Chapter 19 Fish

This chapter describes fish resources in the project area and how the project alternatives could affect these resources. Related watershed information can be found in Chapter 14, Geology and Soils; Chapter 15, Water; and Appendix K, Assessment of Relative Fish Habitat and Fish Population Impacts of I-5 Corridor Reinforcement Project Alternatives and Options.

> Words in **bold** and acronyms are defined in Chapter 32, Glossary and Acronyms.

19.1 Affected Environment

The project area includes rivers and streams that provide habitat for **anadromous** fish species (such as salmon) and **resident** fish species (such as bull trout). These fish-bearing streams include the Columbia River and its Washington tributaries such as the Lower Cowlitz, Coweeman, Kalama, Lower North Fork Lewis, Upper North Fork Lewis, East Fork Lewis, and Washougal rivers and Salmon Creek (see Maps 19-1A through 19-1D).

19.1.1 Special-Status Species

The project area includes rivers and streams that provide habitat for special-status fish species (see Table 19-1 and Maps 19-1A through 19-1D). Special-status species are listed or are candidates for listing as threatened or endangered under the ESA, are regarded as species of concern by the USFWS or the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries), or are listed as endangered, threatened, candidate, sensitive, or monitored by the WDFW or the ODFW. These special-status fish include **evolutionarily significant units** (ESUs) of some salmon species. The ESA allows listing of **distinct population segments** (DPSs) of some species as well as total populations of named species and subspecies. Critical habitat has been designated for some ESA-listed species within the project area (see Maps 19-1A through 19-1D). Critical habitat includes streams and associated riparian habitats that are considered essential to a listed species survival.

Under the federal ESA, a species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future. A species of concern is a species that the USFWS or NOAA Fisheries has concerns about regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA.

Under state laws, the meaning of endangered and threatened is largely the same as under the federal ESA. In addition, under WDFW regulations, a candidate species is one that is under review for possible state listing as endangered, threatened, or sensitive. Monitored species are those monitored by the state of Washington for status and distribution and managed as needed to prevent them from becoming endangered, threatened, or sensitive. Under ODFW regulations, sensitive species are species facing one or more threats to their populations or habitats that can avoid decline to a threatened or endangered status if appropriate conservation measures are implemented.

Table 19-1 Special-Status Fish Species in the Project Area[1]

Species	Federal Status	State Status	Fish-Bearing Stream	Alternatives and/or Options[2,3]
Lower Columbia River Coho (*Oncorhynchus kisutch)*	Threatened	None	Arkansas Creek	Crossover
			Baxter Creek	Central, East, Crossover
			Cedar Creek	Central
			Chelatchie Creek	Central
			Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Delameter Creek	West, Central, East, Crossover
			Goble Creek	Central
			North Fork Goble Creek	Central
			Hatchery Creek	West, Crossover
			Houghton Creek	West
			Jones Creek	East, Crossover
			Leckler Creek	West, Crossover
			Lewis River	West, Central, Crossover
			East Fork Lewis River	West
			Lockwood Creek	West
			Mason Creek	West
			Monahan Creek	West, Central, East, Crossover
			Ostrander Creek	Central, East
			South Fork Ostrander Creek	Central, East
			Pup Creek	Central
			Riley Creek	West
			Rock Creek	Central
			Salmon Creek	West, Central, East
			Sandy Bend Creek	East
			Washougal River	West, Central, East Crossover
			Little Washougal River	West, Central, East Crossover
			East Fork Little Washougal River	Central, East, Crossover
			Whittle Creek	Central, East

Species	Federal Status	State Status	Fish-Bearing Stream	Alternatives and/or Options[2,3]
Lower Columbia River Coho (*Oncorhynchus kisutch)* (continued)	Threatened	None	Unnamed Tributary to Boulder Creek	Central, East
			Unnamed Tributaries to Brezee Creek	West
			Unnamed Tributaries to Coweeman River	West, Central, East, Crossover
			Unnamed Tributaries to Cowlitz River	West, Central, Crossover
			Unnamed Tributary to North Fork Goble Creek	Central
			Unnamed Tributary to Houghton Creek	West
			Unnamed Tributaries to Leckler Creek	West, Central, Crossover
			Unnamed Tributaries to East Fork Lewis River	West
			Unnamed Tributary to Mill Creek	West
			Unnamed Tributary to Ostrander Creek	East
			Unnamed Tributary to South Fork Ostrander Creek	East
			Unnamed Tributary to Turner Creek	West, Crossover
			Unnamed Tributaries to Little Washougal River	West, Central, East, Crossover
Lower Columbia River Chinook (*O. tshawytscha*)	Threatened	WA Candidate OR Sensitive-Critical	Arkansas Creek	Crossover
			Cedar Creek	Central
			Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Delameter Creek	West, Central, East Crossover
			Kalama River	West, Central, East, Crossover
			Lewis River	West, Central, Crossover
			East Fork Lewis River	West
			Monahan Creek	West, Central, East, Crossover
			Ostrander Creek	East
			South Fork Ostrander Creek	East
			Pup Creek	Central
			Salmon Creek	West
			Washougal River	West, Central, East, Crossover
			Little Washougal River	West, Central, East, Crossover
Columbia River Chum *(O. keta)*	Threatened	WA Candidate OR Sensitive-Critical	Arkansas Creek	Crossover
			Cedar Creek	Central

Species	Federal Status	State Status	Fish-Bearing Stream	Alternatives and/or Options[2,3]
Columbia River Chum *(O. keta)* (continued)	Threatened	WA Candidate OR Sensitive-Critical	Chelatchie Creek	Central
			Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Delameter Creek	West, Central, East, Crossover
			Goble Creek	Central
			North Fork Goble Creek	Central
			Leckler Creek	West, Crossover
			Lewis River	West, Central, Crossover
			East Fork Lewis River	West
			Lockwood Creek	West
			Mason Creek	West
			Monahan Creek	West, Central, East, Crossover
			Pup Creek	Central
			Riley Creek	West
			Salmon Creek	Central, East
			Sandy Bend Creek	East
			Washougal River	West, Central, East, Crossover
			Little Washougal River	West, Central, East, Crossover
			Unnamed Tributaries to Coweeman River	West, Crossover
			Unnamed Tributaries to East Fork Lewis River	West
			Unnamed Tributary to Turner Creek	West, Crossover
Lower Columbia River Steelhead (*O. mykiss*)	Threatened	WA Candidate OR Sensitive-Critical	Arkansas Creek	Crossover
			Baxter Creek	Central, East, Crossover
			Cedar Creek	Central
			Chelatchie Creek	Central
			Coal Mine Creek	Central, East
			Colvin Creek	Central, Crossover
			Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Coyote Creek	East, Crossover

Species	Federal Status	State Status	Fish-Bearing Stream	Alternatives and/or Options[2,3]
Lower Columbia River Steelhead (*O. mykiss*) (continued)	Threatened	WA Candidate OR Sensitive-Critical	Delameter Creek	West, Central, East, Crossover
			Gobar Creek	East
			Goble Creek	Central
			North Fork Goble Creek	Central
			Hatchery Creek	West, Crossover
			Houghton Creek	West
			Jones Creek	East, Crossover
			Kalama River	West, Central, East, Crossover
			Little Kalama River	West, Crossover
			King Creek	East, Crossover
			Knowlton Creek	Central
			Leckler Creek	West, Crossover
			Lewis River	West, Central, East, Crossover
			East Fork Lewis River	West, Central, East, Crossover
			Lockwood Creek	West
			Mason Creek	West
			Monahan Creek	West, Central, East, Crossover
			Ostrander Creek	Central, East
			South Fork Ostrander Creek	Central, East
			Pup Creek	Central
			Riley Creek	West
			Rock Creek	Central, East, Crossover
			Salmon Creek	West, Central, East
			Sandy Bend Creek	East
			Washougal River	West, Central, East, Crossover
			Little Washougal River	West, Central, East, Crossover
			East Fork Little Washougal River	Central, East, Crossover
			Whittle Creek	Central, East
			Unnamed Tributary to Arkansas Creek	Crossover
			Unnamed Tributary to Boulder Creek	Central, East

