3.2 Columbia River Bull Trout

3.2.1 Overview

The aquatics species BA, Appendix D, provides an overview of bull trout biology and ecology; these descriptions are incorporated herein by reference. The following is a brief overview of bull trout in the Columbia River DPS.

Bull trout are char native to the Pacific Northwest and western Canada. Bull trout are relatively dispersed throughout tributaries of the Columbia River Basin, including its headwaters in Montana and Canada. The Columbia River DPS includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin and currently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). The Columbia River DPS comprises 141 bull trout subpopulations in four geographic areas of the Columbia River basin. The Project is located within the lower Columbia River geographic area, which includes all tributaries in Oregon and Washington downstream of the Snake River confluence near the town of Pasco, Washington.

The current distribution of bull trout in the lower Columbia River Basin is less than the historical range (Buchanan et al. 1997). Bull trout are thought to have been extirpated from several tributaries in five river systems in Oregon: the Middle Fork Willamette River, the North and South Forks of the Santiam River, the Clackamas River, the upper Deschutes River (upstream of Bend, Oregon), and the Crooked River (tributary to the Deschutes River) (Buchanan et al. 1997). Hydroelectric facilities and large expanses of unsuitable, fragmented habitat have isolated these subpopulations. Large dams, such as McNary, John Day, The Dalles, and Bonneville, separate four reaches of the lower Columbia River. Although bull trout may pass each facility in both upstream and downstream directions, the extent to which bull trout use the Columbia River is unknown. In addition, the nine major tributaries have numerous water storage facilities, many of which do not provide upstream passage.

4.0 ENVIRONMENTAL BASELINE

The aquatic species BA provides an extensive description of historic and current habitat conditions in the Columbia River and estuary (Chapter 2), a description of the complex processes and functions that occur in these riverine and estuarine habitats (Chapter 4), and discussions of coastal cutthroat trout and bull trout within these riverine and estuarine habitats (BA pages 4-10 to 4-12, and Appendix pages D1-7 to D1-10, D2-1 to D2-26, and D3-1 to D3-62); these descriptions are incorporated herein by reference.

The Environmental Baseline section, below, is presented in four sub-sections. The first sub-section (4.1 Lower Columbia River and Estuary Conditions) provides an overview of the current environmental conditions in the Colombia River and estuary. The second sub-section (4.2 Coastal Cutthroat Trout and Bull Trout in the Lower Columbia River and Estuary) reviews current information on coastal cutthroat trout and bull trout in the lower Columbia River and estuary, and discusses the importance of the Columbia River and its estuary's physical processes and resultant habitats to coastal cutthroat trout and bull trout. The third sub-section (4.3 Description of Lower Columbia River and Estuary Baseline Conditions Using a Conceptual Ecosystem Model) presents a framework for describing the complex river and estuary ecosystem processes and functions; how the Project may influence these important ecosystem processes and functions is the foundation for analysis of potential Project effects (presented in 5.0 Effects of Action section, below). The fourth sub-section (4.4 Updated Environmental Baseline Information for Columbian White-tailed Deer and Bald Eagle) updates the Service's terrestrial species opinion with new information on bald eagle and Columbian white-tailed deer in the Project area. Unless otherwise cited, the following information is extracted from the aquatic species BA.

4.1 Lower Columbia River and Estuary Conditions

The Columbia River is naturally a very dynamic system. It has been affected and shaped over eons by a variety of natural forces, including volcanic activity, storms, floods, natural events, and climatological changes. These forces had and continue to have a significant influence on biological factors (e.g., flow), habitat, inhabitants, and the whole riverine and estuarine environment of the Columbia River.

Over the past century, human activities have dampened the range of physical forces in the action area and resulted in extensive changes in the lower Columbia River and estuary. Effects that have been particularly large have occurred through changes to flow hydrographs, isolation of the floodplain, and diking and filling of wetland areas. The Columbia River estuary has lost approximately 43% of its historic tidal marsh (from 16,180 to 9,200 acres) and 77% of historic tidal swamp habitats (from 32,020 to 6,950 acres) between 1870 and 1970 (Thomas 1983). Within the lower Columbia River, diking, river training devices (pile dikes and rip rap), railroads, and highways have narrowed and confined the river to its present location. Between the Willamette River and the mouth of the Columbia River, diking, flow regulation, and other human activities have resulted in a confinement of 84,000 acres of flood plain that likely contained large amounts of tidal marsh and swamp. The lower Columbia River's remaining tidal marsh and swamp habitats are located in a narrow band along the Columbia River and tributaries' banks and around undeveloped islands.

