larger distributary channels in the following locations: 1) the South fork Skagit, in Deepwater Slough, a moderate-sized tidal channel in a floodplain area previously isolated from the river and tides until reconnection occurred in October 2000 as part of a estuary restoration project (J. Klochak, Skagit System Cooperative, pers. comm.); 2) the Snohomish River, in two small tidal channels off Ebey Slough, a large distributary channel (M. Rowse, NMFS, unpublished data); 3) the Snohomish in Union Slough, in the spring of the first year after dike removal and restoration of a previously isolated floodplain area on Spencer Island (Tanner et al. 2002); 4) the Skagit River, adult and subadult bull trout have been recorded migrating through both forks during upstream and downstream migratory movements (F. Goetz, Corps, unpublished data); and 5) the Snohomish River, subadult and adult bull trout have used portions of all three distributary channels—Union, Steamboat, and Ebey Sloughs in upstream and downstream migratory movements during spring, summer and fall, 2002 (F. Goetz, Corps, unpublished data).

Subadult and adult bull trout that enter marine areas pass through or use a wide range of habitats for short or longer-term habitation. The Corps has been conducting a multi-year acoustic telemetry study of sub-adult and adult bull trout use of nearshore marine waters from the Snohomish River to Padilla Bay. Recent data from the Corps study has shown that fish tracked in nearshore and lower river areas were not found at temperatures exceeding 60° F except for one observation at 64° F.

Prior to this study no information was available on the range of salinities bull trout may elect to use. To date, during the documented marine residence phase, March to July, fish have been found in salinities from 1 to 28 parts per trillion (ppt)—during this time period salinity does not appear to limit the habitats bull trout may elect to use. Substrate class does not appear to be important to selection of feeding areas or home territories (see below), as fish were found using substrates from mud, to sand, to large gravels. Turbidity levels also do not appear to influence the habitats selected by sub-adult and adult fish, as the highest density of tagged fish during the study was found in a high turbidity area of Snohomish River delta.

Depth range may change by time of day and may vary by age class. During one nearshore marine tracking survey, the largest tagged fish was found to occupy depths of 30 to 60 feet, a moderate sized fish was found at 10 to 20 feet, and a subadult was found at 5 to 10 feet. The largest tagged fish was found to vary depth by time of day, with the greatest depths occurring during daylight hours and the shallowest depths at night.

10.2.5. Prey

Bull trout utilize the productive shallow waters or estuaries and nearshore marine areas to forage on a variety of prey items, but appear to target juvenile salmonids and small marine fish such as herring, sand lance, and surf smelt, especially keying in on forage fish spawning beaches (Kraemer 1994). Evidence suggests that June is a month where bull trout may aggregate in the outlet of major estuaries seeking juvenile salmon as a preferred prey source. In the Corps acoustic telemetry study, the highest density of tagged fish were found in an aggregation at the outlet of the Snohomish River at the peak of the juvenile Chinook salmon outmigration in late June, 2002. In 2001 at Shilshole Bay, the highest number of adult bull trout caught at one time (three fish in one seine haul), were caught immediately below the smolt passage way at the beginning of the peak Chinook salmon migration (F. Goetz, Corps, pers. comm.). Footen (2000, 2003) has examined bull trout stomach contents. Data from this study indicated the bull trout that were examined ate 40 percent salmon and 60 percent forage fish (comprising sand lance and surf smelt). Recent analysis from the Hoh River shows that late winter prey of bull trout in the lower river was 95 percent surf smelt (S. Brenkman, NPS, pers. comm.).

10.2.6. Migratory Behavior

Data from the Corps study has shown that sub-adult and adult fish show a variety of migratory behaviors in estuary and marine waters including 1) inter-basin migrations of sub-adult and adult bull trout through marine waters whereby fish using any one estuary may come from multiple nearby basins; 2) fish returning to non-natal rearing areas during the winter; 3) selection of a territory they may occupy for up to 4 months (winter, spring, and early summer) and that they may return to year after year; 4) searching behavior where they occupy a feeding area for short periods (days to weeks) before moving to another area; 5) periodic movement back and forth between fresh and saltwater during the typical marine residency period; and 6) change in depth by time of day and by individual fish (discussed above).

