4 SPECIES AND HABITAT INFORMATION – DESCRIPTION OF SPECIES, HABITAT USE, AND CRITICAL HABITAT

Seven salmonid fish runs having population segments that are federally listed under ESA as endangered, threatened, or proposed for listing as threatened spend a portion of their lives in the action area of the Columbia River. These species include 12 Evolutionarily Significant Units (ESUs) identified by NMFS[16] and 2 Distinct Population Segments (DPSs) identified by USFWS.[17] An additional species ESU that is not listed, but only a candidate for listing, is included here for future planning purposes only.

The ESUs and DPSs addressed in this BA are listed in Table 4-1. An ESU includes "any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature" (Waples, 1991a). This population segment must be substantially reproductively isolated from other nonspecific population units and must represent an important component in the evolutionary legacy of the species. The definition of DPS is essentially the same as that for an ESU. The Services issued a joint policy describing DPSs in *Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act* (61 CFR 4722 February 7, 1996).

The listed ESUs are all salmonids (*Oncorhynchus*), a designation that includes a variety of salmon species as well as steelhead trout (*Oncorhynchus mykiss*). Although steelhead trout are commonly called trout, they are closely related to other salmonids scientifically grouped with them in the *Oncorhynchus* genus.

The listed ESUs fall into two life-history strategies. Ocean-type salmon rear in freshwater for only a few weeks to a few months before migrating to sea during their first year of life. Stream-type salmon spend at least a year rearing in freshwater prior to their downstream migration. The listed DPSs are bull trout (*Salvelinus confluentus*) and coastal cutthroat trout (*Oncorhynchus clarki clarki*).

Table 4-1: Federally Listed Salmonid ESUs/DPSs that Occur in the Action Area

Evolutionarily Significant Unit (ESU)	Status	Life History Type	Juvenile Life Stage In Lower Columbia River	Date Listed
Chinook (*Oncorhynchus tshawytscha*)				
Snake River spring/summer	Threatened[1]	Stream	Yearling +	4/22/92
Snake River fall	Threatened	Ocean	Subyearling	4/22/92
Lower Columbia River	Threatened	Ocean	Subyearling	3/24/99
Upper Columbia River spring	Endangered[2]	Stream	Yearling +	3/24/99
Upper Willamette River	Threatened	Ocean	Subyearling +	3/24/99
Chum (*Oncorhynchus keta*)				
Columbia River	Threatened	Ocean	Subyearling	3/25/99
Sockeye (*Oncorhynchus nerka*)				
Snake River	Endangered	Stream	Yearling +	11/2/91
Steelhead trout (*Oncorhynchus mykiss*)				
Snake River	Threatened	Stream	Yearling +	8/18/97
Lower Columbia River	Threatened	Stream	Yearling +	3/19/98

[16]NMFS is responsible for conducting consultations, pursuant to Section 7 of the ESA, for listed fish species that spend all or most of their lives in the marine environment.
[17] USFWS is responsible for conducting consultations, pursuant to Section 7 of the ESA, for listed fish species that spend all or most of their lives in the freshwater environment.

Evolutionarily Significant Unit (ESU)	Status	Life History Type	Juvenile Life Stage In Lower Columbia River	Date Listed
Middle Columbia River	Threatened	Stream	Yearling +	3/25/99
Upper Columbia River	Endangered	Stream	Yearling +	8/18/97
Upper Willamette River	Threatened	Stream	Yearling +	3/25/99
Coho *(Oncorhynchus kisutch)*				
Lower Columbia River/Southwest Washington	Candidate	Stream	Yearling +	7/25/95
Distinct Population Segments (DPS)				
Bull trout (*Salvelinus confluentus*)				
Columbia River	Threatened	Trout	Yearling +	6/10/98
Cutthroat trout (*Oncorhynchus clarki clarki*)				
Southwest Washington/Columbia River	Proposed Threatened	Trout	Yearling +	10/25/99

[1]Threatened: any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

[2]Endangered: any species that is in danger of extinction throughout all or a significant portion of its range.

Because individuals from each of these ESUs/DPSs may be present within the action area as juveniles or adults, or both, they may be affected by the Project directly or by alteration of the habitat they use.

For each ESU of the chinook, chum, coho, sockeye, and steelhead trout, all individuals move through the action area as juveniles on their migration to the ocean and again as adults during their return migration to spawn in the stream where they hatched. However, the amount of time spent in the action area during different life stages and at different seasons varies greatly among the ESUs. Because of the differences in the amount of time each of these salmon types spends in different portions of the system, changes to habitat affect them differently.

Only some individuals from the bull trout and cutthroat trout populations migrate into the action area to rear for a prolonged period. These individuals are referred to as migratory, and may either be fluvial (reside in rivers) or anadromous (migrating to a saltwater environment). The other individuals of these species are “resident”; they will stay in the stream where they hatched throughout their lives and will not migrate through the lower Columbia River. Prior to their upstream migration in the fall and winter, the migratory individuals may pass through the action area to rear in the ocean for a few months or they may stay within the action area to rear, never actually entering the ocean. Neither cutthroat trout nor bull trout spawn in the action area. Both species spawn higher upstream in the tributaries of the Columbia River Basin.