Since the late 1800s, the Corps has been responsible for maintaining navigation safety on the Columbia River. During that time, the Corps has taken many actions to improve and maintain the navigation channel. The channel has been dredged periodically to make it deeper and wider, as well as annually for maintenance. To improve navigation and reduce maintenance dredging, the navigation channel has also been realigned and hydraulic control structures, such as in-water fills, channel constrictions, and pile dikes, have been built. Most of the present-day dike system was built in the periods 1917-23 and 1933-39, with an additional 35 pile dikes constructed between 1957 and 1967. The existing navigation channel dike system consists of 256 dikes, totaling 240,000 linear feet. Ogden Beeman and Associates (1985) termed these Corps activities "river regulation", and noted that navigation channel maintenance activities, for a 100 year period prior to their 1985 report, required closing of river side channels, realigning river banks, removing rock sills, stabilizing river banks, and placement of river "training" features. Most of these baseline river training features and habitat alterations were constructed or occurred before any of the currently-listed aquatic species were placed on the Act's list of endangered and threatened species.

Another very significant change to the Lower Columbia River system has been the reduction of the peak seasonal discharges and changes in the velocity and timing of flows as a result of water storage by Columbia River basin reservoirs. For instance, flow regulation that began in the 1970s has reduced the 2-year flood peak discharge, as measured at The Dalles, Oregon, from 580,000 cfs to 360,000 cfs (Corps 1999).

These aforementioned physical changes also affect other factors in the riverine and estuarine environment. Tides raise and lower river levels at least 4 feet and up to 12 feet twice every day. The historical range for tides was probably similar, but seasonal ranges and extremes in tides have certainly changed because of river flow regulation. The salinity level in areas of the estuary can vary from zero to 34 parts per thousand (ppt) depending on tidal intrusion, river flows, and storms. Flow regulation has affected the upstream limit of salinity intrusion. The salinity wedge is believed to have ranged from the river mouth to as far upstream as RM 37.5 in the past. It is now generally believed that the salinity ranges between the mouth and RM 30. The river bed within the navigation channel is composed of a continuously moving series of sand waves that can migrate up to 20 feet per day at flows of 400,000 cfs or greater, and at slower rates at lesser flows. This rate of river discharge is not experienced as often as it was prior to flow regulation in the Columbia River.

4.2 Coastal Cutthroat Trout and Bull Trout in the Lower Columbia River and Estuary

4.2.1 Coastal Cutthroat Trout

Anadromous coastal cutthroat trout are believed to have been historically distributed in Washington tributaries to the Columbia River as far inland as the Klickitat River (Bryant 1949). Currently, distribution of all life forms of coastal cutthroat trout is believed to be limited to streams below Bonneville Dam (Leider 1997); a single above-Bonneville Dam population of coastal cutthroat trout was reported by Mongillo and Hallock (2001). According to Leider (1997), the status of anadromous coastal cutthroat trout populations in lower Columbia River tributaries is relatively depressed as compared to other populations in Washington. Interagency creel census from the lower Columbia River area indicates that anadromous coastal cutthroat trout harvest averaged 4,200 fish annually from the period of 1975 to 1985 and declined to less than 500 fish annually from 1986 to 1995 (Leider 1997). However, this period of declining coastal cutthroat trout harvest was also marked by changes in hatchery management and angling regulations, which may have made coastal cutthroat trout angling less attractive. Recent data from Mongillo and Hallock (2001) indicates that resident coastal cutthroat densities are relatively high throughout the southwestern Washington area. Washington has had an anadromous coastal cutthroat trout smolt stocking program since the 1940's, and currently stocks eight Columbia River tributaries (Leider 1997).

In Oregon, anadromous coastal cutthroat trout are believed to have been historically distributed from the mouth of the Columbia River inland to Fifteenmile Creek, east of the Hood River Basin (Hooton 1997). Historically 20-30 anadromous coastal cutthroat trout entered the hatchery on a tributary to the lower Sandy River, but none have been seen recently, or detected passing upstream of Marmot dam since 1977 (Hooton 1997). Coastal cutthroat trout inhabiting the Bull Run River have been cut-off from migrations due to several impassable dams, although resident and adfluvial coastal cutthroat trout remain abundant above the dams in reservoirs and tributary streams (Hooton 1997). Streams in the Columbia Gorge historically supporting small populations of coastal cutthroat trout include Latourell, Bridal Veil, Multnomah, Oneonta, Horsetail, McCord, Moffett, Tanner, Eagle, and Herman; current status is unknown for these streams (Hooton 1997). Although the Hood River and tributaries once supported both resident and anadromous coastal cutthroat trout, no anadromous cutthroat were collected at the Powerdale Dam fish trap in the early to mid-1990's (Hooton 1997). Previously, trap counts ranged from a high of 177 in 1969, to four in 1992, and two in 1993 (Hooton 1997). A total of 11 anadromous coastal cutthroat trout were collected at Powerdale Dam fish trap in 2001 (P. Connolly, pers. comm.). Within the Fifteenmile Creek basin, coastal cutthroat trout are known to be present in