In the first year (2002) of the Corps' acoustic telemetry study in the Snohomish River estuary and nearby marine areas, over 50 percent of the reported detections for fish who left the estuary study area (during late spring and early summer) occurred in the Skagit River basin. These fish (sub-adult and adult) have been reported or detected throughout the Skagit River basin, from the Whitechuck River, Upper Sauk, mainstem Skagit below Baker River, down to the estuary. These fish were originally tagged at various places within the study area, including the upper Snohomish River, lower Snohomish, and the nearshore marine shoreline north of the Snohomish (Port Susan). Bull trout tagged in the nearshore marine areas have been found entering and using the lower Stillaguamish River.

Based on these initial study results, there is likely a large degree of mixing of core-populations within estuarine and marine nearshore areas of Puget Sound. This same type of interbasin transfer is being documented by radio telemetry in rivers of the West Olympic Peninsula (S. Brenkman, NPS, pers. comm.). Migration by individual bull trout between river basins is a frequent occurrence in fresh water and is well documented. Prior to recent study, migration by bull trout between basins through estuarine and marine waters has little documentation. The occurrence of marine interbasin migration has been previously reported only for a very few selected individuals based on tag returns to the Washington Department of Fish and Wildlife.

Bull trout may reenter marine waters for a limited period during fall to return to the previous spring/summer feeding area. Fall rains or freshets may trigger this movement. As part of the Corps study, approximately 10 of the tagged fish reentered marine waters briefly, immediately after the first rain and increase in river flow after 4 months of drought during mid-November 2002. Several of these fish returned to areas they were tagged at in spring 2002. All of these fish returned to freshwater areas by early December. Tagged fish did not reenter marine waters again until early March 2003.

Bull trout may home to a feeding territory that they may occupy for up to 4 months (winter, spring, and early summer). In the first year of the Corps study, 98 percent of all tagged fish (49 of 50) left the tidally influenced areas by July 31, with one fish in freshwater tidal areas remaining until August 12. Bull trout may also return to this feeding territory year after year. Approximately 10 percent of all tagged fish returned to the location of tagging the previous year. Examples of these territories were found in all areas of the estuary—freshwater tidal, brackish intertidal, and nearshore marine. Both adult and sub-adult fish displayed this behavior. These territories may range in size from 1 to 2 kilometers in size and from 100 to 500 meters in shoreline length. In contrast to the feeding territory pattern, other individual fish display searching behavior, where they may be tagged at one location but are tracked at multiple locations in marine, estuarine, and freshwater.

10.2.7. Occurrence in the Project Area

Bull trout have been documented in the Green River, although they are rarely observed and the USFWS considers the Green River subpopulation to be “depressed” (USFWS 1999a). Recent discussion by the Puget Sound Technical Recovery Team has concluded that it is unlikely that there is a spawning population of bull trout in the Green River basin. The Green River was described as possessing a “few” Dolly Varden during the 1930s (Pautzke and Meigs 1940). A single native char was reported in Soos Creek in 1956. In April 1978, four adult char were caught by fisherman near the upper range of saltwater intrusion near a site called North Wind weir (D. Moore, MIT, pers. comm.), and a single native char was also observed at the mouth of the Duwamish River in the spring of 1994 (E. Warner, MIT, pers. comm.). In the past 3 years, nine sub-adult and one adult bull trout (total of 10 fish) have been captured in the Duwamish River by consultants working for the Port of Seattle. The most recent capture occurred at Kellogg Island in May 2003. This fish was a large adult, 585 mm, apparently with a full stomach. This fish was recaptured several hours later near where it was released downstream at the Herring House restoration site (J. Shannon, Taylor and Associates; E. Jeanes, R2 Resource Consultants, pers. comm.).

Of the nine subadult char captured by Taylor and Associates within the lower Duwamish River at the Turning Basin: six were caught in August 2000, two were caught in September 2000, and one was caught in September 2002. The size of these fish ranged from 223 to 370 mm with a mean size of about 290 mm, corresponding to mostly sub-adult sized fish. Environmental conditions were not measured at the time of capture in 2000; the single fish captured in 2002 was caught at a water temperature of 64° F. The average size of these fish is smaller than fish sampled out of any other estuary in western Washington (Snohomish, Skagit, Grays Harbor, Shilshole Bay, and Commencement Bay). The timing of capture of these fish is largely outside the range of fish capture for all other estuaries.

