CHAPTER SIX
ENVIRONMENTAL CONSEQUENCES

*6. ENVIRONMENTAL CONSEQUENCES

6.1. Introduction

Subsection 6.1.1 has been added to this section for the Final SEIS to provide updated information since completion of the Final IFR/EIS (August 1999).

6.1.1. [new] Introduction for the Final SEIS

This subsection provides new information and analyses regarding environmental conditions and consequences. This information results from a number of sources and activities since issuance of the 1999 Final IFR/EIS, including the ESA consultation, additional evaluation or analyses regarding sturgeon, smelt, crab, fish stranding, and coastal erosion to respond to state agency comments on the project, and new hydrographic survey data. This section also provides information about project modifications (e.g., revised disposal plans), and new ecosystem restoration features added to benefit the recovery of listed salmonids and other fish and wildlife resources. As discussed in Subsection 4.4.3, the preferred alternative modifies the disposal plan by using existing upland disposal sites, Lois Island embayment and Miller-Pillar ecosystem restoration features, and flowlane disposal sites, rather than ocean disposal for construction and the first 20 years of maintenance for CRM 3-29. The Corps has considered the effects of this modification in the following sections.

6.1.1.1. [new] Ecosystem Model

A conceptual model was developed for the lower Columbia River ecosystem relationships that are significant for juvenile salmonids. The model was used during the ESA consultation process to evaluate the potential effects of the channel improvement project. The model provides an integrated diagram of the major ecosystem links that affect ecosystem structure and function as related to juvenile salmonid production and ocean entry. The model: (1) provides an ecosystem-level scientific framework for evaluating the project; (2) identifies links among physical, chemical and biological indicators; (3) aids in identifying ecosystem-based processes that link salmon and potential effects of the project; and (4) provides a systematic methodology to evaluate monitoring and adaptive management opportunities.

The model presents a scientifically based diagram that illustrates major connections among processes, indicators, and pathways within the system. Because of the complexity of the ecosystem, these connections are illustrated in a series of figures representing a set of linked submodels based on the functional pathways of the system. These pathways include processes within the river system (e.g., habitat formation, tides, bedload transport, accretion-erosion); specific components, or indicators, within the system (e.g., habitat types, food types, physical properties); and the pathways through which these processes and indicators combine to affect the ecosystem (e.g., primary productivity, food web). The basic habitat-forming processes, physical forces of the ocean and river, create the conditions that define habitats. The habitat types, in turn, provide an opportunity for the primary plant production

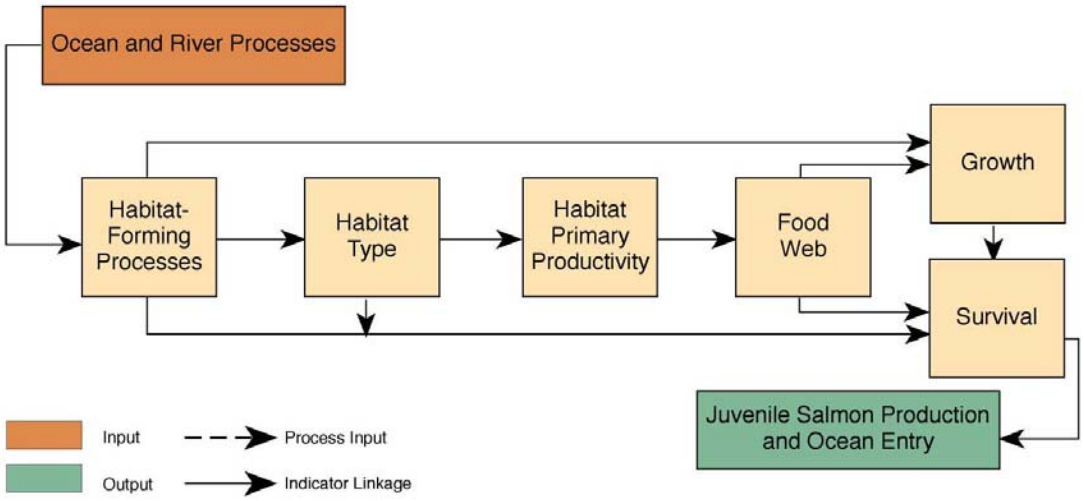
that gives rise to complicated food webs. All of these pathways combine to influence the growth and survival and, ultimately, the production and ocean entry of juvenile salmonids moving through the lower Columbia River. These processes and pathways are developed in the model and outlined in Table S6-1 and shown in Figure S6-1. Table S6-1 also describes the indicators for the functioning of the system.

Table S6-1. Conceptual Model Pathways and Indicators for Juvenile Salmonid Production in the Lower Columbia River

Model Pathways	Pathway Description	Model Components (Indicators)	Indicator Description
Habitat-Forming Processes	Physical processes that define the living conditions and provide the requirements fish naturally need within the river system are included in this pathway.	Suspended Sediment	Sand, silt, and clay transported in the water column
		Bedload	Sand grains rolling along the surface of the riverbed
		Woody Debris	Downed trees, logs, root wads, limbs
		Turbidity	Quality of opacity in water, influenced by suspended solids and phytoplankton
		Salinity	Saltwater introduced into freshwater areas through tidal ocean process
		Accretion/Erosion	Deposited/carved sediments
		Bathymetry	Topographic configuration of the riverbed
Habitat Types	This pathway describes definable areas that provide the living requirements for fish in the Lower Columbia River.	Tidal Marsh and Swamp	Areas between mean lower low water (MLLW) and mean higher high water (MHHW) dominated by emergent vegetation (marsh) and low shrubs (swamp) in estuarine and riverine areas
		Shallow Water and Flats	Areas between 6-foot bathymetric line (depth) and MLLW
		Water Column	Areas in the river where depth is greater than 6 feet
Habitat Primary Productivity	This pathway describes the biological mass of plant materials that provides the fundamental nutritional base for animals in the river system.	Light	Sunlight necessary for plant growth
		Nutrients	Inorganic source materials necessary for plant growth
		Imported Phytoplankton Production	Material from single-celled plants produced upstream above the dams and carried into lower reaches of the river
		Resident Phytoplankton Production	Material from single-celled plants produced in the lower reaches of the river
		Benthic Algae Production	Material from simple plant species that inhabit the river bottom
		Tidal Marsh and Swamp Production	Material from complex wetland plants (hydrophytes) present in tidal marshes and swamps
Food Web	This pathway shows the aquatic organisms and related links in a food web that supports growth and survival of salmonids.	Deposit Feeders	Benthic organisms such as annelid worms that feed on sediments, specifically organic material and detritus
		Mobile Macroinvertebrates	Large epibenthic organisms such as sand shrimp, crayfish, and crabs that reside/feed on sediments at the bottom of the river

Model Pathways	Pathway Description	Model Components (Indicators)	Indicator Description
		Insects	Organisms such as aphids and flies that feed on vegetation in freshwater wetlands, tidal marshes, and swamps
		Suspension/Deposit Feeders	Benthic and epibenthic organisms such as bivalves and some amphipods that feed on or at the interface between sediment and the water column
		Suspension Feeders	Organisms that feed from the water column itself, including zooplankton
		Tidal Marsh Macrodetritus	Dead and decaying remains of tidal marsh and tidal swamp areas that are an important food source for benthic communities
		Resident Microdetritus	Dead and decaying remains of resident phytoplankton and benthic algae, an important food source for zooplankton
		Imported Microdetritus	Dead remains of phytoplankton from upstream that serve as a food source for suspension and deposit feeders
Growth	This pathway highlights the factors involved in producing both the amount of food and access by fish to productive feeding areas.	Habitat Complexity, Connectivity, and Conveyance	Configuration of habitat mosaics that allow for movement of salmonids between those habitats
		Velocity Field	Areas of similar flow velocity within the river
		Bathymetry and Turbidity	River bottom and water clarity conditions that influence the ability of salmonids to locate their prey
		Feeding Habitat Opportunity	Physical characteristics that affect access to locations that are important for fish feeding
		Refugia	Shallow water and other low energy habitat areas used for resting and cover
		Habitat-Specific Food Availability	Ability of complex habitats to provide feeding opportunities when fish are present
Survival	This pathway is a summary of key factors controlling or affecting growth and migration.	Contaminants	Compounds that are environ-mentally persistent and bioaccumulative in fish and invertebrates
		Disease	Pathogens (viruses, bacteria, and parasites) that pose survival risks for salmon
		Suspended Solids	Sand, silt, clay, and organics transported within the water column
		Stranding	Trapping of young salmonids in areas with no connectivity to water column habitat
		Temperature and Salinity Extremes	Temperature or salinity conditions that are problematic to salmonid survival
		Turbidity	Water clarity as it pertains to potential for juvenile salmonids to be seen by predators
		Predation	Potential for piscivorous mammals, birds, and fish to prey on salmonids
		Entrainment	Trapping of fish or invertebrates into hopper or pipeline dredges

Figure S6-1. Conceptual Model for Juvenile Salmonids in the Lower Columbia River



Much of the conceptual model also is relevant for understanding potential impacts to non-listed species and their habitat. For example, the links between the physical/chemical indicators and many biological indicators provide information regarding basic ecosystem functions that are relevant to listed and non-listed species alike. As Table S6-1 indicates, the model provides basic information regarding:

- Habitat-forming Processes (suspended sediment, bedload, woody debris, turbidity, salinity, accretion/erosion, bathymetry).
- Habitat Types (tidal marsh and swamp, shallow water and flats, water column).
- Habitat Primary Productivity (light, nutrients, imported and resident phytoplankton production, benthic algae production, tidal marsh and swamp production).
- Food Web (deposit feeders, mobile macroinvertebrates, insects, suspension/deposit feeders, tidal marsh macrodetritus, resident microdetritus).

For example, if someone was interested in understanding the project's effects on tidal marsh and swamp, they could use the portion of the model that addresses habitat types. Similarly, a question regarding deposit feeders, mobile macroinvertebrates or insects could be answered by reviewing the model's discussion of those indicators. Because the model was developed to review impacts to salmon, there may be some components of the ecosystem that the model does not address; however, the model provides the best available information regarding the lower Columbia River ecosystem.

The new information provided in this chapter of the Final SEIS reflects application of the conceptual model to the project and its anticipated effects on the physical and biological environment. Also included is new information on the anticipated effects of new aspects of the project (e.g., new ecosystem restoration projects), and on the effects of the overall project on other environmental resources (e.g., crab, smelt, sturgeon and other fisheries).

6.1.1.2. [new] Other Sources of New Information Since the Final IFR/EIS

Exhibits J through K-9 were developed to respond to comments received from the resource agencies in Washington and Oregon in 2000. The general methodology and approach was developed with valuable input from these agencies. Coordination continued after issuance of the Draft SEIS, and the Final SEIS addresses additional agency comments. Table S6-2 lists each evaluation report by subject and gives a short description of its content. Specific findings of the reports are discussed in the relevant sections in the remainder of this chapter.

Table S6-2. List of Evaluation Reports

Subject	Description
Sturgeon (Exhibit K-1)	The Corps funded an ODFW/WDFW study to determine sturgeon abundance and distribution in deeper areas of the channel, and their behavior/feeding habits in these areas by using acoustic telemetry (Romano and Rien 2001; Marine Taxonomic Services 2002). The Corps funded USGS to do acoustic tagging to determine sturgeon behavior in deep-water areas, and during dredging/disposal. The report included is the progress report for 2002 work. The final report will be available after 2003 work.
Smelt (Exhibit K-2)	The Corps funded a ODFW and WDFW study to determine: • Presence or absence of smelt spawning areas in the navigation channel to assess the importance of channel spawning areas to the overall production of smelt. • Distribution and abundance of larval migrants within & adjacent to the navigation channel to assess entrainment potential during dredging. • If measures were necessary to minimize the potential effects of dredging to the overall smelt population (Howell et al. 2001; Ward and Rien, 2001).
Fish Stranding (Exhibit K-3)	The Corps contracted with S.P. Cramer & Associates, Inc. for a pilot study on juvenile salmon stranding at three locations in the lower Columbia River.
Dungeness Crab (Exhibit K-4)	The Corps funded Pacific Northwest National Laboratory to conduct additional studies about impacts of dredging to crabs. New information from this work includes: • Statistical analysis to develop a rigorous sampling design for determining entrainment rates in the Columbia River. • Measurement of crab entrainment during dredging. • Conduct an assessment of entrainment impacts to crab population levels and the crab fishery (Pearson et al. 2003). • Develop a crab distribution/salinity model to use in avoiding and minimizing the effects of dredging through scheduling (Pearson et al. 2003).
Sediment Transport (Exhibit J)	The Corps developed a comprehensive evaluation report, *Channel Deepening Sediment Impacts Analysis* (Exhibit J), to address concerns expressed by Oregon and Washington agencies on physical processes in the lower Columbia River. Three distinct areas were analyzed: the river to the estuary, the estuary to the river's mouth, and the littoral zone off the coasts of Oregon and Washington.
State Royalties (Exhibit K-6)	A notification process for sand placement to both the WDNR and Oregon Division of State Lands is described.
Wetlands/Mitigation	Habitat Evaluation Procedures (HEP).
Floodplains (Exhibit K-7)	Detailed floodplain information is provided for all of the least cost and proposed disposal sites.
Washington Critical Area Ordinances (Exhibit K-8)	Compliance with the Critical Areas Ordinance of the local jurisdictions in which activities take place (RCW 36.70B) and details for local jurisdictions within Washington for wetland impacts and mitigation.
Washington Shoreline Master Plan (Exhibit K-9)	Compliance with the Shoreline Master Plan Program of the local jurisdictions in which activities take place

6.2. revised Physical Impacts

This subsection is being updated for the Final SEIS and addresses new information on project effects from the analysis conducted during the ESA consultation, updated hydrographic survey data, disposal plan modifications resulting from the ESA consultation process, and ecosystem restoration modifications and additions. This section also includes updated and new information pertinent to Chapter 5, *Affected Environment*.

6.2.1. No Action Alternative

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

6.2.2. revised 43-foot Channel Deepening Alternative

This subsection has been updated for the Final SEIS. The construction dredging volume has been reduced from 18.4 mcy to 14.5 mcy for the 43-foot channel improvement project (approximately 20% reduction). The rock removal volume was reduced from 590,000 to 490,500 cubic yards (approximately 15% reduction). Of this amount, blasting is needed to remove about 50,500 cubic yards of rock at Warrior Rock near St. Helens, and about 440,000 cubic yards of loose rock will be removed by mechanical dredge at Longview, Vancouver Bar, and Vancouver turning basin. The maintenance dredging volumes presented in the 1999 Final IFR/EIS have not changed.

6.2.2.1. revised Riverbed and Sedimentation

For the Final SEIS, updated information developed by the Corps has been added to this subsection. The Corps also prepared a sedimentation impact assessment, *Columbia River Sediment Impacts Analysis* (Exhibit J) to evaluate the potential changes in sedimentation that may occur with the 43-foot navigation channel project. The conclusions from this assessment are provided below. More information is found in Exhibit J and Exhibit H, *ESA Consultation*, available on the Corps' website.

The historical sediment budgets for the lower Columbia River, estuary, and littoral cell were examined to identify system responses to past natural and human activities. The main focus was on changes to the lower river's sand transport, estuarine sand accretion, and the movement of sand between the estuary and the MCR. It is concluded that there have been decreases in the rates of all three of those processes due to changes in the river flows and the changes in entrance conditions that followed the construction of the MCR jetties. The analysis in Exhibit J concludes that deepening of the Columbia River navigation channel upstream of CRM 3 should not have a significant impact on those processes.

Construction and 20 years of maintenance of the proposed 43-foot navigation channel will likely remove around 70 mcy of sand from the Columbia River and place it upland. Another 40 mcy of dredged sand would be disposed of back in-water, mostly in the estuary. This will cause increased riverbed depths and slight changes in river hydraulics between CRM 3-106.

Deepening will not reduce the available sand supply and the expected hydraulic changes are too small to measurably alter sand transport or erosion/accretion in the river or estuary. There will be no measurable change in hydraulic conditions or sedimentation processes at the MCR. There will continue to be the transport of sand both landward and seaward at the MCR. Although large freshets will continue to have the potential to discharge larger volumes of sand from the estuary to the MCR, flow regulation has made such freshets less likely to occur. The proposed deepening is not expected to impact the littoral sand budgets north or south of the MCR.

Over the last 120 years, navigation channel development has noticeably altered the Columbia River's channel configuration in the river, estuary and the MCR. However, past dredging and channel modifications have not measurably altered sand supply or sand transport in the river or estuary. Excluding the effects of the MCR jetties, past navigation channel development also has not altered the estuary's overall erosion/accretion and bedload transport patterns. The reductions in the Columbia River's net sand discharge to the MCR since the early 1900s are related to lower Columbia River discharges caused by natural climate variations and upstream flow regulation. The potential channel modifications in the Columbia River and estuary from the proposed 43-foot navigation channel are similar to, but much smaller than, those caused by navigation development over the past 100 years. The sedimentation impacts from the proposed 43-foot navigation channel are thus expected to likewise be indiscernibly small.

In addition, the following sections summarize the updated information developed during the ESA consultation process concerning suspended sediment and bedload (more information is contained in Exhibit H, *ESA Consultation*, available on the Corps' website).

Suspended Sediment

The project is not expected to cause changes to sediment (sand) supply or river hydraulics that would alter the rates of suspended sediment transport. The Columbia River bed consists of alluvial sand deposits that vary in thickness from 400 feet in the estuary to 100 feet at Vancouver (Gates 1994). The dredging would remove 3 feet or less of that riverbed material from approximately 56% of the 600-foot-wide navigation channel. The hydraulic effects of dredging 3 feet deeper are very small. Given the consistency in suspended sediment measured at different times and locations, the small hydraulic changes would not likely affect suspended sediment transport rates. Therefore, the volume and rate of suspended sediment transport in the Columbia River will not be changed by the project.

Some temporary increases to suspended sediment concentrations are expected to occur during construction and maintenance dredging activities, as the result of both dredging and the disposal of dredged materials. These dredging and disposal activities will occur in both estuarine and riverine environments. Disposal also will occur in the open ocean, beyond the river mouth. No anticipated actions would cause effects to suspended sediment in the area above Vancouver.

Settling of suspended sediment caused by dredging, disposal, and ship wakes is expected to be rapid. Based on the data indicating that less than 1% of the dredged material is fine enough to remain in suspension following disposal, the Corps estimates that disposal of construction-related dredging will contribute up to 180,000 cubic yards of suspended sediments over the 2-year construction period. Background suspended sediment loads for the same 2-year period have been estimated at 4 mcy. This is a maximum increase of 4.5% in the suspended sediment load and generally equates to less than a 1 milligram per liter (mg/L) increase in suspended sediment concentrations.

In riverine areas where neither dredging nor disposal is occurring, there should be no observable increase in suspended sediment concentration. In areas where dredging and disposal activities occur, there may be noticeable, short-term increases in suspended sediment near hopper dredges and in-water and beach nourishment operations. Dredging operations are likely to cause temporary suspended sediment increases downstream from 0-2 mg/L, depending on the number and type of dredges operating. Flowlane disposal and beach nourishment also are likely to result in temporary suspended sediment increases in the immediate vicinity of these activities (0-20 mg/L for flowlane disposal and 10-30 mg/L for beach nourishment). Those suspended sediment concentrations will diminish to near background levels as the plume moves away from the disposal sites. The Corps' intention is for the channel improvement project to not utilize ocean disposal. If the restoration features in the estuary are not fully implemented, then the alternative would be to dispose of material into the ocean as described in the 1999 Final IFR/EIS. If disposal of sediments occurs at open-water ocean sites beyond the river mouth, it could release discrete sediment plumes of fine suspended sediment that would slowly disperse.

Ship wakes breaking on shore can erode sediment and then suspend the eroded material. Larger waves contain more energy and have greater capability to mobilize sediment. Accordingly, during the ESA consultation process, there was an analysis of whether the proposed activities would lead to more frequent or larger ship wakes. The analysis indicates that little, if any, change is expected (Hermans, SEI Presentation 2001). Hermans analyzed several mechanisms by which ships generate waves. The analysis found that for deep-draft vessels the most important wave mechanism in the Columbia River would be the primary or "suction" wave generation. This mechanism depends on the "blockage" ratio, which is the ratio of the cross-sectional area of the ship to that of the channel. Given the proposed increase in channel depth and the expected increase in vessel draft, the ratio changes very little. The blockage ratio of a 43-foot draft vessel in a 43-foot channel is only 1% to 5% higher than that of a 40-foot draft vessel in a 40-foot channel. However, for the much more numerous smaller ships that would not increase their draft, there would be a slight decrease (in the range of 1% to 5%) in the blockage ratio with the deeper channel. Therefore, while 43-foot draft ships may generate slightly larger wakes than occur now, this would be offset by most ships producing slightly smaller wakes. As a result, the overall changes in wave size caused by the deeper channel are expected to be negligible.

In addition to the deeper channel not causing increased wave sizes, the project also is not expected to cause more frequent waves. While the project would increase the efficiency of

river commerce, it is not anticipated to increase the volume of river traffic. The 1999 Final IFR/EIS found that, "channel deepening in itself will not induce additional ship traffic" or "contribute to development of additional ports or port facilities." This is consistent with historical vessel traffic trends on the Columbia River, as well as the market forces that drive port facility development. Historical data for the existing 40-foot channel shows that the total tonnage carried by ocean-going vessels calling at the lower Columbia River ports has more than tripled since Congress authorized the deepening from 35-40 feet in 1962, while the number of vessel transits has actually decreased slightly. The same trend is expected if the channel is deepened to 43 feet. Regional and national commodity forecasts project cargo volumes transiting the lower Columbia River will double or triple over the next 20 years, but a deeper channel will likely reduce or moderate the volume of vessel traffic relative to a no channel deepening alternative. Therefore, there is no expectation of more frequent ship wakes occurring as a result of the project.

Bedload

Sand from upstream areas is one of the sources of material for habitat-forming processes (accretion) in the estuary. This sand is important to the formation of tidal marsh and swamps and shallow water and flats habitat. An issue arose during the ESA consultation process in 2001 concerning the potential to reduce the quantity of bedload moving downstream to the estuary. This was based on the concern that removing sand from the upstream channel would cause a concomitant reduction in the amount of sand (habitat-forming material) that would reach the estuary. The amount of sand that reaches the estuary is based on the river's sediment transport potential and the available sediment supply. Sediment transport potential is a function of hydraulic parameters such as depth, velocity, slope, and discharge. The available sediment supply comes from upstream discharges, the riverbed and banks, and tributary inflows. Climate, dams, and flow controls have significantly changed flow and sediment transport.

The project will not affect transport potential because the amount of material to be removed from the system is not the limiting factor for bedload movement; flow available to move the material is the limiting factor, and the project will not affect flow. The project will not significantly reduce the sand supply. The project will result in some side-slope adjustment as a result of altered bedload transport direction within the action area. This process will not affect water column or tidal marsh and swamp habitats. The side-slope adjustment process will take 5-10 years, and over that time shallow water and flats habitat at six historic shoreline disposal sites will tend to migrate laterally. All of these shoreline sites have been used for disposal in the past due to their proximity to the dredging action. Two of the six shoreline disposal sites, at CRM 86.2 and CRM 23.5, will be used throughout the project life. The other four shoreline disposal sites are not used for project purposes.

Because the bedload transport rate during side-slope adjustment is the same rate at which normal bedload transport would occur without the project (just in a different direction), the quantity and quality of shallow water and flats habitat is expected to remain constant. The

Corps is proposing to verify these conclusions through a monitoring survey of habitat conditions before, during, and after completion of the project (see Section 6.7).

6.2.2.2. revised Water Surface Elevations

For the Final SEIS, updated information developed on bathymetry has been added to this subsection. Bathymetric changes (as related to bottom elevation contours and water surface) will result from the project. First, dredging will immediately lower the riverbed at the dredge site and lead to long-term changes to the adjacent side slopes. Second, in-water and shoreline disposal will raise bed elevations at the disposal site. The disposal material will then be incorporated into the riverbed, forming sand waves and gradually moving downstream, mainly as bedload transport. Third, the deeper channel will cause a slight effect on water surface elevations, which could result in a change in water depth.

Riverine Reach. Bathymetric changes will include up to 3 feet of deepening in areas of the navigation channel that are currently shallower than -48 feet CRD and some rise in the riverbed at shoreline and flowlane disposal sites. The exact amount of riverbed lowering and the final dredging locations will depend on river bathymetry just prior to construction. There will be no changes in bathymetry in the approximately 40% of the navigation channel in this reach that will not require dredging. In addition, there is a potential for up to 3 feet of deepening along the side slopes adjacent to the dredge cuts.

Shoreline disposal at Sand Island (O-86.2) will periodically alter the bathymetry of the site. Disposal will raise the riverbed of shallow water areas along the beach. Some areas could change from shallow water to beaches. The disposal will erode away in 3-4 years and then the areas will be filled again by disposal.

Flowlane disposal will raise the riverbed intermittently along the channel throughout the life of the project. Flowlane disposal will generally be in portions of the river in or near the navigation channel that are between elevations -50 and -65 feet CRD although some disposal will occur in limited areas as shallow as -35 feet or deeper than -65 feet CRD. The sand will be spread out during disposal by keeping hopper dredges moving as they dump and by frequently moving the discharge pipe from a pipeline dredge. The disposal material will then be incorporated into the riverbed, forming sand waves and gradually moving downstream, mainly as bedload transport. Flowlane disposal is expected to be about 0.5 mcy during construction and 0.5 to 1.0 mcy per year over the first 20 years of maintenance.

There are no predicted changes in water surface elevations downstream of CRM 80 as a result of the project. Modeling predicts water surface reductions would begin near CRM 80 and become progressively larger in the upstream direction. The decreases would be in the range of 0.12-0.18 feet (approximately 2 inches) at CRM 106 (1999 Final IFR/EIS). These reductions would be caused by removal of sediments in the riverine reach of the navigation channel. This change is not expected to have a discernible impact in this area.

Estuary. Bathymetric changes will include up to 3 feet of deepening in areas of the navigation channel that are currently shallower than -48 feet CRD and some rise in the

riverbed at shoreline and flowlane disposal sites. The exact amount of riverbed lowering and the final dredging locations will depend on river bathymetry just prior to construction. There will be no changes in bathymetry in the approximately 55% of the navigation channel in this reach that will not require dredging. In addition, there is a potential for 0-3 feet of deepening along the side-slopes adjacent to the dredge cuts.

Shoreline disposal at Skamokawa (W-33.4) and Miller Sands (O-23.5) will cause bathymetric changes similar to those described for Sand Island. Disposal is expected to occur periodically at Skamokawa and annually on at least part of Miller Sands. The bathymetric changes caused by flowlane disposal in the estuary will be similar to those described for the riverine reach.

Two models were applied to the system to assess the impact of the channel deepening on surface water elevation: the Corps of Engineers, Waterways Experiment Station (WES) applied the RMA-10 model and the Oregon Health Sciences University/Oregon Graduate Institute (OHSU/OGI) applied the ELCIRC (Eulerian-Lagrangian CIRCulation) model as part of their CORIE system. The WES RMA-10 model indicates that the impact of channel deepening on surface water elevation is minimal. Differences between the baseline and with-project condition are estimated to be between -0.02 to 0.02 foot for all locations between the mouth and the upper estuary (Puget Island). Modeling conducted by OHSU/OGI supports the results of the WES model.

River Mouth. No changes to bathymetry in the Deep Water Site (Figures S1-1 and S4-1) as the result of disposal of sediment from the channel improvement project are expected for the first 20 years after construction, as described in the proposed action. Should ocean disposal become necessary for the proposed project, it will create mounding in the Deep Water site that is expected to be permanent. No changes to water surface elevation are anticipated in this reach.

The Corps is proposing to verify all of these conclusions through a monitoring survey of habitat conditions before, during, and after completion of the project (see Section 6.7).

6.2.2.3. revised Salinity

For the Final SEIS, updated information on salinity has been added to this subsection. Salinity is an important indicator in assessing the successful adaptation and outmigration of juvenile salmonids in the lower Columbia River. The concentration of salinity in important habitat and rearing areas of the system and the longitudinal gradient of salinity between the freshwater and ocean environments that bound the estuary portion of the system are particularly important. The location of the ETM, which is an important location of nutrients in the system, is driven by tidal forcing processes that influence salinity intrusion. Salinity also is an important indicator for non-listed species. For these reasons, it is important to determine the extent to which channel deepening actions might change the salinity profile in the action area.

The estuary is the location where saltwater and freshwater are mixed. In the Columbia, as in most river-dominated estuaries, tidal processes and river flow results in a zone of increased turbidity, the ETM. The turbidity in the ETM is the combination of both the concentration of suspended organic matter and the resuspension of organic and inorganic matter from the bottom. The length of the ETM is typically 0.6-3.0 miles. The position of the ETM ranges between CRM 9-18 from Youngs Bay to Tongue Point (Simenstad 1994).

Two models, the WES RMA-10 and the OHSU/OGI model, were applied to the system to assess the impact of channel deepening actions on salinity in the system. Based on modeling results, the channel deepening actions will have little to no impact on salinity intrusion. The Corps is proposing to verify this conclusion through a monitoring survey of habitat conditions before, during and after completion of the project (see Section 6.7).