Fivemile Creek, and suspected to be present in Eightmile Creek, although no information exists on their status and distribution (Hooton 1997). Anadromous coastal cutthroat trout are also present in tributaries to the Lower Willamette River below Willamette Falls. In general, anadromous populations are substantially reduced in abundance from historic levels in lower Willamette River tributaries (Hooton 1997). Anadromous coastal cutthroat trout have not been detected at the North Fork (Clackamas River) Dam since 1958 (Hooton 1997, citing D. Cramer, pers. comm.). Little is known about the status and production of anadromous coastal cutthroat trout in Oregon's lower Columbia River tributaries (Hooton 1997). Oregon has stocked coastal cutthroat trout in tributaries to the Columbia River since at least the 1940's, including most tributaries from Hood River downstream to Lewis and Clark River (Hooton 1997, Johnson et al. 1999). Oregon's anadromous coastal cutthroat trout stocking program in the Columbia River tributaries was terminated in 1994 (Hooton 1997).

Limited information is available about coastal cutthroat trout habitat use and preferences in the mainstem Columbia River or its estuary. Fisheries studies that have been conducted in the estuary and lower river do not clearly define habitat use or preferences of adult or juvenile coastal cutthroat trout. In most studies, coastal cutthroat trout were not the target species and the studies were not designed to sample all available habitats (e.g. Dawley et al. 1985, Bottom et al. 1984). An effort was made to systematically collect and review all available information on coastal cutthroat trout in the Columbia River and estuary. Appendix D of the aquatic species BA provides the summary of this data review effort, and is incorporated herein by reference. The following is a brief review of information on coastal cutthroat trout habitat use and preferences in the Columbia River and estuary, as extracted from Appendix D of the aquatic species BA.

Existing data indicate the lower Columbia River and estuary are used by coastal cutthroat trout for both limited and extensive durations. Available information seems to indicate that, depending upon age, source (wild or hatchery), migratory behavior, and sexual maturity, a variety of coastal cutthroat trout habitat use patterns occur. Based on sampling at Jones Beach from 1977 to 1983, Dawley et al. (1985) reported that coastal cutthroat were in the area March through November, with peak abundance occurring in April through June and in August through September; few fish were present in the winter. Studies of Columbia River tributaries in Washington show that juvenile coastal cutthroat trout migrate downstream from March to June, with peak movement typically occurring in May (Chilcote 1980; Chilcote et al. 1980; Blakely 2000). Additionally, the migration of spawned-out adults (kelts) peaked in May (Dawley et al. 1979 and 1980). However, available information does not clearly indicate whether any of these fish rear for any appreciable time in the upper riverine reach of the Columbia River prior to smolting, or if the riverine portion is used mainly as a migratory corridor. Some cutthroats clearly do not stay in the river for long, as a large fraction of hatchery origin sea-run cutthroat captured in the Columbia River estuary and ocean plume had reached salt water at age-1 (Loch and Miller 1988; Pearcy et al. 1990). Wild fish captured in the plume had spent at least two winters in freshwater, so they may have reared for a time in the upper riverine reach. Loch (pers. comm.) believes that the upper riverine reach, from about Longview to Jones Beach, may be a transitional zone between river and estuary, where juvenile salmonids feed and complete their adaptation to salt water. Length of stay varies: some do not complete the transition and remain in the river, while others move into the estuary or migrate to sea (ibid.). Out-migrant coastal cutthroat trout often feed for an extended period in this transitional zone, and many hatchery coastal cutthroat trout residualize there (ibid.). This behavior has been well documented at Jones Beach where sampling was extensive (Loch 1982), but data for areas farther upstream are fragmentary and only suggestive. Loch (pers. comm., as cited in aquatic species BA) believes that portions of the upper riverine reach above Longview may be generally less hospitable to juvenile coastal cutthroat trout in terms of food and habitat, and may therefore serve more as a migratory corridor than as a long-term rearing area.

Sport fishery catch records show that adult and immature coastal cutthroat trout returning from the estuary and the ocean are captured in the upper and lower riverine reaches, mainly from Jones Beach to the Cowlitz River, mostly from July through September (Schuck 1980; Melcher and Watts 1995; Melcher and Watts 1996; Trotter 1997). The implication of declining catches after September is that the cutthroat trout have moved to other locations, probably into the tributaries to overwinter and, if mature, to spawn. It is possible that some coastal cutthroat trout may overwinter in the Columbia River or estuary. Lucas (1980) states that immature anadromous coastal cutthroat trout from lower Columbia River tributaries may overwinter in deep tributary pools or in the Columbia River estuary, but no substantiating data were presented. Dawley et al. (1985) collected few coastal cutthroat trout in the lower Columbia River and estuary during the winter, suggesting that few coastal cutthroat trout overwintered in those areas. This conclusion is open to question, however, because sampling was scant during this period and did not include all habitats that coastal cutthroat trout may have used. Smolt-size and larger coastal cutthroat trout overwinter in the lower Fraser River, Canada, within freshwater back-channels (Rempel 2001).