The Corps has recently initiated beach-seining efforts in the vicinity of the Turning Basin to document fish presence. If adult Chinook salmon or bull trout are captured, some will be implanted with acoustic tags, and their movements will be tracked by hydrophones installed in the Duwamish and elsewhere. As of September 20, 2005, no bull trout have been captured as part of this study (Jeanes pers comm. 2005).

10.2.8. Analysis of Effects

Species

Bull trout do not spawn within the action area and have not been observed in the Duwamish Waterway during the time of year that the dredging would occur. Consequently, no direct affects to bull trout are expected.

The effects of dredging operations could potentially have a small, but negligible indirect affect on bull trout through potential short-term effects to bull trout prey (juvenile salmonids and forage fish) and their habitat (see Section 6.3). Bull trout prey populations are unlikely to be significantly affected by the proposed dredging operations. Bull trout may forage within the action area during periods of juvenile salmonid outmigration; however, they have never been observed in the Duwamish Waterway during the proposed dredging period.

This information, in combination with the conservation measures described above (Section 7), particularly avoidance of the majority of the juvenile salmon migration period, implementation of day/night dredging protocols to minimize affects to juvenile salmon which might be migrating downstream between mid-January and mid-February and protection of water quality are expected to minimize the potential for adverse, short-term effects to bull trout prey during dredging operations. The temporary loss of benthic invertebrates in the dredge footprint and minor effects on forage fish during dredging is expected to have a negligible effect on long-term habitat quality within the action area. Overall, the effects of the proposed action would be insignificant and discountable due to the temporary duration of the dredging activities and the implementation of the proposed conservation measures to minimize the potential effects to bull trout prey.

Critical Habitat

The USFWS recently designated critical habitat for Coastal/Puget Sound bull trout (70 FR 56211). The Duwamish Waterway is included in the critical habitat designation. This section evaluates the potential for effects to the bull trout PCEs determined to be essential to the conservation of Coastal/Puget Sound bull trout:

(1) Water temperatures ranging from 36 to 59˚ F (2 to 15˚ C), with adequate thermal refugia available for temperatures at the upper end of this range.

Maintenance dredging would not affect water temperatures. Additionally, the colder water temperatures during the winter months proposed for maintenance dredging are within the range of suitable temperatures for bull trout.

(2) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.

Maintenance dredging would not result in the degradation of channel complexity. The area to be dredged is in the center of the waterway in an area that has been dredged for decades. Because the actions will take place in the center of the waterway, side channels, pools and undercut banks will not be affected. Further, maintenance dredging to return the Turning Basin to its authorized depth will not affect stream velocities or other hydraulic characteristics.

(3) Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and Young of the Year (YOY) and juvenile survival.

Maintenance dredging would not affect sediments suitable for success of eggs, embryos, fry or YOY. The Duwamish Waterway does not provide suitable spawning habitat for bull trout. The area to be dredged is composed of sediments that are not suitable as spawning material. YOY bull trout are not known to rear in the Duwamish Waterway.

(4) A natural hydrograph, including peak-, high-, low-, and base flows within historic ranges or, if regulated, a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.

Maintenance dredging would not affect the Duwamish/Green River hydrograph.

(5) Springs, seeps, groundwater sources, and subsurface water connectivity to contribute to water quality and quantity.

Maintenance dredging would not affect any springs, seeps, or groundwater sources that contribute to water quality and quantity.

(6) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

The Duwamish Waterway does not appear to function as a migratory corridor for bull trout per se, however, bull trout might enter the Waterway to feed on juvenile salmon and forage fish. Maintenance dredging would result in a temporarily, localized elevation of TSS in the water column which could affect localized movements of bull trout (but would not block any kind of migratory corridor). Bull trout have never been observed in the Duwamish during the period of the year (winter) when dredging is being proposed. If adult or subadult bull trout were present during dredging, they would typically be in the nearshore areas of the Waterway and could easily avoid any areas of elevated TSS.

(7) An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Maintenance dredging will not affect terrestrial organisms because dredging would occur in the center of the waterway and would not affect shorelines or riparian vegetation.