Riverine Reach. Salinity intrusion does not extend upstream to CRM 40, which is the division between the riverine reach and the estuarine reach. Consequently, salinity is not a parameter that applies in the riverine reach.

Estuary. Based on modeling results presented in the 2001 BA, the channel deepening actions will have little to no impact on salinity intrusion:

- Based on the salinity modeling in the 2001 BA, salinity increases of less than 0.5 ppt would occur in the shallow embayments of the estuary (e.g., Cathlamet Bay, Grays Bay). Salinity increases up to 5 ppt would occur in areas not used by juvenile salmonids (bottom of the navigation channel).
- No measurable difference in habitat opportunity is anticipated.

The computed differences between baseline and with-project conditions for salinity in shallow areas are much smaller than natural temporal variations due to normal variations in freshwater flow and tidal dynamics. Also, the potential upstream shift of the ETM of less than a mile will have an insignificant effect on the distribution of nutrients in the estuary. The new modeling results support the conclusion in the 1999 Final IFR/EIS that no significant biological impact to ESA-listed or non-listed species would result from salinity changes predicted for the proposed channel deepening.

River Mouth. Salinity changes caused by the channel deepening actions in this reach are predicted by both models to be near zero.

6.2.2.4. [new] Accretion/Erosion

For the Final SEIS, this new subsection on accretion and erosion has been added to provide new information (see Exhibit J, *Columbia River Sediment Impacts Analysis*). Some anticipated changes in accretion/erosion due to the project include shoal formation (accretion) and shoreline erosion. Following deepening of the channel, accretion will occur in the navigation channel for some time as the riverbed adjusts (stabilizes) to the new depth via side-slope adjustment. Gradual bank erosion in sandy beach nourishment sites may also

occur for some time, in response to the side-slope adjustment. These effects are addressed in the *Bedload* and *Water Surface Elevation* discussions (Sections 6.2.2.1 and 6.2.2.2).

Riverine Reach. Riverbed side-slope adjustments and some shoreline erosion will alter the accretion and erosion patterns within this reach. Side-slope adjustments that would affect shallow water and flats habitat might occur in the riverine reach at five locations–CRMs 99, 86, 75, 72, and 46 through 42. These are all past shoreline disposal sites and only the CRM 86.2 site is proposed for use in this reach due to the proximity of the dredging needed in this section of the river. These sites do not include tidal marsh and swamp habitat. Side-slope adjustment could cause 10-50 feet of lateral shoreline erosion of sandy beaches in each of those areas; however, this is not expected to reduce shallow water habitat. The alteration of the accretion and erosion patterns will not affect suspended sediment or bedload transport rates. The slight increase in suspended fine sediments during dredging and disposal operations will not increase accretion in the riverine reach because the river will transport those sediments to the estuary.

Estuary. The changes in river hydraulics are very small and are not likely to change accretion or erosion in the estuary. Accretion in the estuary is influenced by the amount and type of sediment being delivered from upstream. This is reflected in the estimated reduction in the amount of flow and estuary accretion of sediments from 2-5 millimeters (mm) per year before flow regulation to about 1 mm per year after flow regulation. The project will cause small increases in fine-grained suspended sediment delivered to the estuary during dredging and disposal operations. Based on the resuspension of less than 200,000 cubic yards (fine material makes up less than 1% of the total volume to be dredged), a fine material deposition rate of 30% (Hubbell and Glenn 1973), and a uniform distribution of deposition throughout the 95,500 acres of open water in the estuary, there would be an average of about 0.1 mm per year of additional accretion during construction. The natural background deposition during that 2-year period would be around 2 mm per year.

Over the long term, the project will have little effect on accretion in the estuary. There will be slightly more suspended fine sediment as a result of maintenance dredging and disposal. Over 20 years, this could result in less than 0.1 mm of estuary deposition above what would be caused by maintaining the existing channel. Although an upstream shift in the ETM may cause a minor change in accretion patterns, the long-term effects are not expected to be detectable.

Sandy sediment within the channel is one potential source of material for habitat-forming accretion in the estuary. During the consultation process, discussion and analysis focused on the potential long-term effects on accretion of removing sand from the upstream channel. The concern was that removing sediment would reduce the source of the estuary's sediment supply. However, the removal of sand from the river will not alter sediment transport to the estuary (Exhibit J). The volume to be dredged over the life of the project is only a tiny fraction of the total volume of sand in the riverbed. In addition, transport potential, rather than sand supply, is the limiting factor in sediment supply to the estuary. Also, sediment

inflow to the dredging area upstream of Vancouver is essentially the same as the sediment transport at CRM 54, indicating the main material source is upstream of the project.

The above changes in accretion are all the result of very slight project-related changes in suspended sediment concentrations. The effects are dispersed throughout the estuary by the distribution of flows. The naturally occurring local accretion and/or erosion rates are influenced by site-specific hydraulics and can be much greater than regional rates caused by the deposition of suspended sediment. As an example, Eriksen (SEI Presentation 2001) found the north channel between CRM 5-7 had in-filled up to 20 feet from 1982 to 2000. Natural accretion and erosion will continue on this scale in the estuary and will likely dwarf any project-related changes.

River Mouth. No changes to accretion/erosion are expected in this reach (see Exhibit J).

6.2.3. revised Proposed Disposal Alternative

As previously discussed in 4.4.3.10, *Disposal Plan Modifications Following Consultation*, two options have been identified for disposal of dredged material originating from CRM 3-29 for the channel improvement project. The first option is similar to Table 4-18, *Proposed Disposal Plan*, in the 1999 Final IFR/EIS.

Under the second option (also described in 4.4.3.10), the Corps would dispose of the material using a combination of ecosystem restoration, flowlane disposal and existing upland and shoreline sites. The Lois Island embayment and Miller-Pillar habitat restoration features are described in Section 4.8.6 and in the BA and Biological Opinions. The description of these features in Section 4.8.6 represents the modified approach to these restoration features from discussions with ODFW and Oregon Department of Land Conservation and Development, and subsequently coordinated with NOAA Fisheries and USFWS. As part of the ESA consultation process, the three federal agencies (NOAA Fisheries, USFWS and Corps) identified these two restoration features as being beneficial to listed salmonid stocks. Should either of these restoration features be substantially modified or discontinued through the public review process for this NEPA document, the Corps' intent would be to use the Deep Water Site for ocean disposal of the balance of the dredged material. Actual disposal would require coordination and concurrence by USEPA.

6.2.3.1. revised Upland Disposal

For the Final SEIS, this subsection has been updated. There was a reduction in the acreage of upland sites impacted by disposal actions during the consultation process (see Exhibit K-5, *Wildlife and Wetland Mitigation*; also Table S4-1). The proposed plan would impact about 1,630 acres of uplands versus 1,681 acres identified in the 1999 Final IFR/EIS. The principal acreage reduction occurred at disposal site O-63.5 where the site was reduced by 20 acres to a total of approximately 25 acres. About 17 acres of riparian forest were protected from loss at O-63.5 and agricultural land impacts at Gateway (W-101) were reduced from 69 to 40 acres. The Gateway site acreage has dropped as a result of applying local permitting standards, which resulted in a portion of the site becoming too narrow to

efficiently use as a disposal site. Disposal site O-42.9 was listed at 59 acres in the 1999 Final IFR/EIS but was reduced to 53 acres in the 2001 BA. Finally, wetland impacts of the project have been reduced from 20 to 16 acres (approximately 20% reduction).

6.2.3.2. revised In-Water Disposal

As stated on page 4-36 of the 1999 Final IFR/EIS, flowlane disposal was estimated at 3 mcy for construction and 24 mcy of maintenance for the first 20 years. The revised disposal plan estimates these quantities to be 2 mcy for construction and 26 mcy for maintenance for the first 20 years.

6.2.3.3. new Ocean Disposal

For the Final SEIS, updated information on ocean disposal has been added to this subsection. Additional baseline studies are reported in Exhibit N. As discussed in Subsection 4.4.3.10, five additional ecosystem restoration actions were developed for implementation as part of the channel improvement project to benefit the recovery of listed salmonids. Approximately 12 mcy of the dredged material proposed for ocean disposal in the 1999 Final IFR/EIS will be used to construct two of the restoration features (Lois Island embayment and Miller-Pillar). Construction of the Lois Island ecosystem restoration features would take all dredged material from the channel improvement project from CRM 3-29 generated during initial construction. The Miller-Pillar ecosystem restoration feature would beneficially use maintenance material for approximately 15 years. The remaining disposal in the estuary will be similar to the maintenance locations (Rice Island, Miller Sand Spit, Pillar Rock and flowlane) used for the 40-foot channel along with Miller-Pillar.

It is anticipated that other beneficial use opportunities will become available during the maintenance period. The Corps intends to not utilize ocean disposal for the channel improvement project. However, if the restoration features in the estuary are not fully implemented and if future opportunities do not arise, then the alternative would be to dispose of material in the ocean as described in the 1999 Final IFR/EIS. In the event dredged material from the channel did go to the ocean, it would be discharged into a site designated under Section 102 of the Ocean Dumping Act. The USEPA concurs with the Corps' proposed action. Such disposal would be in accordance with the then-current Site Management and Monitoring Plan as required by the Act, and would require coordination with, and concurrence by, the USEPA. At this point in time, USEPA anticipates proposing designation of the Deep Water and Shallow Water Sites under Section 102 of the Act.

Restoration of the Lois Island embayment would require approximately 6 mcy of material. Placement of the material at the Lois Island embayment would be during the 2-year construction period. This material would originate from the navigation channel between CRM 3-29. The Miller-Pillar ecosystem restoration feature would utilize approximately 5.5 mcy of material originating from operation and maintenance dredging of Miller Sands Channel (CRM 21.4 to 25.2) and Pillar Rock Range (CRM 25.2 to 28.8) over a 15-year period. These two ecosystem restoration features would utilize all of the initial construction and most of the operation and maintenance material that otherwise would have been

transported to the ocean for disposal. The balance of the O&M material would be disposed of at traditional disposal locations in the estuary.

6.2.4. [new] Ecosystem Restoration Features

For the Final SEIS, this new section on ecosystem restoration has been added to provide new information. Participants at the 2001 Lower Columbia River and Estuary Habitat Conservation and Restoration Workshop established general "Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects on the Lower Columbia River and Estuary, 2001." Habitat themes expressed by the workshop participants were: a) habitat connectivity; b) areas of historic habitat loss; c) linkages to reference site(s); d) passive habitat restoration over habitat creation; e) monitoring and evaluation; and an additional theme of community support and participation.

Habitat connectivity emphasizes the linkages between habitat areas that provide a variety of functions for species at various points of their life. Areas of historic habitat loss pertains to the results of land use activities such as diking, filling and shoreline development that have removed many of the shallow, peripheral wetlands and isolated the lower Columbia River from its floodplain. Linkages to reference site(s) represents a means of evaluating restoration sites on the basis of relatively unaltered reference habitats in close proximity that can serve as a "control" for evaluating habitat change. The participants indicated that passive habitat restoration over habitat creation should receive first priority and when possible, returning the site to historic hydrologic conditions, using or mimicking natural processes, should be prioritized over large-scale earth moving and further engineered solutions. Monitoring and evaluation metrics were to be developed that enhance an understanding of the connection between habitat variables and species. Community support and participation reflected the desire to develop partnerships among communities, organizations, individuals and agencies.

Ecosystem restoration features proposed at Lois Island embayment and Miller-Pillar fit some of these themes. The original construction of Lois Island embayment resulted in the excavation and filling of intertidal marsh and shallow subtidal habitat. The ecosystem feature at Lois Island addresses historic habitat loss through restoration of tidal marsh habitat. Similarly, the restoration effort at Miller-Pillar would restore tidal marsh and intertidal flats habitat in an erosive area. There is linkage to reference sites at both restoration locations. The tidal marsh and intertidal flats habitats immediately east of Lois Island that have been historically unaltered provide an excellent reference site as does the tidal marsh and intertidal flats habitat that abuts Miller-Pillar. Neither Lois Island embayment nor Miller-Pillar represents a passive restoration action, although the intent is to mimic historical tidal marsh and intertidal flats elevations of adjacent habitats. Few readily implementable (defined as public and/or private lands available for restoration use) large-scale restoration projects have been identified in the lower Columbia River estuary.

At these restoration locations, there is a reduction in fishing area due to physical changes to the water depths. There would be a 19% reduction in the select area fishery at Tongue Point and a 14% reduction in fishing area for the commercial gill net drift at Miller-Pillar. See Subsection 6.8.1.

Monitoring and evaluation metrics have been identified for implementation for these ecosystem restoration features based upon criteria presented in the 2001 BA and 2002 Biological Opinions. These large-scale restoration features contribute to the recovery of the ESA-listed species and are a beneficial use of dredged material. They will restore tidal marsh habitat, which is one of the habitat types in the Columbia River estuary that has incurred the greatest historical loss in acreage. They further reduce the impacts at the Deep Water Site from use by the inner channel material. For these reasons, these options are being proposed.

6.3. [revised] Water Quality Impacts

For the Final SEIS, updated information on water quality has been added to this subsection. Navigation channel dredging, in-water and ocean disposal and ecosystem restoration would not result in significant water quality impacts. Dredging of fine-grained organic rich sediments could result in limited short-term elevations of chemicals and possible decrease in dissolved oxygen in the immediate area of the dredging and disposal sites. However, Columbia River navigation channel sediments are predominately medium to coarse grain sand with less than 1% silt or clay and thus differ significantly from the discussion in this paragraph regarding fine-grained, organic rich sediments. Short-term turbidity increases (cloudiness of the water caused by suspended particles) would also be expected from in-water disposal actions. Turbidity measurements were conducted at a beach nourishment site and at an in-water (flowlane) disposal site in the Columbia River. Additional monitoring was conducted at Morgan's Bar during placement of material dredged from the Willamette River. Most material was found to settle rapidly to the bottom with minimum suspension of sediment. This also was true for the fine-grained material from the Willamette River placed at Morgan's Bar.

Background turbidity levels upstream of the disposal site prior to disposal were measured at 3.55, 3.28 and 3.10 NTUs (nephelometric turbidity unit, a unit of measure for turbidity levels in water). Many readings were subsequently measured below this level during disposal site turbidity monitoring. A minimum turbidity reading of 1.82 NTU was recorded while a maximum of 14.38 NTU was recorded. A reading of 12.38 NTU was recorded from water noted to be discolored washing around the front of the open scow while the disposal scow turned to return after disposal. The scow had not yet closed the hopper. This was the only station where water was visibly discolored on the surface. The area affected was minimal and the effect transitory. No other significant discoloration was noted on the surface during or after discharge of the dredged material.

Turbidity induced by dredging and dredged material discharge in the Columbia River appears to be limited and transitory in nature. This is attributable to the coarseness of the dredged material and the lack of fines present. Compared to natural fluctuations in suspended sediment levels, dredging-induced turbidity would be a minor constituent to the Columbia River system.

Although the Columbia River is water quality limited for temperature, bacteria, dissolved oxygen, total dissolved gas, toxics, arsenic, and pH, the proposed project is not expected to cause or contribute to exceeding criteria for temperature, bacteria, pH, or total dissolved gas. Dredging has the potential to cause short-term localized decreases in dissolved oxygen in confined areas of fine-grained organic rich sediments. The potential for such impacts from the proposed project is negligible due to the location and nature of the material to be dredged. Specifically, dredging will predominantly occur in the open channel where the sediments are low in organic material. Water quality effects for the channel improvement project would be similar to what is encountered during maintenance of the current 40-foot channel. It is not anticipated that construction or maintenance of the project would contribute to dissolved oxygen concentration reductions that exceed the applicable water quality criterion. Dredging and disposal activities should not exceed criteria for toxics, and arsenic because sediment screening and testing in the navigation channel indicates that chemicals are well below threshold limits in the sediment. Sediments from the Columbia River channel were found to be suitable for unconfined, open-water and ocean disposal. See Appendix B to the Biological Assessment, and the Corps' April 22, 2002 Amendment Letter to the Biological Assessment (see Exhibit H on the Corps' website).

As discussed in the 1999 Final IFR/EIS, ocean disposal impacts would not be expected to have any impact on water quality outside the immediate area of discharge. Construction of the ecosystem restoration features could be considered a minor reduction of water quality perturbations to the ocean.

The surfactant R-11® is initially proposed for use with Rodeo® herbicide, consistent with the label, to improve efficacy of herbicide uptake by purple loosestrife. The USFWS currently uses R-11® in conjunction with their Rodeo® application to spartina in the Willapa Bay National Wildlife Refuge. Prior to implementation of this ecosystem restoration feature, the Corps will coordinate further with the AMT to ensure that an appropriate surfactant and application protocol is followed. The Corps, in compliance with Term and Condition 5e of the 2002 NOAA Fisheries Biological Opinion, ". . .shall coordinate with NMFS on the development and implementation of the Purple Loosestrife Integrated Pest Management Plan, including prior NMFS review and approval for all over-water use of Rodeo®." This use will be consistent with the state of Washington's general NPDES permit.

A revised Section 404(b)(1) Evaluation prepared for this Final SEIS is included in Exhibit E.

6.4. Sediment Quality Impacts

6.4.1. revised Navigation Channel

For the Final SEIS, the following updated information has been added to this subsection. As discussed in Chapter 1, *Willamette River Construction,* dredging in the Willamette River has been deferred at this time and is not part of the project covered by this Final SEIS. Additional analysis of available sediment quality data relating to Columbia River dredging was conducted as part of the SEI and reconsultation process, and is presented in Appendix B

of the BA (Exhibit H on the Corps' website). Additional information was also provided to the NOAA Fisheries and the USFWS on sediment quality in the Corps April 22, 2002 amendment letter to the BA. This information is provided in Exhibit H (Exhibit H on the Corps' website). The NOAA Fisheries and the USFWS concluded that estimated risk of exposure of ESA-listed salmonids and bull trout from contaminated sediments from project activities is limited (see NOAA Fisheries and USFWS Biological Opinions in Exhibit H). Further, they support implementation of the Corps' contaminant monitoring and evaluation activities proposed in the 2001 BA and have included these activities in the mandatory terms and conditions of the Biological Opinions.

6.4.2. Ocean Disposal

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

6.4.3. [new] Ecosystem Restoration Features

For the Final SEIS, this new section on ecosystem restoration features has been added to provide new information. For the reasons discussed in Section 6.4.1, implementation of the ecosystem restoration features now associated with the project would not have a significant impact on sediment quality in the river, estuary or ocean. For the Bachelor Slough restoration feature, sediment sampling will be conducted prior to project implementation to ensure material to be dredged meets sediment quality criteria. Any necessary refinements to the Bachelor Slough restoration feature will be made during the preconstruction engineering and design phase of the project.

6.5. Hazardous, Toxic, and Radiological Waste Impacts

6.5.1. No Action Alternative

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

6.5.2. [revised] 43-foot Channel Deepening Alternative

For the Final SEIS, the following updated information was added to this subsection. As discussed in Chapter 1, *Willamette River Construction*, the Willamette River deepening has been deferred because parts of the lower Willamette River have been included on the National Priority List under CERCLA. The effects of this remediation will be evaluated in a Remedial Investigation/Feasibility Study prepared for that program.

There has been some infill into the Astoria turning basin since the release of the 1999 Final IFR/EIS. It is estimated that about 90,000 cubic yards of fine-grained material in this turning basin will be sampled and tested in accordance with the *Dredged Material Evaluation Framework* to determine whether the fine-grained material is suitable for in-water disposal.

6.5.3. revised Least Cost and Proposed (Sponsors') Alternatives

For the Final SEIS, the following updated information was added to this subsection.

6.5.3.1. new Ecosystem Restoration Features

For the Final SEIS, this new section on ecosystem restoration features has been added to provide new information. The ecosystem restoration features are not located near or anticipated to have any effect on known hazardous, toxic or radiological waste sites. Implementation of the Bachelor Slough restoration feature is contingent on the Corps' evaluation of sediment chemistry to determine suitability for upland disposal and approval by the WDNR and/or USFWS to dispose of dredged material on their property. Backwater channels are more likely to contain fine-grained sediments (silts) with a high organic content and therefore, a greater likelihood of contaminants (e.g., PCBs, DDT, DDE) than coarser-grained sands with low organic content found in the main navigation channel. Sediment sampling to determine contaminant levels is planned prior to initiating dredging of the slough. If sediment samples fail to meet the established thresholds or an upland dredge material disposal site on Bachelor Island is unavailable, this feature would not be constructed.

6.6. Biological Impacts

6.6.1. revised Aquatic Resources

6.6.1.1. revised No Action Alternative

Since completion of the 1999 Final IFR/EIS, additional information was obtained for Dungeness crab *Cancer magister* (Exhibit K-4); smelt (eulachon) *Thaleichthys pacificus* (Exhibit K-2); and white sturgeon *Acipenser transmontanus* and green sturgeon *A. medirostris* (Exhibit K-1). Also, additional information on non-indigenous species (ballast water) is provided.

Dungeness Crab

For detailed information, see Exhibit K-4, *Evaluation Report Dungeness Crabs* (revised). A modified Dredge Impact Model (DIM) used the observed summer 2002 dredge entrainment rates for crab (number of crab entrained per cubic yard dredged), to calculate adult equivalent loss to the crab population and loss to the fishery by entrainment for maintenance of the existing channel. Entrained crabs were counted by age class and sex, and this information was used in the DIM to calculate adult equivalent losses and loss to the fishery.

These losses are based on numbers of crabs of various age classes and sex that were entrained and how many of those crabs would have been expected to survive to a given age class based on known natural survival rates or to the legal harvest size for the fishery (Pearson et al. 2003).

Crab adult equivalent loss at age 2+ for the "no action" maintenance increment associated with the 40-foot project ranges from a worst case of 114,640 crabs to a best case of 20,772 crabs. This translates to a loss to the fishery of between 18,057 crabs and 3,905 crabs. Projected adult equivalent loss in "no action" maintenance years 1 and 20 are 44,643 and 25,503 crabs, respectively. Projected loss to the fishery in "no action" maintenance years 1 and 20 are 7,031 and 4,017 crabs, respectively. Year 1 was selected because it was anticipated to have the largest dredging volume. Year 20 was selected because it represents a reasonable planning horizon for dredged material management planning. Additionally, 20 years represents a point in time beyond which dredging volumes will be considered constant. Dredged volumes decrease over this period due to declining volumes expected at Flavel Bar (CRM 11-14).

Some impacts to crabs likely occur due to in-water disposal between CRM 3-18. Impacts below CRM 18 are likely not substantial because the area where disposal occurs is small compared to available habitat. Upriver of CRM 18, in-water disposal is not expected to have any significant impact on crab because of lack of available habitat due to low salinity.

Based on the earlier analysis in the 1999 Final IFR/EIS and the evaluation report in Exhibit K-4, the Corps concludes the No Action Alternative will have minimal impact on crab and their habitat and the fishery. It is anticipated that this impact will not have any significant effect on population structure or dynamics. Other factors, such as ocean climate conditions and natural population cycles, have a far greater effect on the crab population levels.

Smelt (eulachon)

As noted in Section 6.1.1.2, the ODFW and WDFW have conducted additional studies regarding smelt. The studies found that:

- The navigation channel was not observed to be the primary outmigration corridor for smelt larvae.
- Larvae were distributed throughout the water column at all sampling locations. At sampling locations situated within the navigation channel, larvae were generally more abundant at the bottom and middle of the water column than at the surface.

The following assessments of the potential impacts of dredging activities under the No Action Alternative on eulachon were based on the results documented in Exhibit K-2, *Evaluation Report Smelt* (revised).

- Given the large numbers of larvae and their distribution across the river channel and through the water column, and the relatively small area where dredging will occur as a percentage of this total, it is unlikely that dredging would have a significant impact (through entrainment) on the outmigrating larval population.

- Dredging is unlikely to directly impact eulachon spawning areas because the dynamic nature of the bottom within the reaches to be dredged would not provide a stable enough substrate that would allow an adhesive smelt egg to incubate for 30 days.
- Eulachon eggs incubating in near-shore areas in the proximity of dredging activities may be affected if these activities alter flow patterns or increase sedimentation. However, hydraulic models indicate dredging will not significantly alter the river's flow patterns. The average annual bedload transport in the main river channel is expected to remain within the existing range.

Dredging activities associated with the No Action Alternative are not expected to have a significant impact on the eulachon larval population, on eulachon spawning areas, or on eulachon eggs incubating in near-shore areas in the proximity of dredging activities. Larval smelt are not entrained in most cases because they are in the water column and outside the effect of the dredging action. Disposal is generally not a concern because most in-water disposal sites are further downstream than the major smelt spawning areas, which are at CRM 56-61 and CRM 67-69. While the current maintenance has some in-water disposal in these areas, this disposal is unlikely to directly impact eulachon spawning areas because the dynamic nature of substrates within the flowlane disposal sites (which are in or adjacent to the main channel) do not provide stable surfaces that would allow an adhesive egg to incubate for 30 days. The typical timing for the maintenance program is from July through October, which is after the typical spawning season for smelt.

White and Green Sturgeon

Green sturgeon are present in the project area. They are an anadromous member of the sturgeon family and range from Alaska to Mexico primarily in marine waters. They feed in estuaries and bays from San Francisco to British Columbia and spawn in fresh water in the mainstem of large rivers. Spawning currently only occurs in a few rivers–the Sacramento and Klamath Rivers in California and possibly the Rogue River in Oregon. No known spawning occurs in the Columbia River. Green sturgeon occur only in the lower 37 miles of the Columbia River (WaterKeepers 2001). They are demersal and occur from inshore water to deeper holes but commonly move to intertidal areas to feed at high tide. Most occur primarily in the lower estuarine portions of the Columbia though occasionally they may move up into freshwater. Green sturgeon are not fished commercially but are a bicatch in other fisheries along the south Washington coast and the Columbia River estuary. Based on recent catch data, it is believed that the population levels are declining (WaterKeepers 2001). Green sturgeon occupy similar habitat as white sturgeon in the estuary and are thought to behave similarly. Therefore, the conclusions of these studies regarding the behavior and potential impacts on white sturgeon should apply equally to green sturgeon.

Exhibit K-1, *Evaluation Report White and Green Sturgeon* (revised), includes a report conducted by ODFW/WDFW that provides information on the effects of dredging and in-water disposal of dredge materials on white sturgeon in the lower Columbia River. Because green sturgeon occupy similar habitat to white sturgeon, and because they are thought to behave similarly, the conclusions of the studies regarding behavior of and potential effects

on white sturgeon should apply equally to green sturgeon. Although no green sturgeon were caught during the studies, green sturgeon have been observed in the study area.

Exhibit K-1 concludes that sturgeon are present in three potential dredge disposal areas in the lower Columbia River. The response of these fish to disposal activities is not known. The study demonstrated some seasonal variability in catch rates that is strong evidence of variable season use. The short-term response of sturgeon to dredge disposal activities will be clarified by telemetry work underway by the U.S. Geological Survey. This added information will provide a more complete assessment of the effects potential loss of habitat (due to dredge-disposal activities) may have on sturgeon. Table S6-3 addresses the potential impacts being studied by the U.S. Geological Survey along with the recommended responses to the impacts, should they occur.

Table S6-3. Study Results on Potential Sturgeon Impacts and Recommended Responses

Potential Impacts	Responses
Direct Mortality (1) Immediate mortality of significant numbers of fish due to burial. (2) Delayed mortality of significant numbers of fish due to burial. (3) Fish survive disposal action.	(1) Do not dispose in area or modify/schedule disposal practices to minimize impact. (2) Do not dispose in area or modify/schedule disposal practices to minimize impact. (3) No mitigation action.
Disturbance (1) Significant numbers of fish leave area permanently. (2) Significant numbers of fish leave area temporarily. (3) Fish do not leave area.	(1) Do not use additional sites in the future or modify/schedule disposal to minimize impact. (2) Schedule use of site to periods of low abundance. (3) No mitigation action.
Feeding Sturgeon feed in site: (1) Significant, long-term effects. (2) Minor, short-term effects. (3) Sturgeon not feeding in site.	(1) Do not use additional sites in the future. (2) No mitigation action. (3) No mitigation action.
Loss of Habitat (1) Do not use habitat after disposal. (2) Return to area a short time after disposal. (3) Return to area a long time after disposal.	(1) Do not use additional sites in the future or modify/schedule disposal to minimize impact. (2) No mitigation action. (3) No mitigation action.

Pacific and River Lamprey

Both species of lamprey use the lower Columbia River in the project area principally as a migratory corridor. They move upstream from the ocean in the spring to spawn in upper reaches of tributary streams in gravel riffles. They build nests or redds similar to salmon. The eggs hatch in a few weeks and the young (referred to as ammocoetes) burrow into the mud near the banks of the tributary streams where they remain for 1-2 years. After this they change into the adult form and migrate downstream to the ocean where they begin a

parasitic/predacious life that lasts for an unknown period of time. Impacts to the lamprey species from dredging and disposal operations are expected to be minimal since during their upstream and downstream migration, they occur primarily in the water column above where dredging would occur.