As adults, returning salmonids may take considerable time to move upstream or may move upstream rapidly once they reach the stream where they originally hatched. Because adults have much less restrictive habitat requirements than juveniles as they migrate through lower Columbia River areas, this BA focuses on the juvenile life stages of the listed species. Figure 4-1 shows some of the life stages of the listed species, as well as their relative sizes.

General life history and associated environmental conditions for ocean-type salmon, stream-type salmon, and trout are discussed in the following subsections. The major river category or reach type – riverine, estuarine, and river mouth – that the species types use during migration and rearing are also discussed. These reaches are illustrated in Figure 1-2.

Figure 4-1: Salmonid Sizes in the Lower Columbia River

4.1 Ocean-Type Salmon

Ocean-type salmon migrate downstream to and through the estuary as subyearlings, generally leaving the spawning area where they hatched within days to months following their emergence from the gravel. Ocean-type salmon ESUs in the Columbia River include some chinook ESUs (lower Columbia River, Snake River fall, and Upper Willamette River) and Columbia River chum salmon ESUs. Consequently, subyearlings commonly spend weeks to months rearing within the action area prior to reaching the size at which they migrate to the ocean. Young salmonids must undergo a physiological transition and develop enough strength, energy, and reserve capacity to adapt to and survive the physical and biological challenges of the ocean environment, as well as to successfully obtain prey in that environment. Juvenile salmonids appear to reach the threshold for this transitional state at a size of 70 to 100 mm. Before fish reach this size, their ocean survival would be difficult.

The first outbound migrants of the lower Columbia River fall chinook and chum may arrive in the action area as early as late February (Herrmann, 1970; Craddock, et al., 1976; Healey, 1980; Congleton, et al., 1981; Healey, 1982; Dawley, et al., 1986; Levings, et al., 1986). The majority of these fish are present from March through June. Outbound Snake River fall chinook begin their migration much farther upstream and arrive in the lower Columbia River approximately a month later. The chinook and chum subyearlings shown to the right were sampled in the shallow water of protected off-channel areas.

Ocean-type subyearlings arrive in the lower river and estuarine portion of the action area at a small size. The earliest migrants can be as small as 30 to 40 mm fork length (i.e., from snout to fork in the tail) when they arrive because some of these fish hatch only a short distance upstream from the action area. Later spring migrants are generally larger, ranging up to 50 to 80 mm. Subyearlings from the mid-Columbia and Snake Rivers tend to be substantially larger (70 to 100 mm) by the time they reach the lower Columbia River. The larger size of the lower Snake River fall chinook, compared with the lower Columbia River chinook and chum, likely indicates some differences in suitable habitat. The larger subyearlings from the Snake River can likely use a greater range of depth and current conditions than the subyearlings of the lower Columbia River ESUs can.

Salmon Subyearlings

Once ocean-type subyearlings arrive in the lower Columbia River, they may remain for weeks to months. Because these fish arrive small in size, they undergo extended lower river and estuary rearing before they reach the transitional size necessary to migrate into the ocean (70 to 100 mm). This larger size is necessary to deal with the physical conditions and predators they face in the ocean environment, as well as to be successful in obtaining prey in that environment. At growth rates of about 0.3 to 1 mm per day (Levy, et al., 1979; Argue, 1985; Fisher and Pearcy, 1990), the subyearlings require weeks to months to reach this larger size. During this time, young chinook increase by about 5 to 8 grams per day or approximately 6 percent of their body weight (Herrmann, 1970; Healey, 1980). Habitat characteristics in each of the three reach types support rearing and migration for the subyearlings, as discussed in the following subsections.

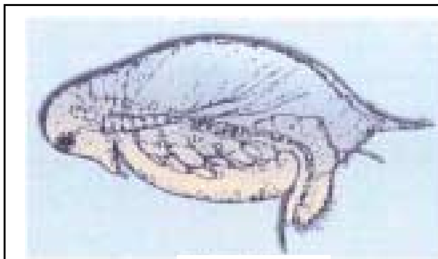
4.1.1 Riverine Reach

Numerous studies of Columbia River salmon have been conducted. Nearly all have begun at Bonneville Dam or farther upstream. A small body of information is available specifically for the riverine reach in the action area; however, it is likely the subyearlings use the lower Columbia River in the same manner that they use other lower river areas of salmon-bearing streams. Most lower mainstem rivers commonly are characterized by a low gradient, fine sediments, and relatively low water velocities that are gradually influenced by tidal forces as they approach the euryhaline estuary. The common physical and biological characteristics of these similar streams provide similar habitats that are inhabited by similar species and life stages of salmonids. Although the mainstem Columbia River shares most of these characteristics, it should be noted that its sediments are generally sandy rather than fine.