Maintenance dredging could affect benthic organisms in and some short distance downstream of the dredge footprint. However, the aquatic macroinvertebrates (benthic only) would not constitute significant prey for bull trout. Bull trout that might occur in the Turning Basin are likely there to feed on downstream migrating salmon and forage fish. Regardless, because of the relatively small size of the dredge footprint, the loss of benthic organisms from dredging would be insignificant compared to the total area of benthic forage areas available in the Waterway (and elsewhere).

Maintenance dredging could potentially have a small, but negligible indirect affect on bull trout through potential short-term effects to bull trout prey (juvenile salmonids and forage fish) and their habitat. However, bull trout prey is unlikely to be significantly affected by the proposed dredging operations.

(8) Permanent water of sufficient quantity and quality such that normal reproduction, growth and survival are not inhibited.

Maintenance dredging would not affect the quantity of water available to bull trout. Short-term water quality degradation would not affect reproduction and would have negligible and discountable effect on growth and survival.

10.2.9. Take Analysis

If bull trout were present in the Duwamish Waterway during dredging, then bull trout could be susceptible to short-term harassment during active dredging. However, bull trout have not been observed in the Duwamish during the dredging period.

In addition, implementation of the conservation measures described above (Section 7), particularly avoidance of the majority of the juvenile salmon migration period, beach seining to detect salmon and bull trout between mid-January and mid-February, implementation of day/night dredging protocols to minimize affects to juvenile salmon which might be migrating downstream between mid-January and mid-February and protection of water quality reduces the potential for incidental take in the form of harm or harassment of bull trout to a negligible level.

Conservation Measures

Conservation measures cited in Section 7 of this BA including avoidance of dredging the majority of the juvenile salmon migration period, restriction on the extent of water quality impacts, beach seining to detect salmon and bull trout between mid-January and mid-February and implementation of day/night dredging protocols to minimize affects to juvenile salmon which might be migrating downstream between mid-January and mid-February would minimize the potential for direct or indirect effects to bull trout.

10.2.10. Effect Determination

Sub-adult bull trout have been documented in the Duwamish Waterway. Therefore, the project may affect the threatened Coastal/Puget Sound bull trout. To date, no bull trout have been observed in the Duwamish during the proposed dredge period. However, should any bull trout present, they would experience negligible effects from the proposed dredging operations.

Conservation measures (as described in Section 7) would minimize the potential for direct or indirect effects to bull trout. In the unlikely event that bull trout would be present during dredging, they would be expected to readily avoid the project area during dredging operations.

Overall, the effects of the proposed action on Coastal/Puget Sound bull trout would be insignificant and discountable. Therefore, the proposed maintenance dredging activities may affect, but is not likely to adversely affect Coastal/Puget Sound bull trout.

Maintenance dredging of the Upper Duwamish Waterway, may affect, but is not likely to adversely affect designated critical habitat for Coastal/Puget Sound bull trout. The action does not affect six of the eight PCEs for bull trout critical habitat. Potential effects of the action on the other two PCEs (prey and migration) are considered insignificant and discountable.

10.3. Chinook Salmon – Puget Sound Evolutionary Significant Unit

10.3.1. Description of Species

Like all Pacific salmon, Chinook salmon reproduce in fresh water but spend the majority of their life cycle in the marine environment. Chinook salmon remain at sea an average of 2 to 4 years before returning to their natal stream to spawn. Chinook salmon prefer to spawn and rear in the mainstem of rivers and larger streams (Williams et al. 1975, Healey 1991). Chinook salmon are generally classified either as ocean or stream type. Ocean-type fish are characterized by a short juvenile freshwater residence time and normally migrate to estuarine areas within their first year (usually around 3 to 4 months after emergence from spawning gravel). They typically return to their natal stream a few days or weeks before spawning. Stream-type Chinook salmon typically spend one or more years in fresh water before migrating to the sea and often return to their natal streams several months prior to spawning. The majority of Puget Sound Chinook salmon, including those from the Duwamish River, are ocean-type, which migrate out of the river, through the estuary, and into marine waters as sub-yearlings.