Species	Federal Status	State Status	Fish-Bearing Stream	Alternatives and/or Options[2,3]
Lower Columbia River Steelhead (*O. mykiss*) (continued)	Threatened	WA Candidate OR Sensitive-Critical	Unnamed Tributaries to Brezee Creek	West
			Unnamed Tributary to Cedar Creek	Central
			Unnamed Tributaries to Coweeman River	West, Central, East, Crossover
			Unnamed Tributaries to Cowlitz River	West, Central, Crossover
			Unnamed Tributary to Coyote Creek	East, Crossover
			Unnamed Tributary to North Fork Goble Creek	Central
			Unnamed Tributary to Houghton Creek	West
			Unnamed Tributary to Kalama River	Central
			Unnamed Tributary to Leckler Creek	West, Crossover
			Unnamed Tributaries to East Fork Lewis River	West
			Unnamed Tributary to Mill Creek	West
			Unnamed Tributary to Ostrander Creek	East
			Unnamed Tributary to South Fork Ostrander Creek	East
			Unnamed Tributary to Turner Creek	West, Crossover
			Unnamed Tributary to Little Washougal River	West
Pacific Lamprey *(Lampetra tridentata)*	None	WA Monitored OR Sensitive-Vulnerable	Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Kalama River	West, Central, East, Crossover
			Lewis River	West, Central, East, Crossover
			East Fork Lewis River	West, Central, East, Crossover
			Salmon Creek	West, Central, East
			Washougal River	West, Central, East, Crossover
Eulachon *(Thaleichthys pacificus)*	Threatened	WA Candidate	Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Kalama River	West, Central, East, Crossover
			Lewis River	West, Central, East, Crossover
			Washougal River	West, Central, East, Crossover
River Lamprey *(L. ayresi)*	None	WA Candidate	Coweeman River	West, Central, East, Crossover
			Cowlitz River	West, Central, East, Crossover
			Kalama River	West, Central, East, Crossover

Species	Federal Status	State Status	Fish-Bearing Stream	Alternatives and/or Options[2,3]
River Lamprey *(L. ayresi)* (continued)	None	WA Candidate	Lewis River	West, Central, East, Crossover
			East Fork Lewis River	West, Central, East, Crossover
			Salmon Creek	West, Central, East
			Washougal River	West, Central, East, Crossover
Bull Trout *(Salvelinus confluentus)*	Threatened	WA Candidate	Lewis River	West, Central, East, Crossover

Notes:

1. This table summarizes special-status fish species that may be present within tributaries to the Columbia River that are crossed by the action alternatives. These species are also potentially present within the Columbia River. Other special-status species are known to use the Columbia River as a migration corridor, but they do not use tributaries to the Columbia River that are crossed by the action alternatives. All species are described in Sections 19.1.1.1 and 19.1.1.2.

2. Alternatives as listed here include their options in most cases. In a few cases, one or more options of an alternative may not cross the listed stream (see Maps 19-1A through 19-1D for more detail).

3. See Maps 19-1A through 19-1D for location of critical habitat.

Sources: 69 Federal Register 77158, December 27, 2004; 70 Federal Register 37160, June 28, 2005; 71 Federal Register 834, January 5, 2006; 75 Federal Register 13012, March 18, 2010; NOAA 2010b; NOAA 2011; ODFW 2008; USFWS 2008b; USFWS 2010d; WDFW 2010a; WDFW 2010c; WDNR 2010g

Fish population categories (primary, contributing, stabilizing) reflect priorities in salmon recovery plans. They describe which populations to target for improvement and to which levels of improvement, to recover salmon species listed under the ESA (NMFS 2012). Through an iterative process, recovery planners for the Washington and Oregon Lower Columbia Region worked together to reach agreement on a target status for each fish population. The target statuses within an ESU or DPS are referred to collectively as the "recovery scenario" for that ESU or DPS. Setting the target status for each population in an ESU or DPS (i.e., developing the recovery scenario) involved consideration of several things including population productivity, genetic diversity, geographical location, and feasibility. Collectively, the target status of each population is consistent with biological viability criteria identified by NOAA Fisheries and is consistent with an ESU that no longer needs the protections of the ESA.

19.1.1.1 Anadromous Species

Lower Columbia River Coho

The Lower Columbia River coho are indigenous to major tributaries of the Columbia River. They are born and live in streams the first year of their life. Coho emerge in the early spring and distribute in tributaries and mainstem habitats where they drift feed within pool habitats. During the fall, **juveniles** generally leave the mainstem rivers and seek channel margins, side channels, off-channel habitats, and floodplain tributaries where they overwinter. The following spring they move seaward, then, return to their home streams at 3 years of age and 8 pounds. Coho are one of the more vulnerable salmon species to degradation of freshwater habitat and water quality because they spend extended periods in fresh water. They are vulnerable to many freshwater predators and require an adequate food supply through all seasons.

Lower Columbia River Chinook

The Lower Columbia River Chinook are also indigenous to major tributaries of the Columbia River. They generally spawn in the mainstems of the larger Columbia River tributaries. Chinook include spring, summer, and fall subspecies, depending on the time of the year they return from the ocean to spawn. Spring Chinook typically migrate to their **spawning** grounds from March through May, summer Chinook from June through July, and fall Chinook from August through November. Spring Chinook are known as "stream-type" salmon because the juveniles spend a year or more in fresh water before going to the ocean. Most summer and fall Chinook salmon are known as "ocean-type" salmon because they leave for the ocean sooner than other species. Summer Chinook spawn in the tributaries and rear in freshwater habitat for up to a year before going to the ocean. Summer Chinook tend to spawn in the lowest reaches of Columbia River tributaries. Fall Chinook juveniles can migrate to the sea a few months after hatching. Chinook average 3 to 4 years in the ocean before returning to their home rivers to spawn.

Columbia River Chum

Columbia River chum are typically found in the lower reaches of larger tributaries of the Columbia River. They seek spawning areas soon after returning to streams from salt water. Chum deposit their eggs from November through February and emerge in a few months as **fry** in the spring. Fry migrate directly to the Columbia River estuary or the sea and spend 3 to 4 years in the saltwater environment before returning. This short residence time and winter spawning behavior allow streams with little or no summer flows to support them. Chum are one of the salmon species least impacted by adverse changes in freshwater habitat quality.

Lower Columbia River Steelhead

Lower Columbia River steelhead are indigenous to major tributaries of the Columbia River. They return from the ocean between March and late September, although some winter steelhead also return through October and later. Steelhead may have the most life-history diversity of any species of Pacific salmon; they interbreed with non-anadromous populations (rainbow trout) and they can spawn more than once. They typically spawn in tributaries, emerge from the gravel in late spring, and spread throughout tributaries and mainstem habitats, migrating downstream as their body size increases. Yearling juvenile steelhead are usually found in **riffle** habitat, but some larger juvenile steelhead are found in pools and faster runs. Smolt emigration takes place primarily from March through June during spring freshets. They may spend 1 to 4 years in fresh water and 1 to 4 years in salt water, with differing combinations of fresh/saltwater residence times.

Eulachon

Eulachon (also known as smelt) are broadcast spawners (dispersing eggs in many locations) that spawn in lower reaches of rivers and tributaries and usually die after spawning. They occur in the Columbia, Coweeman, Cowlitz, Kalama, Lewis, and Washougal rivers in Washington and the Sandy River in Oregon. Eulachon typically spend several years in salt water before returning to fresh water to spawn from later winter through early summer. Shortly after hatching, the larvae are carried downstream and dispersed by estuarine, tidal, and ocean currents. Because juvenile eulachon spend less time in freshwater environments than juvenile salmon, returning eulachon may return to a wider range of spawning sites. In the portion of the species' range south of the U.S.—Canada border, most eulachon production originates in the Columbia River basin. Within the Columbia River basin, major spawning runs return to the mainstem of the Columbia River and the Cowlitz River.

Pacific Lamprey

Pacific lamprey are distributed throughout the major tributaries of the Columbia River. Their life history includes a larval phase that remains in streams, followed by metamorphosis and migration to the ocean. Adults remain in the ocean for 20 to 40 months and are parasitic, feeding on body fluids of other marine species. Returning adults usually enter rivers between April and June, migrate upstream until September, overwinter while sexually maturing, and spawn the following year from March through June. Eggs hatch in 2 to 3 weeks. Larvae burrow in silt and fine sediment to rear for 2 to 7 years, feeding on algae and detritus. Larvae emerge from the sediment and metamorphose into juvenile form. Juveniles out-migrate to the ocean from July through November.

River Lamprey

River lamprey are also anadromous and have life history and freshwater habitat requirements similar to those of Pacific lamprey. Adult river lamprey are of intermediate size, smaller than Pacific lamprey and larger than western brook lamprey (*L. richardsoni*), and typically inhabit estuarine areas. River lamprey is a "satellite" species to western brook lamprey: they interbreed and some genetic techniques cannot tell them apart.

Other Anadromous Fish

Besides these species, several special-status salmon species migrate through the portion of the Columbia River in the project area. All the action alternatives' routes crosses the Columbia River at river mile 120, between Lady Island on the Washington side of the river and a location about 0.5 mile west of the Sandy River near Troutdale, Oregon. The other species occasionally present at this crossing include the following: Snake River sockeye (*O. nerka*) (federal endangered), Upper Columbia River Chinook (federal endangered), Snake River Chinook (federal threatened), Upper Columbia River steelhead (federal threatened), and Middle Columbia River steelhead (federal threatened).

In addition, coastal cutthroat trout (*O. clarkii clarkii)*, is listed in Oregon (sensitive-vulnerable) and uses the Columbia River for migration. The action alternatives do not cross any other fish-bearing streams within Oregon used by coastal cutthroat trout.