Ocean-type subyearlings migrate through the riverine reach of the action area during their downstream migration (about 150 kilometers [km]). Because of this, many spend some time rearing within the riverine reach; however, there is considerable variability in the freshwater rearing period of subyearling populations. Some subyearlings spawned in the lower reaches of coastal tributaries migrate almost immediately to marine areas following emergence from the gravel. Other subyearlings rear in freshwater for weeks to months, particularly those spawned well upstream in larger river systems such as the Columbia. The migration rate for subyearlings undergoing the rearing migration through the riverine reach is likely to be a few to 10 km per day. Subyearlings migrating directly to the estuary migrate at rates of 15 to 30 km per day (MacDonald, 1960; Simenstad, et al., 1982; MacDonald, et al., 1987; Murphy, et al., 1989; Fisher and Pearcy, 1990). Adult salmon returning to the Columbia River migrate through the river mouth throughout the year. The majority move through this area from early spring through autumn.

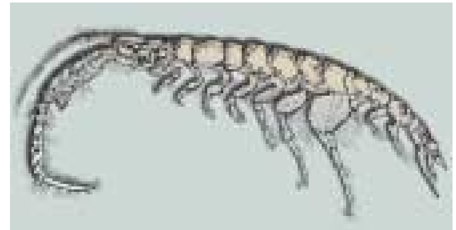
A number of physical characteristics in the riverine reach affect the quality and quantity of habitat available for salmonids. These include the availability of prey, temperature, turbidity, and suspended solids. These characteristics and their relationship to salmonid habitat are discussed in the following paragraphs.

Subyearlings are commonly found within a few meters of the shoreline at water depths of less than 1 meter. Although they migrate between areas over deeper water, they generally remain close to the water surface and near the shoreline during rearing, favoring water no more than 2 meters deep and areas where currents do not exceed 0.3 meter per second. They seek lower energy areas where waves and currents do not require them to expend considerable energy to remain in position while they consume invertebrates that live on or near the substrate. These areas are characterized by relatively fine grain substrates. However, it is not uncommon to find young salmonids in areas with steeper and harder substrates, such as sand and gravel.



Daphnia

Young chinook in the lower Columbia action area consume a variety of prey—primarily insects in the spring and fall and *Daphnia* from July to October (Craddock, et al., 1976). *Daphnia* is the major prey during the summer and fall months, selected more than other planktonic organisms. Young salmonids consume diptera, hymenoptera, coleoptera, tricoptera, and ephemeroptera in the area just upstream from the estuary (Dawley, et al., 1986). Bottom and Jones (1990) recently reported that young chinook ate primarily *Corophium*, *Daphnia*, and insects, with *Corophium being* the dominant prey species in winter and spring and *Daphnia* the dominant prey species in summer. Salmonids commonly feed on *Corophium* males, which apparently are more readily available than the larger females.


Corophium

Corophium is commonly discussed as a primary prey item of juvenile salmonids in the lower Columbia River. *Corophium salmonis* is a euryhaline species tolerating salinities in the range of zero to 20 ppt (Holton, et al., 1984). As shown by the above investigations, it is one of several major prey species consumed by juvenile chinook under existing conditions. No data are available that indicate its historical role in the diet of Columbia River salmon prior to substantial modification of the river system. Nutritionally, *Corophium* may not be as desirable as other food sources for young salmon. According to Higgs, et al. (1995), gammarid amphipods such as *Corophium* are high in chitin and ash and low in available protein and energy relative to daphnids and chironomid larvae.

As a result of substantial runoff from higher elevations, temperature conditions tend to be moderate in the riverine reach during the spring and early summer migration and rearing. Desirable water temperatures for young chinook and chum salmon during their migration downstream range from 6.7 to 13.3° C, with an optimum temperature of 10° C (Bell, 1991). Information on salmonids suggests that in freshwater environments smoltification might be suppressed at temperatures greater than 15° C and that optimal growth occurs in the 10 to 19° C range (Water Temperature Criteria Technical Workgroup, 2001). During late summer migration periods, the water temperatures can exceed 20° C and can approach lethal levels in shallow protected waters of the lower Columbia River. Young salmonids can acclimate to these higher temperatures over relatively brief periods of 24 hours or less (Brett, 1956). Brett (1956) also found they require less than 24 hours to acclimate at temperatures above 20° C. In freshwater, lethal temperature is greater than 23° C for juvenile salmonids and greater than 21° C for adult salmonids (Water Temperature Criteria Technical Work Group, 2001).

