6. EFFECTS OF THE PROPOSED ACTION

6.1 Introduction

'Effects of the action' means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 C.F.R. 402.02). If the proposed action includes offsite measures to reduce net adverse impacts by improving habitat conditions and survival, NMFS will evaluate the net combined effects of the proposed action and the offsite measures as interrelated actions.

'Interrelated actions' are those that are part of a larger action and depend on the larger action for their justification; 'interdependent actions' are those that have no independent utility apart from the action under consideration (50 C.F.R. 402.02). Future Federal actions that are not a direct effect of the action under consideration, and not included in the environmental baseline or treated as indirect effects, are not considered in this Opinion.

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

The proposed Project has several distinct components, including Project construction and maintenance activities, monitoring and adaptive management, and ecosystem restoration and research actions. Section 6 of this Opinion includes sub-sections that address each Project component separately. Section 6.8 of this Opinion summarizes the effects analysis. Section 9 then provides our conclusion whether the Project, as a whole, jeopardizes the continued existence of ESA-listed salmonids or destroys or adversely modifies critical habitat. This is accomplished by aggregating effects to each pathway and indicator, when considered together with effects from interrelated and interdependent actions, cumulative effects and the environmental baseline.

As noted in section 3 of this Opinion, several steps were involved in development of the current proposed action. Those steps included a re-evaluation of potential Project effects, an analysis of these potential effects within the framework of an ecosystem-based conceptual ecosystem model, the development of compliance measures and monitoring conditions to minimize and/or avoid Project impacts, and the development of an adaptive management process to review information from the compliance and monitoring activities and make necessary Project modifications to minimize and/or avoid impacts. By using this 'frontloading' approach, NMFS and the Corps defined a proposed action that minimized or avoided Project-related effects. Therefore, some of the indicators identified in the conceptual ecosystem model are not discussed in this Opinion because the Corps' proposed action successfully avoids effects to them (*see* Table 2-1 of the 2001 BA for indicators not included for analysis in this Opinion).

NMFS used the conceptual ecosystem model, numerical models, and the results of BRT deliberations to analyze potential Project effects. The pathways and indicators defined in the conceptual ecosystem model (*see* Chapter 5 of the 2001 BA) are used herein as a framework to discuss potential Project effects. Pathways and indicators that could be potentially affected by the Project are addressed in sections 6.2.1 and 6.2.2 of this Opinion.

To determine specific physical habitat changes (salinity, velocity, depth) that might occur after Project implementation, the BRT used two numerical models, the Corps of Engineers – WES RMA-10 model and the OHSU/OGI ELCIRC model. The BRT was also assisted by the SEI panel process, which reviewed multiple aspects of the proposed Project (*e.g*., historical and existing status of the Lower Columbia River ecosystem, numerical modeling of hydraulic parameters, including flow and bathymetry; salmonid estuarine ecology; sediments and sediment quality, and monitoring and adaptive management). The 2001 BA (*see* Section 6 and Appendices B, F, and G) provides a complete overview of these analysis techniques and results of quantitative analyses and modeling outputs, and is incorporated herein by reference.

The above analyses addressed the concerns raised in NMFS' August 25, 2000, biological opinion withdrawal letter. The SEI panel process was used to respond to the concerns raised in our August 25, 2000, withdrawal letter, helped to frame major concerns raised in connection with the proposed Project, and identified best available science for additional analysis of Project effects. The Corps also conducted additional numerical modeling for the Lower Columbia River and estuary (*see* above discussion).

To develop the effects analysis for the 2001 BA, the BRT utilized the scientific information identified during the SEI panel process, including the best available science provided by NMFS' Northwest Fisheries Science Center, which describes the effects of bathymetry on ecological conditions of the estuary, and new information regarding potential effects of contaminants that could be released by Project activities. This best available scientific data and information was also used in developing the Terms and Conditions identified in section 12 of this Opinion, the Incidental Take Statement.

NMFS also expressed concern regarding the Corps' ability to restore estuarine habitats as identified in the 1999 biological opinion. This concern has also been resolved. In their 2001 BA, the Corps proposed an expanded set of ecosystem restoration features (*see* Table 8-2 of the 2001 BA) that are included in the proposed action that the Corps has committed to implement. These restoration actions will be funded by the Corps as integral Project components.

The following analysis of potential direct and indirect effects to salmonids and their habitats (sections 6.2 - 6.7 of this Opinion) from construction and maintenance activities uses the conceptual ecosystem model indicators and focuses on Project-related effects to key habitat types. This section also discusses interrelated and interdependent actions and their associated effects. Uncertainty regarding Project-related effects and associated risk to ecosystem indicators is presented, along with monitoring and adaptive management measures proposed by the Corps to reduce Project-related risk and uncertainty. This section of the Opinion also addresses potential effects resulting from proposed monitoring, ecosystem restoration, and research proposals. Finally, NMFS' conclusions on overall Project-related effects are presented.

6.2 Effects from Construction and Maintenance Activities

Project construction, maintenance, and compliance activities may have immediate (direct) effects to salmonids, as well as short-term and long-term (indirect) effects to ecosystem processes and functions of importance to salmonids. Additional activities, interrelated to the proposed action, may also have indirect effects to ESA-listed salmonids. NMFS uses the pathways and indicators from the conceptual ecosystem model as an analytical framework for discussing indirect effects from construction and maintenance activities. NMFS assumed that, if a pathway or indicator is influenced by the Project, then an indirect, short- or long-term impact to salmonids and their habitats may also may occur.

6.2.1 Direct Effects

Direct mortality to salmonids from construction and maintenance activities could occur from entrainment during dredging, disposal, or during in-water blasting activities. NMFS assumes that any salmonid entrained by the dredging activities will suffer injury or perish. Entrainment of organisms by hopper dredging has been evaluated at the mouth and in the Columbia River (Larson and Moehl, 1990; R2 Resources Consultants, 1999). Larson and Moehl (1990) reported that no juvenile or adult salmonids were collected during the four years of the study, even though other pelagic fish species were collected. This study concluded that, because dredging occurred below the depth where salmonids migrate, no salmonids were entrained. Documented entrainment of salmonids occurred during a research study in which the dredge draghead was purposely operated while elevated in the water column instead of within the substrate to determine presence/absence of fish (R2 Resource Consultants 1999). This entrainment incident involved two salmonids. No juvenile salmonids have been entrained during monitored, normal dredging operations in the Columbia River (Larson and Moehl 1990).

Under the Corps' proposed Project dredging procedures, the draghead and/or cutterhead will be buried, to the extent possible, in the sediment of the riverbed during dredging operations. No suction will occur through the draghead and/or cutterhead if it is raised more than 3 feet off the river bottom. Both these proposed "impact minimization" measures reduce the potential for juvenile salmonid entrainment.

Observations of subyearling and juvenile ESA-listed salmonid distribution and relative vulnerability to dredging entrainment impacts were conducted in the Lower Columbia River (Carlson *et al*., 2001, Beeman *et al.* 2003). Research indicated that the majority of salmonids were not utilizing the bottom of the navigation channel, where entrainment might occur during dredging activities. Analysis of hydroacoustic sampling data revealed that, during the highest ESA-listed fish annual abundance in the Lower Columbia River, only 0.0017% of those fish were beside the dredging zone (within three feet of the navigation channel bottom) during the daylight hours; 0.0249% were beside the dredging zone in the evening hours, and 0.0107% were beside the dredging zone at night (Carlson *et al*., 2001). The combination of very limited occupancy by ESA-listed salmonids of deep water locations, and BMPs that restrict dredge draghead or cutterheads to be operated, to the extent possible, under the sediment surface, will ensure that entrainment of ESA-listed salmonids is minimized. It is believed that adult salmonids have sufficient swimming capacity to avoid entrainment, and are further protected by the dredging "impact minimization" actions noted above. NMFS believes that compliance monitoring, to ensure the proposed entrainment minimization measures are implemented, will be important in minimizing any injury or death of salmonids during dredging activities.

One location (Warrior Rock, RM 87.3) may require one-time, in-water blasting. NMFS anticipates blasting could injure or kill salmonids within the blasting area. However, the proposed action minimizes potential direct effects by requiring a blasting plan, using an in-water work window of November 1 to February 28 when salmonid abundance is lowest, and reducing the associated pressure wave by creating an implosion. NMFS believes reducing implosion-induced over-pressure to less than ten psi will minimize blast-related impacts to salmonids. NMFS believes that development of a NMFS-approved monitoring plan, that ensures the proposed blasting measures are implemented, will be important to minimize any injury or death of ESA-listed salmonids during blasting activities.

Dredge material disposal has the potential to cause direct effects to ESA-listed salmonid habitat along the Columbia River. Disposal areas were sited primarily on existing dredged material disposal sites or at locations behind flood control dikes. Typically, these disposal sites provide negligible inputs (*e.g.*, detrital and insect faunal export, large woody debris export) to the Columbia River, and thus are of limited value to ESA-listed salmonids. As a result, direct effects of dredged material disposal are not expected to be significant.

Habitat development, principally riparian and wetland habitats, is the principal thrust for restoration actions. Restoration actions at Webb and Woodland Bottoms locations would occur behind flood control dikes under the current prescription. Insect faunal export from these locations would occur although they would not be as substantial as for locations directly connected to the Columbia River. The proposed restoration feature at Shillapoo Lake occurs behind flood control levees where there is currently no access by ESA-listed salmonids. Construction impacts to wetland habitats would be contained behind the levees and would not affect ESA-listed salmonids.

6.2.2 Indirect Effects

The 2001 BA determined that, of the 38 conceptual ecosystem model indicators that potentially could be influenced by the Project's construction, maintenance, and effects minimization activities, a total of 20 indicators of ecosystem process and function may be influenced. After review of the conceptual ecosystem model (*see* Chapter 5 of the 2001 BA) and the effects analysis in the 2001 BA (*see* Chapter 6), NMFS analyzed five habitat forming process indicators (suspended sediment, bedload, turbidity, salinity, bathymetry) and three key habitat types (tidal marsh and swamp, shallow water and flats, and water column) associated with physical and biological indicators that could be potentially be affected by the Project.

The seven key indicators (insects, macrodetritus, microdetritus, benthic algae, deposit feeders/suspension-deposit feeders/suspension, mobile macroivertebrates, and phytoplankton) that link the prey base to ESA-listed salmonids are integrated into the discussion of key habitat types in which they are primarily found. The habitat complexity, connectivity, and conveyance; feeding habitat opportunity; refugia; and habitat-specific food availability indicators are analyzed as a grouping because they can affect more than one habitat type, and this grouping better reflects an ecosystem approach to impact assessment.

The final indicator analyzed, fish stranding, potentially results from deep-draft vessel traffic that is interdependent to the Project, and is thus addressed in section 6.5 of this Opinion.

Ecosystem Indicator - Suspended Sediment (including an analysis of accretion and erosion). Proposed dredging and disposal actions and future interrelated activities may influence suspended sediment concentrations in the Lower Columbia River, estuary and river mouth. In areas beside dredges and shoreline disposal operations, increases in suspended sediment concentrations may temporarily increase local water column turbidity.

Dredging operations are likely to cause downstream suspended sediment increases of zero to two mg/L, depending on the number and type of dredges operating. Most of the dredging and disposal-induced suspended sediment should rapidly settle onto adjacent substrates. Ocean disposal will result in longer periods of sediment suspension before the sediment settles onto the deepwater substrate. 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 cy of suspended sediments over the two-year construction period.