19.1.1.2 Other Fish Species

Bull Trout

Bull trout, listed as threatened by the USFWS, have a variety of migratory and non-migratory life histories. Stream-resident bull trout complete their entire life cycle in the tributary streams where they spawn and rear. Most bull trout are migratory, spawning in tributary streams where juvenile fish usually rear from 1 to 4 years before migrating to either a larger river or lake where they spend their adult life, then return to the tributary stream to spawn. Resident and migratory forms may be found together, and either form can produce resident or migratory offspring. Bull trout have more specific habitat requirements than most other salmonids. Their distribution and abundance is particularly influenced by water temperature, cover, channel form and stability, spawning and rearing substrate conditions, and migratory corridors. Large patches within these habitat components are necessary to support robust populations. The action alternatives cross critical habitat for bull trout, but do not cross spawning populations.

Western Brook Lamprey

One special-status resident species, western brook lamprey, is listed in Oregon (sensitive-vulnerable), but its occurrence is incidental in the Columbia River where the action alternatives cross this river. The action alternatives do not cross any other fish-bearing streams within Oregon typically used by western brook lamprey.

Other resident fish species native to the project area include cutthroat (*O. clarkii*) and rainbow trout (*O. mykiss)*; largescale, bridgelip, and mountain sucker (*Catostomus macrocheilus, C. columbianus, C. platyrhynchus*); mountain whitefish (*Prosopium williamsoni*), sculpin (*Cottus* spp.), longnose dace (*Rhinichthys cataractae*), speckled dace (*R. osculus),* and northern pikeminnow (*Ptychocheilus oregonensis*). These species are distributed throughout the project area. Coastal cutthroat trout (*O. clarki clarki*) have diverse anadromous and non-anadromous life histories and are capable of spawning multiple times. They use similar habitats to the large-bodied Pacific salmon, but may require smaller gravel sizes for breeding.

Introduced resident species found in the project area include large and small mouth bass (*Micropterus salmoides, M. dolomieui*), brown trout (*Salmo trutta*), brook trout (*Salvelinus* *fontinalis*), crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and brown bullhead (*Ictalurus nebulosus*).

19.1.2 Fish Habitat

Salmon, trout and other fish species have specific freshwater habitat requirements: they need cool, clean (free of contaminants), well-oxygenated water; prefer gravel and cobble streambeds (**substrate**) without excessive fine sediments for spawning; and need a diversity of habitats that support migration, spawning, and rearing. Barrier-free access to and from spawning habitat is essential to these species. Juveniles and adults require abundant food sources, including insects, crustaceans, and other small fish, and juveniles need places to hide from predators such as those provided by large woody debris, boulders, and overhanging vegetation. Fish also need places to hide from periodic high flows and from warm summer temperatures. Riparian vegetation next to streams supports these requirements.

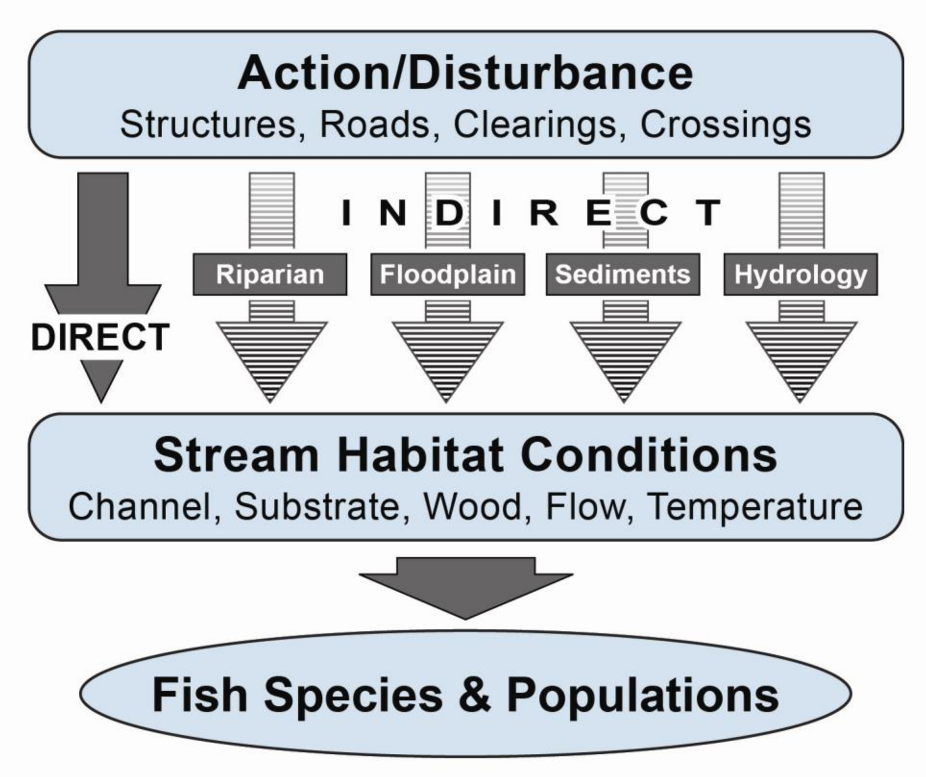
Tributaries in the project area provide diverse habitats for salmon and trout. These habitats were formed by the complex volcanic history and climate (including high precipitation amounts) of the region, and have varied landscapes including forested uplands, lowlands with large floodplain features, and gravel-rich environments (see Chapter 17, Vegetation and Chapter 14, Geology and Soils). These habitats support multiple salmon species with many different life histories.

Eulachon (also known as smelt) also require cool, clean, well-oxygenated water and prefer streambeds free of excessive fine sediment and debris for spawning. Eulachon are only present in fresh water during spawning, incubation, and migration of **larvae** to **estuarine** environments. Migration corridors need to be free of obstructions and with sufficient water flow to assist larvae moving downstream. Eulachon also require cool water temperatures, and prey items available once the larvae deplete their **yolk sacs**. During all adult and larval stages, freshwater habitat needs to be free of contaminants.

Lamprey are susceptible to several threats in freshwater habitat including barriers to migration, poor water quality, predation by non-native species, and stream and habitat degradation. Adults must be able to migrate upstream to spawn, and juvenile forms must be able to move downstream to complete their life cycle. Larvae and eggs need cool stream temperatures. Because larvae colonize streambeds in high densities for 2 to 7 years, a single action that degrades water quality and alters stream channels could affect many age classes.

19.2 Environmental Consequences

Potential impacts to fish range from those activities that could directly affect fish survival, such as degrading water quality or blocking passage, to changes in habitat quality or quantity that can alter the ability of watersheds to support fish over the long-term. To help identify impacts to fish for each alternative, detailed technical analyses were completed (see Appendix K). These analyses were based on the following model that identifies the conceptual relationship between project impacts and fish populations:



The technical analyses include some quantification of impacts from construction and maintenance of substations, transmission line rights-of-way, access roads, and transmission towers. Although they do not provide absolute estimates of impacts to fish resources, they do provide context for evaluating both the magnitude and relative level of project impacts from the action alternatives.

General impacts that would occur for the action alternatives are discussed below, followed by impacts unique to each alternative.

19.2.1 Impact Levels

Impacts were considered **high** where project activities were determined to cause the following:

- Long-term changes in watershed conditions that cause high impairment to hydrology or sediment functions
- Permanent changes in riparian habitat conditions that cause the loss of high large-woody debris recruitment potential
- Permanent changes in riparian habitat conditions that could decrease shade and lead to temperature increases that would adversely affect aquatic life
- Permanent alteration of floodplains that substantially inhibits long-term floodplain inundation patterns and natural rates of channel adjustment
- Direct or indirect habitat changes that cause substantial, short-or long-term risk to ESA-listed or other fish species at the population or ESU scale

Impacts were considered **moderate** where project activities were determined to cause the following:

- Long-term changes in watershed conditions that cause moderate impairment to hydrology or sediment functions
- Permanent changes in riparian habitat conditions that cause the loss of moderate large-woody debris recruitment potential
- Permanent alteration of floodplains that moderately inhibits long-term floodplain inundation patterns and natural rates of channel adjustment.
- Direct or indirect habitat changes that cause moderate, short- or long-term risk to ESA-listed or other fish species at the population or ESU scale.

Impacts were considered **low** where project activities were determined to cause the following:

- Long-term changes in watershed conditions that cause minor change in existing hydrology or sediment functional
- Permanent changes in riparian habitat conditions that cause the loss of low large woody debris recruitment potential
- Permanent changes in riparian habitat conditions that cause the loss of stream shade along streams that already have limited shade and stream cooling
- Permanent alteration of floodplains that results in none or only minor interference with floodplain inundation patterns or channel adjustment processes. Low impacts may occur where existing floodplain development has already significantly impaired floodplain functions.
- Direct or indirect habitat changes that result only in low, short-term risk to ESA-listed and other fish species at the population or ESU scale.

No impact would occur where there are habitat changes or project activities that would cause no discernable short- or long-term impacts to fish life or habitat.