Adult salmon generally are not exposed to temperatures in a lethal range because of their capacity to avoid high temperatures, together with their propensity to remain in relatively open water until they reach spawning areas; however, high temperatures can delay their migrations. There are several examples in the Columbia River of adult migrations halting due to high or low water temperatures. In 1941, extremely high water temperatures (22 to 24° C) apparently resulted in chinook, sockeye, and steelhead adults congregating in small cold streams near Bonneville and Rock Island Dams (Fish and Hanavan, 1948). At the Okanogan River, Major and Mighell (1967) observed that temperatures greater than 21° C blocked sockeye migrations while stable or even rising temperatures below 21° C did not block migration.

Turbidity and suspended solids are a natural part of the riverine habitats occupied by young and adult salmonids. Turbidity refers to light attenuation by materials in the water; suspended solids refers to the amount of mineral particles suspended in the water column. For context, salmonids are produced in systems and estuaries where turbidities are commonly as high as 400 NTU (Murphy, et al., 1989). Turbidity at moderate levels of about 25 to 110 NTU is common in rivers with migrating salmon.

Turbidity can decrease the probability of predation on young salmonids. Gregory and Levings (1998) found that young salmon are less likely to be eaten by piscivorous fish at higher turbidities. Turbidity can also reduce the feeding efficiency of young salmonids. Gregory (1994) found salmonids had reduced foraging rates in turbidity above 150 NTU, but continued to feed at turbidities as high as 850 NTU. Noggle (1978) found salmonids stopped feeding at turbidities greater than 300 mg/L.

Gregory (1988) reported that the reaction distance of young chinook to benthic prey decreased greatly between zero and about 50 NTUs. From 50 to 250 NTUs, however, there was little change in reaction distance, partly because the fish were only reacting to prey within about 8 centimeters at 50 NTU. Growth of young steelhead and coho was reduced by chronic turbidity in the range of 20 to 50 NTUs in freshwater rearing (Sigler, et al., 1984). Turbidity during the spring freshet period may be lower in the

Columbia River under existing conditions than it was under historical conditions because the dams and associated reservoirs lower the water velocity.

Direct survival of young salmonids can be affected by high suspended solid loads. The lethal concentration found to kill 50 percent of a group (LC_{50}) of young salmonids under summer conditions (the most sensitive) is near 1.2 grams per liter (g/L) (Noggle, 1978). Smith (1978) determined the LC_{50} for chum to be greater than 2.5 g/L. The background suspended solid load in the lower Columbia River at 200,000 cfs is .02 g/L (Eriksen, SEI Presentation, 2001). Suspended solids do not appear to influence the homing of adult salmon. Whitman, et al. (1982), found that, although adult chinook tended to avoid Mount St. Helens ash at about 0.65 g/L, ash at average concentrations of 3.4 g/L in the Toutle River did not appear to influence homing performance.

4.1.2 Estuary

The estuarine reach is a complex physical habitat containing a large amount of shallow water habitat. The complex array of side channels, sandbars, and islands provides gentle to moderately sloping shallow water habitat with substrate ranging from sand to fine silt in backwater areas. As in the riverine reach, a number of physical characteristics affect salmon habitat in the estuary, including salinity, temperature, turbidity, and availability of prey.

Subyearling chinook and chum first enter the estuary at about the same time that they enter the riverine reach because some of the fry move rapidly to the estuary by mid-March rather than rearing in the riverine areas (Craddock, et al., 1976; Dawley, et al., 1986; Levy and Northcote, 1982; Healey, 1982; Hayman, et al., 1996). As chinook fry migrate to the estuary, they may remain in the low salinity or even freshwater areas for some time until they have grown somewhat larger (more than 75 mm) (Kjelson, et al., 1982; Levings, 1982; Levy and Northcote, 1982; MacDonald, et al., 1986; Shreffler, 1992; Hayman, et al., 1996). However, some chinook fry appear to move immediately to the outer edges and higher salinity portions of the estuary (Stober, et al., 1971; Kask and Parker, 1972; Sibert, 1975; Healey, 1980; Johnson, et al., 1992; Beamer, et al., 2000). Adult salmon returning to the Columbia River migrate through the river mouth throughout the year. The majority move through this area from early spring through autumn.

Ocean-type fish commonly have the capacity to adapt to highly saline waters shortly after emergence from the gravel. Tiffan, et al. (2000), determined that, once active migrant fall chinook passed McNary Dam 470 km upstream from the Columbia River's mouth, 90 percent of the subyearlings were able to survive challenge tests in 30 ppt seawater at 18.3° C. Other investigators have found that very small chinook fry are capable of adapting to estuarine salinities within a few days (Ellis, 1957; Clark and Shelbourn, 1985). Wagner, et al. (1969), found that all fall chinook alevins tested were able to tolerate 15 to 20 ppt salinity immediately after hatching.