Background suspended sediment loads for the same two-year period have been estimated at four mcy. The Project would have a maximum increase of 4.5% in the suspended sediment load and generally equates to less than one mg/L increase in suspended sediment concentrations. It is likely that these volumes will have limited influence on accretion and erosion in important salmonid habitat areas.

Contaminants associated with dredged and disposed sediments may be resuspended in the ecosystem. Contaminants are discussed in section 6.4.2, below. However, much of the material to be dredged from the navigation channel will originate from existing sand waves, a dynamic natural feature of the river bottom, that are constantly on the move due to current action. These sand waves contain a small percentage of fine sediments and organic material, thus have the potential to carry a limited amount of contaminants into natural resuspension from current action or dredging and disposal.

Dredged materials from Project berth areas are higher in silts and clays, and may have higher potential to create suspended sediments while dredging is occurring, as well as higher potential for associated contaminant resuspension. Materials resuspended by dredging and disposal activities may accumulate within the ETM, and be redistributed into lateral habitats of importance to salmon. The effects of the deposition of additional fine sediments into lateral habitats may be beneficial to those habitats, or detrimental due to the presence of contamination. Resuspension of contaminants related to the Project are further described below. Interrelated and/or interdependent activities, such as deepening of adjacent ports and berths can also have similar influence on suspended sediments. Ship wakes, interrelated to the Project, will cause limited increases in suspended sediment, however, the deepened channel may result in less ship traffic and overall less ship wake-induced suspended sediment.

NMFS believes that Project-related changes to suspended sediment could affect the habitat-forming process of sediment accretion and erosion. The Project-related addition to the suspended sediment load may result in a limited increase in accretion of sediment in lateral habitat areas. However, it is unlikely that this Project effect will have any significant benefit to habitats used by ESA-listed salmonids. As noted above, the effect of turbidity increases from Project activities is discussed in section 6.2.2.3, below.

Ecosystem Indicator - Bedload (including an analysis of accretion and erosion). Riverbed side-slope adjustments and some shoreline erosion are predicted to alter the accretion and erosion patterns within shallow water and flats habitat in the Lower Columbia River at five locations – RM 99, 86, 75, 72, and 46 through 42. A single location in the estuary, RM 22.5, is projected to experience riverbed side-slope adjustments. These six locations are all historic dredge material disposal sites, and provide limited salmonid habitat.

The side-slope adjustment process will take five to ten years to occur after construction. Over that time, shallow water and flats habitat at six shoreline disposal sites will tend to erode toward the shoreline and become deeper. The Corps determined that side-slope adjustments will not occur in natural shoreline areas because these riverbanks are stable, indicating that it is unlikely that tidal marsh and swamp habitat would be affected by side-slope adjustments. The Corps proposes to monitor for any impacts from side-slope adjustments to riparian habitats, including tidal marsh and swamp habitat. This information will enable the Corps and NMFS to track and react to potential changes in side-slope adjustment.

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. The removal of sand from the river via dredging and upland disposal will not alter the ongoing, natural sediment transport process towards the estuary. The volume and rate of the bedload movement is not expected to change with Project activities. The volume of sand to be dredged over the life of the Project represents a small 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. Therefore, it is likely that the impact to bedload processing of sand removal associated with the Project will be of a limited nature.

NMFS believes that Project-related effects to bedload may alter potential habitat for ESA-listed salmonids at one estuarine and five riverine sites. Predicted side-slope adjustments could harm these species' aquatic habitat by alteration of shallow water, shoreline habitat. Shoreline habitats provide important feeding and rearing areas for these species, therefore any effects to these habitats, above those effects or locations predicted in the 2001 BA, are important to monitor and address.

However, these six shoreline sites are highly erosive and unstable, and do not provide high quality habitat for ESA-listed salmonids. Additional effects discussion regarding side-slope adjustment is provided in section 6.3, below.

Ecosystem Indicator - Turbidity. Turbidity affects the ability of light to penetrate into water, and in turn, affects the amount of plant growth that can occur. This is important for habitat development, particularly in the shallow water areas, because the plant growth adds stability and reduces the chance for erosion. Turbidity plumes resulting from Lower Columbia River and estuary dredging and disposal occurs in a "near field" area (Carlson *et al*., 2001).

Increased turbidity from these Project activities are below the known turbidity levels that stimulate avoidance response by juvenile salmonids, as identified by Servizi and Martens (1992).

Some temporary and localized changes to river and estuary turbidity levels are anticipated to occur from the Project. Localized turbidity levels from Project construction and maintenance activities, five to 26 NTUs above background levels, are not likely to produce detectable effects on plant growth in the lower river or estuary. Increased turbidity will be localized to deep water areas where dredging and in-water disposal will occur. These limited increases to Columbia River and estuary turbidity levels will occur in deeper water areas where the majority of ESA-listed salmonids' migration and feeding activities are not occurring. Local turbidity increases in shallow water areas will occur during shoreline disposal. Ocean disposal will result in localized and short-lived periods of increased turbidity. While high levels of turbidity are known to affect salmonid physiology and feeding success, the combined background and Project-related turbidity concentrations within the action area are expected to generally remain well below known salmonid impact levels (*see* 2001 BA Sections 4 and 6.1.4). Any project-related turbidity increases should be limited to the immediate vicinity of the dredge cutterhead or draghead.

Ecosystem Indicator - Salinity. The concentration of salinity in important habitat and rearing areas of the estuary and the longitudinal gradient of salinity between the freshwater and ocean environments that bound the estuary are important to salmonid growth and survival. The Project will change the estuary's cross-sectional profile and have associated effects on estuary salinity gradients. Based on the WES RMA-10 and OHSU/OGI modeling, the largest Project-related impacts on salinity profiles occur at the lowest river flow analyzed (70,000 cfs).

In shallow areas of Cathlamet Bay and Grays Bay, where important juvenile salmonid habitat and food resources exist, the WES RMA-10 model predicted a post-Project salinity increase of 0.1 to 0.15 ppt. The OHSU/OGI model confirmed these predictions. Within the deeper navigation channel, where limited juvenile salmonid habitat and food resources exist, the WES RMA-10 model predicted post-Project salinity increases in the range of 1.0 to 1.5 ppt. The OHSU/OGI model confirmed these findings, but predicted slightly larger increases in salinity than those predicted by WES RMA-10 modeling for Youngs Bay and along the Oregon side of the navigation channel up to Tongue Point.

Modeling runs for higher river flows indicated even smaller post-Project salinity increases in important salmonid habitats. The OHSU/OGI model also was used to determine if, post-Project, there would be a significant change in habitat opportunity, as defined by Bottom *et al*. (2001) and the SEI workshop process. Using the OHSU/OGI model an example of the potential changes to habitat opportunity was developed by modeling Cathlamet Bay for five, one-week model simulations (*see* Table 6-1 of the 2001 BA). The model predicted, for important, shallow water Cathlamet Bay salmonid habitats, there was virtually no difference in the habitat opportunity, pre- and post-Project, for salinity between 0-5 ppt.

Changes to the ETM can effect phytoplankton, nutrient cycling, and availability of salmonid prey primarily within the estuary. Changes in salinity as a result of the Project could result in a permanent shift in the boundaries of the ETM, of up to one mile upstream This upstream movement will affect the location where imported phytoplankton die, and with other accumulated organic matter, are cycled through the estuary system. A change in the location and range of the ETM may affect the distribution of nutrients and thereby the location and abundance of salmonid food in shallow water habitats.

While it is believed salmonids do not feed in the ETM, nutrient cycling from the ETM may transfer to shallow water habitats and to the food items which juvenile salmonids prey on. No change in type or quantity of imported phytoplankton is anticipated in the short-term, and short-term effects to salmonids from predicted shifts in ETM, and subsequent modification in nutrient cycling, is anticipated to be limited. However, long-term impacts of the predicted shift in the ETM, based on potential changes to phytoplankton and nutrients (*see* Table 7-1 of the 2001 BA) over the Project's life are uncertain. NMFS believes the Corps' proposed Columbia River ETM workshop should enhance the understanding of the ETM and its influence on estuary ecosystem function. NMFS expects workshop findings will be discussed within the adaptive management process for the Project. Project modifications will then be implemented, as necessary, to minimize Project-related effects to the ETM.

Ecosystem Indicator - Bathymetry (including an analysis of velocity field). Bathymetric changes will occur in and beside the navigation channel. Dredging will lower the riverbed by three feet, in and beside the navigation channel. Long-term riverbed adjustments will occur on adjacent side slopes (*see* section 6.2.2, above). Within the riverine areas, 60% of the navigation channel will require deepening, whereas only 45% of the navigation channel in the estuary reach will require dredging. In-water and shoreline disposal of dredged materials will cause bathymetric changes by raising river and ocean bed elevations at disposal sites.

The deepened navigation channel will result in a small effect (decrease of up to 0.18 feet) on Columbia River water surface elevations in the upper Project area; an essentially immeasurable decrease (0.02 feet) in water surface elevation in the estuary; and no water surface elevation change in the river mouth reach. Of all ESA-listed salmonids, only Columbia River chum salmon spawning habitat occurs in the Project area. However, these water surface elevations should not impact existing habitats (*e.g.*) spawning and/or rearing, or reduce salmonids' ability to access those habitats.

Water surface elevation reduction would have limited effects on salmonid spawning and survival of eggs in redds upstream from the I-205 Bridge, and minimal impact on juvenile salmonid accessibility to shoreline habitats throughout the Project area. Also, within the upper river portion of the Project, lower water levels may allow marsh progradation (*i.e.*, building out) waterward of the marsh. The OHSU/OGI model evaluated pre-and post-Project water depth differences in terms of hours of habitat opportunity. The model outputs for important, shallow water Cathlamet Bay salmonid habitats, are nearly identical for pre- and post-Project water depths, indicating effects of the proposed action on the water depths will have a limited impact on habitat opportunity.

Changes in bathymetry from dredging and disposal may change river velocity, and thereby affect habitat opportunity. The WES RMA-10 modeling results indicated that average pre- and post-Project velocity differences are small, ranging from approximately -0.2 foot per second to 0.2 foot per second. The largest velocity differences were noted in the navigation channel.

Pre- and post-Project velocity differences in shallow salmonid habitat areas outside the navigation channel ranged from approximately -0.05 to 0.05 foot per second. OHSU/OGI modeling supports these results. The post-Project velocities are well within the range of favorable velocities identified for juvenile salmonids, as defined by NMFS (Bottom *et al*. 2001). The OHSU/OGI model evaluated pre- and post-Project velocity magnitude differences in terms of hours of habitat opportunity. Modeling results were done for vertically-averaged water column velocities and for minimum and maximum water column velocities. Both the spatial distributions and the area-weighted averages for water column velocity were similar for pre- and post-Project. Maximum differences in average hours of approximately 10 to 15% (increase and decrease) between base and plan were predicted for model runs at both low and high flow. In these cases, the model runs for the post-Project scenario estimated higher habitat opportunity hours than the environmental baseline.

Based on the impacts to water depth-associated habitat opportunity, NMFS concludes that there will be limited, short-term effects on feeding habitat opportunity or refugia for yearling and older salmonids. In particular, the changes in water surface elevations projected within the estuarine and riverine reaches are not likely to alter the amount or location of refugia. In addition, changes to river current velocity from the proposed dredging are anticipated to be small (particularly in the side channels and shallow water areas that provide the refugia) and will not affect the function of the available refugia. This is because yearlings are commonly found in areas of both low and relatively high current speeds as they rapidly migrate downstream. Generally, yearlings are not strongly shoreline-oriented, although some are found in shoreline areas.