19.2.2 Impacts Common to Action Alternatives

19.2.2.1 Construction

See Chapter 15, Water and Appendix K for more information about factors influencing hydrologic change and sediment delivery in the project area.

Clearing transmission line rights-of-way and construction of towers, substations, and access roads across or near streams could remove vegetation, disturb soil, decrease soil permeability, increase surface runoff and release sediment that, if delivered to streams, could cause direct impacts to water quality. Excessive peak flows can scour streambeds and cause debris torrents that alter stream channels. Flooding and debris torrents in fish-bearing streams can degrade fish habitats by destroying egg pockets and rearing areas, altering pool and riffle sequences, and removing large woody debris. Excessive peak flows can also flush available nutrients from streams. Water that runs off into streams is not available for recharging ground water sources that contribute to summer flows. Increased peak flows can cause simplified habitats, reduced nutrients, and unsuitable summer conditions, which decrease fish growth and survival. Increased sediment loading in fish-bearing streams can alter habitats and reduce the growth and survival of fish. For many fish species, eggs are deposited among gravels on the stream bottom. When these gravels become clogged with sediments, the free flow of oxygenated water and waste removal is impaired, causing egg suffocation and mortality. Suspended sediments can clog and abrade fish gills, affecting behavior or causing suffocation, and can also reduce water clarity, making it difficult for some fish to find food or detect predators. Turbid water can cause a stress response in salmon, which may cause reduced growth and reduced ability to tolerate additional stressors. Turbid water can also alter outmigration behavior, impair immune system function, and make it difficult for fish to maintain the balance of salt and water in the body.

Precipitation zones and vegetation types crossed by the action alternatives have different snow accumulation and snowmelt, and alternatives and options requiring construction in rain-on-snow zones would cause higher peak flow impacts. Removal of mature conifer forests in the rain-on-snow zone can decrease interception of precipitation by the forest canopy, leading to greater snow accumulation. Decreased canopy cover increases snowmelt by allowing more rain, solar radiation, and wind to reach the snowpack.

The action alternatives cross soil types with different natural erodibility. Construction in more erodible terrain would cause higher sediment delivery impacts. Between about 100 acres and 1,000 acres of vegetation currently highly effective in limiting the water available for runoff would be cleared (depending on the action alternative). About 70 miles of new line, and access roads and two substations would then be built potentially causing additional sediment delivery. However, these impacts would occur across watershed areas of between about 160,000 acres and 240,000 acres. The percent change in runoff and sediment delivery to streams would be less than 1 percent (see Chapter 15, Water, and Appendix K). Long-term changes in watershed conditions would be minor; however, local **high** impacts from sediment delivery could occur. Properly implementing erosion control measures would minimize the amount of sediment delivered to streams. Generally, impacts from long-term changes to watershed function would be **low**.

Large woody debris recruitment potential and stream shade along fish-bearing streams were identified for each action alternative (see Appendix K). Trees and other vegetation would be removed from the transmission line right-of-way, substations, and new access roads constructed along fish-bearing streams, including trees within buffers that are normally protected under the Washington Forest Practices Act (76.09 RCW) and other land use regulations. Vegetation removal would not occur or be minimal at many crossings that do not have trees or important buffers. At these and existing crossings where vegetation has already been removed and is not allowed to regrow, there would be **no** impact. Elsewhere, removing vegetation in riparian areas could decrease large woody debris recruitment potential and streamside shade. Riparian vegetation can moderate stream temperature year-round and riparian forests are a source of large woody debris, which increases channel complexity. Shade loss from streamside vegetation removal can lead to higher stream water temperature, which can decrease fish survival. Removal of future wood sources can impact fish growth and survival through simplification of habitat and destabilization of channel beds, and a reduction in nutrients.

Forested vegetation would be cleared along about 2 to 3 miles of fish-bearing streams. Permanent changes to riparian function at project crossings could occur through the loss of large woody debris recruitment potential or stream shade. At the crossing scale, a range of riparian function would be lost along any action alternative; however, this loss could be buffered by functions provided at the watershed scale. Generally, along any action alternative, crossing-scale impacts to large woody debris recruitment potential and shade from removal of riparian vegetation along fish-bearing streams would range from **low-to-high**. Detailed assessments in Appendix K assumed that all forested vegetation would be removed at each stream crossing; however, this could be mitigated on a crossing-by-crossing basis through very selective clearing. **High** impacts would occur where the current riparian function is greater and its removal would cause a greater loss of riparian function. **High** impacts would occur when the existing large woody recruitment potential is high. **High** impacts would also occur where the existing shade levels provide effective stream cooling. **Low** impacts would occur where there is less loss of riparian function. **Low** impacts would occur when the existing large woody recruitment potential is low or where the existing shade level is already low and provides limited stream cooling.

There are potential impacts to floodplain processes from clearing floodplain vegetation and construction of towers and roadways in the floodplain. These impacts could affect floodplain functions including flood inundation dynamics and rates of channel adjustment, factors that have long-term implications to creation and maintenance of aquatic habitat. In general, the greater the amount of clearing, road building, and tower building in the floodplain, the greater the amount of potential impacts; however, the existing degree of floodplain alteration is also an important consideration. For example, new clearing within floodplains that are already impaired due to diking and fill placement would not have the same degree of impact as clearing in an intact floodplain.

In Chapter 15, Water, numbers of towers and length of roads within the floodplain refers to the FEMA-designated 100-year floodplain. In some cases, these values may differ from the values in this chapter and Appendix K, which used additional techniques for floodplain delineation (for example, aerial photo interpretation and vegetation identification) in addition to the FEMA-designated floodplain boundaries.

Potential impacts to floodplains were assessed (see Appendix K). The total acreage of impact was calculated for each alternative by adding the floodplain areas affected by vegetation clearing, roadway construction, and tower construction together. Total acreages of impact ranged from 7.7 to 21.9 acres. In general, the action alternatives with the greatest total area of impact (i.e., West Alternative and options) also have the greatest amount of existing impairment and human development of floodplains.

Overall, only minor interference with reach-scale floodplain inundation patterns or channel adjustment processes would occur for the action alternatives because of the small total spatial extent of floodplain impacts and the degree of existing floodplain impairment. Higher impacts to floodplain functions are possible at the site-scale, particularly for crossings where floodplain processes are intact. Site-scale mitigation measures, such as locating towers and roads out of channel migration zones and constructing roadways at existing grade, would help mitigate these impacts. Overall impacts on fish from floodplain changes would be **low**.

Collectively, impairment of hydrology and sediment functions, loss of large woody debris recruitment potential and shade, and alteration of floodplains have the potential to affect ESA-listed and other fish species at the population or ESU scale. Generally, action alternatives with more crossings of high-value fish streams would have a greater potential for impact than routes with fewer crossings of low-value fish streams. The value of fish streams can be determined by fish distribution and the quantity and quality of fish habitat (e.g. pools, hydrology, riparian conditions, sediment, water quality, and woody debris). Similarly, routes with greater hydrological, floodplain, riparian, or sediment disturbance are more likely to cause substantial degradation of fish production potential. Although the analyses done to identify fish impacts (using the Integrated Fish Impact index, see box and Appendix K) focus on ESA-listed anadromous salmonids, the results are a general indicator of impacts to other fish and aquatic species. Based on the analyses, none of the alternatives and options would be a substantial risk to ESA-listed salmonids.

Fish indices suggest that the net effect of any project route on anadromous fish populations would be less than 1 percent even using the most pessimistic assumptions for impact at stream crossings (e.g., fish production potential is degraded to zero and no effective mitigation occurs). However, any additional impacts would further degrade the status of ESA-listed species from current levels. Degradation of habitat conditions in high-priority fish populations and stream reaches is also contrary to objectives and strategies identified in the salmon and steelhead recovery plan. Generally, habitat changes from the project would cause **low**, short-term risk to ESA-listed and other fish species.

Integrated Fish Impact Index

The Integrated Fish Impact index estimates the proportional reduction in fish numbers from project-related habitat degradation at the crossing scale. Units of this index are expressed as the average percentage of high priority populations for listed salmon and steelhead species. The Integrated Fish Impact index identifies the percentage by which affected populations are likely to be reduced by project-related habitat changes (see Appendix K).

Accidental oil or gas spills from construction equipment and vehicles could cause petroleum products to enter surface water (see Chapter 15, Water). Petroleum could have toxic effects on fish and may cause direct mortality. Petroleum products can also cause chemical and physical changes in soil and water that can degrade habitat quality and reduce food resources, reducing fish growth and survival. The presence of hydrocarbons in the water column may also impede fish migration. Because BPA would require that fuel be stored and vehicle refueling occur at least 100 feet from rivers and streams and other surface waters, and because spill containment and clean-up procedures would be in place, the effects of accidental spills would be temporary, and limited to small areas. **Moderate** impacts would occur to fish.