While tidal exchange with the ocean tends to keep estuary temperatures at moderate levels (10° to 20° C) throughout the time the outmigrants are present, spring and summer temperatures vary widely in shallow water because tidal flats are exposed by low tides during sunny midday periods. Consequently, young salmonids rearing in shallow water naturally experience a wide range of temperatures within periods of less than a day. The available observations of the behavioral reaction of young salmonids to temperatures in estuarine conditions are variable. Bessey (1976) found hatchery chinook and wild chum avoided water of 16° C. These fry responded immediately to increases of less than 1° C; however, the fry did not avoid rapid increases of more than 1° C per minute. Temperatures in the estuarine reach may range from zero to 26° C, but 12° to 14° C is optimum for young salmon (NMFS, 2000).

In the estuary, turbidity is important in relation to the ETM zone. The ETM zone is discussed in further detail in Section 6.1.4. Relatively high turbidity is a characteristic of the intermixing of freshwater and saltwater in the ETM. However, Jones, et al. (1990), concluded that, in the lower Columbia River, the standing stocks of benthic animals were highest in the protected tidal flat habitats, while those of epibenthic and zooplanktonic organisms were concentrated within the ETM. Because prey species have differing tolerances for salinity, increased salinity in the estuary results in different prey species being available to the rearing fry than those in the freshwater riverine reach, and in a change in the abundance of those prey species that are found in both the estuarine and riverine reaches. In addition, young salmonids in the estuary continue to eat many of the same organisms as are consumed in the riverine reach, but there are shifts in prey abundance. Young chinook and chum at Miller Sands in the upper estuarine reach feed primarily on the pelagic prey *Daphnia longispina* and *Eurytemora hirundoides,* the benthic prey *Corophium salmonis*, and chironomid larvae and pupae (McConnell, et al., 1978). Diet overlaps considerably among the different species. Many yearlings passing through the lower river were found to have empty or less than full stomachs (Dawley, et al., 1986).

4.1.3 River Mouth

As young salmonids leave the estuary, they migrate through the river mouth. Conditions in the river mouth are similar to those in other portions of the estuary – the major difference is the wave and current energy within the river mouth. The ocean area immediately outside the river mouth is characterized by high salinity during low to moderate flows and by high wave energy with no shoreline for protection.

It is likely that young salmonids pass through the river mouth from March through the autumn months during the same time they are present in the estuary. Some individuals may migrate out of the estuary early and other late in the general migration period of each ESU. Outside the river mouth, young salmonids enter the ocean, where high salinity and the absence of available shoreline require them to adapt to a pelagic life style. Pearcy, et al. (1990), found chinook in near-surface waters up to 46 km offshore from Oregon and Washington during the summer months, but absent from this area by mid-September. Orsi, et al. (2000), found juvenile chinook, chum, and pink salmon were most abundant in the shoreline (strait) waters of southeast Alaska during June and July when zooplankton abundance was highest. Food availability may also be a factor in the timing of Columbia River salmon migration; however, Brodeur (1992) concluded that food availability off the Oregon and Washington coasts was not a limiting factor.

Adult Chinook Salmon

Adult salmon migrate through the river mouth and adjacent ocean during their return to the Columbia River. During this period, they do not have any specific habitat requirements. The description provided above for their behavior in the riverine reach applies to the river mouth reach as well.

4.2 Stream-Type Salmon

Individuals of these species rear in freshwater, usually remaining in the stream where they hatched for a year or more before beginning their downstream migration to the ocean. Steelhead trout may rear in freshwater for several years before migrating to the ocean. Sockeye rear in lakes rather than streams. Stream-type ESUs include some of the chinook salmon ESUs (Lower Columbia and Upper Columbia spring), sockeye, coho, and steelhead. Stream-type or yearling salmon migrate to the ocean in their

Smolt

second year of life or later as relatively large smolts (generally 100 to 300 mm; see Figure 4-1) and move quickly through the action area within days to weeks.

Smolts undergo a physiological alteration in the spring that prepares them for migration and saltwater adaptation. Although fish in the various ESUs may migrate at somewhat differing times, smolts tend to be spring migrants that pass through the action area from early April through September. Migration timing varies with species and with distance between the action area and the stream where they hatched.

The larger size of the yearling smolts allows them to occupy a wider range of habitats. Smolts are commonly found farther from shore with a deeper distribution than ocean-type migrants. Johnsen and Sims (1973) compared beach seine and purse seine catches of chinook from fresh water and brackish water sites in the lower Columbia River. The majority of chinook collected from the shorelines by beach seine were in the range of 50 to 80 mm, while the majority of chinook collected from deeper water by purse seine were in the range of 90 to 150 mm. These larger fish collected from offshore locations are the smolt-size juveniles characteristic of stream-type salmon.

4.2.1 Riverine Reach

Stream-type smolts migrate at a relatively large size, commonly in the range of 100 to 300 mm. Their large size allows them to migrate rapidly downstream in the riverine reach because they have the physical capacity to deal with a much larger range of conditions than the subyearling ocean-type salmon.