In addition, yearlings tend to be surface-oriented, but feed over a relatively wide range of depths, from the surface up to five to ten meters deep. For subyearling fish, changes in refugia and feeding habitat opportunity may be more pronounced. While short-term impacts appear to be unlikely, the long-term impacts to habitat opportunity and refugia over the Project's life from these limited bathymetric and hydraulic changes cannot be quantified and are therefore uncertain. Any long-term, negative changes in bathymetric or hydraulic conditions may harm these species' aquatic habitat, thereby negatively effecting refugia and habitat opportunity for these species. Therefore any effects to these habitat conditions, above those effects or locations predicted in the 2001 BA, are important to monitor and address via the adaptive management process.

6.3 Effects from Construction and Maintenance Activities on Key Salmonid Habitats

During the course of this reinitiation of consultation, much discussion centered around the potential effect of construction and maintenance activities on tidal marsh and swamp, shallow water and flats, and water column habitats. The conceptual ecosystem model identified these habitat types as particularly important to juvenile salmonids residing in the estuary. Thus, NMFS has focused on these habitat types in its effects analysis. Below is a detailed examination of these three key habitat types, and the Project-related effects to them.

6.3.1 Tidal Marsh and Swamp

Tidal marsh and swamp habitat occurs sporadically along the margins of shallow water areas of the Columbia River and estuary, with these habitats' most concentrated occurrence in the estuary and downstream portions of the riverine reach. Ocean-type Chinook and chum salmon commonly use these habitats, and stream-type salmonids also will use these habitats during their shorter occupancy periods.

No dredging within the tidal marsh and swamp habitat is planned. Likewise, no filling of tidal marsh and swamp habitat is proposed as a part of the Project. NMFS, in analyzing potential Project effects to tidal marsh and swamp, focused on the habitat-forming processes of salinity and bathymetry that may affect tidal marshes and swamp habitats.

Based on the WES RMA-10 and OHSU/OGI model outputs, the post-Project salinity distribution is unlikely to change within shallow water estuary areas, where much of the tidal marsh and swamp habitat is located. In addition, even if larger post-Project salinity changes occur in the estuary, the dominant marsh plants found in these habitats exhibit wide salinity tolerances. In upriver areas, tidal marsh and swamp habitats will not be influenced by any post-Project changes to salinity distribution, as these habitat features are upstream from salt water influence.

The other major habitat-forming process that may influence tidal marsh and swamp habitat is bathymetry. Predicted post-Project water surface elevation changes range from zero to -0.18 foot, with the smallest elevation changes predicted in the estuary and lower river areas. In fact, tidal marsh and swamp habitat may increase slightly in upriver Project areas as a result of the channel deepening. The predicted decrease in water surface elevation in upriver areas may provide more shallow water habitat that is at the appropriate depth for tidal marsh to develop. This would allow tidal marshes to establish or expand, and may lead to a long-term, small increase in tidal marsh habitats.

Side-slope adjustments are not expected to occur in natural shoreline areas because these areas are stable, indicating that it is unlikely that tidal marsh and swamp habitat would be affected by post-Project side-slope adjustments. The Corps proposes to monitor for any impacts from side-slope adjustments to riparian habitats, including tidal marsh and swamp habitat. This information will enable the Corps and NMFS to track and react to potential changes in side-slope adjustment.

The following are the two specific environmental indicators that could be affected by changes to tidal marsh and swamp habitats:

Insects. Terrestrial insects that form part of the prey base for juvenile salmonids include larval forms, as well as adults. Insect larvae and some adults are often found in the stomachs of salmonids that feed in shallow flats and marsh channels. Salinity intrusion, associated primarily with the main channel, is not expected to change the abundance of insects that are primarily along the water margins in shallow wetlands and marsh channels.

Short-term impacts to insect abundance and diversity are likely to be limited. Based on Table 7-1 of the 2001 BA, the uncertainty and risk of impact to insect production and salmonid food availability, although potentially limited, is uncertain in the long term. Long-term monitoring, as recommended above for areas of side-slope adjustment, will provide information on Project-related effects to insect production.

Macrodetritus and Microdetritus. The production of prey resources important to juvenile salmonids is partially supported by marsh detritus. Resident microdetritus, which is derived from benthic and planktonic algal production, is important to suspension feeders and suspension/deposit feeders. Imported microdetritus is mostly derived from algal production upriver, including that produced above dams. As a primary producer, it is an important food source for suspension feeders and suspension/deposit feeders that form part of the prey base for juvenile salmonids.

The proposed dredging action is not likely to have an effect on the amount or productivity of tidal marsh macrodetritus or microdetritus. This is because no dredging or disposal within the tidal marsh and swamp habitat is planned.

Due to the predicted lowering of water elevation in the upper portion of the Project area, the amount and characteristics of tidal marsh and swamp habitat could result in limited expansion along the shallow water margins of the upper Project area. Increased macrodetritus and microdetritus production may occur from limited marsh expansion upstream from RM 80. Due to the predicted upstream shift of the ETM, there may also be a limited shift in the extent of resident and imported microdetritus food web input. The Project may also result in a small shift in the location of where resident microdetritus dies. Thus, short-term impacts to macrodetritus and microdetritus are likely to be limited. Based on Table 7-1 of the 2001 BA, the risk and uncertainty to this indicator suggests the limited nature of this expansion will have an uncertain benefit to ESA-listed salmonids in the long term.

Tidal Marsh and Swamp Summary. NMFS anticipates negative short-term Project-related effects to tidal marsh and swamp habitats will be limited. As described in the SEI risk assessment, long-term Project effects to tidal marsh and swamp habitats are of moderate uncertainty to occur, but have a low risk to impact habitat (*see* 2001 BA, Table 7-1). Any long-term, negative changes in tidal marsh or swamp habitat may harm ESA-listed salmonids feeding and refugia needs. Therefore, any effects to these habitat conditions above those effects or locations predicted in the 2001 BA will be monitored and addressed over the Project life.

6.3.2 Shallow Water and Flats

Shallow water and flats habitats provide important feeding and rearing areas for ocean-type, ESA-listed salmonids. Stream-type juveniles may also potentially use shallow water and flats habitat within the Lower Columbia River and estuary during their shorter occupancy periods. In addition, adult chum salmon use shallow water habitat for spawning in the riverine reach upstream from the I-205 Bridge. NMFS, in analyzing potential Project effects to shallow water and flats habitats, focused on Project-related effects from side slope adjustments after channel dredging and after shoreline disposal, and also reviewed Project effects to ecosystem indicators that would respond to changes in shallow water and flats habitat.

The entire post-Project navigation channel may experience side-slope erosion and subsequent adjustment of side-slope angle. The erosion and adjustment will, over five to ten years, lower the adjacent riverbed angle until a new, more stable side-slope is established. While side-slope adjustments will occur throughout the Project area in deeper water, where minimal salmonid habitat use is known to occur, some side-slope adjustment will occur in shallow water and flats habitats.

The Corps predicts shoreward erosion from side-slope adjustment to occur in a total of six sandy beach areas: five in the Lower Columbia River (RM 99-86, 75, 72, and 46-42) and one in the estuary (Miller Sands Spit). These areas have shallow water habitats that could be used by salmonids, however, the Corps indicates these are highly erosive areas that have little productivity.

NMFS believes that, even though each of the six sandy beach sites may experience ten to 50 foot lateral erosion into the sandy shoreline, minimal impact to salmonids or their shallow water habitat will occur. As noted in section 6.2.2, above, predicted side-slope adjustments will affect habitat for ESA-listed species by alteration of these six areas with shallow water, shoreline habitat. Shallow water habitats provide important feeding and rearing areas for ESA-listed salmonids, therefore any effects to these habitats, above those effects or locations predicted in the 2001 BA, will be monitored and addressed. However, these six shoreline habitats are highly erosive and unstable, and do not provide high quality habitat for these species.

Shoreline disposal could potentially disturb and shift the location of shallow water habitat at three proposed shoreline disposal sites. No salmonids will be injured during shoreline disposal activities, as dredged materials are discharged above the water line. Therefore, NMFS' analysis focused on the potential for disturbing salmonids that use existing shallow water habitat within these areas. The three shoreline disposal locations have steep side slopes (around 10%) that provide about seven acres per mile of shallow water areas. Shoreline disposal will affect a total of about 4.5 miles or 30 acres of shallow water. While 30 acres of shallow water habitats will be periodically impacted during the Project life, the three disposal sites are all highly erosive and do not contain many of the important habitat features that shallow water habitats typically include, such as low velocity, vegetation, and food sources. These sites had previously been approved by NMFS for shoreline disposal because of their low productivity.

The following is the one specific environmental indicator that could be affected by changes to shallow water and flats habitats:

Benthic Algae. Benthic algae consist primarily of benthic diatoms that occur on sediment grains and larger inorganic material and on macrophytes as epiphytes.

There will be no dredging in the shallow flats and channels where benthic algae primarily occur. Flowlane disposal is not expected to affect benthic algae because it is done below the depth range where benthic algae occur, about 1 meter below MLLW. No dredging or disposal activities are proposed for areas with significant benthic production. The closest potential effect would be from the shoreline disposal at Sand Island (O-86.2). However, the existing currents and erosion rates at the beach nourishment site create a coarse-grained and erosive environment that severely limits the potential for significant benthic production. Accordingly, no effects to benthic production are anticipated in the riverine reach.

Modeling by OHSU/OGI and WES predicts an upstream shift of salinity of less than a mile. Accordingly, there may be an upstream shift in the location of benthic algae production. Any salinity change would occur primarily in the navigation channel, not in productive side channels or lateral habitats. Thus, short-term impacts to benthic algae are likely to be limited. However, long-term Project-related indirect impacts are uncertain (*see* Table 7-1 of the 2001 BA). NMFS believes long-term risk to food web production for ESA-listed species, based on changes to benthic algae production, is limited.

Shallow Water and Flats Summary. NMFS anticipates that negative short-term Project-related effects to shallow water and flats habitats will be limited to areas of side slope adjustment and shoreline disposal. Long-term Project effects to shallow water and flats habitats are of moderate uncertainty, to occur with low to moderate risk to impact habitat (*see* 2001 BA, Table 7-1). Any long-term, negative changes in shallow water and flats habitat may harm benthic production, feeding, migration, and refugia needs for ESA-listed salmonids. Therefore any effects to these habitat conditions, above those effects or locations predicted in the 2001 BA, will be monitored and addressed through the adaptive management process.

6.3.3 Water Column

The upper portion of water column habitat is used for salmonid movement, migration, and feeding. Deeper water column habitat in the Lower Columbia River, estuary and river mouth is less used by salmonids, with water deeper than 20 feet believed to be rarely used. Water column habitat beside the navigation channel, turning basins, and berths will be directly increased to no more than 48 feet deep. The Project may affect water column habitat by short-term blasting activities, by temporary water clarity reduction during dredging and flowlane disposal activities, and by long-term changes in estuary salinity distribution and ETM range.

Blasting will be done once during Project construction, and will occur only during the in-water work window. Blasting may have direct effects to salmonids, and was discussed in section 6.2.1 of this Opinion. Blasting only during the in-water work window minimizes, but does not avoid, direct impacts to ESA-listed salmonids, which may use the Warrior Rock area year-round. As noted in section 6.2.1 above, NMFS believes that development of a NMFS-approved monitoring plan, that ensures that the proposed blasting measures are implemented, will be important to minimize any injury or death to these species during blasting activities.