Estuaries are an important rearing habitat for all species of salmon, but Chinook salmon are probably the most dependent on this type of habitat (Healy 1982). Rivers with well-developed estuaries are generally able to sustain larger ocean-type populations than those without. Salmon use estuaries for rearing, refuge from predators, and as a physiological transition area (Simenstad et al. 1982). Juvenile Chinook salmon rear in estuaries for periods ranging from several days to 2 months. They range in size from 35 to 160 mm in length when entering the estuary (Beauchamp et al. 1983). Ocean-type Chinook salmon are usually smaller and tend to utilize estuaries and coastal areas more extensively for rearing than stream-type juveniles (Healey 1991).

Chinook salmon smolts spend a prolonged period (several days to several weeks) during their spring outmigration feeding in salt marshes and distributary channels as they gradually transition into marine waters. Rapid growth also occurs in estuaries due to the abundance of preferred prey including larval and adult insects and epibenthic crustaceans such as gammarid amphipods, mysids, and cumaceans. As Chinook salmon juveniles mature and move into marine waters, they feed on drifting insects and small nektonic organisms (e.g., calanoid copepods, crab larvae, larval and juvenile fish, and euphausiids) (Simenstad et al. 1982, Healey 1991).

10.3.2. Occurrence in Project Area

Duwamish/Green River Chinook salmon is defined as a native stock with composite production (native and hatchery production). This stock has not shown the same decline in the number of adults returning to spawn in the river as other Puget Sound Chinook salmon stocks. A robust natural spawning run (fish that spawn in the river regardless of hatchery or natural origin) has persisted in the Green/Duwamish basin, and the stock is listed as healthy because it has continued to be strong and has not shown any negative trend in escapement (WDFW 2002 SASI). It is currently estimated that a large proportion, ranging from 25 to 83 percent and averaging 56 percent, of the natural escapement is composed of hatchery reared Chinook salmon that spawn in the river (Kerwin and Nelson 2000). These estimates have been difficult to verify since only a small percentage of hatchery Chinook salmon were marked prior to 2000 (Nelson et al. 2004).

Adult Chinook salmon migrate into the Duwamish Waterway from mid-August through November, with spawning occurring September through November. Past studies have shown Green River Chinook salmon fry emerge from the gravel in late February through April, with peak migration not occurring until mid April (Dunstan et al. 1955, Hilgert and Jeanes 1999, Jeanes and Hilgert 2000). However, surveys conducted from 2001–2003 by Nelson et al. (2004) observed that the early run of juvenile Chinook salmon in the Duwamish estuary occurs as early as January and February, with peaks of outmigration generally occurring from mid-February to mid-March, with another peak in outmigration occurring in May and June.

In 2002, numbers of Chinook salmon caught in beach seines were low, with typical catches of less than two subyearling Chinook salmon per beach seine set in the late winter months. This low catch could have been due to high egg mortality that year. From mid-November 2001 through the first week in January, a series of at least three high flow events occurred, each ranging from 6,000 to 7,000 cubic feet per second (cfs) as measured at Auburn.

Between February 16 and early March of 2003, up to 70 juvenile Chinook salmon per beach seine were caught at RM 6.5 (Nelson et al. 2004). During January and February, approximately 3 percent of the fry sampled near Kellogg Island still had visible yolk, indicating relatively recent emergence from upriver spawning gravels and rapid downstream migration. Healey (1991) notes that fry migrants from other systems have been reported with visible yolk sacs, so this is not a unique occurrence.

In 2003 during the same egg incubation period, high flows did not exceed 1,700 cfs. In 2003, large flood flows occurred in early February, possibly decreasing survival of late emerging fry that contributed to late migrating fingerlings in 2003.

The Corps (2005b) conducted beach and purse seining studies of the Duwamish Waterway in 2004–2005. These studies were conducted to verify the observations by Nelson et al. (2004), that YOY Chinook salmon arrive in the Duwamish estuary earlier than previously believed.

Findings of this study support Nelson’s observations that juvenile salmon upon arrival to the estuary tend to concentrate in the upper estuarine transition portion of the estuary, including the Turning Basin. Also, the Corps study found that as YOY Chinook salmon migrate through the

Turning Basin, they primarily occupy the nearshore regions. Beach seining along the shoreline in the Turning Basin captured between 9.62 and 480.77 YOY Chinook salmon per hectare during the January 20 to March 3, 2005 period and between 0 and 96.15 age 1+ Chinook salmon per hectare during the December 3 and February 25, 2005 period (the larger catches in the nearshore occurred in mid-to late-January and late February; Corps 2005b).