Salmon smolts have been found over a substantial range of water depths, although they tend to remain near the water surface. Because yearlings are not shoreline-oriented like subyearlings, they are found throughout the near-surface water column and have commonly been sampled within the top 6 meters (20 feet) of the water column. Sims and Johnsen (1974) found that less than 5 percent of the chinook they collected using a beach seine near shore were yearlings or older.

Smolts are found in a wide range of current speeds as they move downstream. They tend to avoid low-velocity areas except during brief periods when they hold position against tidal or river currents. Recently, Schreck, et al. (1997, 1998, 2001), determined the swimming speed of yearling chinook and steelhead as they migrated from Bonneville Dam to the estuary. Yearling chinook moved about 140 km in 24 to 90 hours at a rate of 1 to 6 km per hour (0.7 to 3.7 miles per hour). Steelhead smolts have been found to migrate distances of 134 to 143 km in 32 to 90 hours, moving at an average rate of 3.3 km per hour (2 miles per hour) (Durkin, 1982; Dawley, et al., 1986). These fish either remain in the channel where substantial current occurs or are actively swimming at a high rate. Continuous tracking of some individual fish indicates that they remain in major channels where substantial downstream currents occur, and that they move between channels.

Yearling salmon are not associated with specific substrate types in the riverine or estuarine reaches. As stated previously, they tend to be water-column-oriented rather than shoreline-oriented and, consequently, are found in areas with a wide range of substrate types.

Yearling salmonids in the lower Columbia River generally eat the same types of organisms as subyearlings. In the lower Columbia River, they consume diptera, hymenoptera, coleoptera, tricoptera, and ephemeroptera. In the estuary, their diet changes to diptera, cladocerans, and amphipods (*Corophium salmonis, C. spinicorne, Eogammarus confervicolus*) (Dawley, et al., 1986). As in the riverine reach, Bottom and Jones (1990) found young chinook ate primarily *Corophium* in winter and spring and *Daphnia* in summer.

Yearling salmon have temperature and turbidity tolerances similar to those of subyearling salmon, as discussed in preceding sections.

4.2.2 Estuary

Stream-type smolts are present in the estuary primarily in May and June, with small numbers appearing earlier and later in the year.

Smoltification or physiological adaptation to migration and high salinity conditions begins in yearling salmonids before they begin their downstream migration. Salinity challenge tests have routinely shown that yearlings are capable of residing in moderate to high salinities (up to and greater than 20 ppt) long before they reach the saline water of the estuary. Sims (1970) reported that young chinook in the Columbia River that were marked one day in a freshwater area were found the next day in a high salinity area 43 km downstream. Movement from freshwater to saltwater apparently does not place high metabolic demands on young salmon (subyearling or yearling). Bullivant (1961) found no significant difference in oxygen consumption rates in young chinook when in freshwater, dilute seawater, or seawater (35.4 ppt). He interpreted this lack of difference in oxygen consumption rates as an indication that the energy expended on osmoregulation was a small portion of the total energy consumption.

Yearlings tend to stay away from the shorelines in deeper waters (Johnsen and Sims, 1973). Sims and Johnsen (1974) found that less than 1 percent of the chinook they collected in the estuary using beach seine close to the shore were yearlings. Most of the young salmon collected by NMFS in shoreline sampling at Jones Beach and adjacent areas were subyearlings, while yearlings tended to be collected in deeper water (Dawley, et al., 1979, 1981, 1984a, 1984b, 1985a, and 1986).

4.2.3 River Mouth

It is likely that fish move through this area relatively quickly, taking advantage of the outgoing tides that provide rapid currents into the open ocean. Open ocean conditions, characterized by weak currents and higher salinities, are considerably different from conditions in the riverine and estuary reaches. As with ocean-type salmon, steelhead trout and chinook were collected by Pearcy, et al. (1990), from near-surface waters up to 46 km offshore from Oregon and Washington during the summer months, but were absent from this area by mid-September. Food availability off the Oregon and Washington coasts was not a limiting factor for chinook (Brodeur, 1992). In a similar study, Orsi, et al. (2000), found that juvenile chinook, coho, and sockeye salmon were most abundant in shoreline (strait) waters of southeast Alaska in June and July when zooplankton abundance was highest. These waters differ from open ocean conditions because the strait offers greater protection from surf conditions.

4.3 Trout Species

Anadromous cutthroat and bull trout DPS populations migrate through and may rear within the action area as juveniles and adults. Cutthroat and bull trout occur in relatively small numbers in the lower Columbia River compared with the salmonid species (Bottom and Jones, 1990). The cutthroat trout DPS includes populations of Washington coastal streams from Grays Harbor to the Columbia River and its tributaries from the Dalles Dam to the MCR, and the Willamette River and its tributaries below Willamette Falls (see Appendices D-2 and D-3)**.** Information on cutthroat trout in the lower Columbia River generally does not separate this DPS from individuals produced in the Willamette River and other upstream Columbia River tributaries. Published literature does not document the presence of bull trout in the lower Columbia River; however, information from a NMFS biologist indicates that sampling crews occasionally caught bull trout at Jones Beach and in the estuary in the 1960s and 1970s (Coley, pers. comm., 2001).