Temporary water clarity reductions will occur from dredging and disposal activities. A proposed impact minimizing action will require all in-water disposal activities, except shoreline disposal, to occur below 20 feet in depth, where less salmonid use occurs. As noted in the turbidity discussion above, these temporary turbidity increases will not decrease plant growth and subsequent habitat forming processes, nor are the Project-related turbidity levels anticipated to impact salmonid physiology or feeding (*see* 6.2.3, above). Project construction and maintenance activities may occur outside of the normal November 1 to February 28 in-water work period. Therefore increased turbidity may occur during periods of highest salmonid abundance in the Project area. Juvenile salmonids occur primarily at depths shallower than 20 feet, and so would not be expected to be impacted by turbidity from dredging and disposal operations. NMFS believes these slight increases to Columbia River and estuary turbidity levels will occur in deeper water areas where the majority of ESA-listed salmonid migration and feeding activities are not occurring. Therefore, the ESA-listed salmonids should experience only limited harassment from increased water column turbidity.

As noted in the ETM and salinity discussions above, the WES RMA-10 and OHSU/OGI models predicted that there was virtually no difference in the habitat opportunity (*i.e*., salinity "accumulation") between pre- and post-Project modeling runs for important shallow water Cathlamet Bay salmonid habitats. However, a shift in the location of the ETM would occur and may affect the estuarine distribution of nutrients and thereby the location and abundance of salmonid food in shallow water habitats. The risk and uncertainty to the ETM, based on changes in salinity (Table 7-1 of the 2001 BA), is low in the short term, but more uncertain in the long term because of extrapolating modeling results over the life span of the Project.

The following three specific environmental indicators: (1) Deposit feeders, suspension-deposit feeders, and suspension feeders; (2) mobile macroinvertebrates; and (3) phytoplankton could be affected by changes to water column habitats.

Deposit Feeders/Suspension-Deposit Feeders/Suspension Feeders. Limited removal of organisms via dredging and burying of deposit feeders, suspension/deposit feeders, and suspension feeders will occur in portions of the navigation channel deep water areas and the three shoreline disposal sites. Flowlane disposal will bury some animals and, if deposition of sediments is heavy, will result in the partial loss of some communities. Removal and burial effects are expected to be relatively short-lived, with dredge and disposal areas being recolonized by deposit feeders. Deposit feeders occur in low densities in the navigation channel because the sand waves create constantly shifting habitat conditions. In these and other areas of the river, densities fluctuate as a result of constantly changing environmental conditions. No changes to deposit feeders are anticipated in shallow water areas, side channels, or embayments, which are the important locations for salmonid feeding opportunities. Other than the low risk identified to deposit feeders in the bottom of the navigation channel, Table 7-1 of the 2001 BA suggests that the long-term changes from dredging and disposal to deposit feeders, suspension/deposit feeders, and suspension feeders is uncertain. Because deposit feeders, suspension/deposit feeders, and suspension feeders are prey items for ESA-listed salmonids, any removal of these organisms via dredging or disposal may cause short-term harm to these fish species. However, because the loss of food items is limited, will not occur in the most important habitat types, and these invertebrates recolonize dredge and disposal locations rapidly, NMFS believes the potential for such harm is minimal.

Mobile Macroinvertebrates. Dredging will result in removal of mobile macroinvertebrates in the channel. Entrainment by dredges is likely lethal to macroinvertebrates. In addition, flowlane disposal may temporarily bury some animals and, if deposition of sediments is heavy, will result in the loss of some members of the group. Removal and burial effects are expected to be relatively short-lived, with dredged areas being recolonized within six to 12 months (Flemmer, *et al*., 1997). Mobile macroinvertebrates in shallow water, flats, and tidal marsh channels are not likely be affected. ESA-listed salmonids may feed on certain mobile macroinvertebrates, and therefore any loss of these prey items via dredging or disposal may harm these species. However, NMFS anticipates this harm from dredging or disposal to be localized to areas of low importance to these species.

Mobile macroinvertebrates in the estuary appear to be adapted to respond rapidly to disturbances and can recolonize areas following these disturbances. Due to this group's wide salinity tolerance, Project-related changes in estuary salinity are not expected to have an effect on the distribution of mobile macroinvertebrates. In addition, since Project-related temperature and suspended sediment changes are not anticipated or will be limited in nature, mobile macroinvertebrates should not be influenced by limited Project-related changes to these indicators.

<u>Phytoplankton</u>. Because salinity may intrude farther into the estuary as a result of the deeper channel depth, the point where imported phytoplankton contact dilute seawater will be farther upstream from current conditions. Predicted changes in salinity intrusion may affect the location of resident phytoplankton productivity. Based on Table 1 of the 2001 BA, the short-term impacts to imported and resident phytoplankton productivity changes are likely to be limited, and will not harm ESA-listed species. However, long-term impacts over the Project's life, based on the BRT's risk and uncertainty analysis, are uncertain.

<u>Water Column Summary</u>. NMFS anticipates that negative, short-term Project-related effects to water column habitats will be limited to blasting areas and areas where in-water disposal is occurring, and to ecosystem indicators associated with inwater disposal. NMFS believes that development of a NMFS-approved monitoring plan that ensures that the proposed blasting measures are implemented, will be important to minimize any injury or death of ESA-listed salmonids during blasting activities. NMFS believes that only limited harassment from increased water column turbidity will occur to ESA-listed salmonids. Removal of deposit feeders, suspension/deposit feeders, suspension feeders, and mobile macroinvertebrates via dredging or disposal activities may cause short-term harm to ESA-listed salmonids. Long-term Project effects to water column habitats are of moderate uncertainty, with low risk to adverse habitat modification (*see* 2001 BA, Table 7-1). Any long-term, negative changes in water column habitat may harm feeding, migration, and refugia needs of ESA-listed salmonids. Therefore, any effects to these habitat conditions, above those effects or locations predicted in the 2001 BA, are important to monitor and address via the adaptive management process.

6.4 Indicators that Occur in More Than One Key Habitat Type

6.4.1 Habitat Complexity, Connectivity, and Conveyance; Feeding Habitat Opportunity; Refugia; and Habitat-specific Food Availability

In discussion associated with this consultation, consideration was given to whether the proposed Project has the potential, based on post-Project changes in water surface elevation, velocity, and salinity intrusion, to change habitat complexity, connectivity, or conveyance; feeding habitat opportunity; refugia; and habitat-specific food availability associated with tidal marsh and swamps and shallow water and flats habitat areas. These are indicators that may respond to Project-related changes in any of the key habitat types, and therefore reflect an ecosystem approach to impact assessment.

The Corps undertook modeling to examine the potential Project effects on habitat opportunity and key habitat types from changes in water surface elevation, velocity, and salinity intrusion. The OHSU/OGI and WES RMA-10 modeling results indicate slight changes to water surface elevation, velocity, and salinity intrusion. Within Cathlamet and Grays Bays' tidal marsh and swamps and shallow water and flats habitat habitats, modeling predicted post-Project salinity increases of 0.1 to 0.15 ppt, velocity decreases of 0.05 feet per second, and depth changes of less than 0.02 feet. Habitat opportunity, based on a combined analysis of these indicators, shows no significant difference between pre- and post-Project conditions in tidal marsh and swamps and shallow water and flats habitats. The OHSU/OGI modeling also related these physical parameters to the concept of habitat opportunity (*see* Bottom *et al*., 2001). In the modeling example provided by OHSU/OGI, navigation channel improvements are predicted to result in a limited change in habitat opportunity hours for Cathlamet and Grays Bays, based on the depth and velocity criterion and salinity "accumulation."

The two indicators most related to habitat opportunity are feeding habitat opportunity and refugia (*see* Chapter 5 of the 2001 BA). Additional indicators related to habitat opportunity are habitat complexity, connectivity, and conveyance, and habitat-specific food availability. Based on the limited impacts indicated by the OHSU/OGI habitat opportunity modeling results, NMFS believes the Project will have limited short-term effects on tidal marsh and swamps and shallow water and flats habitat habitats. Limited effects to these key habitats should result in limited effects to associated habitat complexity, connectivity, and conveyance; feeding habitat opportunity; habitat-specific food availability; and refugia for ESA-listed salmonids. NMFS anticipates limited harm to ESA-listed salmonids from changes to habitat opportunity and associated indicators.

Model-generated estimates of habitat opportunity provide an indication of limited change to depth, velocity, and salinity within key habitat types (tidal marsh and swamps and shallow water and flats habitat habitats), but do not predict response by key habitat or other related indicators' to Project-related changes in depth, velocity, and salinity over the long term. This fact, combined with the risk and uncertainty indications provided in Table 7-1 of the 2001 BA for habitat opportunity-related indicators, suggest that the long-term impact to these indicators is uncertain. NMFS believes any effects to these habitat conditions, above those effects predicted by modeling or presented in the 2001 BA, are therefore important to monitor over longer time scales and address via adaptive management.

6.4.2 Contaminants

Dredging and in-water disposal activities in the navigation channel turning basins and berths, and in-water disposal activities in the ocean, along with other natural and anthropogenic processes, could expose salmonids to some contaminants. Of particular concern is resuspension of persistent organochlorine contaminants including total polychlorinated biphenyls (PCBs) and the pesticide DDT and its metabolites DDE and DDD ($\sum$DDTs), which have bioaccumulated in resident fish and wildlife within the estuary (*see* terrestrial species Opinion for further description of these concerns). In addition, petroleum compounds, characterized as total polyaromatic hydrocarbons (PAHs), have been identified in Lower Columbia River sediments. The organochlorine and PAH contaminants have the ability to impact growth, survival, and reproduction of juvenile salmon and trout, and can cause sublethal effects such as immune dysfunction (Arkoosh *et al*. 1991; *see also* 2001 BA, Appendix B for further discussion of lethal and sublethal impacts of these chemicals on salmonids). Data collected by NMFS indicate that juvenile salmonids within the Columbia River estuary have contaminant body burdens that may already be within the range where sublethal effects may occur, although the sources of exposure are not clear (NWFSC Environmental Conservation Division, 2001).

Data are sparse regarding the exact pathways for uptake and bioacumulation of contaminants by juvenile salmonids in the Lower Columbia River, or the relationships between sediment and tissue contamination (2001 BA Appendix B for identification of specific pathways for salmonids). Recent studies suggest that sediments are a major source of hydrophobic contaminants to aquatic biota (Zaranko *et al.*, 1997, Maruya and Lee, 1998). In sediments, contaminants are adsorbed to the organic carbon in silt, which is part of the fine particulate fraction. The microbial biofilm that accumulates on the surface of organic particles constitutes the food of certain types of epibenthic invertebrates; together they make up the pathway by which these contaminants enter food chains involving juvenile salmonids. Thus, juvenile salmonids bioaccumulate organochlorine contaminants and PAHs principally from their food (*i.e.*, epibenthic prey species) as opposed to water. NMFS has documented some contaminants in the epibenthic prey species of juvenile salmonids in the Lower Columbia River (NWFSC Environmental Conservation Division, 2001).

In order to adequately address the potential contaminant-related impacts from Project activities, it is important to assess the amount of fine-grained (and thereby potentially-contaminated) material retained in the estuary following dredging and disposal activities. According to the 2001 BA, the Columbia River navigation channel is dominated by coarse-grained materials (primarily sand) with very low organic carbon, although pockets of fine materials are occasionally encountered, such as within the turning basin at Astoria, Oregon. The navigation channel is characterized by sand waves along the riverbed that move downstream. As the downstream sand movement occurs, bedload transport erodes sand from the upstream face, deposits in the downstream trough, and then buries it with more sand eroded from the upstream face. This transport occurs in a layer only a few sand grains thick. The sand that forms the cutline shoals or sand waves is repeatedly re-exposed to the water column. Consequently, fine material mixed in with the sand is likely to be swept away as the layers are exposed to the river currents, resulting in the limited potential for release of fines during the dredging activity. The Corps employed a risk-based analysis (*see* Appendix B of the 2001 BA) to address the potential resuspension of contaminants (total PCBs, ΣDDTs, and total PAHs) produced by Project construction and maintenance activities. The results of the Corps' assessment concluded that contaminant concentrations in the navigation channel sediments posed only negligible risk to juvenile salmonids, whereas some nearshore sediments closest to point sources of contamination posed risks.