An analysis of NMFS data from the lower river and estuary studies in the late 1960's though the early 1980's suggests several spatial and temporal trends in abundance and size of coastal cutthroat trout in the Columbia River estuary. Coastal cutthroat trout were taken in the shallows (beach seining) of the upper freshwater estuary, and in the main channel (purse seining) throughout the estuary for at least April through September, whereas coastal cutthroat trout were seldom taken in the shallows of the lower two-thirds of the estuary (estuarine mixing and marine zones) until May or later. Somewhat higher catch rates in the middle and upper estuary suggest that coastal cutthroat trout were more abundant there than in the lower estuary where catch rates tended to be lower. Frequent catches of more than one coastal cutthroat trout per set, when any were caught at all, indicated that occasional schooling occurred. Trends in size of coastal cutthroat trout by time of year and portion of the estuary were not clear.

Based on the above discussion, coastal cutthroat trout potentially utilize the lower Columbia River and estuary for longer periods than any of the other listed Columbia River salmonids. However, while at least limited numbers of coastal cutthroat trout may occur in the lower Columbia River and estuary throughout the year, and in greater numbers during their seaward and freshwater-return migrations, it is not clear which habitats are of the most importance to this species. Coastal cutthroat trout historically occurred in the Project area, and have adapted to the dynamic ocean, estuarine, and riverine conditions that make up the array of anadromous coastal cutthroat trout habitats. These habitats have been created by natural physical and biological processes. Given the limited information on this species, the Service assumes that properly functioning physical and biological processes and conditions, within the ocean, estuary, and river, are necessary to conserve coastal cutthroat trout and its habitats. The third sub-section (Description of Baseline Conditions Using a Conceptual Ecosystem Model) of the Environmental Baseline section introduces a conceptual model of the lower Columbia River and its estuary, and begins to describe the physical processes and habitat responses that characterize the Columbia River and estuary. These physical processes and habitat responses are the same with which coastal cutthroat trout have evolved, the same processes and responses that have been altered for the past 150 years, and are the same processes that will respond to the Proposed Projects construction, maintenance, and ecosystem restoration activities. It is the physical and biological response to any alteration of these natural processes and functions that are most important to analyzing Project-related effects to aquatic species, including coastal cutthroat trout. This analysis of Project-related effects to coastal cutthroat trout, based on analysis of Project impacts to natural physical and biological processes and functions, is presented in the Effects of Action section.

4.2.2 Bull Trout

Bull trout have been occasionally collected in the lower Columbia River near Puget Island (T. Coley, pers. comm., as cited in BA); no published records of bull trout occurrence in the Columbia River estuary have been located. No information is available indicating any holding, feeding, or other extended use of the lower Columbia River and estuary within the Project area by either juvenile or adult anadromous bull trout. Migratory bull trout populations are known to occur in lower Columbia River tributaries, including the Willamette and Lewis Rivers (63 FR 31647), and migratory bull trout are occasionally collected by fisheries workers and anglers below Bonneville Dam in other lower Columbia River tributaries. It is likely that low numbers of bull trout used the lower Columbia River as a migratory corridor between these tributaries.

Bull trout evolved within the dynamic Columbia River Basin, and rely on natural physical and biological processes and functions to complete its life cycle. As with coastal cutthroat trout, it is the physical and biological response to any alteration of these natural processes that are most important to analyzing Project-related effects to bull trout.

4.3 Description of Lower Columbia River and Estuary Baseline Conditions Using a Conceptual Ecosystem Model

4.3.1 Introduction

In discussions of the complex nature of the lower Columbia River (from Bonneville Dam downstream to the upper end of the estuary at RM 40), estuary (RM 40 to RM 3), and river mouth (RM 3 to the deep water disposal site), the SEI science panel identified the need for a consistent framework for understanding the lower Columbia River, estuary, and river mouth ecosystem. A conceptual ecosystem model was subsequently developed, with assistance of the BRT, of the lower Columbia River, estuary, and river mouth ecosystem relationships that are significant for listed and proposed salmonids. The conceptual ecosystem model is a way to show the interactions and relationships within the lower Columbia River, estuary, and river mouth that, when they are operating properly, help to characterize the lower Columbia River, estuary, and river mouth ecosystem as a whole. The aquatic species BA (Chapter 5) and Appendix E provide an extensive presentation and discussion of the conceptual ecosystem model, and describe the historic and current conditions of the lower Columbia River, estuary, and river mouth using the model. These descriptions are incorporated herein by reference.