Non-indigenous Species

Hundreds of non-native species arrive in waters of the U.S. from foreign seas each day by way of ships' ballast water, hull fouling and fishing activities. Many of these species establish themselves in U.S. waters, and millions of dollars have been spent in attempt to extinguish their invasion through research, control, and management efforts. The invasion of such species can cause reduction in native species numbers and through destruction of habitats and competition with native species for food. The biodiversity and balance of an ecosystem can also be threatened by changes in species interaction and transformations in nutrient rotation and energy flow. As trade patterns change, the number of donor regions increase, and new species become available to be established in non-indigenous regions, making the battle against non-indigenous species difficult to contain. The origin and history of many invasive species remains unknown and researchers can easily overlook the introduction of microscopic species and groups of species that are hard to recognize.

Ballast water is used by shipping vessels for stability and weight throughout a voyage, and to increase their manageability under harsh weather conditions (NRC 1996). Water is pumped into the ballast tanks at the original port where cargo is unloaded and typically discharged at the port-of-call when a vessel receives new cargo. Because ballast water is pumped in along shallow coastal zones, sediment is taken on board with a range of organisms from small viruses to fish living in surrounding waters. With the transfer of ballast water from one coastal zone to another, there is a possibility for the introduction of non-native species entering the port where the ballast water is discharged. Fortunately, it is difficult for many of these organisms to subsist in a new environment due to changes in salinity, food source and temperature, yet those few that do survive have potential to establish populations and cause economic and ecological harm.

Preventing ballast water organisms from establishing themselves begins with the elimination of species released by discharge. Accomplishing this task can be done by not taking on ballast water, killing the organisms during the voyage, or making sure that these organisms are not let go when ballast water is released. However, while limited research has been done to determine the best options of ballast water management, no single method has been proven to remove all unwanted organisms from ballast tanks. Without the presence of natural predators, some of these non-indigenous species have the ability to multiply very quickly, thereby displacing native organisms by preying on them or competing with them for food and space. When a bioinvader disrupts any species that is harvested commercially, or when such non-native species cause damage to structures it causes economic harm. The goal of ballast water management is to minimize the risk of invasion by species that have the potential of causing either economic and/or ecological destruction.

Mid-ocean ballast exchange has been shown to decrease aquatic nuisance species introductions, but also has disadvantages. Since not all ballast water is released during the exchange, removal of 100% of organisms is not guaranteed (Systma and Draheim 2002, personal communication). Exchanging water during rough weather can involve great risks, it cannot be practically applied to U.S. ship traffic, and also is very difficult to enforce. However, marine organisms from coastal zones, estuaries, and rivers are not likely to survive when released into the open ocean; the same is true for ocean organisms when released into coastal or river areas. Beyond the Great Lakes and Hudson River, the U.S. has no mandatory regulations concerning ballast water management. The International Maritime Organization, a United Nations association, recommends all vessels carrying ballast water undergo exchange in the open ocean to minimize risk of releasing non-indigenous organisms to coastal waters. A voluntary reporting system has been a low priority for most ship pilots (Ward 2002).

The Oregon Senate Bill 895 (2001) prohibits discharge of ballast water into waters of the state by vessels that have traveled outside the state waters except when: (1) the vessels have undergone open-sea or coastal exchange, (2) the ballast water originated from the coastal waters between parallel 40 degrees north latitude and the parallel 50 degrees north latitude, or (3) an exchange was not implemented because the vessel operator believed there to be a danger in doing so (ODEQ 2002). In Washington, ballast water management regulations are similar to those in Oregon.

All ballast water management reports must be turned in to the Oregon Department of Environmental Quality or the Merchants Marine 24 hours prior to entry into the state. From January 1 to March 8, 2002, 192 vessels were recorded entering into the waters of Oregon with 100% state compliance. Thirty-nine of those 192 vessels reported their ballast exchange inside the 24-hour window. The total water discharged into Oregon waters during that time was 475,664 metric tons. Of the 192 vessels, 85 were coastal, 10 of which discharged 25,878 metric tons of ballast into Oregon waters (4 discharged illegally). The average distance from shore for coastal discharge was 86.4 miles (Vinograd 2002, personal communication).

A majority of ships that come to port in the Columbia River never travel outside of the coastal zone, traveling north from California or south from the Puget Sound area. It is important to note that these coastal traveling vessels are unable to exchange ballast water, and arrive in the Columbia River as their second or third port-of-call. Therefore, almost 30% of the water currently being discharged into the Columbia River is not exchanged (Smith, personal communication). The short voyages that are taken may permit high survival of ballast water species. While it is difficult to determine the origin of many exotic species that could invade the Columbia River, the Chinese mitten crab, zebra mussel and Eurasian milfoil are known species that have invaded other inland U.S. waters.

The Chinese mitten crab is a native species of the Yellow Sea of Korea and China. Since its discovery in the San Francisco Bay in the early 1990s, this burrowing crab has established itself in the bay and Delta watershed, causing a threat to native invertebrates and various

fisheries. The potential of predation by mitten crabs on salmonid and sturgeon eggs and juveniles is of great concern. Since the mitten crab is a burrowing crab, there is also a concern of increased erosion activity of riverbanks and levees (Systma and Draheim 2002, personal communication). Mitten crabs have clogged pumps, screens and intakes and have caused damage and killed fish at salvage facilities associated with water diversions throughout the San Francisco Bay area (Carlton 2001). While only a handful of mitten crabs have been discovered in the Columbia River (both Chinese and Japanese), these numbers may greatly increase through larval dispersal and intentional release unless some method is found for their control.

Transferred to the U.S. in ballast water and on the hulls of vessels, zebra mussels have caused great environmental and economic harm in the Great Lakes and other inland waters. Zebra mussels attach to intake pipes and large colonies can disturb supplies of drinking, cooling, processing and irrigating water. They can attach to boat hulls, docks, navigation aids, fish ladders and lock structures causing permanent damage (Pennington 2002). Large colonies can alter aquatic ecosystems by filtering out and consuming food meant for native species. This increased filtration encourages unwelcome growth of rooted aquatic vegetation, benthic algae, and insect-like benthic organisms. Due to the large amount of water filtered by zebra mussels and their high body-fat content, they accumulate about 10 times more PCBs and other toxic contaminants than native mussel species. These contaminants can be transferred up the food chain to birds and fish that feed on zebra mussels (Sea Grant Great Lakes Network 2002).

Eurasian milfoil is a freshwater aquatic perennial plant with very fine, feather-like leaves that can adapt to a variety of environments. Watermilfoil negatively impacts aquatic ecosystems by forming dense canopies that completely shade out resident vegetation. Under the mats, temperature and pH levels increase altering water quality. The presence of Eurasian milfoil can interfere with fishing, boating, swimming, and water skiing activities, and dense clumps can clog intake pipes used for irrigation projects and power generation (WDOE 2002). Eurasian milfoil has invaded many of Washington's lakes and rivers and is found in the Columbia River as well. Because of its fast-growth, high reproduction rate, widespread distribution, and difficulty to control, Eurasian milfoil is considered one of the most problematic plants in the northwest region. While Eurasian milfoil appears to be spread from water to water mainly through boating activity, it is also easily picked up in the ballast water of large vessels.

Because of the buoyancy of grain carriers and container ships traveling across the ocean and along the Pacific Coast, the need for ballast is essential to maintain safety and stability. Of the approximately 2,000 commercial deep-draft vessels that travel the Columbia River every year, bulk grain carriers make up almost 25% of the total transits and take on a greater amount of ballast water due to their light weight prior to loading. With increased ballast water regulations in both Washington and Oregon, ballast water exchange is required for those ships entering the Columbia River, unless otherwise specified.

Under the No Action Alternative, there will be no change in vessel practice.

6.6.1.2. revised 43-foot Channel Deepening Alternative

For the Final SEIS, the following information has been added to this subsection for Dungeness crab, smelt, sturgeon, non-indigenous species, and essential fish habitat (EFH).

Dungeness Crab

For detailed information, see Exhibit K-4, *Evaluation Report Dungeness Crabs* (revised). A modified Dredge Impact Model (DIM) used the observed summer 2002 entrainment rates to project crab entrainment and adult equivalent loss and loss to the fishery. Crab adult equivalent loss at age 2+ for project dredging prism (construction and 40-foot channel maintenance) ranges from a worst case of 281,528 crabs to a best case of 38,811 crabs (of these amounts, the increment associated with channel improvement is 166,888 crabs and 18,039 crabs). This translates to a loss to the fishery of between 44,342 and 7,252 crabs (the increment associated with channel improvement project is 26,285 crabs and 3,347 crabs). This loss to the fishery compares to annual landings of 5.3 million crabs in the Washington and Oregon region around the Columbia River.

Transition with volumes over the first 20 years. Maintenance dredging for the 43-foot channel consists of materials that would have been dredged to maintain the 40-foot channel plus additional materials to maintain the additional depth. Project maintenance dredging quantities for the 43-foot channel are somewhat higher than projected quantities for the 40-foot channel in the early years of the project. However, in later years of the project the quantities become nearly equivalent. Projected adult equivalent loss for maintenance of the 43-foot project (including quantities from the 40-foot as well as additional increment due to the 43-foot project) in years 1 and 20 are 56,840 and 25,612 crabs, respectively (the increment associated with channel improvement project is 12,197 crabs and 109 crabs). Projected loss to the fishery for maintenance of the project in years 1 and 20 are 8,953 and 4,035 crabs, respectively (the increment associated with channel improvement project is 1,922 crabs and 18 crabs). In other words, by maintenance year 20 or sooner, entrainment associated with the channel improvement project is effectively equal to that of the No Action Alternative.

As with the No Action Alternative, some impacts to crabs are likely to occur due to in-water disposal between CRM 3-18. The proposed disposal plan may result in a marginally higher impact due to increased flowlane disposal relative to the no-action alternative. Impacts below CRM 18 are likely not substantial because the area where disposal occurs is still small compared to available habitat. Upriver of CRM 18, in-water disposal is not expected to have any significant impact on crab because of lack of habitat due to low salinity. In addition, the Corps through use of the salinity/crab abundance model will attempt to avoid and minimize impacts from in-water disposal.

Based on the Corps' and USEPA's earlier analysis in the 1999 Final IFR/EIS and the evaluation report in Exhibit K-4, while there is a marginal increase in entrainment and indirect effects (habitat disruption) compared to the No Action Alternative, the Corps

concludes the project still has minimal impact on crab, their habitat, and the fishery, and still does not have any significant effect on population structure or dynamics. As with the No Action Alternative, other factors such as ocean climate conditions and natural population cycles have a far greater affect on the crab population levels than would the project. Further, the Corps will use the salinity/crab distribution model to schedule dredging and disposal to avoid and minimize impacts to crab.

Exhibit N, *Physical and Biological Studies of the Deep Water and Shallow Water Sites*, includes information on additional data collection for the near ocean. The Corps and USEPA conducted physical characterization of the ocean sites including side-scan sonar, geophysical information, sediment profiling, sediment trend analysis, and sediment sampling with chemical evaluation. Also, biological data collection began in summer 2002 to include sediment profiling, benthic sampling, crab pot data collection, and trawling to characterize the biological baseline of the Deep Water Site. Crab pot data collection and trawling occurred at the Shallow Water Site. This data serves as the basis for considering measures to minimize impacts to crabs in the event that the ocean sites are used for this project.

Smelt (eulachon)

In general, the findings and recommendations from the state agency research (see Exhibit K-2, *Evaluation Report Smelt*) were that dredging activities associated with channel deepening are not expected to have a significant impact on migrating eulachon larvae (through entrainment), on eulachon spawning areas, or on eulachon eggs incubating in nearshore areas in the proximity of dredging activities. Disposal is generally not a concern because most in-water disposal sites are downstream of the lowest major smelt spawning areas, which are at CRM 56-61 and CRM 67-69. While the current construction plan has some limited in-water (flowlane) disposal at CRM 51-56 and CRM 59-62, this disposal is unlikely to directly impact eulachon spawning areas because the dynamic nature of substrates within the flowlane disposal sites (which are in or adjacent to the main channel) do not provide stable surfaces that would allow an adhesive egg to incubate for 30 days. Impacts to migrating larval smelt from disposal are a concern to the agencies and though they are unsure of the level of impact, they have indicated in the letter in Exhibit K-2 that disposal not occur during the peak of the larval movement downstream. The peak out migration in 2001 was from April 2-18, but can vary. The period of peak larval outmigration will be determined by the agencies prior to construction, but will likely fall within or near this period. The Corps has agreed to schedule construction dredging and disposal to avoid this period. No additional specific actions (e.g., timing restrictions) are recommended because it is unlikely that dredging associated with channel improvement would have a significant impact on eulachon. As discussed in the No Action Alternative, maintenance dredging occurs outside this window.

White and Green Sturgeon

Impacts to sturgeon from the 43-foot channel would be similar to those discussed under the No Action Alternative, although the volumes during the construction period would be greater (see Subsection 6.6.1.1).

Pacific and River Lamprey

Impacts to the lamprey species from dredging and disposal operations are expected to be minimal since during their upstream and downstream migration, they occur primarily in the water column higher than where dredging would occur. It is unlikely that the change in physical parameters predicted with the project will have an effect on their migration or ocean entry.

Non-indigenous Species

While the channel improvement project would provide greater navigation reliability and efficiency with existing vessels, it is not anticipated to increase the volume of river traffic. Therefore, the project would have no effect on the amounts of ballast water brought into the Columbia River.

Essential Fish Habitat

Exhibit I, *Essential Fish Habitat Assessment*, evaluates impacts to ground fish and coastal pelagic habitat. The NOAA Fisheries will review and comment on the EFH assessment for ground fish and pelagic species. The NOAA Fisheries reviewed the EFH for salmonids in the May 20, 2002 Biological Opinion and concluded that there may be adverse effects to a variety of habitat parameters for ESA-listed salmonids. However, NOAA Fisheries concluded that the ESA conservation measures, the reasonable and prudent measures, and terms and conditions, all of which are outlined in the Biological Opinion, address these adverse effects.

6.6.1.3. [new] Ecosystem Restoration Features

This new subsection has been added for the Final SEIS to discuss impacts of the ecosystem restoration features on Dungeness crab, smelt, sturgeon, non-indigenous species and EFH. Impacts of these features on listed salmonids are discussed in the BA (Exhibit H, *ESA Consultation*, available on the Corps website). Also see Section 6.7.1.2.

Dungeness Crab

The ecosystem restoration features, including the new features developed during the ESA consultation, are all located above CRM 18 in areas where the salinity is not expected to support significant Dungeness crab populations. Therefore, creating the restoration features would not be expected to significantly impact crabs.

Smelt (eulachon)

The two ecosystem restoration features that use dredge material in a beneficial manner are downstream of the major smelt spawning areas. The ecosystem restoration features should not have an adverse impact on smelt.

White and Green Sturgeon

Sturgeon are known to use the Lois Island embayment. It is assumed they use the Millar Pillar area but the extent is unknown. Construction of the ecosystem restoration features at these two locations will impact any sturgeon that do use the areas due to the loss of habitat by filling operations. However, sufficient habitat for sturgeon exists in the estuary so this displacement is not expected to have significant impact on sturgeon populations. After completion, benthic productivity in the tidal marsh habitat that will develop is expected to be greater than base condition. Further, detrital export from the tidal marsh component of these features is likely to benefit sturgeon by increasing forage resources for benthic invertebrates in the estuary. A net gain in overall estuarine productivity, including that for sturgeon, would be anticipated from these two ecosystem restoration features. None of the other ecosystem restoration features are anticipated to have any effect on the deep-water areas used by sturgeon.

Pacific and River Lamprey

No impacts are anticipated to the lamprey species from dredging at the temporary sump and disposal operations at Lois Island, and disposal actions at Miller-Pillar. Lamprey occur primarily in the water column higher than where dredging would occur during their upstream and downstream migration. It is unlikely that the change in physical parameters associated with any of the ecosystem restoration features will have an adverse effect on their migration or ocean entry.

Non-indigenous Species

The ecosystem restoration features have no effect on the volume of river traffic. Therefore, these features would have no effect on the amounts of ballast water brought into the Columbia River.

Essential Fish Habitat

See Subsection 6.6.1.2.

6.6.2. revised Wildlife Resources

6.6.2.1. revised No Action Alternative

For the Final SEIS, the following updated information is being added to this subsection. Additional information regarding impacts to wildlife resources from Washington upland disposal sites is provided in Exhibit K-8, *Consistency with Critical Areas Ordinances Including Wetland Mitigation* (revised). Some of these upland disposal sites are used for the No Action Alternative and the proposed project. The discussion as it applies to those disposal sites indicates what the impacts would be under the No Action Alternative. This

exhibit also discusses measures considered and being used to avoid, reduce, minimize or mitigate such impacts. As discussed in Section 6.2.3.1, the size of some of the disposal sites has been reduced, and this reduction has decreased the impact to riparian and wetland habitat. Therefore, a corresponding reduction of impacts to wildlife species that rely on such habitat also would be anticipated.

6.6.2.2. revised 43-foot Channel Deepening Alternative

For the Final SEIS, the following updated information is being added to this subsection. Exhibit K-5, *Wildlife and Wetland Mitigation*, identifies potential impacts of the project from the use of existing and new Washington upland disposal sites for the proposed plan. This exhibit also discusses measures considered and being used to avoid, reduce and minimize impacts and includes a wetland mitigation plan to provide further detail on how wetland impacts will be mitigated.

Since issuance of the 1999 Final IFR/EIS, potential wildlife impacts have been reduced in several ways. Seventeen acres of riparian forest at Lord Island (O-63.5) were afforded protection in the 2001 BA reducing the overall riparian forest impact associated with the project from approximately 67 acres to approximately 50 acres (approximately 25% reduction). In addition, corrections to mapping inconsistencies at the Mount Solo disposal site (W-62.0) have resulted in a reduction of impacts to wetlands from approximately 20 acres to approximately 16 acres (approximately 20% reduction). As noted in Exhibit K-5, the mitigation plan currently calls for restoring or developing 194 acres of wetlands, which represents about a 12:1 ratio of mitigation to wetland impact. Exhibit K-8, *Consistency with Critical Areas Ordinances Including Wetland Mitigation*, contains a more detailed draft wetland mitigation plan for proposed Washington wetland mitigation effort at Woodland Bottoms and Martin Island.

6.6.2.3. revised Least Cost Disposal Alternative

For the Final SEIS, the following updated information is being added to this subsection. The review of disposal sites conducted during preparation of the 2001 BA resulted in a reduction in riparian forest impacts (see Exhibit K-5, *Wildlife and Wetlands Mitigation*). Seventeen acres of riparian forest at Lord Island (O-63.5) were afforded protection in the BA reducing the overall riparian forest impact associated with the project from 67 to 50 acres (approximately 25% impact reduction). As discussed above, correcting mapping inconsistencies at the Mount Solo site (W-62.0) also resulted in reducing wetland impacts associated with the least cost disposal plan from 28 to 24 acres.

6.6.2.4. revised Proposed (Sponsors' Preferred) Disposal Alternative

The Sponsor's preferred disposal alternative incorporates the same changes in Subsection 6.6.2.3, but with a further reduction in impact to agricultural lands from 200 to 172 acres (about 14%) due to reduced disposal acreage requirements at Gateway (W-101) and Mt. Solo (W-62). Under the current plan, the Gateway disposal site is reduced from 69 to 40 acres (approximately 40% reduction) and Mt. Solo has been reduced from 50 to 46 acres.

6.6.2.5. [new] Ecosystem Restoration Features

This new subsection is being added for the Final SEIS to discuss impacts of the ecosystem restoration features on wildlife resources. Five new restoration features were added to the project during the ESA consultation process. These features are in addition to the three discussed in the 1999 Final IFR/EIS. Impacts to ESA wildlife are discussed in the 2001 BA.

The Lois Island embayment habitat restoration will restore 191 acres of tidal marsh habitat for fish and wildlife resources. Waterfowl, shorebirds, raptors, including bald eagles, various songbirds and herons will ultimately benefit from the restoration of tidal marsh habitat as this habitat provides foraging resources for these species. There will be a time delay of 1 to 5 years for wildlife benefits to accrue as vegetation and benthic invertebrate communities pioneer into the restored area and become established. Detrital export from the tidal marsh habitat will provide forage resources for estuarine benthic invertebrates, and ultimately juvenile salmonids The tidal marsh with associated mudflats and shallow subtidal channels that borders the upstream shoreline of Lois Island provides an excellent example of the restoration objective sought as regards to habitat complexity and wildlife use targeted by the restoration action. Bald eagles will be disturbed from portions of their foraging territory during project construction (2001 BA). Use by ducks, grebes, loons, cormorants, gulls and terns would be lessened during the construction years until the feature is completed and plant and benthic invertebrate communities colonize the area and become established.

The purple loosestrife control program is aimed at addressing the spread of this invasive plant species in the estuary between CRM 18-52. Where the plant has become densely established (Wallace Island), native plant diversity and density in the intertidal marsh habitat has been reduced. A reduction in the productivity of the native intertidal marsh vegetation in the estuary would have a substantial impact on the wildlife resources that use the estuary. A reduction in wintering waterfowl usage would impact raptors also, which make use of waterfowl as a forage resource. A monoculture of purple loosestrife could affect insect production and diversity, which would thus impact wildlife species dependent upon this resource (e.g., various songbirds and shorebirds). Implementation of the proposed feature over a 5-year period would result in minor site-specific disturbance to various wildlife species as control and monitoring activities are conducted. Such disturbance would be temporary in nature and only typically entail small, localized areas.

The Miller-Pillar restoration feature would restore 235 acres of tidal marsh/intertidal flats habitat in a currently erosive area where depths increased from -6 feet CRD to about -30 feet CRD. Shallow subtidal habitat is more productive for benthic invertebrates than deeper subtidal areas. Increased benthic invertebrate productivity is important for fish production, which has a bearing on the level of use by grebes, loons, cormorants, gulls, and terns. Use by these species is expected to increase post-construction. The benefits associated with this feature are comparable to Lois Island embayment. Construction disturbance would lessen wildlife use in the immediate area, but is considered relatively minor because the area is not currently frequented by wildlife concentrations. To lessen the presence of cormorants, bird excluders will be placed on top of the pile dikes. King piles at each pile dike would provide perching for bald eagles.

Restoration efforts at Tenasillahe Island would occur in three phases. The interim feature (Phase 1) includes provisions to increase flow and circulation in the 92 acres of interior slough channels (blocked by flood control levees encompassing the island). Improvements to flow and circulation will allow for juvenile salmonids access and egress and allow rearing and foraging activities by juvenile salmonids to occur in these channels. Construction of inlet channels and control structures and improvements to the existing tidegates would be accomplished. Construction of the inlets and outlet improvements would pose a minor disturbance to wildlife, including Columbian white-tailed deer. It is expected that the minor disturbance will simply cause wildlife to avoid the immediate area. Post-construction benefits for wildlife are relatively minor and would accrue from better water quality conditions and associated improvements in benthic invertebrate and aquatic vegetation production. Waterfowl broods rearing in the channels and aquatic furbearers represent species that may benefit from the interim action.

The Cottonwood-Howard Island Columbian white-tailed deer introduction (Phase 2 of the Tenasillahe Island restoration feature) is intended to reintroduce this species to a portion of their historic range on secure habitat. The sponsor ports will purchase the islands, except for portions owned by WDNR. That acreage (approximately 650 acres), outside the project needs for dredged material disposal, will be used for Columbian white-tailed deer range. Other wildlife species present on these islands are not likely to incur any adverse affects from this action.

Implementation of the long-term feature (Phase 3) poses substantial benefits for waterfowl, shorebirds, raptors, gulls and other species that forage in intertidal marsh/mudflat and shallow subtidal habitats. Breaching of the flood control dikes would restore 1,778 acres of intertidal marsh/mudflat and shallow subtidal habitat thus benefiting these species. Fisheries resources would benefit from unimpeded access to the area rearing and foraging activities. The significant increase in primary productivity form tidal marsh vegetation exported to the estuary as detritus would benefit production of benthic invertebrates and thus juvenile salmonids and other fish species that forage on them. The wildlife species incurring the most impact would be the Columbian white-tailed deer, which would lose substantial acreage of artificially maintained habitat (e.g., upland habitat provided through operation of flood control dikes and water control structures).

However, implementation of this long-term feature is predicated upon the delisting of Columbian white-tailed deer, which is dependent upon establishment of three secure and viable deer populations. Given the current condition, e.g., secure and viable populations at the mainland deer refuge and Tenasillahe Island, two additional secure and viable deer populations would have to be established prior to implementation of this feature. A 10-year period has been estimated for accomplishment of this task.

The Bachelor Slough restoration feature entails dredging of the slough to approximately 0 feet NGVD. This action encompasses approximately 85 acres of slough channel along the 2.75-mile length of the slough. Dredging of the slough is contingent upon slough sediments meeting established agency criteria for contaminants and availability of disposal sites on

adjacent lands owned by the USFWS or WDNR. Riparian forest development on the 46 acres of these disposal sites post-deposition represents a key element of this feature. Riparian forest development along 6 acres of the Bachelor Slough shoreline also is included.

Dredging of Bachelor Slough would be conducted between July 1-September 15 to minimize impacts to wildlife, which make greatest use of the Ridgefield National Wildlife Refuge during fall, winter, and spring when wintering waterfowl are present. Anadromous fisheries use is expected to be low in this timeframe due to low, warm waters. The riparian development along the shoreline of Bachelor Slough would benefit resident and Neotropical migrant songbirds, reptiles and amphibians, small mammals and aquatic furbearers. These species would incur some adverse impacts initially as the habitat is converted from an invasive plant (e.g., false indigo and reed canarygrass) to a native riparian forest habitat. With establishment of riparian forest, these species would attain better habitat conditions than at present. This improvement would be associated with a more diverse plant species composition and structural component (e.g., height, varying canopy layers, and ultimately large wood debris on the ground) that would develop as the riparian forest matures.

The upland disposal site on WDNR land is a sandy, previously used dredged material disposal site that has few plant species comprising minor ground cover present. Placement of dredged material, estimated to be relatively silty material, and subsequent development of riparian forest habitat would substantially improve wildlife use at this location for the aforementioned species groups while having a negligible impact on the few species that currently use the location. The other two potential riparian forest development locations are located at upland, presently grassland locations on the Ridgefield National Wildlife Refuge. Species such as savannah sparrows and garter snakes, which make use of this grassland habitat, would be adversely impacted by conversion to riparian forest habitat, which represents the historical habitat that would have occurred on these sites. Riparian forest habitat would support a more diverse array of wildlife species than grassland habitat. Loss of habitat, principally grasslands used for grazing by wintering waterfowl would be minimal.

6.7. Threatened and Endangered Species

6.7.1. revised Aquatic Species

For the Final SEIS, Subsections 6.7.1.1 and 6.7.1.2 have been added to provide information and analyses developed during the ESA consultation concerning impacts to listed salmonids from the project and the ecosystem restoration features. Also, Subsection 6.7.1.3 was added for the Final SEIS to discuss the Biological Opinions.

6.7.1.1. new ESA Consultation Results for the 43-foot Channel Deepening Alternative

Seven salmonid species have population segments that are federally listed under the ESA (endangered, threatened, or proposed for listing) and spend a portion of their lives in the action area of the Columbia River (see Sections 1.3.1 and 2.1 for a definition of the action

area). These species include 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU. The 2001 BA prepared for the ESA consultation and the 2002 Biological Opinions are included as Exhibit H (Corps website) to the Final SEIS. The ESUs and DPSs addressed in the 2001/2002 ESA consultations are listed in Table S6-4. The 2001 BA and 2002 Biological Opinions include extensive information regarding the environmental conditions pertaining to these listed species and formerly designated critical habitat.[2]

Table S6-4. Federally Listed Salmonid ESUs/DPSs in the Action Area

Evolutionarily Significant Unit (ESU)	Status	Life History Type	Juvenile Life Stage in Lower Columbia River	Date Listed
Chinook salmon (*Oncorhynchus tshawytscha*)				
Snake River spring/summer	Threatened	Stream	Yearling +	4/22/92
Snake River fall	Threatened	Ocean	Subyearling	4/22/92
Lower Columbia River	Threatened	Ocean	Subyearling	3/24/99
Upper Columbia River spring	Endangered	Stream	Yearling +	3/24/99
Upper Willamette River	Threatened	Ocean	Subyearling +	3/24/99
Chum salmon (*Oncorhynchus keta*)				
Columbia River	Threatened	Ocean	Subyearling	3/25/99
Sockeye salmon (*Oncorhynchus nerka*)				
Snake River	Endangered	Stream	Yearling +	11/2/91
Steelhead trout (*Oncorhynchus mykiss*)				
Snake River	Threatened	Stream	Yearling +	8/18/97
Lower Columbia River	Threatened	Stream	Yearling +	3/19/98
Middle Columbia River	Threatened	Stream	Yearling +	3/25/99
Upper Columbia River	Endangered	Stream	Yearling +	8/18/97
Upper Willamette River	Threatened	Stream	Yearling +	3/25/99
Coho salmon *(Oncorhynchus kisutch)*				
Lower Columbia River/Southwest Washington	Candidate	Stream	Yearling +	7/25/95
Distinct Population Segments (DPS)				
Bull trout (*Salvelinus confluentus*)				
Columbia River	Threatened	Trout	Yearling +	6/10/98
Cutthroat trout (*Oncorhynchus clarki clarki*)				
Southwest Washington/Columbia River	Proposed Threatened*	Trout	Yearling +	10/25/99

*On July 5, 2002, USFWS withdrew its proposal to list cutthroat trout as threatened. 65 *Federal Register* 44934.