It is important to ensure that sufficient sediment samples are available to adequately characterize the nearshore and channel sediment. During their Sediment Quality Evaluation for the Project, the Corps reported 3 of 23 samples chemically analyzed within or near the navigation channel contained fine-grained sediments with detectable levels of DDT, DDE, DDD, and total PCBs. However, none of these samples exceeded DMEF or NMFS recommended contaminants thresholds. These data and other sediment data were evaluated in the risk assessment for salmonids (*see* Appendix B of the 2001 BA), which concluded that sediments from the navigation channel pose negligible risks to salmonids. However, this Appendix B conclusion was based on relatively few sediment samples collected within the navigation channel, especially below RM 40. The Corps has subsequently submitted additional analysis of all available sediment and contaminants data from the Columbia River navigation channel (Corps' April 22, 2002, addendum). The Corps has determined there are no navigation channel sediment and contaminants data which exceed current DMEF contaminants thresholds. These additional data also do not exceed NMFS' thresholds for PCB's (75 ng/g dry weight for 1% total organic carbon [TOC]) and PAH's (1,000 ng/g dry weight sediment) (NMFS' contaminants thresholds provided by Johnson, NMFS Northwest Fisheries Science Center, 2002).

Due to the highly erosive and dynamic nature of the navigation channel, described above, and based on the Corps' risk analysis results and information provided in the Addendum to the 2001 BA, NMFS believes it unlikely that any contaminants within the navigation channel would be present in high enough concentrations to expose and impact ESA-listed salmonids and bull trout. However, it is unknown how much fine material will be resuspended during Project dredging and disposal activities, or whether or not any of the fine material released would be contaminated. The general lack of organic material and very low organic carbon concentrations in the navigation channel sediments would likely result in rapid transfer of any available carbon and contaminants into salmonid tissues. Even low concentrations of bioaccumulative contaminates would be readily available to salmonids in this situation, and predators higher in the food chain, such as bald eagle, could be more at risk than salmonids. Therefore, NMFS believes additional navigation channel samples should be periodically collected, and all other new sediment quality data evaluated, on a regular basis during Project activities to better determine the distribution of fine materials, carbon, or contaminants within the navigation channel.

In summary, NMFS believes that dredging and inwater disposal activities associated with the Project could release a small amount of fine-grained sediments. It is uncertain as to whether most of these fine-grained sediments would be uncontaminated (due to the erosional forces within the main channel of the river), or if some of the fine-grained material would be associated with contaminants. In the high-energy environment of the navigation channel, any contaminated material would move rapidly through the system and be deposited outside the flow lane in depositional areas within the estuary, or be transported down the flow lane and into the ocean. Any contaminants that did reach riverine and estuarine depositional areas, combined with contaminants transported and deposited due to natural and other non-Project anthropogenic sources, would eventually be redistributed, resuspended, and transferred along the estuary and river food chain.

The contribution of Project activities to contaminant burdens in salmonids is not well defined and, as such, some uncertainty exists as to Project effects to ESA-listed salmonids. NMFS therefore supports implementation of the Corps' contaminants research activities ERA-4 and ERA-5, proposed in the 2001 BA (*see* Table 8-1) and monitoring action MA-5, proposed in the 2001 BA (*see* Table 7-3). However, NMFS believes estimated risk of exposure of ESA-listed salmonids from contaminated sediments from Project activities appears limited (*see* Appendix B of the 2001 BA).

6.5 Effects from Interrelated and Interdependent Activities

6.5.1 Willamette River Navigation Channel Deepening

More than 11 miles of the Willamette River are included in the Project authorized by Congress but are not analyzed in the 2001 BA or this Opinion. Concerns over Willamette River sediment contamination and uncertainty regarding the scope and timing of remedial investigations and actions caused the Corps to remove this portion from the proposed action. Potential effects from any future Willamette River Navigation Channel deepening activity cannot be determined, due to the unknown implications of Superfund cleanup and other remedial actions. If the Corps is to proceed with a Willamette River navigation channel deepening project in the future, the Corps will be required to review the additional effects of this future Federal action through a separate ESA consultation process.

6.5.2 Deepening and Maintenance of Project Berths

Construction and maintenance dredging at a total of seven Lower Columbia River berths, associated with three grain facilities, one gypsum plant, and one container terminal, represent actions that are interrelated and/or interdependent to the Project. However, this Opinion does not provide incidental take coverage for berth dredging, as these activities will undergo future ESA consultation. The future ESA consultation will initiate upon NMFS' receipt of applications for Federal permits, before berth-dredging activities.

Future berth deepening and maintenance activities are likely to have both direct and indirect impacts on listed-ESA salmonids. Direct effects include death or injury due to entrainment during dredging activities. Indirect effects include harm and harassment to ESA-listed salmonids via increased turbidity, loss of food resources, and resuspension of toxic sediments.

Effects from future berth deepening activities will be minimized due to application of dredging and disposal BMPs and other compliance measures (*see* Table 3.2 of this Opinion). Sediment testing, based on DMEF protocols, will ensure dredged materials from berths are disposed in the least impactful method. Additional sediment testing may be required, during additional consultations (*see* discussion of MA-5 in section 3.2.6 of this Opinion). Dredging activities will occur within the November 1 to February 28 inwater timing window, when ESA-listed salmonid abundance is lowest. Dredge activities will occur in deep water, where food resources are limited and most salmonids are not present. Finally, higher quality habitat, associated with key habitat types in the ecosystem conceptual ecosystem model, are not believed to occur at these existing berth features, and therefore impacts to these habitats will be avoided.

NMFS believes berth deepening and maintenance will have limited future adverse effects on ESA-listed salmonids. While some of these adverse effects can be successfully minimized by application of BMPs and compliance measures, a limited amount of harm and harassment of ESA-listed salmonids is likely to occur from berth deepening and maintenance activities. These berth deepening and maintenance activities will undergo future ESA analysis before berth dredging activities to address this incidental take of ESA-listed salmonids.

6.5.3. Development of Port Activities and Deep Draft Vessels

Based on the Corps' 1999 FEIS analysis, future development of other Lower Columbia River port facilities is not analyzed here as an interrelated or interdependent activity because such development will be caused by regional market factors such as commodity demand, not by channel improvements. The Corps' April 15, 2002, addendum further supports the Corps' FEIS conclusion that, aside from berth deepening, potential future port development is not interrelated or interdependent with the Project.

Impacts from interdependent ship wakes would occur only if the Project resulted in more frequent or larger, higher-energy ship wakes. Current impacts from shallow- and deep-draft ship traffic utilizing the 40 foot navigation channel are considered part of the environmental baseline and are not considered interrelated or interdependent to the Project; only future, Project-dependent ship traffic is considered in this analysis.

The Corps analysis of post-Project ship wake effects indicated that larger, fully-loaded ships would have a 1 to 5% increase in "blockage ratio" (indicative of slightly higher ship wake generation), whereas smaller vessels would have a 1 to 5% decrease in "blockage ratio" (indicative of slightly lower ship wake generation). NMFS concludes that these limited increases and decreases in post-Project ship wake are not likely to increase suspended sediment, shoreline erosion, or increase current rates of ship wake-induced salmonid stranding.

In summary, the Corps concluded in their 1999 FEIS that channel deepening will not induce additional ship traffic, or contribute to development of additional port infrastructure or new ports. This conclusion is consistent with historical vessel traffic trends on the Columbia River and with the market forces that drive port facility development.

6.5.4 Non-indigenous Species Introductions

Several non-indigenous aquatic species are believed to have been introduced into the Columbia River via ballast discharge (*e.g*., Asian clam). These non-indigenous species introductions may continue to occur from ongoing vessel traffic, regardless of the Project's deepened channel. Future deep-draft cargo vessel traffic, interrelated and/or interdependent to the deepened navigation channel, also may introduce additional non-indigenous species. Federal authority for management and regulation of exotic species via ship ballast resides with the U.S. Coast Guard. While NMFS believes additional non-indigenous species introductions could have detrimental impacts on Columbia River and estuary ecosystem resources, NMFS does not believe that new boat traffic, interrelated and/or interdependent to the deepened navigation channel, will increase the risk of introduced species above current baseline levels.

Additionally, no other non-Project activities within the Lower Columbia River, estuary or river mouth have been reviewed in this effects analysis. Therefore, any additional actions to deepen or otherwise improve adjacent port facilities not addressed in this Project consultation and conference, would be subject to separate environmental analysis and regulatory review.

6.6 Uncertainty Regarding Project-related Effects and Associated Risk to Ecosystem Indicators as Related to Monitoring Actions

The SEI panel suggested that scientific and management decisions involve a level of uncertainty related to environmental effects and associated risk to the ecosystem from those environmental effects. Uncertainty pertains to the amount of information available to predict a Project-related change to an indicator. For instance, if ample information for an indicator was available, the uncertainty associated with that indicator, in regards to potential Project effects, would be low.

For the purposes of this reinitiation of consultation, risk pertains to the level of threat to the survival or recovery of ESA-listed salmonids from Project-related changes to indicators. For instance, if salmonids are extremely sensitive to small changes in an indicator, then the risk associated with any Project-related changes to that indicator would be high. For purposes of the reinitiation process, including BRT analysis and deliberations, each conceptual ecosystem model indicator was evaluated to determine uncertainties and risk from implementing the proposed Project activities. That information is included in the 2001 BA (*see* Section 7.2), and is incorporated herein by reference.

As noted above in sections 6.2.2 - 6.5 of this Opinion, NMFS believes that Project-related indirect effects to ecosystem indicators will be limited. Key physical processes that likely will have limited changes during the channel construction process include suspended sediment, accretion/erosion, turbidity, salinity, bathymetry, and bedload. The short-term nature of these impacts was discussed during the SEI panel process and verified using the numerical modeling conducted by WES and OHSU/OGI. It should be noted that the levels of Project risk to ecosystem indicators were not high enough to require Project modification, but due to long-term uncertainties, were still of a level that warrants verification through monitoring.

Based on uncertainties regarding potential long-term Project effects and associated risk to salmonids, the Corps proposed a monitoring program (*see* Table 3.5 and section 3.1.6 of this Opinion). NMFS reviewed and commented on the monitoring program as it was developed during the BRT process. The monitoring program addresses the long-term ecosystem uncertainties and risk to the main ecosystem indicators and key habitat features (Table 6.1) addressed in sections 6.2 - 6.7. Monitoring results will be reviewed, and future changes to management will occur if adverse findings are determined.