The basic riverine and estuarine habitat-forming processes—physical forces of the ocean and river—create the conditions that define habitats . The habitat types, in turn, provide an opportunity for the primary plant production that gives rise to complicated food webs. All of these pathways combine to influence the growth and survival of coastal cutthroat trout and bull trout in the lower Columbia River, estuary, and river mouth. The following is a summarization, based on the conceptual ecosystem model, of the lower Columbia River, estuary, and river mouth's ecosystem components, and how these factors collectively influence the growth and survival of the lower Columbia River, estuary, and river mouth's listed and proposed salmonid species, including coastal cutthroat trout and bull trout, rearing in and migrating through the lower Columbia River, estuary, and river mouth (Table 4.1). A brief narrative follows Table 4.1, to provide a summarization of the relationships between various ecosystem components and functions, and their influence on salmonid growth and survival. Specific information is provided, when available, regarding the influence of these ecosystem components on coastal cutthroat trout and bull trout.

Table 4.1. Conceptual Model Pathways and Indicators for Juvenile Salmonid Production in the Lower Columbia River, Estuary, and River Mouth.

Model Pathways	**Pathway Description**	**Model Components (Indicators)**	**Indicator Description**
Habitat-Forming Processes	Physical processes that define the living conditions and provide the requirements fish naturally need within the river system are included in the Habitat-Forming Processes Pathway	Suspended sediment	Sand, silt, and clay transported in the water column
		Bedload	Sand grains rolling along the surface of the riverbed
		Woody Debris	Downed trees, logs, root wads, limbs
		Turbidity	Quality of opacity in water, influenced by suspended solids and phytoplankton
		Salinity	Saltwater introduction into freshwater areas through the tidal ocean process
		Accretion/ erosion	Deposited/carved sediments
		Bathymetry	Topographic configuration of the riverbed

Habitat Types	This pathway describes definable areas that provide the living requirements for fish in the Lower Columbia River	Tidal Marsh and Swamp	Areas between mean lower low water (MLLW) and mean higher high water (MHHW) dominated by emergent vegetation (marsh) and low shrubs (swamp) in estuarine and riverine areas
		Shallow Water and Flats	Areas between 6-foot bathymetric line (depth) and MLLW
		Water Column	Areas in the river where depth is greater than 6 feet
Habitat Primary Productivity	This pathway describes the biological mass of plant materials that provides the fundamental nutritional base for animals in the river system	Light	Sunlight necessary for plant growth
		Nutrients	Inorganic source materials necessary for plant growth
		Imported Phyto-plankton Production	Material from single-celled plants produced upstream above the dams and carried into lower reaches of the river
		Resident Phyto-plankton Production	Material from single-celled plants produced in the lower reaches of the river
		Benthic Algae Production	Material from simple plant species that inhabit the river bottom
		Tidal Marsh and Swamp Production	Material from complex wetland plants present in tidal marshes and swamps
Food Web	The Food Web pathway shows the aquatic organisms and related links in a food web that supports growth and survival of salmonids	Deposit Feeders	Benthic organisms such as annelid worms that feed on sediments, specifically organic material and detritus
		Mobile Macro-invertebrates	Large epibenthic organisms such as sand shrimp, crayfish, and crabs that reside and feed on sediments at the bottom of the river
		Insects	Organisms such as aphids and flies that feed on vegetation in freshwater wetlands, tidal marshes, and swamps
		Suspension/ Deposit Feeders	Benthic and epibenthic organisms such as bivalves and some amphipods that feed on or at the interface between sediment and the water column
		Suspension Feeders	Organisms that feed from the water column itself, including zooplankton

		Tidal Marsh Macro-detritus	Dead and decaying remains of tidal marsh and tidal swamp areas that are an important food source for benthic communities
		Resident Microdetritus	Dead and decaying remains of resident phytoplankton and benthic algae, an important food source for zooplankton
		Imported Microdetritus	Dead remains of phytoplankton from upstream that serve as a food source for suspension and deposit feeders
Growth	The Growth Pathway highlights the factors involved in producing both the amount of food and access by fish to productive feeding areas	Habitat Complexity, Connectivity, and Conveyance	Configuration of habitat mosaics that allow for movement of salmonids between those habitats
		Velocity Field	Areas of similar flow velocity within the river
		Bathymetry and Turbidity	River bottom and water clarity conditions that influence the ability of salmonids to locate their prey
		Feeding Habitat Opportunity	Physical characteristics that affect access to locations that are important for fish feeding
		Refugia	Shallow water and other low energy habitat areas used for resting and cover
		Habitat-Specific Food Availability	Ability of complex habitats to provide feeding opportunities when fish are present
Survival	The Survival Pathway is a summary of key factors controlling or affecting growth and migration	Contaminant s	Compounds that are environmentally persistent and bioaccumulative in fish and invertebrates
		Disease	Pathogens (viruses, bacteria, and parasites) that pose survival risks for salmon
		Suspended Solids	Sand, silt, clay, and organics transported within the water column
		Stranding	Trapping of young salmonids in areas with no connectivity to water column habitat
		Temperature and Salinity Extremes	Temperature or salinity conditions that are problematic to salmonid survival