19.2.2.2 Operation and Maintenance

Properly implementing road drainage BMPs, regular maintenance, and rocking roads would reduce erosion on unpaved roads, minimizing impacts, and ensuring that sediment delivery to streams is not increased (see Chapter 15, Water). Because the amount of sediment reaching a fish-bearing stream would be small and would not create conditions that would adversely affect individuals or populations of fish, **low** impacts would occur.

Continued vegetation maintenance prevents riparian vegetation growth and could reduce stream shade and large woody debris recruitment potential, causing localized increases in water temperature and habitat degradation in any adjacent streams. Crossing-scale impacts to fish habitat could be **low-to-high**.

Continued vegetation maintenance in floodplains has the potential to affect **floodplain hydraulic roughness** (natural barriers such as vegetation that could affect water flow) and nutrient exchange at the site-scale, but none to only minor interference with floodplain inundation or channel adjustment would be expected. Impacts to fish habitat would be **low**.

BPA uses herbicides approved in its Transmission System Vegetation Management Program. Overspray of herbicides used for noxious weed control within rights-of-way and substation yards could affect surface water and fish. BPA bases herbicide selection on toxicity level, proximity to aquatic habitat, and delivery potential. Direct contact with fish can cause mortality, decreased growth and survival, and impaired swimming ability. Fish can be indirectly affected by reductions in prey. Appropriate buffers would be used to prevent herbicides from being deposited in surface waters (BPA 2000b). Any adverse effects would be temporary and localized. **No to low** impacts would occur to fish.

19.2.2.3 Sundial Substation

The Sundial site, including tower reconfigurations, is not close enough to any water bodies to affect fish habitat or water quality, and is located outside the 100-year floodplain of the Columbia River, so **no** impacts on fish would occur.

19.2.3 Castle Rock Substation Sites

Impacts common to action alternatives are in Section 19.2.2. The remaining sections discuss impacts unique to each alternative, and recommended mitigation measures.

19.2.3.1 Casey Road

The Casey Road site is about 1,800 feet upslope of Rock Creek. This stream has presumed presence of Lower Columbia River coho and potential occurrence of Lower Columbia River steelhead. The project would not remove any vegetation along Rock Creek and the site is not within a floodplain. Any runoff, erosion, or sediment delivery would be controlled by use of permeable surfaces, silt fences, and detention ponds. Hazardous waste materials would be disposed of off-site. There is limited potential for petroleum products or herbicides to be delivered to Rock Creek because BPA would follow BMPs requiring that fuel is stored and vehicles are refueled away from aquatic resources. BPA would also apply herbicides at the lowest rate effective for vegetation maintenance. **No-to-low** impacts on fish would be expected.

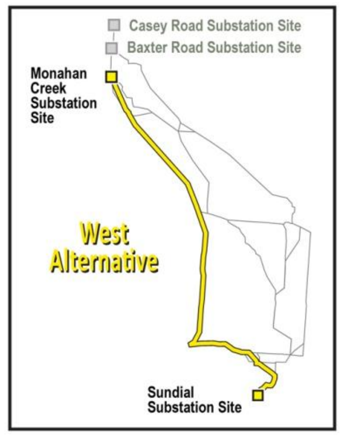
19.2.3.2 Baxter Road

The Baxter Road site is about 1,000 feet upslope of Baxter Creek. Baxter Creek has presumed presence of Lower Columbia River coho and Lower Columbia River steelhead. Three small non-fish bearing streams are within the substation disturbance area. The project would not remove any vegetation along Baxter Creek and the site is not within a floodplain. Any runoff, erosion, or sediment delivery would be controlled by use of permeable surfaces, silt fences, and detention ponds. Hazardous waste materials would be disposed of off-site. There is limited potential for petroleum products or herbicides to be delivered to Rock Creek because BPA would follow BMPs requiring that fuel is stored and vehicles are refueled away from aquatic resources. BPA would also apply herbicides at the lowest rate effective for vegetation maintenance. **No-to-low** impacts on fish would be expected.

19.2.3.3 Monahan Creek

The Monahan Creek site is between Monahan and Delameter creeks. These streams have documented occurrence of Lower Columbia River coho, steelhead, and Chinook salmon and presumed presence of Columbia River chum. The site would be across Delameter and Monahan roads about 450 to 500 feet from these streams. The project would not remove any vegetation along either creek and the site is not within a floodplain. Any runoff, erosion, or sediment delivery would be controlled by use of permeable surfaces, silt fences, and detention ponds. Hazardous waste materials would be disposed of off-site. There is limited potential for petroleum products or herbicides to be delivered to Rock Creek because BPA would follow BMPs requiring that fuel is stored and vehicles are refueled away from aquatic resources. BPA would also apply herbicides at the lowest rate effective for vegetation maintenance. **No-to-low** impacts to fish would be expected.

19.2.4 West Alternative



Transmission line clearing and road construction would cause about 84 miles (1,285 acres) of potential soil disturbance that could contribute sediment to streams through runoff or erosion (see Table 15-2). Compared to the other action alternatives, this would be the least amount of construction and it would cause the least percent increase in runoff (0.09 percent) because almost 80 percent of the land cover in sub-watersheds crossed by the West Alternative is hydrologically immature. **Hydrologically immature** land cover provides little function in intercepting precipitation or moderating snowmelt. There is higher urban development, greater agricultural land cover, and greater hardwood cover. There would also be greater use of existing transmission line clearings. Overall, there would be little decrease in the mature vegetation cover (see Appendix K). Clearing along the West Alternative would cause the greatest percent increase in sediment delivery (0.25 percent) to fish-bearing streams because the West Alternative would cross more erodible terrain. This alternative crosses large areas of unconsolidated sediments that have higher natural erodibility (see Appendix K). This change would occur across a large watershed area of about 161,000 acres. Isolated actions could cause **high** impacts to fish-bearing streams. Generally, however, long-term changes in watershed conditions and functions would be minor and impacts to fish would be **low**.

Riparian vegetation would be cleared at 47 forested crossings of fish-bearing streams (see Table 19-2; number of forested crossings equal the sum of high and low shade function numbers). Compared to other action alternatives, this would be the least number of forested crossings. Nineteen forested crossings would occur where the existing shade level provides effective stream cooling and where shade loss is more likely to cause temperature increases that adversely affect aquatic life; impacts from loss of shade function would be **high**. Ten forested crossings would occur where the existing large woody debris recruitment potential is high; impacts from loss of large woody debris recruitment function at these crossings would be **high**. This is the fewest number of high impacts among the action alternatives because there are relatively fewer forested crossings of fish-bearing streams and because riparian vegetation at these crossings provides relatively lower shade and large woody debris recruitment potential. Crossings are also at lower elevations where hardwood species composition is greater.

Table 19-2 Potential Impacts on Fish and Stream Habitat[1]

Alternatives and Options	Percent Change in Runoff[2]	Percent Change in Sediment Delivery[3]	Total Number of Forested Fish-Bearing Streams Crossed by Transmission Line Corridors and Riparian Function[4] Total Crossings (Shade Function) = Total Crossings (Recruitment Potential)					Average Percent Reduction in Production of Affected Fish Populations[7]	Total Floodplain Impact Area (acres)[8]
			High Shade Function[5]	Low Shade Function[5]	High LWD Recruitment Potential[6]	Moderate LWD Recruitment Potential[6]	Low LWD Recruitment Potential[6]		
West Alternative	**0.09**	**0.25**	**19**	**28**	**10**	**18**	**19**	**0.11**	**18.0**
West Option 1	-0.01	N/C	N/C	-1	N/C	N/C	-1	N/C	+3.9
West Option 2	+0.01	N/C	-1	N/C	N/C	+1	-2	-0.03	-2.7
West Option 3	+0.01	-0.02	+1	+3	+2	+3	-1	-0.02	-2.4
Central Alternative	**0.59**	**0.15**	**49**	**19**	**46**	**16**	**6**	**0.15**	**9.2**
Central Option 1	+0.01	-0.01	+1	+1	+1	+1	N/C	N/C	N/C
Central Option 2	-0.01	+0.01	-9	+4	-7	-1	+3	-0.01	-1.5
Central Option 3	-0.05	N/C	-2	-6	-3	-1	-4	-0.03	+0.3
East Alternative	**1.02**	**0.00**	**35**	**17**	**38**	**13**	**1**	**0.19**	**10.9**
East Option 1	-0.05	+0.01	-11	+5	-11	+4	+1	N/C	-1.8
East Option 2	-0.24	N/C	+5	+2	+6	-1	+2	-0.10	-0.5
East Option 3	+0.03	N/C	+4	N/C	+4	N/C	N/C	-0.10	-0.7
Crossover Alternative	**0.47**	**0.17**	**32**	**23**	**31**	**18**	**6**	**0.20**	**9.0**

Alternatives and Options	Percent Change in Runoff[2]	Percent Change in Sediment Delivery[3]	Total Number of Forested Fish-Bearing Streams Crossed by Transmission Line Corridors and Riparian Function[4] Total Crossings (Shade Function) = Total Crossings (Recruitment Potential)					Average Percent Reduction in Production of Affected Fish Populations[7]	Total Floodplain Impact Area (acres)[8]
			High Shade Function[5]	Low Shade Function[5]	High LWD Recruitment Potential[6]	Moderate LWD Recruitment Potential[6]	Low LWD Recruitment Potential[6]		
Crossover Option 1	+0.01	N/C	+1	+2	N/C	+3	N/c	0.04	+1.7
Crossover Option 2	-0.01	-0.01	N/C	+1	N/C	N/C	+1	N/C	+0.4
Crossover Option 3	-0.07	-0.01	+1	+2	+1	+1	+1	N/C	+0.5

Notes:

N/C – No change from the alternative

1. The value for each option represents the net change from the action alternative. It was calculated as the value added by the option minus the total value in the segments the option replaces.