Table 6.1 Pathways and Indicators to be Addressed by the Monitoring Program

Monitoring Action	Pathway	Indicators
Maintain three hydraulic monitoring stations to investigate pre- and post-Project relationships among flow, tide, salinity, water surface, and water temperature	Habitat-forming processes	Bedload; Salinity
	Growth	Habitat complexity, connectivity, and conveyance; Velocity Field; Feeding Habitat Opportunity
Compare actual to predicted sediment dredge volume	Habitat-forming processes	Bedload
Complete bathymetric surveys to track habitat alterations	Habitat-forming processes	Accretion/Erosion; Bathymetry
	Key Habitat Types	Shallow water/flats habitat
Aerial and ground mapping to track habitat alterations	Key Habitat Types	Tidal marsh and swamp habitat
	Food Web	Suspension/deposit feeders; Insects; Tidal marsh macrodetritus
	Growth	Refugia; Habitat-specific food availability
Review sampling needs for contaminants	Survival	Contaminants

Monitoring Action	Pathway	Indicators
Investigate pre- and post-Project salmonid stranding events	Survival	Stranding

6.7 Effects Resulting from Proposed Monitoring, Ecosystem Restoration, and Research Activities

The BRT identified the monitoring, research and ecosystem restoration components of the proposed action to verify assumptions, reduce scientific uncertainties and provide for long-term beneficial effects to ESA-listed salmonids and their important habitats. Substantial scientific information suggests that certain habitat types play a major role in the long-term viability of salmonid populations, including tidal marsh and swamp habitats, shallow water and flats habitats, and water column habitats. The Corps has therefore identified a number of restoration actions that have a high probability of enhancing the availability and productivity of these habitats for migrating salmonids through the action area. Nevertheless, the implementation of these restoration actions and the implementation of the monitoring and research actions will likely have short-term detrimental impacts of limited scope and duration.

This section reviews the effects of these components of the proposed action on ESA-listed salmonids. NMFS notes the difficultly of quantifying effects to ESA-listed salmonids from monitoring, research, and restoration actions, based upon available information, and further notes that much of the scientific emphasis during this reinitiation of consultation focused upon the effects of the navigation project upon habitat indicators and habitat forming processes that may be of significance to ESA-listed salmonids. The modeling efforts did not seek to directly quantify the long-term effects of these restoration or research activities on habitats of importance to ESA-listed salmonids. Hence, the effects analyses associated with these monitoring, restoration, and research activities are necessarily of a different and more qualitative nature than those associated with the navigation improvements.

6.7.1 Monitoring Program

Section 3.2.6 of this Opinion describes the elements of the comprehensive monitoring program that is part of the proposed action. Table 3.5 enumerates objectives of each element of the monitoring and their relation to the assumptions or predictions associated with this consultation. In Table 6.2, below, NMFS describes the anticipated effects of these monitoring activities. NMFS concludes that the adverse effects of implementing a monitoring program are likely to be limited, and will not cause take of ESA-listed salmonids.

Table 6.2 Proposed Project Monitoring Activities and Effects of Monitoring Program Implementation

Monitoring Activity	Anticipated Effects of Monitoring Program to Salmonids
Maintain three hydraulic monitoring stations: One downstream from Astoria, one in Grays Bay, and one in Cathlamet Bay. Parameters measured would include salinity, water surface elevation, and water temperature.	Over-water access to maintain monitoring stations should have minimal impacts to salmonids and their habitats.
Monitor annual dredging volumes from both construction and O&M activities.	None
Conduct main channel bathymetric surveys throughout Project area.	Over-water access to conduct bathymetric surveys should have minimal impacts to salmonids and their habitats.
Repeat estuary habitat surveys being conducted by NMFS.	Over-water and aerial access to conduct habitat surveys should have minimal impacts to salmonids and their habitats.
Review the SEDQUAL database and other available data to determine if there are areas that would require additional sampling. Review existing contaminants database using NMFS guidelines or trigger values that are more protective of salmonids and trout. Provide notification during construction dredging to monitor for presence of fine-grained material – *i.e.*, oily sheens.	Over-water access to conduct additional sediment surveys, and substrate-disturbing activities associated with additional surveys should have minimal impacts to salmonids and their habitats.
Monitor the incidence of stranding of juvenile salmon on beaches in action area. Field surveys will be made monthly at selected beaches (upper, mid, and lower river) during the April-August out-migration to measure the number of fish being stranded along beaches.	Over-water access to conduct salmonid stranding surveys should have minimal impacts to salmonids and their habitats. Handling of stranded salmonids is anticipated. Procedures for salvaging ESA-listed salmonids are provided in this Opinion's Incidental Take Statement.

6.7.2 Ecosystem Restoration Features

The Corps proposed several ecosystem restoration features to create or improve salmonid habitat, specifically tidal marsh/swamp and shallow water/flats habitat. It is important to emphasize that the ecosystem restoration projects identified below are not being proposed as Project "mitigation." These are restoration features being proposed under Section 7(a)(1) of the ESA to benefit the conservation of ESA-listed salmonids

A number of the new restoration features proposed by the Corps (Purple Loosestrife Control, Tenasillahe Island Interim and Long-term Restoration, and Bachelor Slough Restoration) occur in-water and have the potential, during implementation, to affect ESA-listed salmonids. The translocation of Columbian white-tailed deer to Cottonwood/Howard Island will have no effect on ESA-listed salmonids as the action is upland in nature. Two of the three original restoration actions identified in the FEIS (Columbia River Tidegate Retrofits and Walker-Lord and Hump-Fisher Islands Channel Connectivity Enhancements) occur in-water, so they also have the potential to affect ESA-listed salmonids. Other original FEIS restoration actions (*e.g*. Shillapoo Lake) are disconnected from ESA-listed salmonid habitats and will not have either beneficial or detrimental effects to ESA-listed salmonids. Section 8 of the 2001 BA and Chapter 4 of the Corps 1999 FEIS describe the proposed restoration features and their effects on ESA-listed salmonids. Both descriptions are incorporated here by reference. Subsequent modifications to these proposed restoration features are described below where applicable.

Lois Island Embayment and Millar/Pillar Habitat Ecosystem Restoration. In a letter dated November 13, 2003, to NMFS, the Corps explained that they will be unable to construct Lois Island Embayment and Millar/Pillar Habitat ecosystem restoration features due to Project modifications imposed by the state of Oregon as a result of their 401 certification and Coastal Zone Management Act review.

Purple Loosestrife Control. The original ecosystem restoration feature for purple loosestrife control included an integrated pest management approach using biological agents, herbicides, and mechanical control measures. Subsequent field review revealed the extensive distribution of purple loosestrife in the estuary and the physical difficulty of accessing the area, plus an increased knowledge of the plant's reproductive biology, has led to the conclusion that herbicides and mechanical control measures are inappropriate. Consequently, biological control through the release of up to four approved species of beetle will be utilized to address this invasive plant species and mechanical and herbicide control measure will be dropped from consideration. The four beetle species proposed for use as biological control agents (Table 6.4) are envisioned for distribution to control purple loosestrife, an invasive plant species, between RMs 18-52.

Table 6.3 Effects Summary

Feature	Area Affected by Restoration (acres) 2001 BA	Area Affected by Restoration (acres) Revised	Type, Function, and Value	Location	Disturbance During Construction	Incidental Take
Purple Loosestrife Control Program	300	300	**Type:** Tidal marsh and swamp **Function:** Maintain native tidal marsh plant community; increase detrital export **Value:** High	Throughout the Lower Columbia River	None	None
Tenasillahe Island Interim Restoration[1] (Tidegate/Inlet Improvements)	92	92	**Type:** Backwater/side channel reconnection to Columbia River **Function:** Increase access/egress for ocean-type salmonids **Value:** Moderate	Julia Butler Nation Wildlife Refuge Approximately RM 36	Less than four weeks of increased turbidity during construction	No adults, 36 juvenile salmon
Tenasillahe Island Long-Term Restorations[3] (Dike Breach)	1,778	1,778	**Type:** Tidal marsh and swamp; shallow water and flats habitat **Function:** Provide rearing habitat for ocean-type salmonids; increase detrital export **Value:** High	Julia Butler Nation Wildlife Refuge Approximately RM 36	To be determine during site specific ESA consultation	To be determined during site-specific ESA consultation
Bachelor Slough Restoration[4]	300 (instream restoration) 6 (shoreline) 27 (riparian restoration)	6 (shoreline)	**Type:** Shallow water and flats habitat; riparian forest **Function:** Provide rearing habitat for ocean-type salmonids; increase detrital export **Value:** Moderate (side channel); high (riparian forest)	Approximately RM 90	Less than four weeks of increased turbidity during construction	No adults 20 juveniles
Tidegate Retrofits for Salmonid Passage	38 miles	36 miles	**Type:** Tributary reconnection to Columbia River **Function:** Increase access/egress for ocean-type salmonids; improve access for adult salmonids to headwaters for spawning **Value:** High	Burris Creek-RM 81 Tide Creek-RM 83 Deep River-RM-22 Grizzly Slough-RM 29 Hall Creek-RM 27	Less than one week of increased turbidity for each location	No adults Burris Creek – 6 juveniles Tide Creek – 12 juveniles Grizzly Slough – 12 juveniles Deep River (3 sites) – 36 juveniles

Feature	Area Affected by Restoration (acres) 2001 BA	Area Affected by Restoration (acres) Revised	Type, Function, and Value	Location	Disturbance During Construction	Incidental Take
Walker/Lord and Hump/Fisher Islands Improved Embayment Circulation	335	335	**Type:** Marsh and swamp; shallow water and flats habitat **Function:** Provide rearing habitat for ocean-type salmonids; increase benthic invertebrate productivity **Value:** Moderate	Lord-Walker Approximately RM 62 Hump-Fisher Approximately RM 60	None	None
Cottonwood/Howard Island Proposal[2] Columbia White-Tailed Deer Introduction	1,000	1,000	Type: Translocation of Columbia white-tailed deer Function: Establish secure, viable subpopulation of Columbia white-tailed deer Value: High	Approximately RM 70	N/A	N/A

Notes: The Tidegate Retrofits for Salmonid Passage, Walker/Lord and Hump/Fisher Islands Improved Embayment Circulation, and Shillapoo Lake Restoration features were proposed in the original FEIS (Corps, 1999a). The remaining restoration features were added during the BA reconsultation process.
1This restoration is contingent on hydraulic analysis results.
2This restoration primarily benefits Columbia white-tailed deer.
3This restoration feature is contingent on the delisting of Columbia white-tailed deer.
4This restoration feature is contingent on sediment testing and approval by WDNR.

Table 6.4 Biological control agents identified by the Oregon Department of Agriculture for purple loosestrife (http://egov.oregon.gov/ODA/PLANT/weed_bioagent_targets.shtml).

Scientific Name of Beetle	Common Name of Beetle
Galerucella calmariensis	defoliating beetle
Galerucella pusilla	defoliating beetle
Hylobius transversovittatus	root weevil
Nanophyes marmoratus	seed head weevil

Biological control agents for release in the United States are vetted by the U.S. Department of Agriculture prior to release. The beetle species listed in Table 6.4 for control of purple loosestrife were previously approved by the U.S. Department of Agriculture and have been released at numerous locations in the United States, including a number of locations in Oregon. A news release by the Oregon Department of Agriculture (http://oda.state.or.us/information/news/2002/021002weeds.html) discusses their successful release in Oregon.

Use of biological control agents (four species of beetles) is intended to control the presence, density and distribution of purple loosestrife. Even with successful establishment of these biological control agents, however, a residual population of purple loosestrife will likely remain. By helping to control purple loosestrife in the Columbia River estuary and thereby re-establishing the diverse native vegetation of tidal marsh habitats, this restoration feature is likely to benefit ESA-listed salmonids. These changes should benefit habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia, and habitat-specific food availability.