		Turbidity	Water clarity as it pertains to potential for juvenile salmonids to be seen by predators
		Predation	Potential for piscivorous mammals, birds, and fish to prey on salmonids
		Entrainment	Trapping of fish or invertebrates into hopper or pipeline dredges

4.3.2 Habitat Forming Processes

Habitats are formed primarily by the interaction of hydrodynamic forces and sediment supply. In the lower Columbia River, estuary, and river mouth, both the river and the ocean influence the riverine and estuarine hydrodynamics. Ocean processes, including tidal action and waves, interact with river processes, including currents and sediment transport, in the lower Columbia River, estuary, and river mouth to produce complex hydrodynamics. The net result is deposition (accretion) of suspended sediments to form flats and carving (erosion) to form shallow and deep channels. These habitats may be colonized by marsh and swamp vegetation, as controlled by bathymetry (elevation of substrate) and, in the estuary, salinity (because plants and animals are adapted to certain salinity ranges, the salinity level, as well as seasonal and spatial patterns, strongly influences where species occur in the lower Columbia River and estuary). If the turbidity levels are low enough to allow sufficient light penetration for plant growth, certain areas may develop submerged vegetation such as eelgrass. Woody debris, deposited on the flats, along channel edges, and in marshes and swamps, creates a complex, vertical structure. Habitats in deeper riverine and estuarine areas are formed by bedload transport, which shapes portions of the river and estuary bed into a series of sand waves. In the Habitat-Forming Processes Pathway (below), all of these dynamics and interactions culminate in the expression of habitat types important to coastal cutthroat trout and bull trout in the lower Columbia River, estuary, and river mouth.

4.3.3 Habitat Types

The habitats most directly linked to salmonids in the lower Columbia River, estuary, and river mouth include the tidal marshes and swamps, shallow water and flats, and the water column. Habitat types are generally defined by specific elevation ranges.

Tidal marshes and swamps generally occur between Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW). Tidal marshes begin at lower tidal elevations, slightly above MLLW, and swamps occur at or above MHHW. Juvenile and adult coastal cutthroat trout use the edges of these marshes to feed, and the edges of shallow channels within the marshes as refugia and feeding areas. Tidal marshes can be divided into saltwater marshes and freshwater marshes, each characterized by a distinctive vegetation type. Tidal marshes include tidally influenced areas all the way up to Bonneville Dam, as well as extensive tidal freshwater marshes in the lower Columbia River, particularly those in Cathlamet Bay.

Shallow water and flats occur throughout the intertidal zone and into the shallow subtidal zone in waters up to six feet deep. Benthic algae (largely benthic diatoms) develop on tidal flats and in the shallow subtidal zone within the system. Coastal cutthroat trout use shallow water and flats habitats for feeding and movement.

Water column habitat refers to waters that are greater than six feet deep. Freshwater plankton dominate the fresh and oligohaline portions of the water column upstream, and plankton tolerant of greater salinity dominate the estuary and the river mouth of water column habitats. Coastal cutthroat trout and bull trout utilize water column habitat for feeding and movement.

4.3.4 Habitat Primary Productivity Pathway

A major function of the habitats is to produce food used by organisms in the ecosystem. Habitat primary productivity refers to the amount of material (biomass) produced over time during plant growth that occurs within each habitat type. Primary productivity is driven by light and is supported by inorganic nutrients (e.g., nitrate, phosphate). Inorganic nutrients enter the system from the upstream watershed and the downstream ocean currents and through the breakdown and recycling of organic matter within the system. Live plant material and detritus are the primary sources of organic matter in the food web used by coastal cutthroat trout and bull trout in the lower Columbia River, estuary, and river mouth.

Primary productivity within water column habitat results from imported and resident phytoplankton. Imported phytoplankton are freshwater species produced in large quantities in the upstream watershed (particularly in the reservoirs behind the mainstem Columbia River and tributary dams), whereas resident phytoplankton are produced within the lower Columbia River and estuary.

Primary productivity within the shallow water and flats habitat results mostly from benthic algae. Shallow water habitats can also produce filamentous algae and flowering grasses such as eelgrass; however, the majority of primary productivity within the river's shallow water areas comes from benthic algae.

Primary productivity within tidal marsh and swamp habitat comes from the marsh and swamp vegetation, which includes emergent plants, shrubs, and trees.