The YOY Chinook salmon were twice as abundant during the nighttime versus daytime beach seining events. They were first captured on January 20. Because of their premature condition (yolk sacs present), the study concluded that they might not be able to arrive earlier than mid- to late January (i.e, if freshets occurred earlier, the alevin Chinook salmon may not have been sufficiently developed to emerge from the gravel bed).

Purse seining at eight locations in the Waterway (the deeper portion of the waterway where dredging would occur) revealed very few age 1+ Chinook salmon during this period (no YOY Chinook salmon were caught in the main channel). Between 2.4 and 12.02 age 1+ Chinook salmon per hectare (57 fish total over the 20-week period) were caught by purse seine between December 17, 2004 and February 4, 2005 (Corps 2005b). This data indicated that YOY Chinook salmon were not present or were in low abundance in the main channel.

The following can be summarized from Corps (2005):

- The arrival time of YOY Chinook salmon in the Duwamish Waterway appears limited by developmental stage.
- During the period sampled in 2004–2005, YOY were first captured in nearshore beach seines on January 20, peaking in early February, then again in late February.
- Highest numbers of YOY Chinook salmon (64 percent of total captured) were captured at the two upstream most stations (Turning Basin and Trimaran).
- YOY were only captured in the nearshore beach seines (none were caught by purse seine in the mid-channel areas.
- There were twice the numbers of YOY caught in nighttime versus daytime beach seines.
- Age 1+ Chinook salmon were caught in very low numbers throughout the study period, both in the nearshore and in the main channel.

10.3.3. Analysis of Effects

Species

Between FY 2007 and FY 2011, the Corps is proposing to conduct maintenance dredging of the Upper Duwamish Waterway on a 1- to 3-year dredge cycle. Based on the currently prescribed in-water work windows for the Duwamish, maintenance dredging could occur between October 1 and February 15 of each year. However, in order to avoid interfering with Tribal fisheries that occur in the Waterway, the Corps restricts its maintenance dredging of the Turning Basin until the Tribal fishery has concluded (typically January 1 of each maintenance dredging cycle).

The occurrence of adult Chinook salmon migrating through the action area during the anticipated dredging period (December 1 through February 15) is unlikely based on the timing of adult upstream migration (mid-August through November) and spawning (September through November).

However, YOY and juvenile Chinook salmon can be present in the Waterway beginning in mid-January. The duration of each dredge is 4 to 6 weeks; thus, the dredging activity, if started in early December, may be occurring beyond mid-January, when early migrating Chinook salmon could be present in the Waterway.

Since YOY and age 1+ Chinook salmon could occur in the Waterway while the area is being dredged, there is some potential for dredging activities to adversely affect them. Although this potential exists, realized effects are expected to be relatively minor for several reasons:

- Dredging would occur only in the deeper channel and would not physically alter nearshore habitats or affect other important habitat features such as cover or refugia.
- Although benthic invertebrates in the dredge footprint and for some distance below the dredge footprint would be affected, potential affects to prey for juvenile Chinook salmon in the nearshore would be negligible and discountable (e.g., juvenile Chinook salmon would typically be preying on insects and epibenthic organisms in the nearshore areas).
- Dredging would occur in the earliest part of the outmigration, and the number of Chinook salmon transiting the Turning Basin at that time would be small compared to the total outmigration.
- Dredging activity would increase suspended sediments in the water column in the vicinity of the dredge, but compliance with the Section 401 permit would restrict turbidity to below 5 NTUs above background when ambient turbidity is less than 50 NTUs and no more than 10 NTUs above background when ambient is above 50 NTUs at a distance of 600 feet from the dredge.
- Chinook salmon are acclimated to the ambient suspended sediment concentrations in the Duwamish Waterway, which are variable and can average 76 mg/l in the winter when dredging would occur.
- Despite continued dredging of the Turning Basin and channel, the Green River Chinook salmon stock is listed as healthy and has not shown any negative trend in escapement.