Tenasillahe Island Tidegate and Inlet Modifications. This ecosystem restoration feature will improve both habitat connectivity and water quality of interior channels at Tenasillahe Island that are currently located behind flood control dikes and tidegates. NMFS anticipates that this action will benefit ESA-listed salmonids by opening up access to productive rearing and refuge areas that are not now accessible to juvenile salmonids. This action will result in improvements to water quality, habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia and habitat-specific food availability.

Juvenile salmonids should be able to access additional acres of productive tidal marsh and swamp habitat for rearing and foraging upon modification of the tidegates and potentially the construction of the inlet channels. Construction impacts from tidegate modification and inlet construction are anticipated to be of short duration (a few days to two weeks). However, since in-water work would be required, some limited-duration harassment of ESA-listed salmonids from the turbidity plume may occur. Through appropriate timing, impacts to juvenile salmonids in the immediate construction area can be further minimized. NMFS anticipates that this action will benefit ESA-listed salmonids by opening up access to productive rearing and refuge areas that are not now accessible to juvenile salmonids. This action will result in improvements to water quality, habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia and habitat-specific food availability.

Modification of the main tidegate feature, a three-barrel structure, will likely occur out of the water as the tidegates are located in a concrete lined well in the center of the flood control dike. The secondary tidegate will likely be modified in the dry also by removing the tidegate from its hinges during low tide and immediately installing a modified tidegate. However, if our hydrologic analysis indicates that these structures should be lowered or tidegates added, then soil disturbance of either the existing flood control levee or the adjacent stream substrate would occur as excavation and/or installation of cofferdams would occur.

Construction of inlet channels would require some excavation in the upper tidal zone that can be accomplished during low tide to limit turbidity. However, since in-water work would be required, some limited-duration impact to ESA-listed salmonids from the turbidity plume may occur. Through construction during the inwater work period (July 1 to September 15), impacts to juvenile salmonids in the immediate construction area can be further minimized.

Incidental take for this action was estimated as zero adults and 36 juvenile salmonids. Adult salmon in the Columbia River during the construction period will be migrating upstream following the main channel or main side channels of the Columbia River. Multnomah Slough, into which the two tidegate structures at Tenasillahe Island empty, would receive only incidental, transitory use by adults migrating upstream. The openings of the tidegates, which are setback from the main channel of Multnomah Slough, offer no attraction (*e.g.* cool water outflow) for adult salmon or steelhead. The proposed inlet channels, one abutting the mainstem Columbia River and the other Clifton Channel, a main side channel, lie beside migration routes for adult salmon and steelhead. As noted above, inlet construction would occur during low tide in a narrow corridor of tidal marsh/mudflat habitat that does not represent a migratory corridor for adult salmonids. Consequently, we have determined that the proposed action would result in zero incidental take of adult salmonids.

Juvenile salmonids may occur in low numbers in the vicinity of the tidegate outlets and inlet channels. Haskell *et al.* (2004) monitored and evaluated juvenile salmonid usage of main channel, backwater, marsh, and T-channel locations at Crims Island, Columbia River Mile (RM) 54-57 from May through September 2003. The Crims Island location is considered comparable to the Tenasillahe Island restoration location (RM 36-38) for water conditions (temperature, dissolved oxygen, flow) and use by juvenile salmonids. Haskell *et al.* (2004) reported the capture of three species of juvenile salmonids at Crims Island: Yearling and subyearling Chinook salmon, yearling and subyearling coho salmon, and chum salmon. Subyearling Chinook salmon comprised approximately 4% of the total fish captured at Crims Island; the other salmonids comprised 0.01% or less of the total fish captured (Haskell *et al.* 2004). They reported that seasonal abundance of subyearling Chinook salmon at Crims Island was highest in late April to early May and that by late June, these subyearlings were primarily found only at the mainstem beach sampling location. They attributed the increase in water temperature to the seasonal decrease in presence of juvenile salmonids at the Crims Island location. Haskell *et al.* (2004) reported a catch per unit effort level of approximately 6 or fewer subyearling Chinook salmon per hour after the middle of July for backwater locations at Crims Island.

Comparable results are expected for the Tenasillahe Island tidegate and inlet locations. Water temperatures at the two-tidegate locations on Multnomah Slough, Tenasillahe Island, are expected to be too warm for substantial use by juvenile salmonids before the start of the inwater work period. Consequently, their presence at these tidegate locations would be minimal. The inlet locations at Tenasillahe Island are considered comparable to the main channel sampling location at Crims Island reported by Haskell (2004). Subyearling Chinook density at the mainstem beach location at Crims Island was as high as approximately 0.6 fish per square meter through July 29, but decreased thereafter to 0.2 fish per square meter or less (Haskell 2004).

The incidental take level for simple replacement of the tidegates would be zero juvenile salmonids if only the flapgates are replaced during low tide when water is not present on the site. If sheet pile cofferdams were required at these locations, inwater work at low tide would take an estimated eight hours at the single barrel location and 16 hours at the 3-barrel location. Installation of sheet pile cofferdams would occur during low tide when minimal water is within the confines of the cofferdam with final closure at the lowest tide stage. Water temperature, closure at the low tide stage, and disturbance associated with construction of the cofferdam should effectively preclude most juvenile salmonids from the location. However, potential exists to entrap juvenile salmonids behind the cofferdam as the structure is closed. We estimate that 6 juvenile salmon could be entrapped during cofferdam closure (one hour operation) at each location for an incidental take of 12 juvenile salmonids associated with tidegate construction.

Construction of inlet pipes through the flood control levee would have a similar impact to tidegates. Placement of sheet pile cofferdams on the riverward side of the levee could result in the entrapment of juvenile salmonids. Again, water temperature, closure at the low tide stage and disturbance associated with construction of the cofferdam should effectively preclude most juvenile salmonids from the location. However, potential exists to entrap juvenile salmonids behind the cofferdam as the structure is closed. We estimate that 6 juvenile salmon could be entrapped during cofferdam closure (one hour operation) at each inlet location (2) for an incidental take of 12 juvenile salmonids.

The construction of inlet channels, should it require two low tide events to complete construction, could result in the entrapment of some juvenile salmonids in the inlet channel during the next low tide when construction resumes. The riverward end of the inlet channel is intended to blend into the existing tidal marsh topography thus allowing for juvenile salmonids to readily escape on the falling tide. Construction efforts, with a tracked excavator and bucket, could result in a shallow trench initially that could serve to trap juvenile salmonids on the falling tide. Entrapment of these juvenile salmonids would likely occur during a one-hour period as the tide falls below the surface elevation of the tidal marsh at the inlet channel locations and water remains pooled in the completed portion of the inlet channel, thus entrapping juvenile salmonids. Turbidity in the constructed channel during construction activity on the second low tide event could thus take entrapped juveniles. We are estimating that 6 juvenile salmonids could be incidentally taken during each inlet channel construction effort for an incidental take of 12 juvenile salmonids during this phase of the operation. Upon completion of the inlet channel to the inlet pipe and initiation of operations of the inlet systems, the incoming and outgoing tide would quickly erase any elevation difference between the inlet channel and adjacent tidal marsh thus eliminating the potential for entrapment of juvenile salmonids.

Tenasillahe Island Historical Habitat Restoration. Long-term Tenasillahe Island restoration features will only occur if Columbian white-tailed deer are delisted and the eventual long-term Tenasillahe Island restoration plan is consistent with the Julia Butler Hansen National

Wildlife Refuge's purpose and goals. This restoration action will be developed in the future, and therefore would undergo site-specific Section 7 ESA consultation when fully designed. Conceptually, NMFS believes that should this project be undertaken, numerous ecosystem indicators would be benefitted, including tidal marsh and swamp habitat, and all pathways associated with habitat primary productivity, food web, salmonid growth, and salmonid survival.

Bachelor Slough. The original project was designed to increase river flows traveling through Bachelor Slough, with associated improvements in water quality and habitat connectivity. Juvenile salmonids would be more likely to be drawn into Bachelor Slough under these changed conditions during the outmigration. Cooler temperatures would be beneficial to fish drawn into Bachelor Slough. Additionally, 6 acres of riparian habitat would be restored along the Bachelor Slough shoreline, plus additional riparian forest habitat would be developed on the disposal areas associated with this activity.

The revised project is limited to the development of six acres of riparian forest habitat along Bachelor Slough and potentially some additional riparian forest habitat on Washington Department of Natural Resources land should it be used as a disposal site for borrow material from the restoration action along Bachelor Slough. Dredging of Bachelor Slough is no longer under consideration due to lack of an adjacent, cost efficient disposal location. Riparian forest restoration slated for dredged material disposal sites was dropped from consideration after sediments from Bachelor Slough were determined to be sand, not silt. The Ridgefield National Wildlife Refuge did not want sand placed on refuge lands nor were they going to allow for borrow of topsoil from refuge lands to cap the sandy disposal material. Consequently, the proposed action was scaled back to simply encompass the riparian forest restoration along Bachelor Slough.

Riparian forest restoration would provide for detrital and insect export to the Columbia River. Permanent riparian forest habitat would provide for export of large woody debris to the Columbia River and its estuary over the long term.

Excavation along the Bachelor Slough shoreline to remove exotic vegetation and some soil overburden would occur in early May to prepare a bare mineral soil for onset of seed distribution by native cottonwoods and willows which begins approximately mid-May. Construction activities would be out of the water. The construction area would be sloped from the base of the flood control dike to the ordinary high water mark. Potentially, higher waters from a Columbia River freshet may cover part or all of the restoration area post-construction. Some release of sediment and associated turbidity can be expected from the site under these conditions. Establishment of seedling trees and other vegetation should preclude such discharges in subsequent years. Due to the project timing and the current, low quality salmonid habitat in Bachelor Slough, NMFS does not believe this project will have long-term adverse effects on ESA-listed salmonids.

Incidental take for this restoration feature is estimated a zero adults and 20 juveniles. The construction timeframe during May coincides with the period when migrant adult spring Chinook and steelhead are in the Columbia River. These adults could potentially transit the project area by first accessing Lake River and then returning to the Columbia River via Bachelor Slough. Juvenile salmonid outmigrants representing most Columbia River ESUs could be transiting through Bachelor Slough in May as the timeframe is near the peak period for juvenile outmigrants.

The construction effort in early May would occur above the ordinary high water (OHW) mark. Bank sloping would occur but would grade from the landward edge to OHW at Bachelor Slough. The construction effort would not leave depressions and/or swales that could entrap adult or juvenile salmonids should a freshet occur post-construction that would overtop the construction area. Given that construction would occur above the OHW mark and would be either discontinued or delayed if water levels exceeded OHW, and banks would be gradually sloped, we have determined that no adult salmonids would be incidentally taken by the proposed action. These factors would similarly limit incidental take for juvenile salmonids.

The potential exists that during the first year post-construction for a limited number of juvenile salmonids to become stranded as the tide recedes during a freshet event that exceeds the OHW mark or from wave action in Bachelor Slough during water levels exceeding OHW. Wave action generated by wind is probably minimal as the slough is relatively narrow with levees along both shorelines. Recreational boat traffic is apparently not substantial and would be a limited source of waves. There is no commercial boat traffic on Bachelor Slough. Ship wake, greatly attenuated, from the Columbia River Navigation Channel does enter the upstream reach of Bachelor Slough and would reach the upstream limits of the proposed restoration action. We have estimated this incidental take from stranding to be 20 juvenile salmonids based on the limited chance of a freshet event that exceeding the OHW mark or from wave action in Bachelor Slough during water levels exceeding OHW. Vegetative cover would be established by May of the year following construction and should preclude juvenile salmonids from approaching the shoreline-water interface where stranding as the tide recedes would be expected to occur.