4.3.5 Food Web Pathway

The base of any food web is the plant material produced over time or the primary productivity within each habitat type. The food web described in the conceptual model includes macrodetritus, the large, complex forms of dead plants, primarily from tidal marsh plants. Macrodetrital webs are supported by tidal channels and backwater sloughs, marshes and swamps, vegetated riparian habitats, and other shallow water and low velocity habitats. This food web also includes microdetritus, the material from simple-celled plant or organic particles. Microdetritus can be in the form of imported microdetritus if they are derived from imported phytoplankton, or resident microdetritus if they are derived from resident phytoplankton. Small animals that shred the larger plant matter and microbes, including bacteria, protozoa, and fungi, facilitate the breakdown of detritus. In addition to making the organic matter useful to the food web, these breakdown processes recycle inorganic nutrients needed by the plants for primary production.

Salmonids, including coastal cutthroat trout and bull trout, eat invertebrate prey species that are supported by resident and imported microdetritus, and macrodetritus from tidal marsh and swamp plant material. The relative amount of food and food energy depends on the abundance of each habitat type (e.g., tidal marshes) and the input of nonresident material from upstream sources. Several types of invertebrate prey species make up the next level up the food chain from the primary producers and their detritus.

Mobile macroinvertebrates are large epibenthic organisms, such as sand shrimp, mysids, and Dungeness crab, that reside on the river bottom and feed on bottom sediments and byproducts of primary productivity. Mysids are the primary macroinvertebrates that are relevant to the coastal cutthroat trout and bull trout food web. Deposit feeders are benthic animals that feed by consuming organic matter in sediments. The term deposit feeders refers to both surface and subsurface deposit feeders, which include marine annelids (polychaetes), and freshwater annelids (oligochaetes), and benthic crustaceans. Suspension feeders are organisms that feed from the water column itself. For zooplankton and benthic/epibenthic organisms, this is accomplished primarily through "filter feeding". Suspension/deposit feeders are benthic and epibenthic organisms that feed on or at the interface between the sediment and the water column. Floating insects (larvae and adults) appear to be important in the diet of most of the salmonid species and age classes in the salmonid food web. Many of these insect types feed on live tidal marsh plants. All life stages of coastal cutthroat trout feed on both aquatic and terrestrial invertebrates, and older coastal cutthroat trout as well as bull trout feed on other fish that also use these invertebrate food items.

There has been a shift in the food web within the lower Columbia River. Tidal marsh and swamp vegetation and macrodetritus have declined. The benthic/epibenthic food web, which was a prominent feature of the historical lower Columbia River ecosystem, no longer produces as varied or rich a food web (Sherwood et al. 1990). The current ecosystem is now more dependent on a "microdetrital" food web supported by the estuary turbidity maximum (ETM) zone in the mainstem channels.

The ETM results from the combination of two processes, strong tidal forces and its interaction with the salt wedge in the lower Columbia River. This combination results in elevated levels of suspended particulate matter. The physical process occurs when strong tidal forces push salinity upriver beneath the outflowing river water. The turbulence caused by this tidal forcing results in resuspension of sediment and other particulate material present on the river bed.

Concurrently, dissolved material in the river water flocculates when it comes into contact with the salt wedge pushing its way up river. The interaction of these forces results in the ETM.

The ETM supports the detrital food chain and salmon production, and in the current estuary the ETM sustains the highest secondary productivity (Simenstad et al. 1990). Fish and invertebrate community surveys in the Columbia River estuary provide strong evidence that physical processes that promote concentration of organic matter and the maintenance of zooplankton populations within the estuary control the feeding environment for estuarine fishes (Bottom and Jones 1990). With the degradation of the macrodetrital food chain, the ETM has assumed an important role in providing food for salmon that enables them to mature properly and enhances their ability to survive.

4.3.6 Growth Pathway

Salmonids, including coastal cutthroat trout and bull trout, are adapted for using a complex mosaic of many habitat areas as they migrate downstream, and during their residence in the lower Columbia River, estuary, and river mouth. This mosaic of habitats used by salmonids is referred to as habitat complexity. An absence or reduction in the natural complexity of habitats available may affect the salmonids' ability to reach food resources needed for growth. Habitat conveyance is the opportunity for salmonids to move over flats and into tidal marsh systems as the water level rises and falls with the tide and with river flow. Connectivity refers to links and spatial arrangements among habitats in the mosaic of changing habitat areas. Feeding habitat opportunity reflects the variable access among feeding, rearing, and refuge habitats along the migratory corridor. Habitat-specific food availability needs to exist for salmonids to feed within the set of habitats. Lastly, low current velocity, shallow water areas provide productive feeding areas for salmonids. However, because salmonids are visual predators, turbidity and uneven bathymetry may influence their ability to successfully capture prey items.

4.3.7 Survival Pathway

Besides growth, a variety of factors interact to affect the ultimate survival of salmonids, including coastal cutthroat trout and bull trout, in the lower Columbia River, estuary, and river mouth. Factors that can negatively affect survival include contaminants, predation, suspended solids, temperature and salinity extremes, stranding, entrainment, and competition.