Subadult coastal cutthroat move into and through the lower river area in the spring. Many remain in the estuarine reach of the lower river prior to returning to the stream where they hatched in the late summer to fall. All of these fish appear to remain in the lower river or adjacent ocean areas for only a portion of a year before returning to freshwater. Subadult cutthroat commonly migrate to the lower river after at least 1 and up to 5 or 6 years of rearing in the stream where they hatched. In the lower river they appear to use both shallow water and offshore areas. Because of their large size, they tend to feed on larger invertebrates and small fish. Anadromous adults of these species commonly return to the lower river and adjacent ocean areas in subsequent years, where they remain for several months prior to their spawning migration to the stream where they hatched.

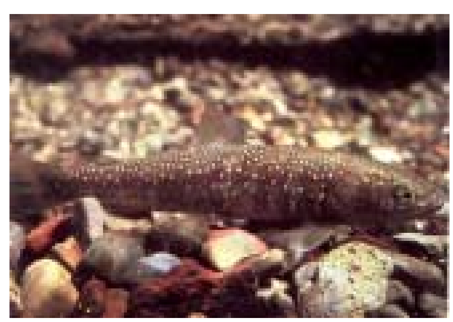
Anadromous cutthroat and bull trout are similar in that they represent only part of the total population of the species from any specific area (see Appendix D-3; Kraemer, 1994). Unlike salmon, many individuals of these species from within the same watershed do not migrate to the sea. For those individuals that do migrate, both species undergo prolonged rearing in freshwater of one to several years prior to migrating to the ocean. After a few months rearing in the estuary or nearby ocean areas, they return to spawn in later winter to early spring. Many individuals make multiple annual migrations to the ocean or estuary.

Anadromous cutthroat trout rear for 1 year to as long as 6 years in freshwater before beginning their migration to the ocean (Trotter, 1997). A review of data records at the NMFS Hammond Laboratory found records of cutthroat being collected from the lower Columbia River for most months in which sampling occurred (Young, pers. comm., 2001). Johnsen and Sims (1973) collected a substantial number of cutthroat trout in May and June, but only two in March, and none in July, implying that cutthroat trout migrate into and through the lower river primarily in the spring with the salmon smolts. Dawley, et al. (1979), concluded that downstream migration of juvenile and adult cutthroat appears to occur in April and May, peaking in early May. Loch (1982) provides data indicating that migration begins in mid-April, peaks in early May, and ends in early June. Cutthroat migrate downstream primarily in March to June (see Appendix D-3). Return of adult cutthroat into the Columbia River begins in early July, peaks in late July and early August, and ends by mid-September as these adults enter tributaries to spawn (Loch, 1982).

Juvenile cutthroat migrate downstream at a relatively large size. Loch (1982) reported the mean size of migrants to be 181 mm. Many cutthroat trout are more than 200 mm in length when they migrate to the estuary (see Appendix D -3).

4.3.1 Riverine Reach

The lower Columbia riverine reach provides both a migratory pathway and rearing habitat for cutthroat trout as they move downstream to the estuary and ocean (see Appendix D-3). The collection of cutthroat in purse seine catches and beach seine catches in the freshwater portion of the lower river (Johnsen and Sims, 1973; Sims and Johnsen, 1974) indicates that these migrants use both water column and shoreline habitats.



Bull Trout

Cutthroat trout feed on both invertebrates and small fish in the riverine reach, as they commonly do in streams (Trotter, 1997). Bull trout in freshwater feed primarily on whitefish (*Prosopium williamsoni*), sculpins, and young salmonids, although they also consume insects, amphibians, crayfish, and other available food (Kraemer, 1994). They appear to shift predominantly to fish, including young salmonids, as they increase in size and migrate downstream.

4.3.2 Estuary

Seining at Jones Beach, near the upper extreme of the estuary, at times has captured cutthroat trout offshore in the main channel (Dawley, et al., 1985a). Dawley, et al. (1985a), reported that cutthroat trout catches in the main channel declined during mid-summer months, while shoreline catches remained relatively high, suggesting that cutthroat trout reared in shallow littoral habitats at Jones Beach during the summer. Results of beach and purse seine sampling at other sites throughout the estuary, reported in Appendix D-3, indicated that cutthroat trout occurred in the channel throughout the estuary during spring and summer. In the shallows, they were present in the upper estuary spring through summer, but were seldom found in the lower two-thirds of the estuary until August and September. It is believed that young cutthroat trout may use side-channel habitat in the estuary, but no sampling has been conducted to confirm or refute this (see Appendix D-3).