[2] Although NOAA Fisheries had formally designated critical habitat for salmonid species under its jurisdiction, the designations have since been withdrawn by the agency. Nevertheless, potential impacts of the project on the formerly designated critical habitat were analyzed in the 2001 Biological Assessment and 2002 NOAA Fisheries Biological Opinion. USFWS has not yet formally designated critical habitat for bull trout.

The 2001 BA (Exhibit H on the Corps' website) provides detailed information and environmental analyses for a number of topics relevant to the conservation of threatened and endangered salmonids. NOAA Fisheries and USFWS adopted much of this analysis in their 2002 no-jeopardy Biological Opinions. Summary information and analyses are provided in the following sections at the ecosystem pathway level as described in the conceptual model (habitat-forming processes, habitat types, habitat primary productivity, food web, growth, and survival). The effects discussed in the BA and Biological Opinions for individual ecosystem indicators are linked to this larger ecosystem scale by addressing how these effects might change the ecosystem pathways.

Effects on Pathways

This section addresses the specific effects of the project on the respective indicators at a broader ecological level of analysis (ecosystem pathways).

Habitat Forming Process Pathway

Potential changes to the seven individual ecosystem indicators (suspended sediment, bedload, woody debris, turbidity, salinity, accretion/erosion, and bathymetry) that are important to forming the three primary habitats (tidal marsh and swamp, shallow water and flats, water column) for juvenile salmonids in the lower Columbia River were identified and analyzed as follows.

- There will be short-term, localized increases in suspended sediment concentrations in the immediate vicinity of dredging and disposal operations. There may be as much as a 4.5% increase in the total suspended sediment load in the lower Columbia River as a result of dredging and disposal from the project. Increased suspended sediment levels would tend to improve habitat-forming processes in the estuary by providing additional materials to form tidal marsh and swamp habitat. However, the increased suspended sediment load is likely too small to have a measurable effect on habitat-forming processes.

- The project may temporarily shift the direction of bedload movement along the sides of the navigation channel as a result of side-slope adjustments, which may cause erosion at some previous beach nourishment sites. This process will take 5-10 years and would not affect water column or tidal marsh/swamp habitats. Over that time, shallow water and flats habitat at six historical shoreline disposal sites will tend to move shorewards into former areas of artificial beach that have slowly eroded. All of the shoreline sites have been used in the past for dredge disposal. Two of the six historical disposal sites, Sand Island (CRM 86.2) and Miller Sands Spit (CRM 22.5), would be used throughout the life of the project. Because the bedload transport rate during maintenance sideslope adjustment would occur at the same rate at which normal bedload transport would occur without the project (just in a different direction), the quantity and quality of shallow water and flats habitat is expected to remain constant in the river and estuary reaches.

- There will be short-term, localized increases in turbidity levels in the immediate vicinity of dredging and disposal operations. Short-term localized turbidity levels of 5-26 NTUs that could be caused by the project are not likely to produce detectable effects on plant growth in the lower river. Not only is the amount of increase too low, but it also will be localized to the immediate areas where dredging and disposal occurs. The highest levels of turbidity would occur in deep water and sandy beach areas that are not suitable salmonid habitat.

- Salinity increases of less than 0.5 ppt in the shallow embayments of the estuary (Cathlamet and Grays Bays) would occur. Salinity increases up to 5 ppt would occur in the bottom of the navigation channel. The computed differences in modeling between base and with project conditions for salinity in shallow areas are much smaller than natural temporal variations due to normal variations in freshwater flow and tidal dynamics. Differences computed for the channel bottom are increases up to 5 ppt. This will not affect habitat-forming processes in any of the three primary habitat types.

- The salinity wedge could potentially be shifted upstream (up to 1 mile), resulting in a possible shift in the ETM location. The potential ETM shift would occur in a relatively small part of the south channel. It would generally remain within the current range or path of the ETM, with up to a 1-mile shift in the upstream boundary. This change is smaller than the existing daily fluctuations caused by flow conditions. The ETM suspends nutrients in the estuary, which are then distributed by tides and currents in the river system. Any fluctuation in the location of the ETM that may result from the project is not expected to affect the tidal influences and currents that distribute nutrients throughout the estuary. The effect of the potential ETM shift on distribution of nutrients in the estuary is expected to be so small that it cannot be measured.

- Bathymetric changes will include up to 3 feet of deepening in areas of the navigation channel that are currently shallower than -48 feet CRD and some rise in the riverbed at shoreline and flowlane disposal sites. Also, there is a potential for 0-3 feet of deepening along the side slopes adjacent to the dredge cuts. Water surface elevation could be affected between CRM 80-146. The decrease could be as much as 0.18 foot (approximately 2 inches) at the upstream end of the project, which is not anticipated to affect habitat-forming processes. The 3-foot lowering of the channel bathymetry will occur in 56% of the navigation channel, which is not expected to directly impair habitat-forming processes because the water depth increase is limited to the channel and will add 3 feet to water column type habitat. Flowlane disposal occurs in water column habitat and will not have an effect on habitat-forming processes for any of the habitat types. Habitat opportunity, as defined by Bottom et al. (2001), considers water depth and velocity conditions that provide favorable habitat for juvenile salmonids. Using this definition, physical modeling results are nearly identical for the base and with-project conditions, which indicates that the project will not have an impact on habitat opportunity as it relates to water depth in the estuary. Shoreline disposal will occur in areas where salmonid habitat is not present and will not affect habitat-forming processes.

Therefore, modeling performed for the project, as well as the analysis provided during the ESA consultation process, indicates that there will not be a significant effect on habitat-forming processes as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Habitat Types Pathway

Potential changes to the three primary habitat types for juvenile salmonids in the lower Columbia River (tidal marsh and swamp, shallow water and flats, water column habitat) were identified and analyzed as follows.

- Side-slope adjustments may cause a shift in the location of shallow water habitat-forming processes in areas where the navigation channel is adjacent to previous shoreline disposal sites. Shoreline disposal could potentially disturb and shift the location of shallow water habitat at the three proposed disposal sites: Sand Island, Miller Sands Spit, and Skamokawa Beach. While the three sites have the potential to affect salmonid habitat areas, an assessment of the sites concluded that they do not contain many of the important habitat features used by salmonids for rearing, such as low velocity, vegetation, and food sources. These areas likely provide a corridor for migrating salmonids and, consequently, there is some potential effect from the project.

- Water column habitat will be directly affected by the increased depth (about 3 feet) of the water column within a portion of the navigation channel in the action area.

- Drilling and blasting actions (blasting is needed to remove about 50,500 cubic yards of rock (see Table S1-1) at Warrior Rock near St. Helens may affect water column habitat. Blasting will be done during the preferred in-water work window when salmonid abundance is lowest and will minimize impacts to listed stocks. The blasting plan will be designed to further minimize any impacts by keeping over pressures above the blast zone to less than 10 pounds per square inch. This level is generally believed by NOAA Fisheries to be below the level at which salmonids would be adversely affected. A state approved plan for blasting will be developed to further minimize impacts. Based on the above, the potential impacts to water column habitat would be minimized.

- Water clarity may be reduced temporarily in very localized areas by the action of the dredge head on the bottom of the navigation channel and by flowlane disposal of dredged material.

- Proposed dredging timelines are consistent with the Biological Opinion for maintenance dredging because dredging occurs in areas where salmon are not present at depths greater than 20 feet. Dredging and disposal during construction will be conducted over a 2-year period in selected areas of the channel. Although this is outside of the normal November 1 through February 28 in-water work period, it is not anticipated to have significant effects on listed salmonids. Salmonids normally do not occur to any extent in

the areas being dredged or the disposal sites (except the three shoreline sites). Juvenile salmonids normally migrate along the channel margins using the side slopes as structure. They occur primarily at depths less than 20 feet and should not be affected by dredging and disposal operations. Although they can occur near the three shoreline disposal sites, these sites are highly erosive and do not provide much, if any, habitat. Therefore, potential impacts associated with project timing would be minimized.

Therefore, the analysis provided during the ESA consultation indicates that there will be no measurable effects on the primary habitat types as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Habitat Primary Productivity Pathway

Potential changes to the six factors (light, nutrients, imported and resident phytoplankton production, benthic algae production, and tidal marsh/swamp production) that are important to primary productivity within salmonid habitat were identified and analyzed as follows.

- Short-term reductions in light may result in localized, short-term reductions in photosynthesis by benthic plants and phytoplankton. However, these changes likely will not be of sufficient duration to result in a loss of vegetation or measurable biomass production. The ephemeral and transient nature of the project activities suggests that a reduction in light penetration would occur for only very short periods of time. In addition, the reductions will occur primarily in deep-water areas that do not support large amounts of vegetation other than phytoplankton.

- Change in salinity intrusion may affect the location of resident phytoplankton productivity, the location where imported freshwater phytoplankton contact intolerable salinity extremes, and the location of benthic algae productivity. These productivity changes are anticipated to be undetectable. No change in type or quantity of imported phytoplankton within the system is anticipated. In addition, while resident phytoplankton will expand its range in correlation with any upstream expansion of salinity, this effect on phytoplankton will not be measurable because the upstream expansion of salinity is not anticipated to be measurable. There may be a small upstream expansion of benthic algae production, but this is difficult to determine because a myriad of diatom species that make up the flora are euryhaline. None of these slight changes would have a measurable effect on primary productivity within the system.

Therefore, the analysis provided during the ESA consultation indicates that there will be no measurable effects on habitat primary productivity as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Food Web Pathway

Potential changes in eight relevant components (deposit feeders, mobile macroinvertebrates, insects, suspension/deposit feeders, suspension feeders, tidal marsh macrodetritus, and resident/imported microdetritus) of the food web in the lower Columbia River were identified and analyzed as follows.

- Limited removal and burying of deposit feeders, suspension/deposit feeders, and suspension feeders will occur in portions of the navigation channel and deep water areas. Removal and burial effects on these organisms are expected to be relatively short-lived, with dredge and disposal areas being recolonized post-construction. These organisms occur in low densities in the navigation channel because the sand waves create unstable habitat conditions. In these and other areas of the river, densities fluctuate as a result of constantly changing environmental conditions. No changes to these organisms are anticipated in shallow water areas, side channels, or embayments, which are the important locations for salmonid feeding opportunities. The Corps' monitoring program includes a post-project survey of ecosystem conditions that addresses these organisms in shallow water areas.

- Dredging and disposal actions will result in loss of adult and juvenile mobile macroinvertebrates. Although some mortality of mobile macroinvertebrates by dredging and disposal operations will occur, this mortality is expected to have an insignificant effect on overall populations in either the estuary or the river mouth. Mobile macroinvertebrates are adapted to respond rapidly to disturbances and to recolonize areas following these disturbances. Mobile macroinvertebrates can be an important food item for salmonids in estuaries. Changes in mobile macroinvertebrate populations resulting from project actions are not anticipated to affect the salmonid food web.

- There may be a slight upstream shift in the ETM, which would be accompanied by a slight shift in the focus of resident and imported microdetritus food web input.

Therefore, the analysis provided during the ESA consultation indicates that there will be no significant effects on the food web as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Growth Pathway

No potential changes were identified to the six factors (habitat complexity, connectivity and conveyance; velocity field; bathymetry and turbidity; feeding habitat opportunity; refugia; and habitat-specific food availability) that can influence the growth of salmonids.

Survival Pathway

Eight factors were identified that can influence the survival of salmonids (contaminants, disease, suspended solids, stranding, temperature and salinity extremes, turbidity, predation, and entrainment). The following potential change to these factors was identified and analyzed as follows:

- A turbidity plume associated with dredging and disposal activities could increase salmonid predation. Increases in suspended sediments are likely to be very localized in deeper water and sandy shoreline areas and will be of short duration. For juvenile salmonids, the turbidity increase is unlikely to affect survival because juveniles do not use these areas.

Additional analysis of available sediment quality data relating to Columbia River dredging was conducted as part of the SEI and reconsultation process, and is presented in Appendix B of the Biological Assessment (Exhibit H on the Corps' website). Further information was also provided to the NOAA Fisheries and the USFWS on sediment quality in the Corps April 22, 2002 BA amendment letter. This information is provided in Exhibit H (on Corps website). The NOAA Fisheries and USFWS concluded that the estimated risk of exposure of ESA-listed salmonids and bull trout from contaminated sediments from project activities was limited (see NOAA Fisheries and USFWS Biological Opinions in Exhibit H). Further, they support implementation of the Corps' contaminant monitoring and evaluation activities proposed in the 2001 BA and have these included activities in the mandatory terms and conditions of the Biological Opinions.

Also, the Corps analyzed whether the increase in channel depth would result in larger vessel sizes and/or load capacity, which could result in increased vessel speed, larger wake, and increase juvenile salmon stranding (Exhibit K-3, *Evaluation Report Fish Stranding*). A 2001 analysis of whether the deeper draft ships will produce larger waves in a deeper channel indicates that little, if any, change in wave size is expected (Hermans, SEI Presentation, 2001). Hermans analyzed several mechanisms by which ships generate waves. The analysis found that for deep-draft vessels the most important wave mechanism in the Columbia River would be the primary or "suction" wave generation. This mechanism depends on the "blockage" ratio, which is the ratio of the cross-sectional area of the ship to that of the channel. Given the proposed increase in channel depth and the expected increase in vessel draft, the ratio changes very little. The blockage ratio of a 43-foot draft vessel in a 43-foot channel is only 1% to 5% higher than that of a 40-foot draft vessel in a 40-foot channel. However, for the much more numerous smaller ships that would not increase their draft, there would be a slight decrease (in the range of 1% to 5%) in the blockage ratio with the deeper channel. Therefore, while 43-foot draft ships may generate slightly larger wakes than occur now, this would be offset by most ships producing slightly smaller wakes. As a result, the overall changes in wave size caused by the deeper channel are negligible.

In addition to the deeper channel not causing increased wave sizes, the project is also not expected to cause more frequent waves. While the proposed channel improvements would increase the efficiency of river commerce, it is not anticipated to increase the volume of river traffic. Accordingly, there is no expectation of more frequent ship wake instances occurring as a result of the channel improvements and the channel improvement project is not expected to have a significant change in the stranding of juvenile salmonids.

Therefore, the analysis indicates that there will be no measurable effects on survival of salmonids as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Potential Short-term Effects

The conceptual model was used to evaluate how identified effects to the ecosystem (as determined from the pathways analysis) may affect the listed and candidate salmonid species (short-term effects). It also addressed potential effects on the Columbia River ecosystem over the 50-year life of the project (long-term effects). The following are the potential short-term effects that have been identified through application of the model.

- There may be a temporary loss of shallow water habitat associated with dredge material disposal at three shoreline disposal sites. One shoreline disposal site is located in the riverine reach at Sand Island (O-86.2). The site is a beach nourishment site intended for disposal during both construction and maintenance dredging. Two shoreline disposal sites are located in the estuarine portion of the action area, Miller Sands Spit in the estuary at O-23.5 and Skamokawa Beach at W-33.4. A narrow band of shallow water will be affected by disposal at these shoreline disposal sites. However, because there is so little actual habitat within the potential disturbance areas for the three disposal sites, there is very little potential for actual effects on salmonids. The proposed compliance actions are anticipated to be adequate to prevent effects on listed species. Monitoring will be performed to ensure that this conclusion is accurate.

- Drilling and blasting activities may affect water column habitat. The compliance actions associated with drilling and blasting activities are anticipated to be adequate to prevent effects on listed species. Monitoring will be performed to ensure that this conclusion is accurate. If monitoring identifies impacts to listed species, then appropriate compensation will be negotiated with NOAA Fisheries and USFWS.

- Proposed dredging timelines are consistent with the Biological Opinion for maintenance dredging. In addition, dredging will occur in areas that salmonids do not use at depths greater than 20 feet. The compliance actions associated with project timing are anticipated to be adequate to prevent effects on listed species. Monitoring will be performed to ensure that this conclusion is accurate. If monitoring identifies impacts, then appropriate compensation will be negotiated with NOAA Fisheries and USFWS.

Potential Long-term Effects

During the ESA consultation process, concerns were identified regarding potential long-term effects of the project. These have centered on minor changes that may be caused by project actions that are not detectable in the short term, but may affect listed salmonid habitat over the next 50 years. This also could include ecosystem effects that are not identifiable, given the current understanding of the ecosystem. Areas for which concern has been expressed during the ESA consultation include those related to the ETM, formation and preservation of tidal marsh and swamp habitats, habitat opportunity changes in isolated geographic areas, and elimination of connectivity between habitats for juvenile salmonids.

None of the identified potential effects are anticipated to measurably affect salmonids; however, there is uncertainty associated with ecosystem processes that warrant implementing specific impact minimization, monitoring, and evaluation actions. Table S6-5 presents a summary of the risks and uncertainties associated with the assessment of effects for the project identified by the SEI panel of independent scientists and the BRT, which is made up of federal agency representatives (NOAA Fisheries, USFWS and Corps).

Ecosystem evaluation also is being proposed that is aimed at advancing the knowledge base for the recovery of the listed salmonids. Table S4-7 outlines the proposed ecosystem evaluation activities. This evaluation may result in identification of effects that are not currently understood, given the current knowledge of the ecosystem. The proposed monitoring actions and compliance actions for the channel improvement project are discussed in the following sections.

Monitoring Actions

The monitoring actions proposed for the project will help to ensure that the conclusions of the project analysis regarding minor effects on habitat and individuals are correct. The monitoring actions are for indicators where the levels of uncertainty and risk from project effects warrant gathering additional information. It should be noted that these levels of risk were not high enough to alter the conclusions concerning the effects on the listed and candidate salmonid species, but are still of a level to warrant verification through monitoring. This includes potential effects on indicators related to potential for take of individuals of the listed and candidate salmonid species, as well as their habitat. Monitoring actions are summarized in Table S6-6. The contents of Table S6-6 include conceptual model indicator(s) addressed by each monitoring action; description of the monitoring task to be implemented; technical justification for each of the monitoring tasks; relative uncertainty and risk from project effects identified by the Corps, NOAA Fisheries, and USFWS and the analysis for each of the indicator(s); duration of the monitoring proposed for each task; and analysis of monitoring data for each monitoring task.

Compliance Actions

Compliance actions are those actions that will be taken during the implementation of project actions to avoid or minimize potential effects on listed and candidate salmonid species. These compliance measures prescribe safeguards, techniques, and guidelines that will be followed to avoid or minimize take. Tables S6-7 and S6-8 address BMPs for project disposal and dredging actions, as well as timing restrictions associated with these actions. Further, the Corps proposes to use compliance actions identified in these tables to ensure the project minimizes or avoids take of individual listed or candidate salmonid species or their habitat.

These compliance actions have been developed over time through the Corps' dredging program, and they are considered to represent the best management practices for dredging and disposal to minimize any adverse effect to listed species or their habitat. These actions will be monitored by onsite inspection under established quality assurance processes. If the inspection identifies new information that potentially warrants a change, it will be reported to the AMT for consideration of changes to the compliance measures.

Table S6-5. Risk and Uncertainty Conceptual Framework

Pathway	Indicator	Uncertainty	Risk
Habitat-Forming Processes	Suspended sediment	L Lots of available data Empirical method	L Sensitivity very low No to small change
	Bedload (main channel)	M Limited data Empirical equation	L Sensitivity low Change none
	Woody Debris	H No data Professional judgment	L+ Sensitivity low to medium No change
	Turbidity	M+ Limited data Judgment, conceptual model	L Sensitivity low Small change
	Salinity	L Limited to abundant data Strong scientific methods	L+ Sensitivity moderate Small change
	Accretion/erosion (shallows)	M Limited data Empirical	L Sensitivity low No to small change
	Bathymetry (channel)	L Abundant data Models strong scientific method	M- Sensitivity low Measurable change
Habitat Type	Tidal marsh and swamp habitat	M Limited data Conceptual model	L+ Sensitivity moderate No to small change
	Shallow water and flats habitat	M Limited data Empirical	M-L+ Sensitivity moderate to high Small change
	Water column habitat	M Limited data Judgment and empirical	L Sensitivity low None to small change
Habitat Primary Productivity	Light	M Limited data Conceptual model	L Sensitivity low No change
	Nutrients	M+ Limited data Professional judgment	L Sensitivity low No to small change
	Imported phytoplankton production	M Limited data Professional judgment	L Sensitivity low Small change
	Resident phytoplankton production	M Limited data Professional judgment	L Sensitivity low Small change
	Benthic algae production	H Limited data Professional judgment	L+ Sensitivity low No to small change
	Tidal marsh and swamp production	M Limited data Conceptual model	L+ Medium sensitivity No to small change

Pathway	Indicator	Uncertainty	Risk
Food Web	Deposit feeders (channel bottom)	M Limited data Conceptual model	L Sensitivity low Small change
	Deposit feeders (side channels)	M Limited information Judgment-empirical Conceptual model	M Sensitivity medium No to measurable change
	Mobile macro-invertebrates	M Limited data Judgment-empirical	L Sensitivity low No change
	Insects (side channel, tidal marsh)	H None to limited data Judgment	M Sensitivity medium Small change
	Suspension/deposit feeders	M Limited information Judgment - empirical Conceptual model	M Sensitivity medium Measurable change
	Suspension feeders (side channel)	M Limited information Judgment - empirical Conceptual model	M Sensitivity medium No to measurable change
	Tidal marsh macrodetritus	H No available data Professional judgment	L+ Sensitivity medium Small change
	Resident microdetritus	H No available data Professional judgment	L+ Sensitivity low Small change
	Imported microdetritus	M Limited data Empirical	L+ Sensitivity medium No change
Growth	Habitat complexity, connectivity, and conveyance	L+ Limited data Strong scientific methods	M Sensitivity high No to small change
	Velocity field	L Limited data Modeled data 2x	L Sensitivity low No to measurable change
	Bathymetry and turbidity	H Limited data to no data Professional judgment	M Sensitivity medium to high No to little change
	Feeding habitat opportunity	L Limited data Some modeling	L+ Sensitivity medium to high No to little change
	Refugia	L Limited data Conceptual model	L+ Sensitivity High No change
	Habitat-specific food availability	M No to little data Conceptual model	M Sensitivity high Small change

Pathway	Indicator	Uncertainty	Risk
Survival	Contaminants	M Lots of data/limited Empirical methods/professional judgment	M Medium sensitivity Change measurable
	Disease	L Much data Some empirical	M- Sensitivity high No change
	Suspended solids	L Lots of data Empirical method	L Sensitivity very low No to small change
	Stranding	L Much data Empirical method	M Sensitivity high Small change
	Temperature and salinity extremes	L+ Some data Modeling temp. data literature	M Sensitivity high No to small change
	Turbidity	M+ Limited data Judgment Conceptual Model	L Sensitivity low Small change
	Predation	M Limited data Some studies	M Sensitivity high No to low change
	Entrainment	L Abundant data Empirical method	M Sensitivity high No change

Key: H = high; M = medium; L = low.

Table S6-6. ESA Section 7(a)(2) Monitoring Actions for Dredging and Disposal

Monitor Action No.	Indicator	Monitoring Task	Justification	Uncertainty and Risk[1]	Duration	Data Analysis	Trigger for Management Changes
MA-1	Salinity, velocity, water surface, habitat complexity, connectivity, and conveyance, and habitat opportunity.	The Corps will maintain 3 hydraulic monitoring stations, 1 downstream of Astoria, 1 in Grays Bay, and 1 in Cathlamet Bay. Parameters measured include salinity, water surface, and water temperature.	Physical changes related to channel deepening are expected to be small and concentrated near the navigation channel.	Salinity L, L+; velocity L, L; bathymetry L, M-habitat complexity, connectivity, and conveyance L+, M	7 years: 2 years before, 2 years during, and 3 years after construction	An analysis conducted to determine pre- and post-project relationships among flow, tide, salinity, water surface, and temperature.	Post-project data exceeds defined threshold values. Determine if task should continue and appropriate funding source.
MA-2	Dredging volume, bedload.	Annual dredging volumes, construction and O&M.	To ensure scale of the project does not change.	Bedload M, L	Life of the project.	Actual volumes will be compared to predicted.	Dredging volumes exceed capacity of the disposal plan.
MA-3	Accretion-erosion, bathymetry (main channel).	Main channel bathymetric surveys throughout project area.	Side-slope adjustments expected to occur intermittently adjacent to the navigation channel.	Accretion/erosion M, L bathymetry L, M-	7 years: 2 years before, 2 years during, and 3 years after construction	Bathymetric changes will be tracked to determine if habitat is altered.	Habitat alteration in main channel due to side-slope adjustment.
MA-4	Tidal marsh, swamp, flats, refugia, habitat complexity, connectivity & conveyance, suspension-deposit feeders, insects, macrodetritus and habitat specific food availability, juvenile salmonids in peripheral habitats/habitat opportunity.	Repeat estuary habitat surveys being conducted by NOAA Fisheries (Bottom and Gore 2001 proposal).	Identify if there is a change to habitat due to deepening.	Tidal marsh and swamp habitat M, L+; flats habitat M, M-L+; suspension-deposit feeders M, M; deposit feeders M, M; suspension feeders M, M; insects H, M: macrodetritus H, L+; habitat-specific food availability M, M; feeding habitat opportunity L, L+	One time survey conducted 3 years after completion of the deepening.	Habitat mapping from aerial photos and ground surveys.	Changes to individual habitat types that are based on defined threshold values. Determine need for other surveys.

Monitor Action No.	Indicator	Monitoring Task	Justification	Uncertainty and Risk[1]	Duration	Data Analysis	Trigger for Management Changes
MA-5	Contaminants	The Corps, USFWS and NOAA Fisheries will annually review any new sediment chemistry from the lower Columbia River and estuary from sources such as SEDQUAL database and known permit applicants and determine if there are any changes in the "Management Area Ranking" as defined in the DMEF manual.	Ensure that channel construction and maintenance do not disturb undetected deposits of fine-grained material, potentially causing redistribution of contaminants that pose a risk to salmonids and trout.	Contaminants M, M	2 years before construction, 2 years during construction, and annually during maintenance.	New sediment samples will be obtained in accordance with the DMEF manual and will be compared to the NOAA Fisheries guideline for the protection of salmon.	Any exceedance reported to the AMT to determine if consultation should be reinitiated. Corps, NOAA Fisheries, and USFWS will meet annually or as new circumstances arise to review new data showing changed condition that would trigger the need for additional sediment testing. Changed conditions include spills, new listing of chemicals, changes in guidelines or threshold values, or other indicators that suggest there is a reason that further testing may be required.
MA-6	Stranding	Monthly field surveys at selected beaches (upper, mid, and lower river) during April-August outmigration to measure if fish are being stranded.	Identify if there is a change in stranding due to deepening.	Stranding L, M.	One year before deepening and 1 year after deepening.	Compare pre- and post-project stranding counts.	If there is an increase in fish stranded, proposals would be developed and presented to decision makers.

[1] In this column L = low, M = medium, and H = high. A + sign means that the L, M, or H is of higher concern; a - sign means that the L, M, or H is of lower concern. The first L, M, or H after the indicator is the factor identified for uncertainty; the second L, M, or H after each indicator is the factor identified for risk. These factors were identified by the Corps, Sponsor Ports, NOAA Fisheries, and USFWS.

Table S6-7. Minimization Practices and Best Management Practices for Dredging

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
Hopper Dredging					
CA-1	Entrainment (survival) Benthic Invertebrates Deposit Feeders	Maintain dragheads in the substrate or no more than 3 feet off of the bottom with the dredge pumps running.	This restriction minimizes or eliminates entrainment of juvenile salmonids during normal dredging operations.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
CA-2	Habitat Complexity Bathymetry & Turbidity Feeding Habitat Opportunity Suspension-Deposit Feeders Deposit Feeders Mobile Macroinvertebrates	Dredge in shallow water areas (less than 20 feet) only during the recommended ESA in-water work period for the Columbia River of November 1 until February 28.	Areas < 20 feet deep are considered salmonid migratory habitat. Dredging or disposal in these areas could delay migration or reduce/eliminate food sources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
Pipeline Dredging					
CA-3	Entrainment (survival) Benthic Invertebrates Deposit Feeders	Maintain cutterheads in the substrate or no more than 3 feet off of the bottom with dredge pumps running.	This restriction minimizes or eliminates entrainment of juvenile salmonids during normal dredging operations.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
CA-4	Habitat Complexity Bathymetry & Turbidity Feeding Habitat Opportunity Suspension-Deposit Feeders Deposit Feeders Mobile Macroinvertebrates	Dredge in shallow water areas (less than 20 feet) only during the recommended ESA in-water work period for the Columbia River of November 1 until February 28 and July 1 to Sept 15 for certain restoration features.	Areas less than 20 feet deep are considered salmonid migratory habitat. Dredging or disposal in these areas could delay migration or reduce or eliminate food sources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
General Provisions for All Dredging					
CA-5	Contaminants Water Column Habitat	The contractor will not release any trash, garbage, oil, grease, chemicals, or other contaminants into the waterway.	Protect water resources.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored ad directed. Any in-water release will be immediately reported to the nearest Coast Guard Unit for appropriate response.
CA-6	NA	The contractor, where possible, will use or propose for use materials considered environmentally friendly in that waste from such materials is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, disposal will be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	Dispose of hazardous waste.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored as directed. Any in-water release will be immediately reported to the nearest U.S. Coast Guard Unit for appropriate response.