The Corps is also proposing several conservation measures to further minimize the potential affects to Chinook salmon and other aquatic species. When maintenance dredging occurs after January 15, the Corps proposes to monitor weather and river flow to identify conditions associated with downstream migration (freshets); conduct weekly exploratory sampling (beach seining in select nearshore areas) to monitor emigration; and once a freshet occurs, increase beach seining to three times per week to document numbers, size, and pattern of juvenile out migration that occurs during the dredging period. Once beach seining has confirmed that Chinook salmon are moving downstream into the Turning Basin, the Corps will initiate a day/night dredge protocol. Because most of the outmigrating Chinook salmon appear to be present in the nearshore at night, nighttime dredging would be limited to the center of the channel to maximize the distance between the dredging operation and the nearshore.

Based on the forgoing, maintenance dredging of the Duwamish Waterway could have an adverse affect on Chinook salmon present during the dredging operations primarily through being exposed to elevated suspended sediment concentrations. However, the potential affects would not result in jeopardizing the Puget Sound Chinook salmon ESU. Implementation of the conservation measures will further reduce the potential for long-term affects to the species.

Critical Habitat

NMFS recently designated critical habitat for 19 ESUs of salmon and steelhead in the Pacific Northwest and California, including Puget Sound Chinook salmon (70 FR 52630). The Duwamish Waterway is included in the critical habitat designation. This section evaluates the potential for effects to the PCEs determined to be essential to the conservation of Pacific coast salmon (including Puget Sound Chinook salmon)

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

Maintenance dredging will not affect Chinook salmon spawning and larval rearing sites that are generally upstream of RM 25.

(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, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

Maintenance dredging would not adversely affect freshwater rearing conditions because the segment of the waterway to be dredged is entirely estuarine habitat.

(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 channel, and undercut banks supporting juvenile and adult mobility and survival.

Maintenance dredging would not adversely affect freshwater migration corridors as the segment of the waterway to be dredged is entirely estuarine habitat.

(4) Estuarine areas free of obstruction with water quality, water quantity, and salinity, conditions supporting juvenile and adult physiological transitions between fresh-and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The dredging is in an area where physiological transitions between freshwater and saltwater occur. Adult Chinook salmon would not be present in the Waterway during dredging.

YOY age 1+ Chinook salmon outmigrants could be present in the project area when dredging is occurring. However, the juveniles would be in greatest concentration in the Turning Basin shallows. Although some YOY and age 1+ outmigrants could be exposed to elevated TSS, the effects of the dredging would be short-term and localized, and not expected to significantly delay rearing or migration in nearshore areas of the Waterway.

Since dredging would occur only in the central channel, it is expected to have a negligible effect on forage food organisms for emigrating salmon (e.g. insects and epibentic organism in shallower, nearshore areas). There will be no impact to salinity regimes or natural cover.

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.

The maintenance dredge site is located within a half mile of RM 5.5. Consequently, maintenance dredging would have no affect on nearshore marine areas.

(5) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The maintenance dredge site is located within a half mile of at RM 5.5. Therefore, the maintenance dredging activities would have no affect on offshore marine areas. (Potential affects of dredged material disposal at the offshore PSDDA site in Elliott Bay have been evaluated as part of a separate Section 7 consultation, which concluded that disposal activities would not adversely affect Chinook salmon critical habitat.)

10.3.4. Take Analysis

Because the proposed maintenance dredging operations may be conducted during downstream migration periods, Chinook salmon could be susceptible to short-term harm (from elevated TSS) and harassment during their migration periods. Maintenance dredging could create the likelihood of injury to such an extent as to disrupt normal behavior patterns during peak migration periods. However, adoption of the conservation measures listed in Section 7 of this BA, including avoidance of the peak juvenile salmon migration period, restricting elevated turbidity to within 600 feet down current of the dredge, monitoring the Waterway to identify when salmon are beginning their downstream migration, and altering dredging protocol to maximizing the distance between the dredge and salmon emigrating in the nearshore reduces the potential for incidental take.

10.3.5. Conservation Measures

Conservation measures cited in Section 7 of this BA including avoidance of dredging the majority of the juvenile salmon migration period, restriction on the extent of water quality impacts, beach seining to detect salmon between mid-January and mid-February, and implementation of day/night dredging protocols to minimize affects to juvenile salmon that may be migrating downstream between mid-January and mid-February would minimize the potential for direct or indirect effects to Chinook salmon.