Columbia River Tidegate Retrofits. The Corps originally proposed to retrofit the tidegates on five tributaries to the Columbia River, and to conduct additional tidegate retrofit activities on other tributaries in the future. The Oregon tributaries include Tide Creek, Grizzly Slough, and Hall Creek (Warren Slough), and the two Washington tributaries include Burris Creek and Deep River. Further information on these proposals is in Chapter 8.4 of the 2001 BA, in the 2001 BA addendum, and Chapter 4 of the Corps 1999 FEIS. That information is incorporated here by reference. Construction actions are of short duration (*e.g*., less than one week per structure) and soil disturbance, thus turbidity, would typically be limited in nature. If the entire tide gate and associated culvert require replacement, temporary coffer dams would be placed on each end of the culvert to preclude sediment impacts to the stream. However, since inwater work would be required, some limited duration harassment from the turbidity plume may occur to ESA-listed salmonids. The tidegate at Hall Creek (Warren Slough) was retrofitted by others subsequent to publication of the Final Supplemental EIS (2003) and has been dropped from further consideration.

Juvenile salmonids could be expected on either the downstream side or upstream (tributary) side of each tidegate location proposed for modification. Juvenile salmonids are assumed to be present immediately upstream of the tidegate location have either originated in that specific tributary or were able to enter the tributary through the tidegate. The exception to this assumption would be Burris Creek, where the local diking district previously plugged the tidegate and relied on a pump station to discharge water from within the district. No adult salmonids are thought to ascend Burris Creek at this time as there is no means for their passage through the flood control levee.

The Tide Creek location is on the mainstem Columbia River at approximately RM 82. Burris Creek occurs at RM 81 on a sidechannel of the Columbia River. Grizzly Slough (RM 28) and Deep River (RM 22) tidegate locations are both well off-channel at locations adjacent to the widest portion of the Columbia River estuary. Grizzly Slough is a small back channel separated from a main back channel (Blind Slough) by a flood control levee. Thus it has no spawning habitat. The Deep River tidegate locations, approximately three, contain spawning and/or rearing habitat upstream of the tidegate locations.

Construction actions at each location are projected to be of short duration (*e.g.*, less than one week per structure) and soil disturbance resulting in increase turbidity would typically be limited in nature. Construction would occur between July 1 and September 15, the inwater work period, when the fewest juvenile salmonids are expected to present in the area. If the entire tide gate and associated culvert require replacement, temporary sheet pile cofferdams would be placed around each end of the culvert to preclude sediment impacts to the tributary stream and to the system that the tributary discharges. Installation of the two sheet pile cofferdams at each tidegate location would occur during low tide when minimal water is within the confines of the cofferdam with final closure of the cofferdam at the lowest tide stage. Water temperature, closure at the low tide stage, and disturbance associated with construction of the cofferdams should effectively preclude most juvenile salmonids from the location.

However, potential exists to entrap juvenile salmonids behind each cofferdam at these tributary locations as the structure is closed. The Corps estimates that 6 juvenile salmon could be entrapped behind each cofferdam during closure (one hour operation) at each location. The estimate of 6 juvenile salmon entrapped at these locations is predicated upon Haskell *et al.* (2004). They reported a catch per unit effort level of approximately 6 or fewer subyearling Chinook salmon per hour after the middle of July for backwater locations at Crims Island (*see* discussion under 6.7.2.4 Tenasillahe Island Tidegate and Inlet Modifications for greater detail).

Incidental take is estimated at 12 juvenile salmonids (6 juveniles per cofferdam) for Tide Creek, 12 juvenile salmonids for Grizzly Slough, 36 juvenile salmonids for three locations on Deep River, and 6 juvenile salmonids for Burris Creek. Total incidental take is estimated at 66 juvenile salmonids with take occurring only during construction.

Although adult salmonids will either pass by or through the tidegate locations proposed for modification, no incidental take is anticipated for adult fish. The construction period (July 1 to September 15) is outside the timeframe when adults ascending spawning streams would occur. The nature of the construction action precludes entrapment of adults. They would easily avoid an area where a cofferdam is being constructed due to the associated disturbance. The construction locations are well off main channel, even in the case of Tide Creek, so as not to disturb or take main channel adult migrants.

The tidegate retrofit restoration feature is estimated to provide or improve anadromous fish access to 38 miles of tributary streams. These tributaries contain spawning, stream rearing, and (near their confluence with either the Columbia River or a more major tributary) backwater channel and freshwater marsh habit for rearing and/or overwinter refuge from floods. Additionally, the Corps would replace additional tidegates, if additional tidegate retrofit projects were identified. This action should result in short- and long-term improvements to habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia, and habitat-specific food availability by reconnecting the Columbia River to these tributary streams.

Walker/Lord and Hump/Fisher Islands Channel Connectivity Enhancements. The purpose of this restoration action is to improve water flow and circulation through this island complex, thereby lowering embayment temperatures and creating a network of channels. This feature should increase habitat connectivity and improve foraging conditions for juvenile salmonids. Construction activities are primarily upland in nature and involve construction of a channel in a historical dredged material deposition area. A brief period of in-water construction would occur when the channels are daylighted to the embayment and river. Opening of the ends of the channels would occur at low tide to limit sediment discharge. The channel at the Walker/Lord Island location was completed in September 2004; all excavation occurred in the dry.

Given the short duration of the construction action and the fact that material to be excavated is primarily medium-grained sand, turbidity in adjacent waters should be of short duration and extent. Construction timing would typically be late summer to take advantage of lower water levels, dry soil conditions, and the general absence of fish. As a result, the potential for short-term adverse impacts to salmonids would be minimized. Due to timing and location of the inwater action, NMFS does not believe this restoration action will take ESA-listed salmonids. This restoration will provide some short- and long-term improvements to habitat complexity, connectivity, or conveyance; feeding habitat opportunity; refugia; and habitat-specific food availability indicators.

Martin Island Embayment Modification. The Martin Island embayment modification will not be constructed due to objections from the State of Washington.

6.7.3 Ecosystem Research Actions

Ecosystem research actions are measures proposed by the Corps to assist the efforts of the Corps, NMFS, FWS, and others in understanding the broader issues of the Lower Columbia River, estuary and river mouth. These research actions address indicators of the salmonid conceptual ecosystem model, and are intended to provide useful information for the conservation and recovery of ESA-listed salmonids. The annual and cumulative results will be presented to the adaptive management team. NMFS strongly supports implementation of these ecosystem research activities.

Effects to ESA-listed salmonids are expected to occur from implementation of ecosystem research activities. Because any impact to ESA-listed salmonids from research activities is directed and intentional, instead of incidental to the purpose of the action, the future implementation of these research activities may require the issuance of research permits authorizing direct take of ESA-listed salmonids by NMFS under Section 4(d) or 10(a)(1)(A) of the ESA.

6.8 Summary of Effects of the Proposed Action on the Biological Requirements of Proposed and ESA-Listed Salmonids

NMFS' analysis in section 6.2.1 of this Opinion indicated that direct effects to ESA-listed salmonids would be limited. NMFS concurs with the Corps' general assessment of potential Project indirect effects during the two-year construction period of navigation improvements. Based on the conceptual ecosystem model, impacts to key physical processes will adversely affect habitat forming processes, *i.e.*, the "building blocks"of salmonid habitat in the Lower Columbia River, estuary and river mouth. These key physical processes include suspended sediment, accretion/erosion, turbidity, salinity, bathymetry, and bedload. Short-term indirect effects to these key physical processes will be of a limited nature during the Project construction period as discussed during the SEI panel process, and validated using the numerical modeling conducted by WES and OHSU/OGI.

Based on these direct and indirect Project effects, NMFS believes that population abundance, growth rate, spatial structure, and diversity of ESA-listed salmonids will not be appreciably reduced. NMFS also believes that the Project will not appreciably reduce, other than during short-duration and limited locations of salmonid avoidance of dredging and disposal operations, the distribution of ESA-listed salmonids. Of all ESA-listed salmonids, only Columbia River chum salmon spawning habitat occurs in the Project area. However, NMFS believes the direct and indirect effects of the Project will not appreciably reduce any of the ESA-listed salmonid ESUs' population numbers, distribution within each ESU, or reproductive success.

The 2001 BA characterized changes to key habitats and indicators over the life span of the Project as not being significant because they are within the natural variation of river conditions or will not change river conditions at all (*e.g.*, bedload changes, volume and rate of suspended sediment transport, water level changes to the estuary, structure, distribution, net productivity, and detritus production of marshes and swamps, the location of mobile macroinvertebrates, velocity changes in shallow water habitats and available refugia, salinity changes as they impact habitat types, bathymetry, and the impact on habitat opportunity as it relates to water depth in the estuary).

During the reinitiation of the consultation process in 2001-2002, NMFS identified certain issues regarding long-term effects of the Project. Those issues centered on limited physical effects associated with Project actions that are not detectable in the short term, but that may affect ESA-listed salmonid habitats over the life span of the Project. These include ecosystem effects that are not quantifiable based on the NMFS' review of best available science and our current understanding of the ecosystem. Topics of concern identified during this reinitiation 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 relied on by juvenile salmonids.

The changes to physical processes resulting from the Project will likely result in incremental changes in the physical conditions in the Lower Columbia River, estuary and river mouth. Any changes in a static system should be predictable, using modeling and other tools. However, the ecosystem of the Lower Columbia River, estuary and river mouth is not a static system. Numerical modeling cannot account for this non-static state. As acknowledged in the 2001 BA, these changes will result in a new dynamic equilibrium in the Lower Columbia River ecosystem over the life span of the Project.

Notwithstanding the Corps' assessments, NMFS believes that the predicted changes to the physical system should not be extrapolated over the life span of the Project without additional monitoring and verification. In the OHSU/OGI modeling for the reinitiation of consultation, the predicted changes to habitat opportunity in Cathlamet Bay for five one-week model simulations (Table 6-1 of the 2001 BA) are from model simulation runs over a short time duration. Based on the information provided in the 2001 BA, extrapolating these results over the life span of the Project, instead of limiting those results to the period modeled, does not acknowledge model limitations or long-term variability in the ecosystem.

A key conclusion from both the SEI panel process and BRT discussions was that even using the best available scientific data, there remains a degree of risk and uncertainty with our ability to link the physical changes in habitat elements predicted from the Project with long-term effects - either positive, negative or neutral - to ESA-listed salmonids or their habitats. The BRT conducted a qualitative risk and uncertainly analysis (*see* Table 7-1 of the 2001 BA). That analysis documented the need for a precautionary approach to the protection of ecosystem elements (*i.e.*, key indicators within each pathway of importance to salmonids). In order to address the risk and uncertainties associated with key salmonid pathways and indicators identified in this Opinion, the Corps proposes, and NMFS concurs, with the continued development and implementation of a robust monitoring program and adaptive management process.

7. CRITICAL HABITAT

7.1 Defining Proposed and Designated Critical Habitat

7.1.1 Status of Critical Habitat

ESA Section 3(5)(a) defines 'critical habitat' as the specific areas within: (1) The geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features essential to the conservation of the species; (2) which may require special management considerations or protection; and (3) specific areas outside the geographical area occupied by the species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species. In determining what areas are critical habitat, agency regulations at 50 C.F.R. 424.12(b) require that NMFS must "consider those physical or biological features that are essential to the conservation of a given species ..., including space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance are representative of the historical geographical and ecological distribution of a species."

The regulations further direct us to "focus on the principal biological or physical constituent elements . . . that are essential to the conservation of the species," and specify that the "known primary constituent elements shall be listed with the critical habitat description." The