Table S6-8. Best Management Practices for Disposal

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
Flow Lane Disposal					
CA-7	Accretion/Erosion	Dispose of material in a manner that prevents mounding of the disposal material.	Spreading the material out will reduce the depth of the material on the bottom, which will reduce the impacts to fish and invertebrate populations.	Life of contract or action.	Maintain until new information becomes available that would warrant change.
CA-8	Bathymetry & Turbidity (Survival) Suspended Solids	Maintain discharge pipe of pipeline dredge at or below 20 feet of water depth during disposal. Exceptions are Miller-Pillar and Lois Island restoration features.	Reduces the impact of disposal and increased suspended sediment/turbidity to migrating juvenile salmonids; are believed to migrate in upper 20 feet of the water column.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Upland Disposal					
CA-9	Suspended Solids Turbidity (Survival) Bathymetry & Turbidity	Berm upland disposal sites to maximize the settling of fines in the runoff water.	This action reduces the potential for increasing suspended sediments and turbidity in the runoff water	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
CA-10	Habitat Complexity, Connectivity & Conveyance, Insects, Resident Macrodetritus, Microdetritus, Large Woody Debris	Maintain 300-foot habitat buffer for new upland disposal sites - Gateway 3 (W-101), Fazio B (W-96.9, interior ½) Mt. Solo (W-62) and Puget Island (W-44). Otherwise use existing dredged material disposal locations to avoid loss of non-impacted lands within ESA salmonid critical habitat zone.	Maintains important habitat functions.	Life of contract or action.	Maintain until new information becomes available that would warrant a change.
Shoreline Disposal					
CA-11	Habitat Complexity, Bathymetry & Turbidity, Feeding Habitat Opportunity, Suspension-Deposit Feeders, Deposit Feeders, Mobile Macroinvertebrates	Disposal of material in shoreline areas will be done concurrently with the dredging operation. Timing restrictions will be based on the dredging operation not the shoreline disposal operation. Only three erosive shoreline disposal areas are proposed - Sand Island (O-86.2), Skamokawa (W-33.4) and Miller Sands Spit (O-23.5).	Shoreline disposal sites are highly erosive and do not provide much, if any, juvenile salmonid habitat. Thus, it is not necessary to limit disposal actions to the in-water work period even though it is a shallow water area.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
CA-12	Stranding	Grade disposal site to a slope of 10% to 15%, with no swales, to reduce the possibility of stranding juvenile salmonids.	Ungraded slopes can provide conditions on the beach that creates small pools or flat slopes that strand juvenile salmonids when washed up by wave action.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Ocean Disposal					
CA-13	N A	Dispose of in accordance with the site management and monitoring plan, which calls for a point dump placement of any material from the project during construction. The plan is to place any construction material in the SW corner of the Deep Water Site.	This action minimizes conflicts with users and impacts to ocean resources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
General Provisions for All Disposal					
CA-14	N A	Dispose of hazardous waste.	The contractor, where possible, will use/propose materials that are environmentally friendly in that their waste is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, material disposal will be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored as directed. Any in-water discharge will be immediately reported the nearest U.S. Coast Guard Unit for appropriate response.

Adaptive Management

The AMT was established to provide input to evaluation and monitoring results and then render management decisions on adapting project implementation actions to counter or negate adverse effects. The AMT and proposed monitoring actions are intended to validate the conclusions of the 2001 BA, help minimize take of listed species, and ensure that proposed activities will not jeopardize listed species or adversely modify designated critical habitat [ESA Section 7(a)(2)]. The proposed monitoring plan, on which the AMT will rely for appropriate data, will monitor to address uncertainty and risk related to potential project effects over the long term and to validate assumptions used in analyzing project effects. The Biological Opinions specified that the adaptive management process would conform with NOAA Fisheries guidance found in *Federal Register* July 1, 2000. The draft implementation plan was transmitted to the Services on December 18, 2002. When finalized, the plan will be posted to the Corps' website.

The adaptive management process will include input from the tribes, state resource agencies and interested stakeholder groups. The meetings will be semi-annual and open to the public; evaluation proposals, results and decisions will be posted to the Corps' website. The input provided by the Columbia River Inter-Tribal Fish Commission, the tribes and the states will be considered in making recommendations to the adaptive management workgroup. The AMT is prepared to meet with the Columbia River Inter-Tribal Fish Commission, member tribes, and the states to discuss areas of concern before making decisions.

The Corps intends to have a process separate from the ESA adaptive management process for state issues related to water quality and coastal zone authorities because these issues are much broader. This process has been proposed and recently discussed with WDOE, ODEQ, Oregon Department of Land Conservation and Development, and USEPA as an adaptive management process to deal with 401 and CZMA concerns with both states, and to discuss both the channel improvement project and the MCR project from a regulatory perspective.

6.7.1.2. [new] ESA Consultation Process Results for the Ecosystem Restoration Features

The 2001 BA determined that the new ecosystem restoration features might have a short term adverse effect on salmonids but that over the long term would benefit these species by: (1) providing shallow water and intertidal marsh habitat, (2) increasing connectivity and complexity, (3) provide rearing habitat for ocean-type salmonids, (4) increase detrital export, (5) maintain native tidal marsh plant communities, (6) increase benthic invertebrate productivity, (7) increase access/egress for ocean-type salmonids, and (8) improve access for adult salmonids to headwaters for spawning (for a more detailed discussion, see Exhibit H on the Corps' website).

6.7.1.3. [new] Biological Opinions for the Final SEIS

On May 20, 2002, the NOAA Fisheries and USFWS transmitted their final Biological Opinions to the Corps (see Exhibit H on Corps' website). These opinions determined that the channel improvement project, including dredging, disposal, operation and maintenance, monitoring, adaptive management, evaluation, and ecosystem restoration, is not likely to jeopardize the continued existence of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, one candidate ESU, bald eagles, or Columbian white-tailed deer. Also, NOAA Fisheries concurred that the project is not likely to adversely affect northern (Steller) sea lions. The main findings of the Biological Opinions are summarized below.

- Direct impacts to listed fish could occur during dredging, disposal, and blasting activities. Fish could be pumped into dredges, thereby causing injury or death. Fish could be harmed by dumping of dredged sediments, as these materials could smother food items, create turbidity in the water, or release contaminants into the ecosystem. Removal of a single, deep-water rock formation would require underwater blasting, which could injure or kill fish.

- Indirect impacts to fish habitat, especially shallow water marshes and swamps, could occur during dredging and disposal. Changes to river and estuary currents (velocity), changes in water depth, and changes in ocean saltwater flow into the estuary could impact fish habitats.

- Protective measures that will minimize and avoid direct impacts to listed fish will be implemented. Monitoring and dredging restrictions, including keeping the dredge "cutterhead" in the river bottom where fish don't occur, will ensure fish are not pumped into dredges. Blasting restrictions, including timing restrictions and minimizing the 'blast zone" will avoid impacts to fish. Disposing of dredged materials may create adverse turbidity effects for fish, but turbidity "plumes" will be minimized by disposal of materials into deeper water areas that have fewer fish. Some fish prey will be harmed by disposal of materials.

- Computer models indicate that the project's indirect impacts to Columbia River and estuary water depth and velocity will mainly occur in the navigation channel, not in important marsh and swamp habitats. These predicted habitat changes in the navigation channel are small, and will have limited impacts to listed fish. Limited shallow water and shoreline habitat will be eroded; however, these habitats do not currently provide important listed fish habitat. The models do indicate that ocean salt water will extend farther into the estuary than currently. Salt water extension will occur in the deep-water navigation channel, and the regulatory agencies believe this salt water extension will not impact listed fish, fish prey, or important marsh and swamp habitats.

- Contaminants samples collected in the navigation channel, where project dredging will occur, have not exceeded current USEPA or NOAA Fisheries contaminant thresholds. The science panel carefully reviewed all available information on contaminants and

project impacts to fish from these chemicals. As a result of these contaminants analyses, the two regulatory agencies have determined it unlikely that the project will risk the health and survival of listed species.

- Careful monitoring of long-term changes to shallow water beaches, marshes, and other important fish habitat features will occur. The monitoring actions will track project impacts and ensure that unanticipated effects can be rapidly addressed. An adaptive management team will be charged with altering or stopping the project, should any unforeseen impacts be discovered.

- These limited impacts, and the long-term monitoring and adaptive management programs, indicate the project will not jeopardize listed fish species. The project will not adversely modify or destroy critical habitat for salmonids.[3]

- Restoration and evaluation actions are integral components of the project. The ecosystem restoration features will restore 2,204 acres of tidal marsh habitat (Lois Island embayment, Miller-Pillar and Tenasillahe long-term, Phase 3); 177 acres of side-channel habitat (Bachelor Slough and Tenasillahe interim, Phase 1); 335 acres of embayment habitat (Lord-Walker/Hump-Fisher); 52 acres of riparian forest habitat (Bachelor Slough); 650 acres (Cottonwood/Howard Islands, Phase 2) for Columbian white-tailed deer reintroduction; provide for 470-839 acres (Shillapoo Lake) wetland management; purple loosestrife control in tidal marsh habitat between CRM 18-52; and will make available 38 miles of currently inaccessible salmonid habitat (tidegate retrofits).

Both Biological Opinions also contain Incidental Take Statements, which include mandatory terms and conditions. The terms and conditions implement and make enforceable the monitoring and compliance actions discussed above. They also provide additional detail regarding the adaptive management process, reporting, and other reasonable and prudent measures to minimize take of listed species.

On November 14, 2002, the USFWS proposed to designate critical habitat for threatened bull trout in the Columbia River Basin. Critical habitat is proposed for the Mainstem Columbia River Critical Habitat Unit, from the MCR (CRM 0) to Chief Joseph Dam (CRM 545). This proposed critical habitat unit includes the Columbia River within the channel improvement project action area. Section 7(a)(4) of the ESA requires, when critical habitat is proposed, that federal agencies to confer with the Service on any action which is likely to adversely modify or destroy proposed critical habitat.

The proposed Mainstem Columbia River Critical Habitat Unit serves as a migration corridor, provides foraging habitat, and is an overwintering area for bull trout. Three primary constituent elements are provided by the Columbia River to bull trout in the project

[3] As noted previously, although NOAA Fisheries had formally designated critical habitat for salmonid species under its jurisdiction, the designations have since been withdrawn by the agency. Nevertheless, potential impacts of the project on the formerly designated critical habitat were analyzed in the 2001 BA and 2002 Biological Opinion. The USFWS has not yet formally designated critical habitat for bull trout.

area: water quality, migratory corridor, and an abundant food supply. The Corps believes that, based on the extensive analysis found in the Corps' 2001 BA and the USFWS's 2002 Biological Opinion, the project will not adversely modify or destroy proposed critical habitat in the action area. Therefore, no additional conferencing is necessary. Upon finalization of the bull trout critical habitat rule, and if the Columbia River within the project's action area is formally designated as critical habitat, the Corps will reinitiate ESA consultation with the USFWS. The AMT will remain updated on the USFWS's progress in finalizing the critical habitat rule, and ensure that coordination between the Corps and the USFWS continues.

6.7.2. revised Wildlife Species

The following updated information is being added to this subsection for the Final SEIS. Impacts to terrestrial species under USFWS jurisdiction for dredging, disposal, operation and maintenance and the three original ecosystem restoration features (Shillapoo Lake, tidegate retrofits and enhanced embayment circulation) and Miller-Pillar were addressed in the 1999 BA to the USFWS for the channel improvement project (1999 Final IFR/EIS, Exhibit G) and in the Final SEIS. Those determinations are incorporated by reference. New and updated information in this section relates to the potential effects of the new ecosystem restoration features on threatened and endangered wildlife species.

Project impacts to marine mammals and sea turtles were addressed in the BA for the DMMP (Corps 1998) and in the 1999 Final IFR/EIS. The conclusion of "no effect" from that BA also applies to the new ecosystem restoration features and evaluation actions, and is incorporated by reference.

Ten USFWS listed terrestrial species (Columbian white-tailed deer, bald eagle, marbled murrelet, western snowy plover, brown pelican, Oregon silverspot butterfly, Howellia, golden paintbrush, Bradshaw's lomatium, and Nelson's checkermallow) occur in the general project area for the new ecosystem restoration features. For detailed information on these species, see the BAs and Biological Opinions previously published for the DMMP (Corps 1998) and the 1999 Final IFR/EIS. Two species, the peregrine falcon and the Aleutian Canada goose, have been delisted since the 1999 Final IFR/EIS was completed and are not addressed in this Final SEIS.

Seven of the 10 species listed above and under USFWS purview (marbled murrelet, western snowy plover, Oregon silverspot butterfly, Howellia, golden paintbrush, Bradshaw's lomatium, and Nelson's checkermallow) do not occur in the areas identified for the new ecosystem restoration features and evaluation actions or were addressed in the previous BA (Exhibit G of the 1999 Final IFR/EIS). Therefore, it is the Corps' determination that there will be "no effect" to these seven species from the five new proposed ecosystem restoration features and the evaluation actions set forth in the 2001 BA. The new ecosystem restoration features and evaluation actions would have no effect on hump-backed, right, fin, sei, blue, or sperm whales, or on Pacific leatherback, loggerhead, green, or Pacific Ridley sea turtles. These species do not occur in the area for these restoration features or evaluation actions.

Potential impacts for Columbian white-tailed deer, brown pelicans, and bald eagles associated with the new ecosystem restoration features and evaluation actions are addressed in Chapter 8 of the 2001 BA for the channel improvement project (also see Exhibit H and the USFWS Biological Opinion on the Corps' website).

Implementation of the Tenasillahe Island interim ecosystem restoration feature may affect, but is not likely to adversely affect, Columbian white-tailed deer. The long-term restoration feature at Tenasillahe Island was determined to have no effect on Columbia white-tailed deer as implementation of the feature is contingent upon the species being delisted. The Lois Island embayment, purple loosestrife control, Cottonwood-Howard Island Columbian white-tailed deer reintroduction, and Bachelor Slough ecosystem restoration features may affect but are not likely to adversely affect bald eagles. Long term, the ecosystem restoration features are generally expected to be beneficial to bald eagles. Implementation of the Lois Island embayment, purple loosestrife control, Miller-Pillar, Tenasillahe Island interim and long-term actions, Lord-Walker and Hump-Fisher embayments, and Bachelor Slough ecosystem restoration features may affect, but are not likely to adversely affect Northern sea lions. Other ESA-listed species that may occur in the project area were determined not to be affected by implementation of the ecosystem restoration features.

As noted above, on May 20, 2002, the USFWS transmitted its final Biological Opinion to the Corps. This opinion, together with the 1999 USFWS Biological Opinion, determined that the channel improvement project, including dredging, disposal, monitoring, adaptive management evaluation, and all ecosystem restoration features, is not likely to jeopardize the continued existence of bald eagles or Columbian white-tailed deer.

The 2002 USFWS Biological Opinion also contains updated Incidental Take Statements for bald eagles and Columbian white-tailed deer. The updated Incidental Take Statements include mandatory terms and conditions to minimize take of listed species. Some of the benefits afforded to wildlife species associated with ecosystem restoration features include establishing secure viable sub-populations of Columbian white-tailed deer, and providing increased waterfowl, shore bird, wading bird, and raptor habitat.

The Corps will implement four terms and conditions outlined in the USFWS's Biological Opinion to monitor contaminants and bald eagle productivity. These terms and conditions represent an extremely conservative approach to assess the situation. Isaacs and Anthony (2002) provide detailed information on the breeding bald eagle population and their reproductive success for Recovery Zone 10, the lower Columbia River, from 1973 to present. Total breeding territories surveyed in 1973 was one; for 2002, that number increased to 95 of which 89 (94%) were occupied. Young/occupied territory in 2002 was 1.02. The 5-year average for young/occupied territory in Recovery Zone 10 has increased from 0.77 in 1998 to 0.92 in 2002. The habitat management goal for Recovery Zone 10 is 47 bald eagle territories, and the recovery population goal is 31 territories (USFWS 1986, *Pacific Bald Eagle Recovery Plan*). Present data demonstrates these goals have been substantially surpassed. As discussed elsewhere in the Final SEIS, the channel improvement project will not increase contaminant loading in the lower Columbia River; therefore, no impact to these species would be expected.

The following information on state-listed threatened or endangered species (sandhill cranes and lower Columbia River coho) has been added in response to comments on the Draft SEIS.

Sandhill crane use occurs in the Vancouver Lowlands and the species does occur in the vicinity of disposal site W-101.0 during fall and spring migration. They would be expected to utilize waste grain at these locations, provided tillage operations post-harvest of cereal grain or silage corn, the predominant crops grown there, has not eliminated the waste grain. Their use of the location is generally dependent upon crop grown and tillage operations implemented. Foraging for invertebrates such as earthworms may occur on tilled lands.

The Corps has reviewed the Final Washington State *Sandhill Crane Recovery Plan* and determined that the channel improvement project, including the proposed wildlife mitigation, is consistent with the final plan. The Corps will only use a 40-acre disposal site in the Columbia Gateway property. The wildlife habitat value of the property has been determined and wildlife mitigation efforts will be implemented at the Woodland Bottoms mitigation site. Mitigation at Woodland Bottoms will include 132 acres in long-term pasture and 97 acres in wetland habitat that will benefit sandhill cranes. As discussed above, the mitigation plan for the project assessed the habitat value of the W-101 disposal site and more than compensates for any impact to it. The wildlife mitigation plan provides for securing lands and habitat development in Woodland Bottoms which is documented by WDFW in their final sandhill crane recovery plan as lands used by this crane population. Given the extensive array and acreage of State Wildlife Management Areas (Sauvie Island, Oregon, approximately 12,000 acres; Shillapoo Lake, Washington, 2,371 acres; and Ridgefield National Wildlife Refuge, 5,150 acres) in the area, plus private agricultural lands, and the full mitigation effort for this project, it is not anticipated that the project would adversely affect sandhill cranes. Further, should the Port of Vancouver's independent Columbia Gateway development be implemented, the Port of Vancouver will develop mitigation measures for their project-related impacts.

Lower Columbia River native coho salmon listed as endangered under the State's ESA spawn in small, relatively low gradient tributaries in the lower Columbia River. Juveniles rear in these tributaries for two years before migrating to the ocean. Adult coho return to spawn as three year olds. Lower Columbia River coho are predominately of hatchery origin, with only the Clackamas and Sandy Rivers still having wild runs. Most of the coho juveniles in the channel improvement project area are of hatchery origin and are released from mainstream and tributary hatcheries as smolts. Coho juveniles are considered stream type since most of their rearing occurs in the tributary areas. Consequently, the analysis of the impacts to federally listed stocks with stream type juveniles by the channel improvement project consultation would apply for coho as well. In addition, all the monitoring and restoration actions proposed for the federally listed stocks would be beneficial for juvenile coho as well. Adult coho return in the same time frame as federally listed stocks of adult fall chinook and would use the same habitat. Consequently, the assessment done for adult fall chinook would be applicable for coho. As a result, the BA and Biological Opinions prepared

for the channel improvement project for the federally listed stocks in the Columbia River is considered adequate for the assessment of impacts to lower Columbia River coho.

In that assessment, the Corps and Services developed a conceptual model of the lower Columbia River ecosystem relationships that are significant for salmonids. This model also applies to lower Columbia River coho. Because the habitat requirements of adult salmonids are limited in the lower Columbia River, the model focuses on juvenile salmonids. The conceptual model incorporates the best available science for adult and juvenile salmonids. The basic habitat-forming processes-physical forces of the ocean and river-create the conditions that define habitats. The habitat types, in turn, provide an opportunity for the primary plant production that gives rise to complicated food webs. All of these pathways combine to influence the growth and survival and, ultimately, the production and ocean entry of juvenile salmonids moving through the lower Columbia River.

The conceptual model also demonstrates that the project complies with the Survival Guidelines in ORC 635-100-135. Specifically, the analysis demonstrates that the project should not degrade water quality, reduce stream flows, affect gravel in spawning areas, or adversely affect riparian habitat. The ESA analysis, including the conceptual model, demonstrates that the project and any incidental take associated with it will not adversely impact the long term conservation of lower Columbia River coho or its habitat, or significantly decrease the likelihood that the fish will recover. The ESA analysis also demonstrates that the project complies with the Survival Guidelines in ORC 635-100-135. Specifically, the analysis demonstrates that the project should not degrade water quality, reduce stream flows, effect gravel in spawning areas, adversely affect riparian habitat, or impair fish migration.

Although none of the changes identified in the conceptual model from the channel improvement project are believed to have a measurable effect on existing habitat types, the Corps is proposing to implement compliance measures to ensure effects will be minimized and will also monitor to confirm this conclusion. In addition, proposed ecosystem restoration and evaluation actions will benefit lower Columbia River coho. Based on the above, the project will not have a significant effect on native lower Columbia River coho.

The following information on mink and river otter has been added in response to comments on the Draft SEIS

Henny et al. (1996) evaluated mink and river otter populations on the lower Columbia River (CRM 11-119.5) and the influence of environmental contaminants. They conducted a population estimate for river otter and estimated 286 individuals comprised the population along the lower Columbia River. No population estimates were derived for mink, although Henny et al. (1996) states that the population is extremely low. Conversely, a habitat suitability evaluation they conducted for the lower Columbia River indicated that habitat was excellent in many segments. They determined that a number of organochlorine and polychlorinated biphenyls were significantly higher in river otter from the lower Columbia River than a Coast Range reference population. Henny et al. (1996) noted that these

contaminants were rarely correlated with CRM for age class 0 otters, never correlated for age class 1 otters, and almost always correlated with age 2+ otters. Low residue concentrations may explain the result for age 0 otters. Age 1 otters are dispersing from their natal areas and thus may confuse the issue. Adults (age 2+) are relatively sedentary in their home range. Their spatial information showed that river otter collected at CRM 119.5 typically contained the highest concentration of contaminants. The author's considered this to be the Portland-Vancouver area when in actuality it corresponds to Camas-Washougal, Washington. As discussed elsewhere in the Final SEIS, the channel improvement project will not increase contaminant loading in the lower Columbia River; therefore, no impact to these species would be expected.

6.8. Socio-Economic Resources

6.8.1. revised Economic Impacts

For the Final SEIS, the following information is added to this subsection. As discussed in Section 4.5.1.3, the ecosystem restoration features at Lois Island embayment and Miller-Pillar will impact commercial fishermen. A net-pen program and associated select area fishery have been established at Tongue Point. Restoration at Lois Island embayment would reduce the available acreage for commercial fishing by 191 acres or roughly 19% of the select area fishery acreage base at Tongue Point. The restoration feature would create intertidal marsh and intertidal flats habitat, which is not conducive to commercial fishing as compared to the uniform depth, open water area that currently exists.

Implementation of the Miller-Pillar restoration feature would eliminate 14% of the Miller Sands drift acreage base for drift net (gill and/or tangle net) fishing. The construction of the pile dike field plus development of tidal marsh habitat at Miller-Pillar would preclude commercial fishing activity at this location. Long term, the proposed restoration features are intended to aid the recovery, and ultimately assist in the delisting of Columbia River ESA-listed ESUs.

The reintroduction of Columbian white-tailed deer to Cottonwood-Howard Island is intended to assist development of another secure and viable population of this species. The feature would assist attainment of the Columbian white-tailed deer recovery plan goals and objectives, and aid efforts to delist this species. The Tenasillahe Island long-term feature, which is dependent on delisting of Columbian white-tailed deer, would provide a substantial acreage base for habitat restoration for ESA salmonids and many wildlife species. This would contribute to the delisting of ESA listed salmonids and aid in the reduction of socio-economic constraints associated with listed species.

Two identified project actions could affect the Dungeness crab population, dredging and disposal. As discussed in Section 6.6.1.2, dredging impacts to crab are anticipated to be small. The crab population in the estuary is only part of the total crab population in the area. Current entrainment evaluation indicates that the loss to the fishery during construction would be between 44,342 and 7,252 crabs (the increment associated with channel

improvement project is 26,285 crabs and 3,347 crabs) and between 8,953 and 4,035 crabs annually from maintenance. These losses compare to the average annual commercial harvest of 5.3 million adult crabs in the Washington and Oregon region around the Columbia River. Therefore, the project is not anticipated to adversely affect the crab fishery.

Under the preferred option, construction material from CRM 3-29 would be used for creation of tidal marsh habitat at the Lois Island embayment restoration feature. Dredged material would be placed in a temporary sump between CRM 18-20 in and adjacent to the southern boundary of the navigation channel. Crab populations at the temporary sump are expected to be low because water conditions do not meet the crabs' required salinity range. Additionally, with implementation of the preferred option, no dredged material would be placed in the ocean. Post-construction of the Lois Island ecosystem restoration feature, maintenance material would be used to create the Miller-Pillar ecosystem restoration feature and also be disposed at locations currently used for 40-foot channel maintenance (Rice Island, Miller Sands Spit, Pillar Rock Island, flowlane).

6.8.2. revised Land Use

The following updated information is being added to this subsection for the Final SEIS. However, no updating of the existing information in subsections 6.8.2.1 to 6.8.2.4, and subsections 6.8.3 through 6.8.5 and 6.8.7 is necessary because the new ecosystem restoration features and the revised disposal plan (with reduced dredging volumes, reduced rock removal volumes, reduced ocean disposal, reduced upland disposal site acreage, and reduced impacts on agricultural land, riparian habitat and wetland habitat) would have less impact on land use, air quality, noise, aesthetics, and cultural resources than would the alternatives analyzed in the 1999 Final IFR/EIS.

The ecosystem restoration features outlined in the 2001 BA will not result in any significant land use changes. Restoration features at Lois Island embayment and Miller-Pillar will result in the restoration of tidal marsh and intertidal flats habitat in areas presently 18-30 feet deep. No land use change is associated with the purple loosestrife control program. The interim and long-term features at Tenasillahe Island, Bachelor Slough, and Shillapoo Lake will occur on USFWS refuge lands or on a WDFW wildlife management area (Shillapoo) and will result in changes in management prescriptions. However, land use will still be directed toward fish and wildlife management. Tidegate retrofits for salmon passage and the improved embayment circulation at Walker-Lord and Hump-Fisher Island complexes would not impact land use practices at these locations. Reintroduction of Columbian white-tailed deer to Cottonwood and Howard Islands, given purchase of these islands by the Sponsor Ports, would not alter land use at these locations.

Additional information regarding consistency with land use requirements is provided in Exhibit K-8, *Consistency with Critical Areas Ordinances including Wetland Mitigation* and Exhibit K-9, *Consistency with Washington Local Shoreline Master Programs*.

6.9. revised Secondary Impacts

For the Final SEIS, the following updated information is being added to this subsection. Section 4.6.3 of the 1999 Final IFR/EIS and this Final SEIS identify the berthing areas that will require deepening to benefit from the project.

Deepening the federal navigation channel could result in future modification to other berthing areas and non-Corps side channels that are not part of the authorized federal project. The effects of this type of future activity are covered in the 1999 Final IFR/EIS. Further, development of any non-Corps side channels would be subject to regulatory review and approval under the Clean Water Act, Section 10 of the Rivers and Harbors Act of 1899, ESA, and NEPA.

In the 1999 Final IFR/EIS, there was an inconsistency that showed berths at the Ports of Astoria and Longview had dredged volumes of 46,500 cubic yards and 28,000 cubic yards, respectively. These berths are not expected to be deepened as a result of the project.

Current information indicates that the U.S. Gypsum sheetrock facility (formerly Port of St. Helens) near Rainier, Oregon will require berth deepening to benefit from channel deepening. Impacts from deepening at this site are anticipated to be similar to those expected for deepening other berths, as analyzed in the 1999 Final IFR/EIS. Any such deepening will be subject to additional environmental review and permitting, including additional sediment sampling, under NEPA, the Clean Water Act, and ESA prior to implementation.

6.10. revised Mitigation

The following information is being added to this section for the Final SEIS. However, no updating of the existing information in subsections 6.10.1, 6.10.2, or 6.10.2.1 is necessary (see the Final IFR/EIS, August 1999).

The Corps and the resource agencies have met and further coordinated since the issuance of the Draft SEIS. As a result, the Corps has modified the final mitigation plan. Exhibit K-5, *Wildlife and Wetland Mitigation*, includes a mitigation plan that provides further information regarding the creation of the mitigation sites. The plan concludes that the mitigation ratio for wetland impacts (approximately 12:1) significantly exceeds the ratio required under local and state requirements. Exhibit K-8, *Consistency with Critical Areas Ordinances Including Wetland Mitigation*, also contains a more detailed draft wetland mitigation plan for proposed Washington wetland mitigation projects (Woodland Bottoms and Martin Island).

The following changes to the project are likely to affect the conclusions in the habitat evaluation procedure (HEP) analysis used to develop the mitigation plan:

- Reduction in impact to riparian forest from 67 acres to 50 acres (approximately 25%) due to reduced disposal at Lord Island (O-63.5).