10.3.6. Effect Determination

Adult, sub-adult, and juvenile Chinook salmon utilize the lower Duwamish River. Therefore, the project may affect the threatened Puget Sound Chinook salmon. However, adult Chinook salmon would not be expected in the Waterway when dredging would be occurring. Overall, there may be some minor effects of the proposed action on juvenile Chinook salmon as they migrate through the Waterway to seawater. Therefore, the proposed maintenance dredging activities may affect, likely to adversely affect Puget Sound Chinook salmon. However, because the dredging has the potential to affect only a small portion of the run, and conservation measures which would minimize the potential for juvenile salmon to be exposed to elevated TSS, the potential affects of maintenance dredging are not expected to result in jeopardizing the Puget Sound Chinook salmon ESU.

Maintenance dredging of the Upper Duwamish Waterway, may affect, but is not likely to adversely affect designated critical habitat for Puget Sound Chinook salmon. The action does not affect five of the six PCEs for salmon critical habitat. Potential effects of the action on PCE 4 (estuarine habitats) are considered insignificant and discountable.

11. ESSENTIAL FISH HABITAT (EFH) ANALYSIS AND DETERMINATION

Public Law 104-267, the Sustainable Fisheries Act of 1996, amended the Magnuson-Stevens Act, which regulates fishing in US waters, to establish requirements for EFH descriptions in federal Fishery Management Plans (FMPs) and to require federal agencies to consult with NMFS on activities that would adversely affect EFH. The Pacific States Fishery Management Council (PSMFC) amended the Pacific Groundfish Fishery Management Plan and the Coastal Pelagic Species Management Plan (1998a, 1998b) to designate waters and substrate necessary for spawning, breeding, feeding, and growth of commercially important fish species.

The Corps has previously consulted with NMFS on the potential effects of dredged material disposal on EFH. Consequently this EFH analysis only evaluates potential effects to the estuarine composite EFH present in the Duwamish Waterway. If the Corps identifies a beneficial use for dredged material, the Corps will consult with NMFS on the potential effects of that beneficial use on EFH before dredging occurs.

Corps maintenance dredging occurs exclusively in soft substrate areas within the Duwamish Waterway. Dredging operations could impact demersal fish species that inhabit the soft bottom of the river channel (e.g., flatfish), as well as pelagic fish such as herring and salmon (adult and juvenile Chinook salmon, coho salmon, and pink salmon utilize the habitats of this estuarine composite EFH). However, none of the EFH species is known to spawn or breed in the area of the Turning Basin.

The Turning Basin has been dredged for several decades, and benthic productivity of the dredge footprint is likely diminished compared to areas not subject to dredging at regular intervals. The dredging period evaluated in this analysis (FY 2007 to FY 2011) could include dredging the area one to five times (since 1990, dredging has occurred roughly every other year). Although maintenance dredging during the upcoming dredge period would temporarily diminish benthic productivity of the dredge site, the size of the area (ca. 8 acres) and the loss of forage food organisms for ground fish and pelagic EFH species is likely very minor, considering the long-term. The dredge area also lies 5.5 miles upriver from saltwater intrusion and use of the area by groundfish and pelagic EFH species is likely marginal. Purse seine surveys confirm only minor use of the Waterway by starry flounder and English sole (Corps 2005a).

For Pacific salmon EFH species, the temporary decrease in benthic production in the Turning Basin would have only a minimal effect on their forage base. The Duwamish Waterway serves strictly as a migration corridor for adult salmon. By the time adult salmon reach the Turning Basin, they have largely ceased feeding. Juvenile salmon rearing and migrating through the Waterway would be primarily consuming organisms in the nearshore, and not the deeper waters of the navigation channel.

Conservation measures proposed in Section 7 of this BA will act to conserve this estuarine EFH and reduce potential effects on associated species. Conservation measures cited in Section 7 of this BA including avoidance of dredging the majority of the juvenile salmon migration period, restriction on the extent of water quality impacts, beach seining to detect salmon between mid-January and mid-February, and implementation of day/night dredging protocols to minimize affects to juvenile salmon which might be migrating downstream between mid-January and mid-February would minimize the potential for direct or indirect effects to EFH species.

The Corps believes the combination of the conservation measures detailed above will reduce effects on EFH to the point that the effects will be insignificant and discountable, and thus the proposed dredging operation may affect, but is not likely to adversely affect EFH.

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