2. Represents the percent change in hydrologically immature vegetation in watersheds crossed by the action alternatives; hydrologically immature vegetation increases snow accumulation and snowmelt (see Appendix K).

3. Represents the percent change in sediment delivery in watersheds crossed by the action alternatives (see Appendix K).

4. This assessment focuses on the loss of riparian function from transmission line corridor crossings at fish-bearing streams. The length of stream cleared is at least 150 ft. and, because of stream orientation and sinuosity, it is often greater. At these scales, loss of wood recruitment could be enough to significantly alter geomorphic processes (Montgomery et al. 2003) and the loss of stream shade could be enough to warm streams to levels harmful to fish inhabiting the stream reach (Cristea and Janisch 2007). In comparison, riparian clearing would not be required at substations. Clearing of forested vegetation would be required at 10 or fewer new access road crossings for any alternative or alternative option; clearing would be limited to 30 ft.

5. Stream shade function is based on canopy closure, elevation, and WaDOE stream temperature standards. Crossings were classified into low and high categories using the assessment protocols in the WaFPB Manual (2011b). Canopy closure determinations were based the visibility of the stream surface and stream banks. Determinations were based on aerial photo interpretation at each crossing. Elevations were determined from USGS topographic maps. WaDOE stream temperature standards were determined from FPARS data (see Appendix K).

6. Large woody debris recruitment potential is based on the dominant vegetation types, average tree size classes, and stand density classes found within 100 ft of the stream at each crossing. Crossings were classified into low, moderate, and high categories using the assessment protocols in the WaFPB Manual (2011b). Determinations were based on aerial photo interpretation at each crossing. Low LWD recruitment potential is associated with hardwood dominated stands and high LWD recruitment potential is associated with mixed or conifer dominated stands (see Appendix K).

7. The Integrated Fish Impact index estimates the proportional reduction in fish numbers associated with project-related habitat degradation at the crossing scale. Units of this index are expressed as the average percentage of high priority populations for all listed salmon and steelhead species. The Integrated Fish Impact index identifies the percentage by which affected populations are likely to be reduced by project-related habitat changes (see Appendix K).

8. Sum of potential floodplain impacts within the transmission line corridor based on acreage of vegetation clearing, towers, and roads. Assumes 30 ft. width for new roads, 20 ft. width for reconstructed roads, and a 66-ft. diameter circle for towers. Overlapping impact areas were accounted for in the summed values.

Hardwoods are not as effective as conifers in providing shade for streams, including fish-bearing streams. Streams at lower elevations also tend to be wider and forest canopies cannot fully cover the stream surface. At lower elevations, air temperatures are higher and more shade is required to cool streams to adequate temperatures. It is less likely that there will be enough shade to adequately cool these streams. Hardwoods are also not as effective as conifers in providing large woody debris function and break down at a faster rate.

The West Alternative would clear 12.6 acres of floodplain vegetation and has a total floodplain impact area of 18 acres (includes towers, roads, and new right-of-way vegetation clearing) (see Appendix K). These amounts are the highest of the action alternatives. The number of new towers and the length of roads in the floodplain would also be the highest of the action alternatives. Broad floodplain areas of streams with potential fish populations would be crossed in the lower portions of large river systems, including the Lewis, East Fork Lewis, Salmon Creek, and Coweeman River. A large amount of floodplain area would also be crossed in the Lacamas Creek valley upstream of Lacamas Lake. Although the West Alternative would have a high total impact area, this route crosses floodplains that are already greatly affected by existing agricultural and residential uses that have caused widespread clearing, road construction, ditching, filling, and grading. Although the total amount of floodplain clearing would be 12.6 acres, as much as 86 percent of the total floodplain area is already cleared, which suggests considerable existing impairment to floodplain processes and their suitability for aquatic resources. An even greater portion of these floodplains are further affected by existing ditching and filling. Because of the existing degree of impairment and disconnection of floodplains crossed by this alternative, impacts to fish from floodplain-related impacts would be **low**.

The West Alternative has among the lowest fish impacts based on the Integrated Fish Impact index (see Appendix K and Table 19-2). The Integrated Fish Impact index estimates the average percent reduction in affected fish production (see Table 19-2). Fish production potential is generally higher because the West Alternative has a greater number of crossings and many occur at relatively high-value streams for anadromous species. However, project-related habitat effects would be relatively low compared to other alternatives because many stream crossings occur where conditions in the right-of-way are already altered. This alternative would generally require much less clearing of highly-functioning riparian vegetation (see Appendix K).

The average percent reduction in production of affected fish populations for the West Alternative would be about 0.11 percent (see Table 19-2), the lowest of the action alternatives. The West Alternative would not pose a substantial risk to listed species because only a fraction of the potential fish production is likely to be lost due to project effects; impacts would be **low**.

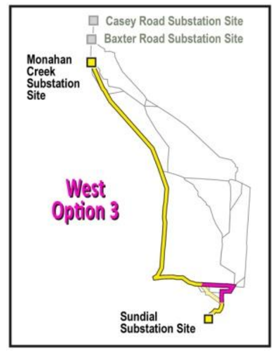
19.2.4.1 West Option 1

West Option 1 would replace a portion of the alternative that follows existing right-of-way just east of Vancouver with an option that is farther west and closer to Vancouver. This portion of the alternative includes replacing one of the existing 230-kV lines with a new double-circuit 500-kV line. The existing 230-kV line and the new line would be placed on new 500-kV towers. Impacts would be the same as the West Alternative on watershed function (**low**), riparian function (**low-to-high**; no added high impacts), floodplain (**low**), and from habitat changes affecting ESA-listed and other fish species (**low**).

19.2.4.2 West Option 2

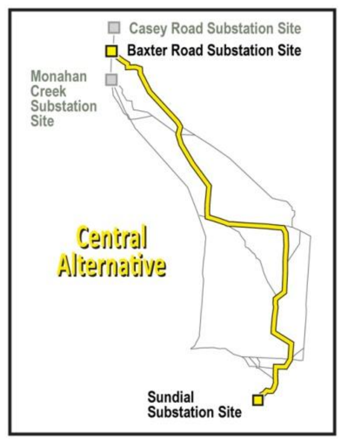
West Option 2 would replace a portion of the alternative in the rural residential areas north of Camas with an option farther to the east in the same area. Impacts would be the same as the West Alternative on watershed function, floodplain functions, and from habitat changes affecting ESA-listed and other fish species (all **low** impacts). Impacts to riparian function would also be similar (**low-to-high**), with one fewer stream with high shade function affected.

19.2.4.3 West Option 3



West Option 3 would replace a portion of the West Alternative in the rural residential areas north of Camas with a route crossing rural residential and rural areas farther east. Impacts would be the same as the West Alternative on watershed function, floodplain functions, and from habitat changes affecting ESA-listed and other fish species (all **low** impacts). Impacts on riparian function would also be similar (**low-to-high**), with one more stream with high shade function, and two more streams with high potential for large woody debris affected.

19.2.5 Central Alternative



Transmission line clearing and road construction would cause about 104 miles (1,503 acres) of potential soil disturbance that could contribute sediment to streams through runoff or erosion (see Table 15-2).. Among the action alternatives, this would be the greatest amount of construction, but it would cause relatively moderate percent increases in runoff (0.59 percent) and sediment delivery (0.15 percent) to fish-bearing streams because moderate levels of mature conifer vegetation would be cleared and less erodible terrain would be crossed. Compared to the West Alternative, there is less existing development, less agriculture, and more conifer cover. Losing more of this conifer cover decreases the amount of vegetation available to intercept snow and rain and causes a higher rate of snowmelt (see Appendix K). Still, the loss of mature vegetation would not be as great as the East Alternative. Compared to the West Alternative, the underlying geology along the Central Alternative is mostly hard rock that does not easily erode. Though more soil would be exposed, there would be less sediment delivery to fish-bearing streams. These changes would occur across a large watershed area of about 218,000 acres. Isolated actions could cause **high** impacts to fish-bearing streams. Generally, however, long-term changes in watershed conditions and functions would be minor, and impacts would be **low**.