- Reduction in impact to agricultural lands from 200 acres to 172 acres (approximately 14%) primarily due to the reduced disposal acreage required at the Gateway site (W-101) and Mt. Solo (W-62).
- Reduction in impact to wetlands from 20 acres to 16 acres (approximately 20%) due to a reduction at the Mt. Solo site resulting from correcting a mapping inconsistency.
- Reduction of the Martin Island embayment mitigation action from 32 acres to approximately 16 acres to address the comments received from the State of Washington and Cowlitz County.
- Modification to Woodland Bottoms wetland mitigation unit is planned via removal of levees along Burris Creek to affect a more natural hydrologic regime.

The Port of Portland has purchased 190 acres at the Webb location near Westport, Oregon. Seventy-four acres will be used for wildlife mitigation purposes. In the event Martin Island is acquired in its entirety, the Corps would be agreeable to discussing additional actions on the 80-acre parcel currently not included in the HEP analysis. If the entire balance of the island is not available and additional mitigation is required, then the Corps intends to develop additional mitigation acreage on the Webb Site.

6.10.2.2. revised Proposed (Sponsor's Preferred) Disposal Alternative

See the discussion in Section 6.10 and Exhibit K-5, *Wildlife and Wetland Mitigation*, concerning updated information for this alternative for the Final SEIS.

6.11. revised Unavoidable Adverse Impacts

The following updated information has been added for the Final SEIS. Deepening the navigation channel would impact benthic and fisheries habitats not previously disturbed by dredging. Additional impacts could occur because these volumes are higher than maintenance dredging, however, the overall volume of dredged materials has been reduced by 21% and rock removal has been reduced by 17% (dredged sand reduced from 18.4 mcy to 14.5 mcy; rock removal reduced from 590,000 cubic yards to 490,500 cubic yards). Disposal of dredged material would adversely affect additional in-water and upland areas, including 172 acres of agricultural land, 50 acres of riparian forest habitat, and 16 acres of wetlands. As described in the preceding section, these habitat losses would be replaced through mitigation actions. Additional tidal marsh and intertidal flats habitat, wetlands, and riparian habitat would be restored through the proposed ecosystem restoration actions.

6.12. revised Cumulative Impacts

The following updated information has been added to this section for the Final SEIS. Cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

In accordance with the Council on Environmental Quality's guidance on cumulative effects, this analysis focuses primarily on effects that are truly meaningful, i.e., important issues of national, regional, or local significance. It is also focused on actions that potentially affect the same environmental resources as the channel improvement project, and on resources that have been historically affected by cumulative actions in the project area. A number of these important issues (e.g., impacts to wetlands) were identified in scoping undertaken for the 1999 Final IFR/EIS and in comments received by stakeholders and agencies on that document. This set of issues was refined as a result of the ESA consultation process, Washington's and Oregon's initial denial of Section 401 certification in 1999, and additional comments received on the Draft SEIS. Based on this iterative process of refinement, the cumulative impact analysis focuses on:

- water quality;
- sedimentation and sediment transport;
- sediment quality (in particular, toxic contamination);
- aquatic and wildlife resources (in particular, crab (including effects of ocean disposal), and wetland issues); and,
- threatened and endangered species (in particular, salmonids)

Certain past, present, and reasonably foreseeable future actions impact, or have the potential to impact, these environmental resources within the geographical area at issue for the project (see Chapter 2, *Study Area Description*). The identified actions are:

- operation and maintenance of the Mouth of the Columbia River Federal Navigation project (MCR);
- operation and maintenance, and potential deepening of the Willamette River navigation channel;
- operation and maintenance of the Upper Columbia-Snake River navigation channel project;
- operation and maintenance of the Federal Columbia River Power System (FCRPS);
- port, industrial, urban and agricultural development; and,
- large-scale restoration, recovery and remediation efforts.

Most of these actions are in the project's study area. The Upper Columbia-Snake River navigation channel is not in the study area, but is being reviewed specifically to respond to comments on the Draft SEIS.

This section is organized as follows. First, Subsection 6.12.1 summarizes the channel improvement project's impacts on each of the specified environmental elements. Next, Subsection 6.12.2 discusses past, present, and reasonably foreseeable actions, again with a focus on the selected environmental elements. A number of significant restoration, remediation, and recovery actions also are underway, or are reasonably foreseeable. They also are taken into account in the cumulative impact analysis. Finally, Subsection 6.12.3 evaluates the project's impacts, together with past, present, and future actions.

6.12.1 [new] Channel Improvement Project

The starting point in a cumulative impact analysis is a review of the potential impact of the proposed project. It is this impact that must be added to the impacts of other past, present, and reasonably foreseeable future actions. The potential impacts of the channel improvement project have now been well studied and documented. They are discussed in detail in the Corps' 1999 Final IFR/EIS, 2001 BA, and this Final SEIS, as well as in the NOAA Fisheries and USFWS Biological and Conference Opinions. They are briefly summarized below. References to the appropriate sections of the 1999 Final IFR/EIS and Final SEIS are provided.

Water Quality

Section 6.3 of this Final SEIS concludes that navigation channel dredging and in-water and ocean disposal would not result in significant water quality impacts.

Sedimentation and Sediment Transport

The potential impacts of the channel improvement project on sedimentation and sediment transport in the lower Columbia River, estuary and littoral cell have been updated in this Final SEIS. In general, they are expected to be indiscernibly small. Specifically, Exhibit J concludes that the project will not alter sand discharge to the Pacific Ocean. Accordingly, the project is not anticipated to affect coastal accretion or erosion (1999 Final IFR/EIS and Final SEIS at Section 6.2; Final SEIS, Exhibit J).

Sediment Quality

The channel improvement project will have no significant impact on sediment quality in the ocean, river or in the upland disposal sites. Review of thousands of samples indicates that sediments in the Columbia River portion of the navigation channel are primarily sand with a low percent organic content. They are suitable for unconfined in-water and upland disposal. Where contaminants have been detected, they are far below established levels of concern (i.e., DMEF, NOAA Fisheries). Accordingly, the dredging, disposal, and beneficial reuse of these sediments associated with the project (including ecosystem restoration features) is not anticipated to adversely affect sediment or water quality (1999 Final IFR/EIS and Final SEIS at Section 6.4).

Aquatic and Wildlife Resources

There is expected to be some crab entrainment caused by dredging as well as some impact associated with flowlane disposal in the lower estuary. Estimates of crab losses by direct measurement of entrainment are shown to be minimal [e.g., worst case total loss to the fishery from construction is 44,342 crabs (the increment associated with channel improvement project is 26,285 crabs), as compared with an annual harvest of 5.3 million crabs in the Washington and Oregon region around the Columbia River, the highest

projected annual loss to the fishery from maintenance dredging of 8,953 crabs]. Disposal impacts in the estuary and indirect effects are also expected to be minimal. Neither of these impacts from the channel improvement project is anticipated to have any significant effect on population structure or dynamics. Further, the Corps will use the salinity/crab distribution model to schedule dredging and disposal to avoid and minimize impacts to crab.

The preferred alternative for the channel improvement project shifts away from ocean disposal of dredged material for construction and the first 20 years of maintenance, as the dredged material previously planned for ocean disposal is currently planned to be beneficially used for two restoration features and placed in existing disposal sites (flowlane, Rice Island, Miller Sands Spit, Pillar Rock Island) in the estuary. Even if it should become necessary to dispose of material from the project in the ocean, the limited amount of material to be disposed as part of this project is not anticipated to have significant effects on crab populations in the Washington and Oregon region around the Columbia River (1999 Final IFR/EIS and Final SEIS at Section 6.6.1).

Dredging is not expected to have a significant impact on smelt spawning or distribution of smelt larvae in the main navigation channel. Disposal of dredged material in flowlane sites has the potential to bury juvenile sturgeon; however, in most normal disposal operations, sturgeon would likely escape burial. Disposal will cover the benthic invertebrates that sturgeon may use as a food supply. Loss of this food supply may reduce the value of these areas as rearing areas for sturgeon. Effects on sturgeon in deeper water areas are currently the subject of ongoing studies, which will be used, as necessary, to develop measures in consultation with state resource agencies to further avoid and minimize impacts to sturgeon (1999 Final IFR/EIS and Final SEIS at Section 6.6.1).

The ecosystem restoration features are neither expected to significantly impact crabs, nor to have any adverse impact on smelt due to their location relative to these resources. Construction of restoration features at Miller-Pillar and Lois Island embayment may initially impact sturgeon due to filling of the embayment and loss of benthic invertebrates. However, a net gain in overall estuarine productivity, including that for sturgeon, is anticipated (1999 Final IFR/EIS and Final SEIS at Section 6.6.1).

The project's potential wildlife impacts have been reduced since the 1999 Final IFR/EIS. The amount of habitat loss has been reduced (28 fewer acres of agricultural land affected, 17 fewer acres of riparian habitat affected, and 4 fewer acres of wetlands affected). There also has been a reduction in the total acreage of 29 upland disposal sites (i.e., exclusive of shoreline disposal sites and the Lonestar gravel pit), impacted by disposal actions (1,630 acres versus 1,681 acres; Final SEIS Section 6.2.3.1). Finally, under the preferred alternative, with beneficial reuse of dredged materials for construction of ecosystem restoration features at Lois Island embayment, Miller-Pillar, and other changes to the disposal plan, it is projected that ocean disposal should not be necessary for construction and the first 20 years of maintenance (1999 Final IFR/EIS and Final SEIS at Section 6.6.2).

Threatened and Endangered Species

After extensive analysis of the potential impacts of the channel improvement project, NOAA Fisheries and USFWS concluded that the project is not likely to jeopardize the continued existence of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU, or likely to destroy or adversely modify their designated critical habitat (2002 Biological Opinions). NOAA Fisheries and USFWS concluded that any expected impacts to key physical processes potentially affecting listed fish species would be limited and short-term in nature. They further concluded that there is some low level of risk and uncertainty surrounding the long-term biological response to physical change, but that monitoring and adaptive management will address the limited risk and uncertainties (Final SEIS Section 6.7.1). The project also is not likely to jeopardize the continued existence of bald eagles or Columbian white-tailed deer, and is not likely to adversely affect Steller sea lions (2002 Biological Opinions; 1999 Final IFR/EIS and Final SEIS at Section 6.7.2).

Sandhill cranes (state endangered) are present in the project area. The proposed 40-acre disposal site W-101.0 is within a larger area used by cranes during part of the year. The Corps' wildlife mitigation plan addresses the potential lost habitat value associated with use of this disposal site and more than compensates for the loss through the Woodland Bottoms mitigation site. The Corps has reviewed the Final Washington State *Sandhill Crane Recovery Plan* and determined that the channel improvement project, including the proposed mitigation, is consistent with the final plan. Mitigation at Woodland Bottoms will include 132 acres in long-term pasture and 97 acres in wetland habitat that will benefit sandhill cranes. Given the extensive array and acreage of State Wildlife Management Areas (Sauvie Island, Oregon, approximately 12,000 acres; Shillapoo Lake, Washington, 2,371 acres) and Ridgefield National Wildlife Refuge (5,150 acres) in the area, plus private agricultural lands, and the full mitigation effort for this project, it is not anticipated that the project would adversely affect sandhill cranes (1999 Final IFR/EIS and Final SEIS at Section 6.7.2).

Restoration and Mitigation Features

To accurately assess the impacts of the channel improvement project, it is necessary also to consider its positive effects, including the proposed ecosystem restoration component. The primary purpose of the proposed ecosystem restoration features is to restore habitats lost due to historic activities and to restore habitat conditions that would contribute to the recovery and long-term viability of listed fish species. These features also would provide benefit to many other species of fish and wildlife. In addition to the original ecosystem restoration features evaluated in the 1999 Final IFR/EIS, additional restoration features are proposed. Table S4-1 of the Final SEIS identifies acreage and stream miles provided by each restoration feature plus their type, function and value for fish and wildlife resources. The ecosystem restoration features added during ESA consultation represent an increment in the overall effort to address historic cumulative impacts to fish and wildlife habitat and resources in the study area (1999 Final IFR/EIS and Final SEIS at Section 6 generally).

Further, to the extent there are projected adverse effects to wildlife and wetlands, the channel improvement project includes a detailed mitigation plan to more than compensate for these effects. The mitigation plan was developed through a cooperative interagency process that included both state and federal resource managers. The mitigation plan involves development or substantial improvement to 194 acres of wetland habitat and 202 acres of riparian forest habitat, plus 132 acres of permanent pastureland. The wetland mitigation acreage represents about a 12-fold increase over projected losses, would result in a net gain of wetland habitat, and significantly exceeds the ratio typically required under local and state requirements. Riparian mitigation plans represent nearly a four-fold increase over projected losses and would also increase the riparian habitat acreage from existing levels (1999 Final IFR/EIS and Final SEIS at Section 6.10; 1999 Final IFR/EIS at Exhibit G; Final SEIS at Exhibit K-5).

6.12.2 new Past, Present, and Reasonably Foreseeable Future Actions

6.12.2.1 new Mouth of the Columbia River Federal Navigation Project

The Corps began dredging at the mouth of the Columbia River (MCR) in 1904. The MCR navigation project consists of a 0.5-mile wide navigation channel extending for about 6 miles through a jettied entrance between the Columbia River and the Pacific Ocean. The northerly 2,000 feet of the MCR channel is maintained at 55 feet (+5 feet for over-depth dredging), and the southerly 640 feet is maintained at 48 feet (+5 feet for over-depth dredging). The current MCR project refers to the Corps' ongoing dredging to maintain the Congressionally authorized MCR navigation channel, which has not changed substantially since 1984. The Corps removes 4-5 mcy of sand and sediment from the channel each year. There is no plan to deepen or otherwise change the Congressionally authorized MCR project at this time.

Historic MCR ocean disposal sites A, B, E and F have been used in their original USEPA-designated site dimensions since 1977 and in their expanded site dimensions since 1993 (sites A, B, F) and 1997 (site E). These sites were determined by USEPA (1991) to be inadequate to provide future capacity for the MCR project as well as the potentially deepened river navigation channel under study at the time. Site designation studies were conducted by USEPA and Corps, and two new ocean disposal sites selected for designation by USEPA (1999 Final IFR/EIS). A new in-water disposal site at the North Jetty was approved in 1999 for disposal of dredged material and to reduce erosion at the base of the jetty. In 2002, a proposal for placement of MCR maintenance material at Benson Beach was assessed. This site is within the surf zone of Benson Beach in Fort Canby State Park, north of the north jetty. The Corps Portland District provided dredged material to the "test project" that is sponsored by Pacific County under permit PN 200-2-001174 issued by the Seattle District, in order to determine the feasibility for addressing beach erosion. Approximately 44,000 cubic yards of MCR maintenance material was successfully placed at Benson Beach during the 2002 dredging season. The USEPA is currently initiating the designation for the Shallow Water Site (formerly expanded Site E) and a new Deep Water Site.

The baseline of the ongoing MCR project and its relationship to the channel improvement project study area is reflected in the assessment of existing conditions in the 1999 Final IFR/EIS (Section 5), Final SEIS (same) and 2001 BA (Chapter 2). A 1983 EIS (Corps 1983) addressed the MCR navigation channel and its maintenance. Information in the 1983 EIS has been updated through several environmental assessments. However, dredging practices have essentially remained the same since 1983.

The area off the MCR is a productive biological environment that is influenced by a variety of complex physical processes. The major short-term processes that affect the area are tides and local winds and currents. River flow also has a major seasonal impact on the area. The nearshore areas are subjected to high current and wave energy and populated by biological organisms adapted to this high-energy environment. The offshore area is less active and populated by organisms adapted to more stable environments (Corps 1999).

Bottom sediments at the proposed nearshore sites are primarily sand containing little or no silt or organic material. No rock or other unusual bottom features exist within the sites (Corps 1999). Baseline studies conducted at the Deep Water Site confirm that bottom sediments are primarily fine-grained sands, particularly within the smaller placement area. The percent fines increase with the increased distance from shore and with depth (Corps 1999; 1999 BA). Side scan sonar data from this site show that the surface is uniform and nearly featureless with little detectable differentiation in material type. The only apparent geomorphic feature within the surveyed area is a band of low relief seafloor undulations in the eastern portion of the site (Corps 1999; 1999 BA).

Previous studies have demonstrated that offshore biological communities exhibit considerable seasonal and yearly variation in structure and species composition. Species assemblages would likely vary between the proposed sites. Based on offshore area studies, the Deep Water Site would likely contain higher numbers and diversity of benthic species than nearshore areas (Corps 1999).

A variety of anadromous and resident fish occur within the Columbia River offshore area. Occurrence of adult migratory species in the offshore area is correlated primarily with their period of upstream migration. Juvenile migratory species are present following their migration out of the estuary. Resident species occur throughout the year with many using the estuary and nearshore area for rearing and as a nursery area. Species present include various flatfish, rockfish, and other demersal species (Corps 1999). Field reconnaissance at Benson Beach found evidence of clam populations, including razor clams. Dungeness crabs were also present within the area to be affected by disposal. The WDFW has stated that the Benson Beach area is too unstable to be a productive razor clam bed, juvenile rockfish, flatfish, or lingcod settling or rearing area, or baitfish spawning area. For the same reason, Dungeness crabs are rarely, if ever, found in the surf zone on this beach (Burkle 2000, personal communication).

Almost all of the Columbia River offshore area experiences some type of commercial fishing activity. The major fisheries are for bottom fish, salmon, crab, and other species of

shellfish. Crab fishing occurs from December to September with the majority of the catch occurring early in the season. Most crab fishing occurs north of the Columbia River mouth at depths ranging from 25 to 250 feet MSL. Dungeness crab population numbers are subject to large cyclic fluctuations in abundance. Catch records for the fishery are generally believed to represent actual population fluctuations. Modeling studies by Higgins et al. (1997) has shown that small scale environmental changes such as delay in the inshore currents in the Spring by a short period of time can dramatically impact survival of young of the year crab, but have no effect on adults and older juveniles inshore. Bottom fishing by trawl for flatfish, rockfish and pink shrimp occurs year-round throughout the entire offshore area, primarily at depths offshore from disposal sites. Commercial and recreational salmon fishing occurs over much of the offshore area. Fishing seasons and quotas are set by the Pacific Fisheries Management Council and state agencies (Corps 1999).

Federally listed threatened and endangered species which may occur in the offshore area include 15 wildlife species and 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU. Wildlife species potentially affected by the disposal actions include blue, fin, sei, right, hump-backed and sperm whales, northern (Steller) sea lion, Columbian white-tailed deer, loggerhead and Pacific leatherback sea turtles, brown pelican, marbled murrelet, western snowy plover, bald eagle, and Oregon silverspot butterfly. Adults and juveniles of the listed salmonid stocks are present in the lower river year-round. Biological Assessments have been prepared to address the likely presence of these species within the Columbia River estuary and offshore area and potential effects of the proposed disposal actions (Corps 1999; 1999 BA).

Environmental Impact Studies

A number of studies provide information about the evolution of the MCR project and its environmental impacts. Relevant studies are identified in this section. The next section contains a discussion of the results of these studies.

Physical and biological resources of the Columbia River offshore area have been investigated since the mid 1970s, including recent site monitoring and evaluation studies conducted by the Portland District Corps for ocean disposal sites. Information from these studies is included in the 1999 Final EIS/IFR, in subsequent baseline studies for the Deep Water Site (Corps 1999; 1999 BA), and in this Final SEIS (Exhibit N, *Physical and Biological Studies of the Deep Water and Shallow Water Sites*). Although the Congress has authorized the channel improvement project and the MCR project as two separate projects, the Corps and USEPA have, where appropriate, coordinated the review of relevant impacts. For example, the 1999 IFR/EIS reviews the long-term disposal plan and its impacts for both the channel improvement and MCR. Similarly, crab entrainment studies conducted in 2002 reviewed impacts from both projects.

Concerns over possible entrainment of Dungeness crabs, salmon and other fish have been addressed by separate studies, such as *Entrainment of Dungeness Crabs by Hopper Dredge at the Mouth of the Columbia River, Oregon and Washington* (Larson 1993) and *Entrainment of Outmigrating Fish by Hopper Dredge at the Columbia River and Oregon*

Coastal Sites (R2 Resource Consultants, Inc. 1999). Recent studies of the impacts of dredging and disposal to Dungeness crabs include: initial estimates of crab entrainment during dredging (Pacific International Engineering, 2002 using the Dredge Impact Model of Armstrong et al. 1987 and Wainwright et al. 1992); statistical analysis of historic data to develop a rigorous sampling design for determining entrainment rates in the Columbia River; assessment of population level entrainment impacts (Pearson et al. 2003); and salinity-crab distribution model to estimate the portion of the estuarine crab population vulnerable to dredging (Pearson et al. 2003).

Findings of No Significant Impact (based on Environmental Assessments) were made in relation to the expansion of existing sites (1993 and 1997) and the development of new disposal sites (North Jetty Site, 1999; Benson Beach in May 2002). The Benson Beach Finding of No Significant Impact noted that Benson Beach could be used in conjunction with existing ocean disposal sites A, F, expanded Site E and the North Jetty disposal site. Although these existing sites were not the subject of the Benson Beach Environmental Assessment, use of the existing sites and the channel dredging was addressed by reference.

In early 2002, the Corps issued a *Statement of Findings* regarding maintenance dredging of the MCR (*Statement of Findings Maintenance Dredging at Mouth of the Columbia River*, May 2002). The proposed action was the maintenance dredging of approximately 4-5 mcy of material annually and the disposal of it in nearby designated offshore sites, and potentially at the Benson Beach demonstration site. The *Statement of Findings* is effective for five concurrent dredging years. The *Statement of Findings* referred to the *Environmental Assessment Maintenance Dredging at the Mouth of the Columbia River New Disposal Site Oregon-Washington*, May 2002 (Benson Beach Environmental Assessment); *Section 404(b)(1) Evaluation Columbia River at the Mouth Channel Maintenance New Disposal Site*, May 2002; and *Finding of No Significant Impact, Maintenance Dredging at the Mouth of the Columbia River New Disposal Site Oregon-Washington*, May 2002. The MCR project's specific effects on coastal erosion were considered in a 2002 study annexed to this channel improvement Final SEIS (Exhibit J).

Environmental Impact Findings

Water Quality

Dredging in the Mouth of the Columbia River will disturb bottom sediments. The States of Washington and Oregon most recently certified that this activity complied with state water quality standards on April 22, 2002. This certification documents that the MCR maintenance dredging does not have significant adverse impacts to water quality.

Sedimentation and Sediment Transport

Exhibit J, a 2002 study on sedimentation, found that the reduction in the Columbia River's net sand discharge to the MCR since the early 1900s is related to lower Columbia River flood discharges and not the navigation channel or the MCR jetties (Final SEIS, Exhibit J).

Declines in the Columbia River's average annual sand transport are related to global climate variations and upstream flow regulation. The reduced sand flow from the river has contributed to the reduction in sand accretion in the estuary, and the MCR jetties (constructed in the early 1900s) have reduced sand transport from the MCR into Baker Bay and across Clatsop Spit into the south channel caused by ocean waves. However, the jetties caused a large discharge of sand from the MCR and vicinity, to the ocean. The sand which was eroded from the inlet and south flank of the inlet following jetty construction has deposited in the outer delta, on Peacock Spit, and the shorelines along Long Beach, Washington, and Clatsop Plains, Oregon. Excluding the historic effect of the MCR jetties, navigation channel development and maintenance, including maintenance of the MCR project, has not altered the estuary's overall accretion/erosion or bedload transport patterns.

The 1983 MCR assessment concluded that material placed in disposal sites A, B and F was not expected to leave the general vicinity, and material from site E was expected to move mostly north and northwest with a smaller volume moving to the south and southeast depending upon waves and tidal conditions (Corps 1983). The area of shoaling was expected to move farther into the estuary. *Id*. Greater stratification and increased salinity intrusion was predicted to occur in the estuary, a slightly larger introduction of ocean water during flood tides was expected, but no problems with ship generated waves were anticipated. *Id.*

Placement of dredged material at Benson Beach is a demonstration project to determine its feasibility as a long-term disposal alternative that contributes sand to the littoral system. If effective, placement of dredged material at Benson Beach could help reduce the need for ocean disposal in the future (Benson Beach Environmental Assessment).

Sediment Quality

The material dredged for MCR maintenance is similar to that to be dredged for the channel improvement project, and similarly, does not raise significant concerns regarding contaminants. Material to be dredged from the MCR was evaluated in conjunction with the 1983 EIS (evaluation under Section 103, Marine Protection, Research and Sanctuaries Act, Appendix D, 1983 EIS) and has been reassessed periodically by the Corps and EPA. Periodic reassessment and characterization as needed would occur pursuant to the DMEF. Pollution levels of MCR sediments were generally low, and disposal of dredged material was predicted to have no adverse effect on the biota in the immediate vicinity. The sediments are in an area of high current and wave action, large bedload movement and shifting bars and are distant from significant sources of pollution. They also generally contain very low levels of organic materials and fine sediments.

Aquatic and Wildlife Resources

Preliminary data (Pearson et al. 2003) resulting from entrainment studies conducted aboard the *Essayons* hopper dredge from July 9 through October 13, 2002 showed that dredging of the MCR in 2002 (consisting of approximately 2.7 mcy) resulted in entrainment rates of 0.06 crab per cubic yard and were separated by age class: 0^+ (0.003), 1^+ (0.014), 2^+ (0.032),

and 3^+ (0.010). Entrained crabs were counted by age class and sex, and predicted adult equivalent losses were calculated. These calculations employed a modified version of Wainwright et al. 1992 (see Pearson et al. 2003). The data predicts how many crabs at a given age class would be lost to the fishery in the future based on numbers of crabs of various age classes entrained and how many of those crabs would have been expected to survive to a given age class based on known natural survival rates. Pearson et al. (2003) estimated adult equivalent losses at age 2^+ of approximately 108,000 crabs and at age 3^+ of approximately 49,000 crabs. The number of male recruits lost to the fishery was estimated at approximately 6,000 crabs. These calculations were based on sampling within an approximately 3 month period during the dredging season of one year, but abundance by age class can vary by year and by season (McCabe et al. 1986) and may explain differences in observed entrainment rates among studies.

Regarding macroinvertebrates and fishes, benthic communities disturbed by dredging are expected to recolonize the area (Corps 1983). Increased estuary salinities predicted from the 1984 deepening of the MCR project were expected to cause an upstream shift of marine habitat and marine species but the extent of change could not be predicted at that time. *Id*. However, now that the project had been deepened, future maintenance dredging of the existing MCR project is not anticipated to result in any further change in the salinity regime of the estuary. A loss of benthic organisms and a reduction of overall productivity are also expected as a result of material being placed in disposal areas. *Id*. Temporary turbidity is anticipated but is not expected to have a significant adverse effect on fish and other aquatic life forms (*Statement of Findings* 2002).

Fisheries (from Disposal at the Deep Water and Shallow Water Sites)

Fine sand (0.25 mm diameter) falls at about 6 feet per minute through water, which approximates the descent rate of the disposal material (Corps 1983). Therefore, dredged material would completely reach the bottom of the Shallow Water Site in about 10 minutes and the Deep Water Site in about 35 minutes. The natural sediment transport rate at the Shallow Water Site is high, moving mostly to the north and northwest (Corps 1983). Resuspension of disposed material is unlikely at the Deep Water Site once the material has settled to the bottom. Material placed in the Deep Water Site would likely remain in place or move very slowly. Sediment transport analysis conducted in the offshore area indicate that sediment movement through the Deep Water Site location is in dynamic equilibrium, i.e., rates of erosion and accretion are essentially equal (Corps 1999). Dredged material placed at the Deep Water Site would be coarser than sediments existing at the site but would contain similar chemical constituents (Corps 1999; 1999 BA). Previous studies at offshore sites demonstrate that ambient sediment covers the dredged material within about 1 year (Corps 1999). Little turbidity is expected from disposal of these sediments.

Benthic organisms within the disposal sites would be subjected to burial. Most benthic organisms would not likely survive burial from the disposal action. Recolonization of the site would be expected after disposal stopped. Demersal fish and shellfish would either avoid the disposal activity or be buried. Studies conducted by Chang and Levings (1978)

and the Corps (1999) on crab and flatfish burial from dredged material disposal concluded that test dumps had no apparent adverse effects on flatfish but resulted in some mortality to crabs. The tests resulted in no obvious physical damage such as cracked carapaces or detached legs. Most crabs remained on the surface following the test dumps. All but a few crabs that were buried during the test disposal were found dead after 72 to 96 hours. The cause of death was not apparent from the tests. These studies were conducted under limited conditions, i.e., small buckets or tanks, and are not conclusive relative to burial response under actual disposal conditions in the open sea. Portland District Corps biologists believe that survival rates of crabs from disposal in the open sea would be high (Corps 1999).

Preliminary data (MEC Analytical Systems 2002, unpublished progress report) show that in late spring/early summer of 2002, trappable crabs (trapped using crab pots) were more abundant, smaller, and had softer carapaces in the Shallow Water Site than in the Deep Water Site. The majority of crabs trapped at both sites were female. In fall of 2002, trappable crabs were more abundant and had harder carapaces in the Shallow Water Site than in the Deep Water Site, but were similar in size. The majority of crabs trapped at the Shallow Water Site were females and at the Deep Water Site were males. Crabs, in general, were more abundant and larger in fall than in late spring/early summer. Preliminary numerical data is presented below:

Site	Season	# Crabs	Crab Density[1]	% Female	Size[2]
Shallow	sp/su	451	~25	~75	~5.1
Deep	sp/su	82	<2	~80	~5.5
Shallow	fall	852	~39	~69	~5.9
Deep	fall	1,313	~27	~10	~5.9

[1] Crab density measured in crabs per pot per 24-hour soak
[2] Crab size (carapace length) measured in inches

Two crab pot-sampling locations were located in what is now the 103 portion of the Deep Water Site in fall of 2002 (48 hour deployment of traps). A total of 124 crabs were trapped in these two sites and about 79% were males. These numbers do not appear aberrant compared to other sampling locations within the Deep Water Site, but data has not been analyzed yet.