Contaminants may affect the health (physiological integrity) of salmonids and may result in disease as well as a reduced ability to physiologically adapt to saltwater, avoid predators, forage effectively, and seek and find shelter. Contaminants can be taken up directly through the water column or through contaminated prey. Predation is a major factor affecting salmonid survival in the lower Columbia River, estuary, and river mouth. Birds, including Western grebes, cormorants, gulls, terns, and great blue herons, are known to prey on salmonids. Piscine and pinniped predators also may prey salmonids. Suspended solids, which can be a major contributor to turbidity, may affect survival by reducing the ability of salmonids to see prey, and indirectly cause mortality via starvation. Temperature and salinity extremes typically stress fish, which may lead directly or indirectly to mortality. Stranding can occur when fish are washed up onto higher ground by waves or ship wakes, or if they are caught for extended periods of time in a shallow pool during an extended low tide. Fisheries biologists have observed stranding of salmonids in the lower Columbia River system. Entrainment refers to the uptake of fish during dredging. Finally, competition between and among members of the outmigrating salmonid populations may play a role in survival; however, little is understood or documented regarding the effects of competition in the lower Columbia River, estuary, and river mouth.

4.4 Updated Environmental Baseline Information for Columbian White-tailed Deer and Bald Eagle

4.4.1 Columbian White-tailed Deer

As noted in the terrestrial species opinion, Columbian white-tailed deer occur on islands and mainland habitats in the middle portions of the Project area. Columbian white-tailed deer numbers on Tenasillahe Island and mainland areas decreased as a result of the 1996 Columbia River floods. Since 1996, the four major sub-populations have remained stable or increased in numbers (A. Clark, pers. comm.). The estimated 2001 numbers of Columbian white-tailed deer, and the doe:buck:fawn ratio, is provided in Table 4.2.

Table 4.2. Estimated 2001 numbers and sex/age ratios of Columbian white-tailed deer, by geographic area/sub-population.

Area	Estimated Deer Numbers	Sex and Age Ratios
Julia Butler Hansen mainland	120-140	31:100:49
Tenasillahe Island	130-150	50:100:18
Puget Island	150	68:100:49
Westport Flats/Wallace Island	170-180	47:100:40
Crims Island	42-65	unknown
Brownsmead Flats	5-15	unknown

Several ecosystem restoration activities are proposed in locations that support Columbian white-tailed deer sub-populations. Short-term and long-term habitat restoration activities are proposed at the Tenasillahe Island sub-population area, and noxious weed control is proposed on Wallace Island.

Long-term habitat restoration at Tenasillahe Island is proposed, if and when Columbian white-tailed deer are delisted and Tenasillahe Island habitat restoration plans are found by the Service to be compatible with Julia Bulter Hansen National Wildlife Refuge's purposes and goals. This long-term Project action would potentially reduce the Columbian white-tailed deer carrying capacity on Tenasillahe Island. Proposed Project purchase of Cottonwood/Howard Island, and subsequent introduction of Columbian white-tailed deer to this island complex, may allow for a new, secure sub-population of Columbian white-tailed deer to be established. The Columbian white-tailed deer recovery plan requires, for delisting of the Columbia population, a minimum of 400 Columbian white-tailed deer to be maintained within at least three viable sub-populations in suitable, secure habitat.

4.4.2 Bald Eagle

Bald eagle nests occur at or near several of the ecosystem restoration activity locations. In addition, bald eagles perch on pilings, trees, stumps, mud flats, and other locations throughout the Columbia River and estuary (A. Clark, pers. comm.); these perch locations may be adjacent to the ecosystem restoration projects. Three bald eagle pairs nest either on or in close proximity to Lois Island embayment restoration project (Tongue Point/Mill Creek; Lois Island/John Day Point; Cathlamet Bay), one pair nests on Miller Sands Island near the Miller/Pillar habitat restoration project; two pairs nest on Tenasillahe Island (Tenasillahe/North Hunting Island; Clifton Channel/Tenasillahe West) near the Tenasillahe Island interim and long-term restoration actions; and approximately 30 bald eagle pairs nest within or adjacent to the Columbia River estuary, where the purple loosestrife control activities will occur. Bald eagles do not currently nest on Cottonwood/Howard Islands. Two bald eagle nesting territories occur near the Bachelor Slough restoration project (Bachelor Island; Mallard Slough).

5.0 EFFECTS OF ACTION

5.1 Introduction

The proposed Project has several distinct components, including Project construction and maintenance activities, monitoring and adaptive management, and ecosystem restoration and research actions. The Effects of Action section includes sub-sections that address each Project component separately. Section 7.0 (Conclusion) will aggregate effects from each Project component, and, combined with effects from interrelated and interdependent actions, cumulative effects, environmental baseline, and the proposed action, will determine whether the Project, as a whole, jeopardizes the continued existence of proposed coastal cutthroat trout or threatened bull trout.