Riparian vegetation would be cleared at 68 forested crossings of fish-bearing streams (see Table 19-2). Among the action alternatives, this would be the greatest number of forested crossings. Most forested crossings (49) would occur where the existing shade level provides effective stream cooling and where shade loss is more likely to cause temperature increases that adversely affect aquatic life; impacts to loss of shade function would be **high**. Most forested crossings (46) would also occur where the existing riparian vegetation provides high large woody debris recruitment potential; impacts to loss of large woody debris function would be **high**. This is the greatest number of high riparian function impacts among the other alternatives because of the greater number of forested crossings and because riparian vegetation at these crossings provide relatively greater shade and large woody debris function. Stream crossings, including fish-bearing streams, along the Central Alternative tend to have greater conifer species composition, narrower streams, and are at higher elevations. Conifers are more effective than hardwoods in providing shade. Forest canopies often can fully cover the stream surface along narrower streams. At higher elevations, air temperatures are lower and it is more likely that shade cover will adequately cool these streams. Conifers are also more effective than hardwoods in providing large woody debris in streams, including fish-bearing streams, and tend to remain intact and effective for a longer period of time.

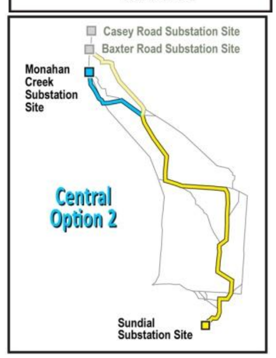
The Central Alternative would clear 8.1 acres of floodplain vegetation and has a total floodplain impact area of 9.2 acres (includes towers, roads, and new right-of-way vegetation clearing) (see Appendix K). These amounts are near the lowest of the action alternatives because the route crosses smaller stream systems with small floodplain areas with potential fish populations. The number of new towers and length of roads in the floodplain area would be the lowest of the action alternatives. Also, there are more existing cleared areas in many of these floodplains. Because the amount of total impact area is small and existing floodplains are already impaired and disconnected, impacts to fish from floodplain-related impacts would be **low**.

This alternative generally falls between the West and East alternatives based on the Integrated Fish Impacts index (see Table 19-2). The number of anadromous fish-bearing stream crossings, amount of riparian clearing, functional rating of riparian zones, and fish production potential all fall in the middle range between the West and East alternatives (see Appendix K).

The average percent reduction in production of affected fish populations for the Central Alternative would be about 0.15 percent (see Table 19-2). The Central Alternative would not pose a substantial risk to listed species because only a fraction of the potential fish production is likely to be lost due to project effects; impacts would be **low**.

19.2.5.1 Central Option 1

Central Option 1 would begin at the Casey Road substation site and the transmission line would cross unpopulated forest production and open space land. Impacts on watershed function (**low**), floodplain function (**low**) and from habitat changes to ESA-listed and other fish species (**low**) would be the same as the Central Alternative. Impacts on riparian function would also be similar (**low-to-high**), with one more crossing with high shade function and high potential for large woody debris affected.

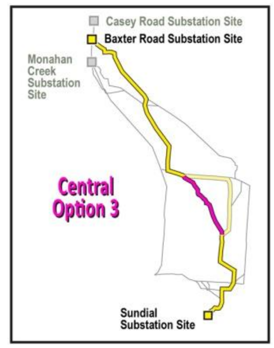


19.2.5.2 Central Option 2

Central Option 2 would begin at the Monahan Creek substation site and would remove the portion of the Central Alternative crossing the Cowlitz River north of Castle Rock and running farther to the southeast. This option would add a new route running southeast from the

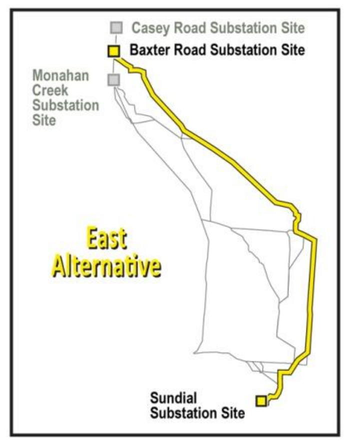
Monahan Creek substation site through sparsely populated land, crossing the unincorporated community of West Side Highway next to SR 411, the Cowlitz River and I-5, and running through largely unpopulated land toward the east. Impacts would be the same as the Central Alternative on watershed function, floodplain functions, and from habitat changes to ESA-listed and other fish species (all **low** impacts). Impacts on riparian function would also be similar (**low-to-high),** but with nine fewer streams with high shade function, and seven fewer streams with high potential for large woody debris affected.

19.2.5.3 Central Option 3



Central Option 3 would replace the Lewis River crossing near Ariel and a portion of the Central Alternative between Ariel and Venersborg, with a downstream river crossing and a new route running directly southeast from Ariel through rural residential areas toward Venersborg. Impacts would be the same as the Central Alternative on watershed function, floodplain functions, and from habitat changes to ESA-listed and other fish species (all **low** impacts). Impacts on riparian function would also be similar (**low-to-high**), but with two fewer streams with high shade function, and three fewer streams with high potential for large woody debris affected.

19.2.6 East Alternative



Transmission line clearing and road construction would cause about 98 miles (1,455 acres) of potential soil disturbance that could contribute sediment to streams through runoff or erosion (see Table 15-2). Compared to the other action alternatives, this would be the second greatest amount of construction, and it would cause the largest percent increase in runoff (1.02 percent) to fish-bearing streams because it clears the greatest amount of mature vegetation. Compared to the West Alternative, there is less existing development, less agriculture, and more conifer cover. Losing more conifer cover decreases the amount of vegetation available to intercept snow and rain and causes a higher rate of snowmelt (see Appendix K). Compared to the West Alternative, the underlying geology along the East Alternative is mostly hard rock that does not easily erode. Though more soil would be exposed, there would be less sediment delivery to fish-bearing streams. These changes would occur across a large watershed area of about 209,000 acres. Isolated actions could cause **high** impacts to fish-bearing streams. Generally, however, long-term changes in watershed conditions and functions would be minor, and impacts would be **low**.

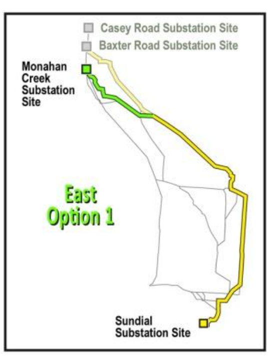
Riparian vegetation would be cleared at 52 forested crossings of fish-bearing streams (see Table 19-2). Compared to other action alternatives, this would be the third most forested crossings. Most forested crossings (35) would occur where the existing shade level provides effective stream cooling and where shade loss is more likely to cause temperature increases that adversely affect aquatic life; impacts would be **high**. Most forested crossings (38) would also occur where the existing riparian vegetation provides high large woody debris recruitment potential; impacts to loss of large woody debris function would be **high**. This is the second greatest number of high impacts among the action alternatives. Similar to the Central Alternative, crossings along the East Alternative provide greater shade function for streams, including fish-bearing streams. Crossings tend to have greater conifer species composition, narrower streams, and are at higher elevations. Conifers are also more effective than hardwoods in providing large woody debris. But there would be relatively fewer high impacts along the East Alternative than the Crossover Alternative because fewer fish-bearing streams would be crossed.

The East Alternative would clear 9.8 acres of floodplain vegetation and has a total floodplain impact area of 10.9 acres (includes towers, roads, and new right-of-way vegetation clearing) (see Appendix K). These amounts are near the middle of the action alternatives, but closer to the Central and Crossover alternatives than the West Alternative (and options) because the alternative crosses smaller stream systems with small floodplain areas with potential fish populations. The number of new towers and length of roads are less than the West and Crossover alternatives. Also, there are more existing cleared areas in many of these floodplains. Because the total impact area is small and existing floodplains are already impaired and disconnected, new impacts to floodplain processes would be **low**.

This alternative falls between the Central and Crossover alternatives, but is closer to the Crossover Alternative based on the Integrated Fish Impacts index (see Table 19-2). Fish production potential is relatively low because the number of anadromous fish-bearing stream crossings would be lower than other action alternatives and this alternative would generally cross smaller, higher elevation streams inhabited at relatively low densities by a limited number of species (typically steelhead and coho). However, many of these crossings would require substantial clearing of relatively high-functioning riparian vegetation (see Appendix K).

The average percent reduction in production of affected fish populations for the East Alternative would be about 0.19 percent (see Table 19-2). The East Alternative would not pose a substantial risk to listed species because only a fraction of the potential fish production is likely to be lost due to project effects; impacts would be **low**.