The most abundant commercially important fish caught (via otter trawl) during both late spring/early summer and fall of 2002 at the Shallow Water Site included tom cod (228 caught in late spring/early summer and 45 caught in late summer) and eulachon (356 caught in late spring/early summer and 788 caught in late summer) and at the Deep Water Site included Pacific sanddab (1,072 caught in late spring/early summer and 249 caught in late summer) and rex sole (168 caught in late spring/early summer and 228 caught in late summer).

On wildlife, adverse impacts are minimal for pelagic birds and nonexistent for waterfowl, shorebirds, and terrestrial birds and mammals (Corps 1983). Also, the maintenance dredging planned for the next 5 years will not impact any wetland areas (Statement of Findings 2002).

The dredging and disposal activities associated with MCR maintenance are nearly identical to the activities proposed for the channel improvement project. Accordingly, conclusions regarding the project's limited short-term effects on listed fish suggest similar limited effects from MCR maintenance. A 1990 salmon study concluded that migrating juvenile and adult salmon are not entrained during MCR dredging since the dragheads are at or slightly below the bottom surface (Larson and Moehl 1990). A further study in 1999 also suggests that dredging activities as currently practiced are not likely to entrain juvenile salmonids, including those listed under the ESA (*Entrainment of Outmigrating Fish by Hopper Dredge at the Columbia River and Oregon Coastal Sites* 1999). The MCR maintenance complies with the ESA (NOAA Fisheries, 1999 Biological Opinion). In the 1999 Biological Opinion, NOAA Fisheries concluded that operation and maintenance program for the Columbia River navigation channel, which includes the portion of the channel at the MCR, was not likely to jeopardize the continued existence of listed species.

Restoration and Mitigation

A current *Site Management/Monitoring Plan*, as required by the Marine Protection, Research, and Sanctuaries Act and jointly prepared by USEPA and the Corps, will govern use of the ocean disposal sites in the future. The *Site Management/Monitoring Plan* covers issues such as: the times, quantities, and physical/chemical characteristics of dredged material dumped at the sites; disposal controls, conditions, and requirements to avoid and minimize potential impacts to the marine environment; and monitoring site environs to verify that unanticipated or significant adverse effects are not occurring from past or continued use of the disposal sites, and that permit terms are met (for non-Corps disposals). A new *Site Management/Monitoring Plan* will be included in USEPA's designation package and will need to be reevaluated and updated periodically.

6.12.2.2 [new] Willamette River Navigation Channel

Deepening

Deepening of the Willamette River federal navigation channel is part of the Congressionally authorized project for channel improvement. Specifically, the existing 600-foot-wide navigation channel is authorized to be deepened from -40 feet to -43 feet CRD, from river mile 0 to river mile 11.6 on the Willamette River. The three turning basins located at river miles 4, 10, and 11.7 on the Willamette River also are authorized to be deepened. Accordingly, the 1999 Final IFR/EIS includes an assessment of the environmental impacts of the Willamette deepening project.

However, as indicated earlier in this Final SEIS, the Willamette River portion of the project has been deferred because large parts of the Willamette channel have been listed by USEPA on the National Priorities List under CERCLA on December 1, 2000. A site investigation performed by the USEPA found a pattern of contaminated sediments in Portland Harbor (from approximately river miles 3.5 to 9.2). As a result of that site investigation and subsequent to the issuance of the 1999 Final IFR/EIS and Chief's Report to Congress, this

stretch of the river was listed. Subsequently in March 2002, a memorandum of understanding was signed by USEPA Region 10, the Corps Portland District, and the Oregon Department of Environmental Quality to facilitate and encourage a more streamlined and effective means of carrying out the agencies' statutory and regulatory responsibilities.

Although the USEPA and Corps are coordinating closely on all sediment and permitting related activities in the Willamette River, the Corps has made it clear that any deepening of the Willamette River will be deferred until the completion of the remediation investigation and remediation decisions related to contaminated sediments in Portland Harbor. The Superfund listing creates uncertainty surrounding the timing and details of any channel improvements in the Willamette River.

Cleanup under the Superfund program will involve extensive study of the area, evaluation of alternatives, and public involvement in the selection of a final remedy that is protective of human health and the environment. The final remedy selected by USEPA may result in changes to the previously proposed channel improvements for the Willamette River– changes that cannot be anticipated at this time. Any improvements to the channel in the Willamette River will therefore take place under conditions different from those found today, i.e., conditions reflecting the Superfund cleanup. Accordingly, the sponsor ports and the Corps will not move forward on deepening in the Willamette River channel until plans are fully in place for any necessary remediation. At such time as the sponsor ports and the Corps may proceed with channel improvement activities for the Willamette River, the Corps will conduct appropriate additional NEPA review.

As noted above, the potential environmental effects of the authorized Willamette River channel deepening were reviewed in the 1999 Final IFR/EIS. Effects unrelated to sediment contamination (e.g., potential effects of dredging activities on migrating salmonids) are not qualitatively different from the effects of the channel improvement project generally and therefore, are anticipated to be limited. Further, for the reasons discussed for the channel improvement project generally, Willamette deepening would not be anticipated to have any effect on sediment transport and sedimentation in the estuary or mouth of the river. Similarly, because the project is located well above the reach of the river inhabited by Dungeness crab, Willamette deepening would have no effect on this resource.

However, attempting to further specify impacts of Willamette deepening at this time would be largely speculative because the details of the cleanup (e.g., quantities and locations of material to be removed) are not yet known. Accordingly, the details of deepening activities required after cleanup (e.g., the quantity, location and nature of channel material remaining after cleanup that needs to be dredged for deepening) also are not yet known.

Again, at such time as the sponsor ports and Corps may proceed with channel improvement activities for the Willamette River, appropriate additional NEPA and ESA review will be conducted. Detailed analysis of issues related to Willamette River contaminants will be available as part of USEPA's *Remedial Investigation and Feasibility Study*.

Maintenance

Maintenance dredging for the deep draft navigation channel in the Willamette River is conducted, on average, every 3-4 years. The last maintenance dredging operation was in 1997. Up to 0.5 mcy of material is removed each time the 40-foot authorized channel is dredged, and up to 2 feet of advance maintenance dredging is performed. The dredged material ranges from medium silt to medium sand. In recent history, this material has been placed in the flowlane in the Columbia River near river mile 100. Since the lower Willamette River was placed on the National Priority List for contaminated sediments, no maintenance dredging has been performed. Most of these contaminated sediments occur outside the navigation channel. Any future maintenance dredging of the Willamette River navigation channel will be conducted pursuant to the March 2002 Letter of Agreement between USEPA Region 10, Oregon Department of Environmental Quality, and the Corps concerning the lower Willamette River.

With the exception of dredging potential contaminated sediments, the impacts of which will be minimized through the letter of agreement, effects of dredging the deep-draft navigation channel are expected to be similar to that described for the channel in the Columbia. The dredging and disposal locations are below the photic zone and the migratory corridor for fish. Consequently, these areas do not provide much, if any, productive habitat for aquatic species.

6.12.2.3 [new] Upper Columbia/Snake River Navigation Channel

The Columbia and Snake River navigation projects include the entire inland navigation system that provides navigation from the mouth of the Columbia River near Astoria, Oregon, to port facilities on the Snake and Clearwater Rivers in Lewiston, Idaho, and Clarkston, Washington. This section discusses the portions of the navigation projects that are above the Bonneville Dam, the Upper Columbia-Snake River navigation waterway. This waterway has historically required dredging to, among other things, maintain shoal areas that impede navigation, and remove sediment that impedes hydraulic flow.

The navigation channel between Vancouver, Washington and The Dalles, Oregon, is maintained annually through hopper dredging in various reaches, mostly below Bonneville Dam. The channel is dredged to provide 17 feet of depth for users, with 2 feet of advance maintenance performed to ensure adequate depth between dredging operations. An average of 150,000 cubic yards of medium grain sand is removed from shoals that occur in the navigation channel each year. This material is placed in the flowlane within or adjacent to the navigation channel downstream of the dredging areas.

Impacts from dredging this reach are expected to be minimal. The areas to be dredged are disturbed annually and are at or below the photic zone in the Columbia. Consequently, these areas are not likely very productive and do not provide much highly productive habitat for aquatic resources including listed species. Dredging occurs during the recommended in-water work period of 1 November to 28 February; consequently, the impacts to migrating salmon are expected to be small.

The navigation channel above The Dalles Dam is authorized to 14 feet of depth. It rarely requires maintenance dredging. The last time it was dredged, a total of about 25,000 cubic yards were removed. Any dredging that would be done in this reach would take place between mid-December and mid-March. It is unlikely that the minimal dredging that occurs in this reach would have any major effect on aquatic resources or listed species. Though there would be some alteration of habitat during dredging and disposal, the sites would be expected to recover to the previous level of production and remain at that level until it was disturbed again in the future.

In 2002, the Final DMMP/EIS presented the Corps programmatic plan for the five locks and dams on the *upper* portion of the Columbia and Snake Rivers navigation project: McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. The plan provides for maintenance of the navigation channel for 20 years, for management of dredged material from these reservoirs; and for maintenance of flow conveyance capacity at the upstream extent of the Lower Granite reservoir for the remaining economic life of the dam and reservoir project (to year 2074). The DMMP defined an operations and regulatory preference for beneficial use of all dredged sediments where practicable and established a Local Sediment Management Group to review sediment issues and help implement the DMMP. The USEPA, Region 10, was a cooperating agency on the DMMP/EIS and will co-chair the management group with the Corps. The DMMP anticipated formation of the Regional Dredging Team.

The DMMP/EIS contains four alternatives to maintain the existing, authorized federal projects. Alternative 1 continues historic maintenance of the authorized navigation channel in the study area. It would involve maintenance dredging with in-water disposal. Alternative 2 involves the same dredging activities as alternative 1, but with changes in dredging methods, work window, and disposal location for silt. Dredged materials would be placed in water to create shallow-water fish habitat beneficial to salmonid species. This alternative also includes raising the levee at Lewiston up to 3 feet at critical locations to maintain flow conveyance. Alternative 3 uses the same dredging activities as Alternatives 1 and 2, but with upland disposal of dredged material. The 3- foot levee raise is included. Alternative 4 (the selected plan) also considers the same dredging activities and the 3-foot levee raise. In addition, Alternative 4 includes a management strategy for dredged material that focuses on beneficial uses: for each dredging activity, the Corps would identify potential beneficial uses and coordinate the uses with a Local Sediment Management Group.

Although the DMMP/EIS is currently the subject of a preliminary injunction, the injunction is based on the alleged failure to adequately consider alternatives, not the accuracy or adequacy of information regarding potential impacts contained in the document.

Relevant Impacts

The DMMP/EIS reviews the environmental impacts of Alternatives 1 through 4. Since Alternative 1 represents historic maintenance, its effects as outlined in the DMMP/EIS indicate the past and present environmental impacts of the Upper Columbia/Snake

navigation project. The impacts of the Upper Columbia/Snake navigation project apply only to the extent that they affect the environment or resources of the channel improvement project area.

Water Quality

All alternatives considered in the DMMP/EIS for the Upper Columbia/Snake River navigation project are expected to have a temporary, direct adverse effect on water quality, mostly because of turbidity plumes caused by the dredging and, where proposed, in- water disposal. However, it is anticipated that elevated turbidity levels would be confined and will stay within the "mixing zones" (established under Clean Water Act Section 401 water quality certification) allowed for this activity, and allowable turbidity downstream of the mixing zone would not be exceeded.

To date, sediment contaminant levels have been at low levels that allow in- water disposal, and this is not expected to change. However, the Corps will continue its sediment sampling protocols.

Construction of levees proposed under Alternatives 2, 3, and 4 could result in short-term, minor water quality impacts due to runoff and erosion. These concerns would be minimized with the implementation of a site-specific Erosion/Sedimentation Control Plan and construction best management practices. The levees would also be stabilized by hydroseeding immediately after construction.

Direct, temporary, minor impacts due to erosion may occur as a result of construction and disposal operations at the Joso upland site as proposed in Alternative 3. Mitigation measures would be implemented to offset any impacts, including use of a containment berm, implementation of an Erosion/Sedimentation Control Plan and best management practices, and regular stabilization during disposal.

Impacts from beneficial use of the dredged material proposed in Alternative 4 could vary depending on the use but would be subject to Erosion/Sedimentation Control Plan measures and best management practices.

Sedimentation and Sediment Transport

Most of the sediment to be dredged in the Upper Columbia/Snake navigation project is sands and gravel that have deposited in the reservoirs. The only sediment impacts downstream of the dredging and disposal sites are expected to be localized, short-term increases in turbidity, caused by the release of small amounts of fine-grained sediments. Therefore, maintenance activities in the Upper Columbia/Snake navigation project would not be anticipated to have any effect on sediment transport and sedimentation in the estuary or mouth of the Columbia River.

Sediment Quality

Comments on the channel improvement project Draft SEIS raised concerns about whether dredging upriver contaminated materials may redistribute contaminants and represent a risk for salmon that utilize these habitats. The DMMP for the Snake/Upper Columbia Navigation project concludes that fine sediment is the only dredged material that is potentially contaminated, and sampling data indicates little if any contamination in fine river sediments in the areas proposed to be dredged. Thus, there is a low risk of changes to water quality because of release of chemicals of concern from the sediments. Dredged sediments will be evaluated pursuant to the revised regional *Dredged Material Evaluation Framework* and guidance of the Regional Dredging Team to check for any change over time.

Aquatic and Wildlife Resources

The Upper Columbia/Snake navigation project has no impacts on aquatic and wildlife resources (e.g., Dungeness crab and wetlands) in the study area of the channel improvement project.

Threatened and Endangered Species

Anadromous salmon and steelhead stock from several ESUs listed as threatened or endangered under the ESA that are found in the channel improvement project area also pass through the McNary reservoir and lower Snake River. The dredging activity associated with all four alternatives would have the same indirect, minor, short-term effects on aquatic ecosystems by disturbing sediments and removing macroinvertebrate species (which are prey species for resident and migratory fish). However, recolonization of macroinvertebrates would occur relatively rapidly. Because dredging and disposal activities would only occur during authorized in-water work windows, impacts to salmonids would be minimized. NOAA Fisheries has determined that the proposed actions would not cause jeopardy to anadromous fish species listed under the ESA.

The creation of in-water fish habitats under the DMMP selected alternative 4 works to mitigate the environmental impacts on salmonids. Some of the beneficial uses proposed in alternative 4 create salmonid habitat directly. Other potential beneficial uses may reduce risks to listed species (e.g., capping of contaminated sediments).

Moreover, the Corps has recently selected the action it will take as a result of the Lower Snake River Juvenile Salmon Migration Feasibility Study. The study examined ways of improving salmon passage through the four lower Snake River dams and reservoirs: Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. Structural changes in the selected action include spillway improvements, upgrading adult fish passage systems, upgrading juvenile fish facilities, additional fish transportation barges, turbine upgrades, removable spillway weirs and surface bypass structures. Operational changes include improving the coordination and implementation of spill, flow augmentation and juvenile fish transportation.

6.12.2.4 [new] Federal Columbia River Power System

Another ongoing project that directly affects the Channel Improvement Project study area is the Federal Columbia River Power System (FCRPS). The Bureau of Reclamation and Corps own and operate the system of hydropower projects on the Columbia and lower Snake Rivers, which collectively provide about 75% of the electricity used by Pacific Northwest residents and industries. The Bonneville Power Administration (BPA) markets and distributes the power generated from these dams.

The FCRPS project facilities include Bonneville, The Dalles, John Day, and McNary Dams (Lower Columbia River facilities); Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak Dams (Lower Snake River/Clearwater River facilities); Grand Coulee, Albeni Falls, Libby, Hungry Horse and Chief Joseph Dams, and Banks Lake Pump Storage (Upper Columbia River facilities). The FCRPS is relevant to the cumulative impacts analysis only to the extent to which it interrelates with the environment or resources of the channel improvement project area.

Water Quality

The operation and configuration of the FCRPS has two primary effects on water-quality-related salmon survival: dissolved gas supersaturation and water temperature. Total dissolved gas is generated when water is spilled at dams. Falling water entrains volumes of air and carries the air into the stilling basin. Hydrostatic pressure at depth in the basin forces the entrained gases into solution, causing supersaturation. Spilling waters is the most benign way to move non-transported juvenile downstream migrants past the dams, while avoiding passage through the turbines. But, the total dissolved gas generated by the spilling strategy can exceed current water quality standards (110% total dissolved gas). To address this problem, nearly all Columbia/Snake River projects now have spill deflectors, which reduce the impacts of dissolved gas supersaturation. In addition, monitoring programs now appear to accurately detect total dissolved gas levels, and spill adjustments can be made to restrict gas below the level considered safe for salmonids.

Hydroelectric dams also modify natural water temperature regimes in the mainstream Columbia River. Snake River basin storage reservoirs are known to affect temperatures by extending water residence times and by changing the heat exchange characteristics of affected river reaches. As with dissolved gas supersaturation, dam operation is manipulated to address the problem. To minimize water temperature related effects on juvenile fall chinook, Dworshak Dam is routinely operated to release large amounts of cool water during the months of July and August when elevated temperatures are a concern.

Wide-scale mitigation measures for water quality are also proposed. The 2000 FCRPS Biological Opinion recommended that the action agencies, coordinating through the Water Quality Team, should annually develop a 1- and 5-year water quality plan for operation and configuration measures at FCRPS projects. Appendix B of the Biological Opinion accordingly contains a federal agency proposal for development of a water quality plan for the Columbia River mainstem.

Sedimentation and Sediment Transport

The FCRPS reservoirs alter river flows via flow regulation and this, in turn, has permanently altered river and sediment discharges in the channel improvement project area. The reservoirs store water during the spring snowmelt, reducing the freshet discharges. The reduced discharges have caused large reductions in sediment transport during the spring freshet. The stored water is released during the fall and winter to increase hydroelectric power generation. Those releases cause little increase in sediment transport because the river discharges remain below critical levels to initiate large-scale sediment transport. Hydroelectric power releases also cause relatively minor hourly river discharge fluctuations that do not alter sedimentation (this Final SEIS, Exhibit J).

Sediment Quality

While the FCRPS may decrease the potential downriver transport of any contaminated sediments by trapping them behind the dams, the operation of the FCRPS is not anticipated to have any significant adverse effect on sediment quality within the channel improvement project study area.

Aquatic and Wildlife Resources

The FCRPS has altered flow patterns in the Columbia River, contributing to reductions in flood levels and frequencies, and altered seasonal salinity intrusion in the estuary. The reduced flooding has subsequently reduced the input of detritus (nutrients) into the river. This reduction in nutrient supply and the altered salinity pattern has likely had some impact on the river's aquatic resources. The reduced flooding also has impacted riparian habitat and wildlife along the river (see next section regarding threatened and endangered species).

Threatened and Endangered Species

Construction and operation of the FCRPS have affected anadromous salmonids in several ways. These include inundation of spawning habitat, changes in migration rates and conditions of juvenile fish through the reservoirs and at the dams, changes in adult migration conditions, and improved habitat for predators of juvenile salmonids. Hydrosystem effects include both direct (e.g., turbine morality) and indirect effects (e.g. delayed mortality, due to such mechanisms as changes in estuary arrival times; FCRPS Biological Opinion 2000).

In 2000, a FCRPS Biological Opinion considered whether the effects of FCRPS configuration, operations, and maintenance are likely to jeopardize the continued existence of 12 listed species of salmonids and cause the destruction or adverse modification of their designated critical habitat (at the same time, the Bureau of Reclamation also consulted on 19 of its projects in the area. The Biological Opinion does not apportion the relative impacts of the FCRPS and Bureau projects).

The 2000 FCRPS Biological Opinion concludes that the proposed operation and configuration of the FCRPS and Bureau of Reclamation projects are likely to jeopardize the continued existence of Upper Columbia River spring chinook salmon, Snake River fall chinook salmon, Snake River spring/summer Chinook salmon, Snake River steelhead, Upper Columbia River steelhead, Middle Columbia River steelhead, Columbia River chum salmon, Snake River sockeye salmon, and to adversely modify their designated critical habitat. However, the Biological Opinion proposes Reasonable and Prudent Alternatives in relation to these fish and concludes that, with their implementation, the projects are *not* likely to jeopardize the continued existence of these ESUs or to destroy or adversely modify their designated critical habitat. These conclusions are based on elements of the Reasonable and Prudent Alternatives that remedy shortcomings of the projects. The Biological Opinion also includes an incidental take statement containing various terms and conditions to avoid and minimize take to the maximum extent practicable. For example: ESA-listed fish must be handled with extreme care and kept in water to the maximum extent possible during sampling and processing; adequate circulation and replenishment of water in holding units is required; when using gear that captures a mix of species, ESA-listed fish must be processed first to minimize the duration of handling stress.

The Biological Opinion also concludes that the projects are not likely to jeopardize the continued existence of the Upper Willamette River chinook salmon, Lower Columbia River chinook salmon, Upper Willamette River steelhead, Lower Columbia River steelhead, or to destroy or adversely modify their designated critical habitat.

Further relevant information is contained in a series of White Papers produced in 2000 by NOAA Fisheries. One White Paper considers the effects of river flow through the hydropower system on anadromous salmonids. Other White Papers address the effects of dam passage on salmonids, and the effects of transporting juvenile salmonids around dams.

The continued operation of the FCRPS also is not likely to jeopardize the continued existence of bull trout in areas downstream of Hells Canyon Dam and in the Upper Columbia River Basin (USFWS 2000 Biological Opinion).

Comments on the channel improvement project SEIS suggest the possibility of oil spills or leaks from the dams, and impacts on salmonids and water quality. The impact of oil spills, leaks, and discharges form the Columbia River dams is addressed in existing documents. The Corps provides a single consolidated document (Spill Response Plan) to meet multiple spill response planning requirements as identified under OSHA's HAZWOPER Standard, RCRA's Contingency Plan, SARA Title III's Emergency Planning and Community Right To Know Act, the Oil Pollution Act, the Clean Water Act, and the State, Area, Regional, and National Contingency Plans for spill response.

In the 1980s, the Corps Portland District recognized the potential impacts of having poly chlorinated biphenyls (PCBs) in and around its operating projects. The Corps has taken prudent and proactive steps to eliminate the use of PCBs in following areas: main unit transformer oil; bushings and associated electrical equipment (sealed and oil-filled type); light ballasts.

The impacts of historic leaks and spills from Columbia River dams within the Portland District over the last 10-15 years are a matter of public record. The National Response Center (http://www.nrc.uscg.mil) provides detailed information on the type and size of spills from Northwest power projects. In all cases, following relevant federal and state guidance, the Corps has worked cooperatively with state and federal agencies to remediate spills and confine them within the structure (powerhouse, spillway, etc.).

The 2000 FCRPS Biological Opinion does not consider the possibility of oil spills or leaks from the dams as a potential significant impact.

Restoration and Mitigation Projects

The continued operation and maintenance of the FCRPS, as analyzed in the 2000 Biological Opinions, includes a number of mitigation measures. For example, it augments water volume to improve juvenile salmonid migration.

Moreover in November 2002 the BPA, the Bureau of Reclamation and Corps released the *Final 2003/2003-2007 Implementation Plan* for the FCRPS (incorporated by reference). The plan identifies and describes the specific measures that the three agencies plan to implement in fiscal years 2003-2007 and addresses the actions called for in the 2000 Biological Opinions. The goals of the plan are: to avoid jeopardy and assist in meeting recovery standards for Columbia Basin salmon, steelhead, bull trout, sturgeon, and other ESA-listed aquatic species that are affected by the FCRPS; to conserve critical habitats upon which salmon, steelhead, bull trout, sturgeon, and other listed aquatic species depend, including watershed health; and to assure tribal fishing rights and provide non-tribal fishing opportunities; and balance other needs (e.g. other native fish and wildlife, human needs; tribal culture resources).

Mitigation efforts by the agencies are already underway pursuant to the "Endangered Species Act 2002 Annual Implementation Plan for the Federal Columbia River Power System" (2002 1-Year Plan).

6.12.2.5 [new] Port, Industrial, Urban and Agricultural Development

While not caused by or connected to the channel improvement project, some urban, industrial and port development is reasonably foreseeable within the project study area. Of these potential projects, the Port of Vancouver's proposed Columbia Gateway development is analyzed in detail here because is perhaps the largest and also was the subject of significant comments on the Draft SEIS. When the 1999 Final IFR/EIS was prepared, the Port of Portland's West Hayden Island Development project had been proposed and was in the process of being permitted. However, since that time the Port has withdrawn its development plans, withdrawn its permit applications, and is holding the property in long-term strategic reserve. Therefore, the project is not considered reasonably foreseeable for the purposes of a cumulative impact analysis.

Columbia Gateway Project

The Gateway project refers to the Port of Vancouver's proposal for development at Columbia Gateway in Vancouver, Washington. The property is located in the Vancouver Lake lowlands area and spans river miles 100-102 along the Columbia River. The project involves planned development of water, heavy, and light industrial uses. The proposal involves 1,094 acres of property, designated by the Port as parcel 2 (35 acres), parcel 3 (517 acres), parcel 4 (112 acres), and parcel 5 (430 acres).

A Draft EIS for the Gateway project was released on August 27, 2002. The Gateway DEIS analyzes four alternatives. Alternative 1 is No Action. Alternative 2 proposes water development of parcel 3, and no development on parcels 4 and 5. Alternative 3 involves heavy industrial and water development in parcel 3 and light industrial development in parcel 5. Alternative 4 involves water development in parcel 3, and light industrial development in parcel 5. The Gateway FEIS is scheduled to be completed in early 2003.

The Gateway DEIS reviews the potential significant adverse impacts of Alternatives 1 through 4, as well as the mitigation measures. Some of the impacts are relevant to the cumulative impact analysis of the channel improvement project and some are not. Those of key relevance are discussed in more detail.

Water Quality

No significant adverse impacts on water quality are expected under Alternative 1. Under Alternatives 2, 3, and 4, development operations are expected to generate industrial wastewater, sanitary sewage, and stormwater. Pollutants will accumulate on paved surfaces and be washed into the storm drain system. Placement of dredged material could potentially affect water quality. Construction will cause the soil surface to be exposed and erosion could occur. Eroded sediment could be washed into surface water bodies. The Gateway DEIS provides for the following potential mitigation measures: discharging industrial wastewater and sanitary sewage to the City's treatment systems; implementing storm water treatment measures; undertaking construction and discharging water in accordance with new or revised National Pollutant Discharge Elimination System permits, and employing best management practices for construction activities in or near wetlands and buffers.

Sedimentation and Sediment Transport

The Port's proposed development activities at Gateway are not anticipated to have any effect on sediment transport and sedimentation in the estuary or mouth of the river. The Gateway DEIS addresses localized sedimentation issues in its discussion of earth and geotechnical impacts. There are no expected earth and geotechnical impacts under Alternative 1. Under Alternatives 2, 3, and 4, construction of marine structures would require initial and maintenance dredging. Upland disposal of dredged material could raise the water table. Site preparation would generate strippings and require extensive areas of cuts and fills. Site grading would result in large exposed areas susceptible to erosion. Boat basin construction

under Alternatives 3 and 4 would require dredging and/or excavation and may generate turbid water. Periodic maintenance dredging may be needed.

To mitigate earth and geotechnical impacts, the Port proposes a range of mitigation measures. For example, Alternative 2 mitigation includes: performing in-water construction work during time windows prescribed by natural resource agencies; revegetating and restoring disturbed ground surfaces; protecting exposed surfaces from erosion through engineered erosion control and water quality plans; establishing final floor grades above anticipated flood levels; providing subdrainage for subsurface structures; and, stripping ground surface prior to excavation or placement of structural fill and stockpile strippings for use in landscape or filling in mitigation areas. For Alternatives 3 and 4, additional mitigation measures include using material excavated from boat basin to construct fills in other areas.

Sediment Quality

Under Alternatives 2, 3 and 4, it is possible that dredge spoils or other materials deposited on site as fill could contain contaminants. To address this issue, dredged materials will be tested prior to placement. Further, dredging activities will be subject to review, including sediment sampling and ESA evaluation, as part of the permitting process for in-water work. Such review will likely avoid and minimize the effects of dredging any contaminated materials that may be discovered.

Aquatic and Wildlife Resources

The Gateway DEIS addresses aquatic and wildlife resources (particularly habitat) issues in its discussion of wetlands, hydrology and water quality. There are no expected significant and adverse impacts under Alternative 1. Alternative 2 is predicted to impact 111 acres of wetlands. Under Alternatives 3 and 4, development will fill about 84 acres of wetlands.