Young cutthroat trout in estuarine areas eat crab larvae, insects, gammarid amphipods, young smelt, salmonids, and greenling (see Appendix D-3). Adult cutthroat in estuaries eat Pacific herring (*Clupea harengus paullasi*), threespine stickleback (*Gasterosteus aculeatus*), and bay shrimp (Loch, 1982). Young and adult bull trout (when present) in estuaries likely eat any small fish available, including the same species consumed in riverine and ocean areas.

Cutthroat Trout

4.3.3 River Mouth

Juvenile cutthroat trout are present in the coastal ocean waters in early summer, but are absent by September (Pearcy, et al., 1990). They are also found as far as 46 km offshore. Growth rates of juveniles during this period of ocean rearing were about 1 mm per day. The juvenile cutthroat trout collected off the Oregon and Washington coast had spent 1 to 4 years rearing in freshwater prior to migrating to the ocean. Pearcy, et al. (1990) found that young cutthroat trout fed predominantly on fish, including hexagrammids, scorpenids, northern anchovy (*Engraulis mordax*), and red Irish lord (*Hemilepidootus spinosus*). In late summer, euphausids, hyperiid amphipods, and decapod larvae were an important part of their diet. Growth of juvenile cutthroat trout in the ocean is about 1 mm per day (Pearcy, 1997). Kraemer (1994) reported that Puget Sound bull trout fed on Pacific herring (*Clupea harengus paullasi*), Pacific sand lance (*Ammodytes hexapterus*), and young salmon when in saltwater areas.

4.4 Critical Habitat

Section 4(a)(3)(A) of the ESA requires designation of critical habitat for listed species. The ESA defines critical habitat as the areas essential to the conservation of a listed species. Table 4-2 describes critical habitat as designated for 12 of the listed species within the action area. Critical habitat has not yet been designated for coho, bull trout, or coastal cutthroat trout.

Table 4-2: Critical Habitat Designations and Descriptions

Species		Date off Critical Habitat Designation	Description of Critical Habitat[18]
Chinook			
	Snake River spring/summer	December 28, 1993 (revised October 25, 1999)	Columbia River and estuary to confluence with Snake River, Snake River, and tributaries to Hells Canyon Dam
Chinook			
	Snake River fall	December 28, 1993	Columbia River and estuary to confluence with Snake River, Snake River, and tributaries to Hells Canyon Dam
Chinook			
	Lower Columbia River	February 16, 2000	Columbia River, estuary and tributaries from Grays and White Salmon Rivers to Willamette and Hood Rivers
Chinook			
	Upper Columbia River	February 16, 2000	Columbia River, estuary and tributaries upstream of Rock Island Dam, downstream of Chief Joseph Dam (excluding Okanogan River)
Chinook			
	Upper Willamette River	February 16, 2000	Columbia River and estuary, Clackamas and Willamette Rivers, and tributaries above Willamette Falls
Chum			
	Columbia River	February 16, 2000	Columbia River, estuary and tributaries downstream from Bonneville Dam
Coho			
	Lower Columbia River/SW Washington	Not yet designated	N/A
Sockeye			
	Snake River	December 28, 1993	Columbia River and estuary to confluence with Snake River, Snake River and tributaries from confluence with Columbia to confluence with Salmon River, Salmon River
Steelhead trout			
	Snake River	February 16, 2000	Columbia River and estuary to confluence with Snake River, Snake River and tributaries
Steelhead trout			
	Lower Columbia River	February 16, 2000	Columbia River, estuary, and tributaries between Cowlitz and Wind Rivers in WA,

[18] Critical habitat includes the riparian areas adjacent to listed rivers and streams. Riparian areas are defined as those areas adjacent to a stream that provide the following functions: shade, sediment transport, nutrient or chemical regulation, streambank stability, and input of large woody debris or organic matter (65 FR 7764). Critical habitat for salmonids in the Columbia River, as defined by NFMS, ends at the jetties at the MCR and does not include marine areas.

Species	Date off Critical Habitat Designation	Description of Critical Habitat[18]
		Willamette and Hood Rivers in OR
Steelhead		
Middle Columbia River	February 16, 2000	Columbia River, estuary, and tributaries (except Snake River) between Mosier Creek in OR and Yakima River in WA
Steelhead		
Upper Columbia River	February 16, 2000	Columbia River, estuary, and tributaries upstream of Yakima River, downstream of Chief Joseph Dam
Steelhead		
Upper Willamette River	February 16, 2000	Columbia River and estuary up to Willamette River, Willamette River and tributaries above Willamette Falls up to Calapooia River
Bull trout		
Columbia River	Not yet designated	N/A
Coastal cutthroat trout	Not yet designated	N/A
Southwest Washington/Columbia River		

In general, specific habitat characteristics have not been identified in the designation of critical habitat. Within the Columbia River critical habitat, chinook are likely to be most sensitive to changes related to the Project because subyearling chinook require protected shoreline habitat during their migration and rearing. This habitat is commonly shallow with current velocities not exceeding 0.3 meter per second. Critical habitat incorporates the water, substrate, and adjacent riparian zone to 300 feet inland.