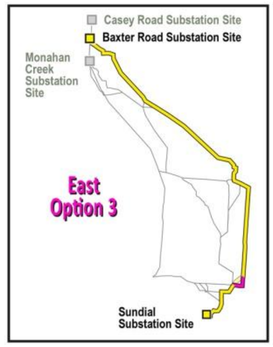
19.2.6.1 East Option 1

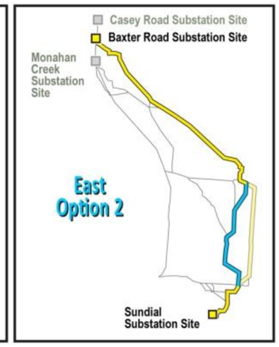


East Option 1 begins at the Monahan Creek substation site and would remove the portion of the East Alternative crossing the Cowlitz River north of Castle Rock. The option would use segments southeast of the Monahan Creek substation site that run through sparsely populated land, cross the Cowlitz River and I-5 and run through largely unpopulated land toward the east. Impacts would be the same as the East Alternative on watershed function, floodplain functions, and from habitat changes affecting ESA-listed and other fish species (all **low** impacts). Impacts on riparian function would also be similar (**low-to-high**), with 11 fewer streams with high shade function, and 11 fewer streams with high potential for large woody debris affected.

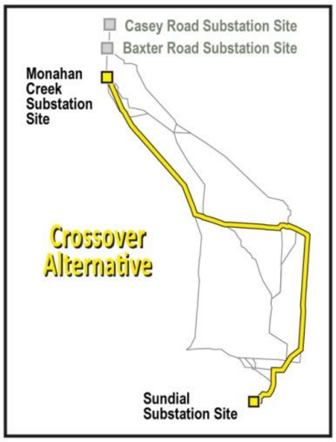
19.2.6.2 East Options 2 and 3

East Option 2 would replace a portion of the East Alternative between Yale and the rural residential areas north of Camas with a route farther to the west. East Option 3 would replace a short portion of the alternative in unpopulated land with a new route through unpopulated land. Impacts would be the same as the East Alternative on watershed function, floodplain functions, and from habitat changes affecting ESA-listed and other fish species (all **low** impacts). Impacts on riparian function would also be similar (**low-to-high**). East Option 2 would affect five more streams with high shade function, and six more streams with high potential for large woody debris. East Option 3 would affect four more streams with high shade function, and four more streams with high potential for large woody debris.





19.2.7 Crossover Alternative



Transmission line clearing and road construction would cause about 95 miles (1,422 acres) of potential soil disturbance that could contribute sediment to streams through runoff or erosion (see Table 15-2). Compared to the other action alternatives, this would be the third greatest amount of construction and would cause relatively moderate percent increases in runoff (0.47 percent) and sediment delivery (0.17 percent) to fish-bearing streams because moderate levels of mature conifer vegetation would be cleared and less erodible terrain would be crossed. Compared to the West Alternative, there is less existing development, less agriculture, but more conifer cover. Losing more of this conifer cover decreases the amount of vegetation available to intercept snow and rain and causes a higher rate of snowmelt (see Appendix K). Still, the loss of mature vegetation would not be as great as the East Alternative. Also compared to the West Alternative, the underlying geology along the Central Alternative is mostly hard rock that does not easily erode. Though more soil would be exposed, there would be less sediment delivery to streams. This change would occur across a large watershed area of approximately 184,000 acres. Isolated actions could cause **high** impacts to fish-bearing streams. Generally, however, long-term changes in watershed conditions and functions would be minor, and impacts would be **low**.

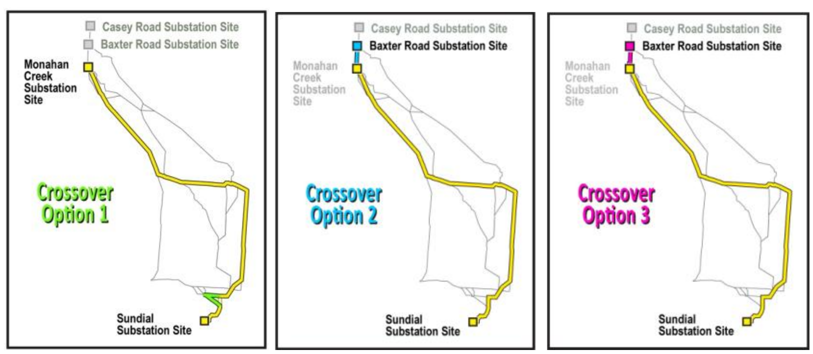
Riparian vegetation would be cleared at 55 forested crossings of fish-bearing streams (see Table 19-2). Compared to other action alternatives, this would be the second most forested crossings. Most forested crossings (32) would occur where the existing shade level provides effective stream cooling and where shade loss is more likely to cause temperature increases that adversely affect aquatic life; impacts from loss of shade function would be **high**. Most forested crossings (31) would occur where the existing riparian vegetation provides high large woody debris recruitment potential; impacts to loss of large woody debris function would be **high**. This is the third greatest number of high impacts among the action alternatives. Similar to the Central Alternative, crossings along the Crossover Alternative provide greater shade function for streams, including fish-bearing streams. Crossings tend to have greater conifer species composition, narrower streams, and are at higher elevations. Conifers are also more effective than hardwoods in providing shade and large woody debris. Relatively fewer high impacts would occur along the Crossover Alternative because fewer fish-bearing streams would be crossed.

The Crossover Alternative would clear 7.3 acres of floodplain vegetation and has a total floodplain impact area of 9 acres (includes towers, roads, and new right-of-way vegetation clearing) (see Appendix K). These amounts are the lowest of the action alternatives because the route crosses smaller stream systems with small floodplain areas with potential fish populations. The number of new towers and length of roads would be less than the West Alternative, but more than the East and Central alternatives. Also, a large amount of clearing has already occurred within many of these floodplain areas. Because the total impact area is small and existing floodplains are already impaired and disconnected, impacts to fish from project-related floodplain impacts would be **low**.

This alternative would potentially have the highest impacts on fish, based on the Integrated Fish Impacts index (see Table 19-2). Fish production potential is higher at this alternative's crossings, and highly-functioning riparian vegetation would be cleared. This alternative would cross a greater number of anadromous fish-bearing streams, including many low to intermediate elevation streams that produce more fish and more species of fish on a per unit-length basis. Affected populations are more frequently identified in the salmon recovery plan as high priorities for habitat protection or restoration (see Appendix K).

The average percent reduction in production of affected fish populations for the Crossover Alternative would be about 0.20 percent (see Table 19-2), the highest of the action alternatives. Still, the Crossover Alternative would not pose a substantial risk to listed species because only a fraction of the potential fish production is likely to be lost due to project effects; impacts would be **low**.

19.2.7.1 Crossover Options 1, 2 and 3



Impacts would be the same as the Crossover Alternative on watershed function, floodplain functions, and from habitat changes affecting ESA-listed and other fish species (all **low** impacts). Impacts on riparian function would also be similar (**low-to-high**). Crossover Option 1 would affect one more stream with high shade function. Crossover Option 3 would affect two more streams with high shade function, and one more stream with high potential for large woody debris.

19.2.8 Recommended Mitigation Measures

Mitigation measures included as part of the project have been identified (see Table 3-2). The following additional mitigation measures have been identified to further reduce or eliminate adverse impacts on fish resources by the action alternatives. If implemented, these measures would be completed before, during, or immediately after project construction unless otherwise noted.

- Route transmission lines to minimize the length of stream cleared.
- Avoid or minimize clearing of riparian and floodplain vegetation where possible.
- Plant riparian vegetation, hydroseed, or use geotextiles to stabilize stream banks.
- Place wood instream along streams cleared for transmission line crossings.
- Apply silvicultural treatments (hardwood conversion to conifer to improve conifer component and thinning) in adjacent riparian forests to improve adjacent timber stand conditions and subsequently, riparian function.
- Ensure that new or reconstructed floodplain roads are at grade and do not reduce flood inundation extents. Ensure that roads and towers are not placed in areas that would disrupt channel migration processes (e.g., lateral migration or avulsions).
- Follow all mitigation measures contained in any Biological Opinions issued by NOAA Fisheries and/or USFWS for ESA-listed fish species.
- Develop a compensatory mitigation plan to offset unavoidable impacts to fish habitat

19.2.9 Unavoidable Impacts

If erosion control mitigation measures are implemented, there would still be some increase in erosion and runoff to fish-bearing streams. Riparian vegetation would also be removed within and outside of the right-of-way and along some new access roads at fish-bearing streams. This would reduce shade at these streams, which could lead to increased temperatures that could affect fish. Removing vegetation also decreases the amounts of large woody debris and litter that could fall into streams, which would reduce the benefits to fish derived from this material, such as increasing channel complexity and aiding the formation of pool and backwater eddies necessary for fish survival. Reducing future wood sources can also lead to simplification of habitat and destabilization of channel beds over time. This would reduce the production of affected fish species in these streams. Clearing vegetation in currently connected and functional floodplains would have some impact on hydraulic roughness and could potentially increase the incidence of **channel avulsions** that are beneficial to fish. Clearing floodplain vegetation could also affect nutrient exchange with the stream as well as long-term large wood recruitment and stream shade.

19.2.10 No Action Alternative

The No Action Alternative would have **no** impact on fish because no construction would take place. Impacts from operation and maintenance of existing transmission lines would continue unchanged. Impacts from other land uses such as forest production, rural and urban land development, agriculture, and hydroelectric projects would continue.