Under Alternative 2, there are no expected adverse impacts on hydrology. Regarding water quality, development operations will generate industrial wastewater, sanitary sewage, and stormwater. Pollutants will accumulate on paved surfaces and be washed into storm drain system. Placement of dredged material could potentially affect water quality. Construction will cause soil surface to be exposed and erosion could occur. Eroded sediment could be washed into surface water bodies. Some hydrologic change will occur in wetlands under Alternative 3. Water quality impacts are expected to be the same as for Alternative 2.

To mitigate impacts on wetlands, hydrology and water quality under Alternative 2, 103 acres of wetlands would be created or restored and 8 acres of existing wetland sloughs would be enhanced. Under Alternatives 3 and 4, 60 acres of wetlands would be created and 38 acres enhanced. To compensate for water quality impacts under all alternatives, industrial wastewater and sanitary wastewater will be discharged into the City's wastewater, collection, treatment and disposal system, and a stormwater treatment plan and treatment ponds will be constructed. Best management practices will be used for all construction activities in or near wetlands and associated buffers. There also are mitigation measures to apply during construction.

The Gateway DEIS also specifically reviews impacts to vegetation and wildlife. There are no expected impacts under Alternative 1. Alternative 2 is predicted to result in the loss of 857.4 habitat units. Alternative 2 is predicted to impact potential foraging and loafing habitat for sandhill cranes. Alternative 3 would result in loss of 1,151.9 habitat units. Alternative 3 is also predicted to impact some potential foraging and loafing habitat for sandhill cranes.

To mitigate the potential adverse impacts on vegetation and wildlife under Alternative 2, 240 acres of wetland and upland habitat will be created and enhanced resulting in a net gain of 51 habitat units for eight evaluation species. Under Alternatives 3 and 4, 324 acres of habitat will be created and enhanced, resulting in a net gain of about 99 habitat units. To compensate for loss of low quality sandhill crane habitat, the proposed habitat mitigation plan under Alternative 2 will provide 70 acres of high quality grains, 34 acres of improved grassland, and 50 acres of enhanced emergent wetland. For Alternatives 3 and 4, 130 acres of high quality grains, 58 acres of improved grassland, and 50 acres of enhanced emergent wetland will be provided.

Threatened and Endangered Species

Alternatives 2 and 3 would eliminate a current bald eagle nesting site and potential foraging habitat. Other impacts include loss of perching habitat and a former nest site, although some perch trees and potential nest trees would remain.

A Biological Assessment and Management Plan for the bald eagle will likely be required, and the Gateway DEIS anticipates mitigation measures such as establishing black cottonwood and other native trees to provide perching and future nesting trees. A former nest site will be enhanced under Alternatives 2, 3 and 4 and, in addition, under Alternatives 3 and 4, additional trees will be established around a former nest site.

Impacts on salmon are covered in the Gateway DEIS discussion on habitat and fisheries. There are no expected impacts to habitat and fisheries under Alternative 1. Under Alternatives 2 and 3, nearshore habitat losses of between 15.8-25.4 acres could result depending on flow events (2-, 5-, and 10-year). Under Alternative 4, the equivalent predictions range between 8.6-15.9 acres. Under Alternatives 3 and 4, the boat basin dredging also will alter topographic landscape including shallow water habitat and creation of predator habitat. Boat basin traffic is also predicted to impact habitat quality and fish use. Some disruption of nearshore habitat ecology is also possible under Alternatives 3 and 4. Again, the permitting process for in-water work will include appropriate review of potential effects on listed fish species though the ESA consultation process.

To mitigate the potential adverse impacts on habitat and fisheries, specific mitigation measures will be developed depending on actual development that occurs. However, general conservation and mitigation measures have been developed to address potential impacts. For example: preserving natural shoreline/bankline and nearshore habitat where possible; using bioengineered bank treatments along shoreline to reduce erosion and promote riparian

growth; where possible, removing areas of shoreline hardening and implement restoration; if possible, avoiding placement of fill waterward of ordinary high water mark.

Other Historic and Reasonably Foreseeable Development in the Study Area

Past development in the channel improvement project study area includes diking for agricultural development, filling for urban developments, port developments, and related infrastructure development such as roads and railroads. The baseline impact of past development on the study area is reflected in the assessment of *Affected Environment* (see 1999 Final IFR/EIS and Final SEIS at Section 5).

As described in Section 3.4 of the Final SEIS, while not caused by or connected to channel improvement, some future development of port facilities is reasonably foreseeable within the study area. Industrial growth could result in additional dredging around dock facilities and additional dredging for deeper access channels to enable ports to compete with other west coast port facilities. Continued urban and industrial development in the study area is also reasonably foreseeable in response to regional and national economic trends.

As noted above, when the 1999 Final IFR/EIS was prepared, the Port of Portland's West Hayden Island Development project had been proposed. However, since that time the Port has withdrawn its development plans and is holding the property in long-term strategic reserve. Therefore, the project is not considered reasonably foreseeable for the purposes of a cumulative impact analysis.

Sedimentation and Sediment Transport

Historic dredging, pile dike fields and shoreline disposal have combined to increase the depth and reduce the width of the riverbed; however, navigation development has not measurably altered Columbia River sand transport (Exhibit J, Final SEIS). Future dredging in the project area that is unrelated to the project would be expected to have minimal impacts on sedimentation and sediment transport for the same reasons as the channel improvement project.

Sediment Quality

Future dredging, other remedial techniques, and aquatic ecosystem restoration in the project area that is unrelated to the channel improvement project may encounter areas with contaminated sediments, particularly in the Willamette River. A discussion of future CERCLA activities on the Willamette is contained elsewhere in the Final SEIS. However, all these activities will be subject to appropriate review, including sediment sampling and analysis pursuant to the *Dredged Material Evaluation Framework* and coordination through the Regional Dredging Team structure and ESA evaluation, as part of the permitting process for in-water work. Such review will likely avoid and minimize the effects of dredging and disposal of any sediment, contaminated or clean.

Aquatic and Wildlife Resources, Including Endangered Species

Much of the significant wetland loss in the study area can be attributed to diking and/or a 20,000-acre increase in urban development that has occurred since the 1880s. Agricultural lands along the lower Columbia River continue to incur losses from urban and industrial development plus mining for gravel resources. Agricultural and urban/industrial land development is also principally responsible for an estimated 13,800 acres of riparian forest loss since the 1880s.

Future development in the project area would likely result in localized increases in environmental impacts to habitat including wetland, riparian and shallow water habitat and agricultural lands. It also is likely that there will be impacts on water quality, and potentially on other environmental resources. More specifically, urban growth will increase demand for electricity, water and buildable land in and near the study area, will affect water quality, and increase the need for transportation, communication, and other infrastructure. These impacts will probably affect habitat features such as water quality and quantity important for ESA-listed species. There will likely be both positive and negative effects on listed species and their habitats due to inconsistency among local governments (NOAA Fisheries Biological Opinion, Ch. 8; USFWS 2002 Biological Opinion, Ch. 6). Industrial growth could potentially result in alteration and loss of riparian areas, increased pollution, and alteration and loss of shallow water habitat. *Id*.

Restoration and Mitigation

Initiatives by state, Tribal and local governments will seek to mitigate or restore the environmental impacts of historic and future development. For example, natural resource protections are a central feature in Oregon's statewide land use planning program, which will govern future development in Oregon. Similar protections exist in Washington's Growth Management Act, which will govern future development in that state. State and federal requirements under the Clean Water Act and ESA are also expected to reduce future wetland/riparian habitat losses and provide appropriate mitigation for unavoidable losses. Habitat restoration programs by the States of Oregon and Washington, the National Estuary Program, and the Corps' Ecosystem Restoration Program also have the potential to restore large areas. Most local governments in Oregon and Washington are considering ordinances to address effects on aquatic and fish habitat from different land uses. While effective implementation of these programs is difficult to predict because of uncertainties in policy and funding, the overall effect is to address some historic losses while limiting and mitigating for future losses (NOAA Fisheries Biological Opinion, Chapter 8; USFWS 2002 Biological Opinion, Chapter 6).

Portland Harbor/Willamette River Cleanup

Historic activities and development around the Willamette River have resulted in contaminated sediments in some areas of Portland Harbor, and the Portland Harbor has been named by USEPA to the National Priority List. A *Remedial Investigation/Feasibility Study*

has been initiated. Therefore, cleanup of the lower Willamette River is reasonably foreseeable. However, the *Remedial Investigation/Feasibility Study* has not yet been completed and a remedy has not been selected.

Therefore, it is not possible at this time to determine the nature or magnitude of any short-term or long-term impacts of the cleanup action on the project area or whether such impacts would be cumulative to any impact of the channel improvement project. However, given the statutory purpose of the CERCLA, it is very likely that the cleanup actions will be designed to minimize both the short term and long-term effects of contaminated sediments in the Willamette River and their cleanup, including the possibility that the sediments are a source of contaminants to the Columbia River. The cleanup also will likely minimize contaminant concerns associated with future deepening of the Willamette River. Again, at such time as the sponsor ports and the Corps may proceed with channel improvement activities for the Willamette River, the Corps will conduct appropriate additional review under NEPA and ESA.

6.12.2.6 [new] Large-scale Restoration and Recovery Efforts

In addition to the ecosystem restoration features of the channel improvement project, there are a number of other restoration and recovery activities underway or proposed in the project area. These activities reflect incremental efforts to address historical environmental damage and are part of the total picture necessary for evaluating the potential cumulative impacts of the channel improvement project. Significant efforts and examples include:

The Lower Columbia River Estuary Partnership (LCREP) works with private environmental groups, federal, state and local governments on ecosystem protection of the lower Columbia River. The LCREP develops a Comprehensive Conservation and Management Plan to address land use, water quality, and species protection. The LCREP works with the USFWS on recovery planning for salmonids (USFWS 2002 Biological Opinion, 6.3).

In December 2000 a team of nine federal agencies (the Federal Caucus) released a long-term strategy to recover threatened and endangered fish in the Columbia Basin. The Basin-wide Salmon Recovery Strategy is the core of the federal recovery initiative under the ESA. It contains strategies related to habitat, hydropower, hatcheries, and harvest.

In July 2000 Idaho, Montana, Oregon, and Washington released recommendations for the "Protection and Restoration of Fish in the Columbia River Basin."

Oregon's Plan for Salmon and Watershed measures includes numerous programs designed to benefit salmon and watershed health in the lower Columbia River.

Washington has adopted legislative and administrative programs that either directly or indirectly work to restore and mitigate effects on the habitat of listed species. Legislative initiatives include the 1998 Salmon Recovery Planning Act, the Watershed Planning Act 1998, the Salmon Recovery Funding Act, and the Wild Stock Recovery Initiative Act

1992. Washington States' Forest and Fish Plan is a set of administrative rules designed to establish criteria for forest activities that will improve conditions for listed species. Estuary restoration projects, including acquisition of diked lands and reconnecting them with the Columbia River estuary, are being investigated by various entities. The Lower Columbia Fish Recovery Board is drafting recovery plans for the lower Columbia region. Washington is developing TMDL management plans on each of its 303(d) water-quality-listed streams. Washington also has programs in place to restrict water rights appropriations due to endangered species concerns.

Tribal governments are also engaged in watershed and basin planning designed to improve aquatic and fish habitat. For example, the "Spirit of the Salmon" plan is a joint restoration plan for anadromous fish in the Columbia River Basin prepared by the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. Future implementation of the plan should have positive cumulative impacts on listed species and their habitat (USFWS 2002 Biological Opinion, 6.4).

In addition, there are a number of private environmental groups working in the lower Columbia River on conserving and restoring ecosystem functions that benefit salmonids. They are coordinating their work through LCREP's science working group. Overall, their actions should have positive cumulative impacts on listed species and their habitats. (USFWS 2002 Biological Opinion, 6.5).

Washington also has published a final recovery plan for sandhill cranes. The plan should guide state and local efforts to both control adverse effects of proposed projects and engage in affirmative recovery activities. The plan identifies target population objectives and strategies to increase the breeding population of greater sandhill cranes to the point that it can be delisted, and to conserve essential habitat for the nonbreeding flocks of sandhill cranes. The strategies and tasks include: monitoring populations; protecting habitat; managing breeding territories; and, coordinating and encouraging cooperation with agencies, landowners, nongovernmental organizations, and funding sources.

Large-scale restoration and recovery efforts are intended to restore historic functions to different parts of the Columbia River ecosystem. These improvements are expected to improve certain aspects of water quality, although it is not possible to specifically quantify all of these benefits.

All these activities entail the evaluation of any cumulative impact of the channel improvement project, which must be considered not only in combination with projects such as the MCR and FCRPS, but also with these restoration and recovery efforts. In addition, all significant future development and restoration projects will be subject to additional independent environmental reviews by state and federal agencies under NEPA, the Clean Water Act, the ESA, and similar state programs, which will serve to avoid and minimize adverse effects wherever possible, and provide appropriate mitigation for unavoidable resource or habitat losses.

6.12.3 [new] Cumulative Impact of the Channel Improvement Project When Added to All Past, Present, and Reasonably Foreseeable Future Actions

The sections above have outlined other past, present, and reasonably foreseeable future actions that may impact significant environmental resources in the channel improvement study area. This section assesses the incremental impact of the channel improvement project when added to these other actions. The project's absence of significant impacts, and the benefits to be provided by the ecosystem restoration features, provides the starting point; the question is whether that conclusion must be altered at all when the project's impacts are added to the impacts of the other actions.

Because the cumulative effects analysis requires consideration of historic actions as well as reasonably foreseeable future ones, it is apparent that, for most of the environmental resources covered by this analysis, historic actions have resulted in significant impacts. For example, construction of the FCRPS has modified river flows in a way that affects sedimentation and sediment transport in the lower river; historic industrial activities have resulted in sediment contamination in portions of the Willamette River; historic development has resulted in significant wetland and other habitat losses in the project area; and many human activities and other factors have resulted in depleted populations of fish species requiring their protection under the ESA.

However, to evaluate this project's cumulative impacts, it also is necessary to look forward in time. Future actions, including this project, are taking place in a dramatically different regulatory and political climate than did the most damaging historic actions. Specifically, future actions are subject to detailed review at the federal, state or local level, or some combination thereof. As appropriate, this review includes NEPA or SEPA, ESA, Clean Water Act, CZMA, state wetlands and growth management regulations, and local protections for critical resources. Accordingly, unlike historic actions, future projects will avoid and minimize effects to key resources, and provide appropriate mitigation for unavoidable losses.

As discussed above, future actions include many efforts at restoration and recovery of resources and habitats impacted by historic actions. Inherent in these projects is the expectation that they will provide benefits over time to numerous environmental resources in the project area. It is against this entire background of historic and anticipated future actions that the potential impacts of the project, both adverse and beneficial, must be evaluated.

Water Quality

As noted in Section 6.3, the Columbia River is water quality limited for temperature, bacteria, dissolved oxygen, total dissolved gas, toxics, arsenic, and pH. These water quality limitations reflect historic as well as modern activities. While future activities will includes discharges of these parameters, such discharges will occur in a regulatory landscape that is far more restrictive and which will include specific plans to address these pollutants.

With regard to the actions discussed in this section, the cumulative impacts of the project when taken together with other actions are not likely to be significant.

Sedimentation and Sediment Transport

Exhibit J to the Final SEIS contains a comprehensive analysis of the past, present, and reasonably foreseeable sedimentation impacts to the Columbia River estuary and littoral cell. In essence, it contains a cumulative impact analysis in relation to sedimentation. Specifically, Exhibit J discusses the impacts of flow regulation associated with the FCRPS, the upper river navigation projects, the MCR project, and the channel improvement project.

In sum, the channel improvement project will not alter sand discharge to the Pacific Ocean. This would only occur if the amount of available sand, or the capacity of the sand transport system, were reduced; the project will do neither.

The Columbia River's average annual sand transport has declined considerably from the late 1800s to present. However, past navigation channel development is not responsible for the decline. The MCR jetties (constructed in the early 1900s) have reduced sand transport from the MCR into Baker Bay and across Clatsop Spit into the south channel. However, they caused a large discharge of sand from the MCR and vicinity, to the ocean. Following jetty construction, the sand that was eroded from the inlet and south flank of the inlet deposited in the outer delta and on shorelines. Past dredging and channel modifications upstream of CRM 40 have not measurably altered the available sand supply or sand transport in the river.

Flow regulation has reduced sand transport in the river. The FCRPS reservoirs alter flow patterns and this, in turn, has altered river and sediment discharges in the project area. The reservoirs store water during the spring snowmelt, reducing the freshet discharges. The reduced discharges have caused large reductions in sediment transport during the spring freshet.

While other actions, including primarily flow regulation and MCR jetty construction early in the 20th century, have affected sedimentation and sand transport in the estuary and lower river, the channel improvement project is not expected to have any measurable positive or negative effect on this resource because it does not alter the available sand supply or sand transport in the river.

Sediment Quality

As noted above, historic actions have resulted in sediment contamination in some parts of the project area, including parts of the lower Willamette River. However, with the protections provided by the Clean Water Act and other relatively new regulatory tools for source control, sediment conditions in the project area should not be subject to significant future degradation. Further, through active sediment cleanup and natural processes, existing

sediment conditions, particularly in the lower Willamette, should improve significantly over the long term.

In theory, there is some potential for incremental impacts because of the proximity of the Willamette River, the proposed clean up of that river, and deferred plans to deepen it. The remedial investigation and feasibility study for the Willamette have not yet been completed and a cleanup plan has not been selected. Therefore, it is not possible at this time to determine the precise nature or magnitude of any short-term or long-term impacts of the cleanup action on the project area. However, the driving purpose of the CERCLA remedial investigation, feasibility study, and remedy selection process is to devise methods for managing the contaminated material during clean up and over the long-term to reduce exposure to humans and the environment. Therefore, the Willamette cleanup is very likely to result in a significant long-term incremental improvement in sediment conditions in the project area. Any future deepening will occur in an environment that has undergone the rigorous Superfund remediation and will have to be consistent with that remediation.

Other development projects in the study area that involve dredging may encounter contaminated sediments. If they do, review through the permitting process for in-water work will determine how to avoid disturbing contaminated materials or handle them in such a way as to minimize exposure to humans and the environment.

Again, the channel improvement project does not, of itself, create sediment quality concerns because the Columbia River channel sediment to be dredged is primarily sand with a low percentage of organic content and, where detected, very low levels of contaminants. Therefore, dredging and disposal of this material, much of which is already naturally suspended and resuspended as it is transported along the bottom, does not add to any existing contamination issues or pose a risk to human health or the environment.

Accordingly, while historic actions have resulted in localized sediment contamination in some parts of the larger project area (i.e., outside of the areas to be dredged), the channel improvement project is not expected to make an incremental contribution to sediment quality degradation. Further, over the long-term, sediment cleanups and other processes should actually result in improved conditions in the project area.

Aquatic and Wildlife Resources

Crab

According to the Pacific Fisheries Management Council, the crab resource is currently healthy (October 22, 1999 letter from Pacific Fisheries Management Council to Corps). Pacific Northwest National Laboratories (Pearson et al. 2003) estimated total maximum loss to the fishery from the project of 44,342 crabs during construction (the increment associated with channel improvement project is 26,285 crabs), and up to 8,953 crabs annually during maintenance. In addition, entrainment data from 2002 annual maintenance dredging for the MCR indicates a loss to the fishery of approximately 6,000 crabs. Based upon comparison

of the study results with the average annual harvest in the Columbia River area (5.3 million crabs), the cumulative impacts of the channel improvement project and the MCR project to the crab resource and crab fishery are minimal, and are not anticipated to have any significant effect on crab population structure or dynamics.

Wetlands

While historic development in the project area has caused significant wetland loss, these actions occurred in a regulatory landscape that is very different from that which exists today. While future development will likely have localized impacts on wetlands, under the current regulatory regime, wetlands are unlikely to suffer significant losses. Moreover, initiatives by state, Tribal and local governments will operate to mitigate the unavoidable environmental impacts of development.

The channel improvement project is itself an example of the reduced impacts and significant mitigation involved in present day development. As outlined above, the potential wetland impacts of the project have been reduced from 20 to 16 acres since the 1999 Final IFR/EIS, and a detailed wetland mitigation plan will operate to offset wetland impacts. The mitigation plan involves development or substantial improvement to 194 acres of wetland habitat, representing about a 12-fold increase over projected losses. Also, the channel improvement project will result in the implementation of ecosystem restoration features, which are intended to restore a substantial acreage of wetland habitat.

The Columbia Gateway project illustrates the same trend. Some of the Gateway project alternatives are predicted to have wetland impacts in the project area. There are no expected impacts under Alternative 1, but impacts of the other alternatives range from 84 to 111 acres. However, like the channel improvement project, the Gateway plans include significant mitigation. Depending on the alternative, between 60 and 103 acres of wetlands would be created or restored, and between 8 and 38 acres would be enhanced. Including upland habitat as well as wetland habitat, between 240 acres (Alternative 2) and 324 acres (Alternative 4) of habitat will be created or enhanced resulting in a net gain of between 51 and 99 habitat units.

Other actions considered in this cumulative impact analysis have no predicted impact on wetlands in the channel improvement project study area. The MCR maintenance dredging planned for the next 5 years is not expected to impact any wetland areas. Neither the Upper Columbia-Snake River navigation channel project nor the FCRPS has impacts on wetlands in the channel improvement project area. Due to the uncertainty surrounding the Willamette River clean up, it is not possible at this point in time to evaluate potential impacts of the clean up on wetlands, although given USEPA Region 10 policies and practices at other CERCLA sites in the Pacific Northwest, it is potentially positive. Any future deepening project will, like the channel improvement project, include appropriate mitigation.

In sum, while historic actions have had adverse effects on wetlands in the study area, the channel improvement project is not expected to make an incremental contribution to those

negative effects. By contrast, the project's mitigation plans and ecosystem restoration features will improve the overall wetland acreage. And, future development in the area (including Gateway) is expected to follow the same trend: significant mitigation that will counterbalance or even outweigh any adverse effects on wetlands. Other restoration actions in the lower Columbia River, particularly for wetland habitat, also are being pursued by numerous entities.

Threatened and Endangered Species

Salmonids

Similar to other resources, salmonids have been detrimentally impacted by historical actions, but present and future actions (including the channel improvement project) are not, in the aggregate, expected to have significant overall impacts. Specifically, the dams and reservoirs that comprise the FCRPS have impacted spawning habitat, migration rates, and migration conditions; increased predator risks; and, caused turbine morality. However, in the modern regulatory and political environment, potentially adverse effects of future actions are not expected to be significant, or are expected to be offset by mitigation actions and restoration initiatives.

The channel improvement project itself has no significant impacts on salmonids. It is not likely to jeopardize the continued existence of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU. The project's impacts on physical processes that affect salmonids will be limited and short-term. While there is a low level of risk and uncertainty surrounding long-term biological responses, these will be addressed through monitoring and adaptive management.

In addition, the new ecosystem restoration features of the project will restore substantial habitat for salmonids. For example, the restoration projects at Lois Island embayment (191 acres), Miller/Pillar (235 acres), Tenasillahe Island Long-term Restoration (1,778 acres), Bachelor Slough (85 acres), and Walker-Lord and Hump-Fisher Islands (335 acres) will provide detrital export to the estuary and rearing habitat for juvenile salmonids. The tidegate retrofits (38 stream miles), and the Tenasillahe Island Interim Restoration (92 acres of side channel habitat) features will increase access and egress for juvenile salmonids. The tidegate retrofits will also improve access for adult salmonids to headwaters for spawning.

The present and reasonably foreseeable future actions discussed in this section do not materially change the cumulative impact. The MCR and the proposed actions in the upper Columbia/Snake River navigation channel have been found not to jeopardize listed anadromous fish species. Likewise, the *future* operation of the FCRPS is not likely to jeopardize the continued existence of four of the listed salmonids in that area, or to destroy or adversely modify their designated critical habitat. The FCRPS's most significant adverse impacts on eight other listed salmonids can be avoided by the reasonable and prudent alternatives proposed by NOAA Fisheries and the USFWS. While the Gateway project is expected to have impacts, for example on salmonid habitat, the Gateway DEIS recognizes

that the ESA consultation process will ensure the impacts are properly managed. When the Services conduct that consultation, they will establish the baseline condition, which will reflect the impacts that have occurred since the Biological Opinions discussed in this section. The baseline condition will incorporate past activities in a manner consistent with the cumulative impact requirement under NEPA. The potential impacts of any future Willamette channel deepening or unspecified future development cannot be determined at this time.

Moreover, to the extent that there are any adverse impacts on salmonids by present and future actions, they must be considered with the mitigation efforts included to offset them. For example, in-water fish habitats will be created as part of the Columbia/Snake navigation channel, and a number of significant changes will be made pursuant to the *Lower Snake River Juvenile Salmon Migration Feasibility Study*. Practices implemented under the MCR's management/monitoring plan will minimize its impacts. Pursuant to the FCRPS implementation plans, a wide range of measures are being implemented to avoid jeopardy, assist in meeting recovery standards, and to conserve critical habitats. Specific mitigation measures will be developed in relation to the Gateway project depending on actual development; however, general mitigation measures include preserving natural shoreline/bankline and nearshore habitat where possible. A number of general mitigation and remediation activities, such as the *Basin-Wide Salmon Recovery Strategy*, also operate to offset past, present, and future impacts on salmonids.

Accordingly, while historic actions have resulted in adverse impacts on salmonid populations that pass through the study area, the channel improvement project is not expected to have negative incremental impacts on salmonid populations. This conclusion is consistent with analysis in the 2002 Biological Opinions. For example, NOAA Fisheries concluded that, *taking into account cumulative effects*, in addition to other factors, the channel improvement project was not likely to jeopardize the continued existence of ESA-listed salmonids or result in the destruction or adverse modification of their designated critical habitat. (NOAA Fisheries, 2002 Biological Opinion, Section 9.6). Over the long term, recovery work should result in improved salmonid populations.

Sandhill Crane

The sandhill crane is a Washington state-listed endangered species, listed at least partly due to historical actions within the study area of the Columbia River Channel Improvement Project. However, that situation is being addressed by the recently completed *Sandhill Crane Recovery Plan*, and the channel improvement project is consistent with that plan. Sandhill cranes are present in an area that contains a proposed disposal site under the channel improvement project. However, the Corps' wildlife mitigation plan addresses the potential lost habitat value associated with the disposal site. Mitigation at Woodland Bottoms will include 132 acres in long-term pasture and 97 acres in wetland habitat that will benefit sandhill cranes. Ratios of land recovered through mitigation to land adversely affected by the project are 12:1, 4:1 and approximately 1:1, respectively, for wetlands, riparian habitat, and agricultural lands. Due to these mitigation plans, together with the

extensive acreage of State Wildlife Management Areas, National Wildlife Refuges, plus private agricultural lands in the area, it is not anticipated that the project would adversely affect sandhill cranes.

The other actions considered in this cumulative impact analysis either have no impact on sandhill cranes, or the mitigation plans are expected to similarly outweigh the adverse effects. Specifically, the MCR project, the upper Columbia/Snake River navigation channel, and the FCRPS are not expected to have any impacts on sandhill crane populations in the study area. Due to the uncertainty surrounding the Willamette River clean up, it is not possible at this point in time to evaluate potential impacts of the clean up on sandhill cranes. If necessary, any future deepening of the Willamette River will include appropriate mitigation. Alternatives 2 and 3 of the Gateway project are predicted to impact potential foraging and loafing habitat for sandhill cranes. However, to compensate for loss of low quality sandhill crane habitat, the proposed habitat mitigation plans for Gateway increase acreages of high quality grains, improved grassland, and enhanced emergent wetlands.

In conclusion, while historic actions have resulted in adverse impacts to sandhill cranes, the channel improvement project is not expected to result in incremental adverse impacts on the populations or their habitat. Mitigation efforts associated with the channel improvement project, the Gateway project, and other future actions in the study area should actually result in increased crane habitat.

Conclusion

There are inherent uncertainties in any cumulative impact analysis. However, based on available information, the incremental impact of the channel improvement project, when added to the impacts of other projects and developments described in this section, is not anticipated to be significant. One of the fundamental reasons is the minimal adverse impact of the project itself.

Moreover, the mitigation features of the channel improvement project, and the other projects, operate to offset impacts that do exist. In addition, the ecosystem restoration and evaluation actions that are part of the project are intended to provide net environmental *benefits* for several key environmental resources. Finally, as discussed above, several federal, state, Tribal, and non-governmental efforts are being developed or are underway to provide similar environmental benefits for resources in the project area.

6.13. revised Relationship Between Short-term Uses of the Environment and Maintenance and Enhancement of Long-term Productivity

The NOAA Fisheries and USFWS May 20, 2002 Biological Opinions concluded the ecosystem restoration features will provide benefits to the habitat types identified in the Conceptual Model (see Chapter 5 of the 2001 BA). When implemented in coordination with NOAA Fisheries and other entities conducting habitat conservation/restoration activities, these features should complement those activities currently occurring in the lower Columbia River and estuary. For these reasons, the NOAA Fisheries and USFWS concluded that the proposed ecosystem restoration features would benefit ESA-listed salmonids and their habitats. In addition, the ecosystem restoration features will enhance the long-term productivity of the Columbia River ecosystem for many other species that are not listed under the ESA.

6.14. Irreversible and Irretrievable Commitments of Resources

No updating of the existing information in this section is necessary for the Final SEIS (see the Final IFR/EIS, August 1999).