Volume II, Chapter 9
Cowlitz Subbasin—Upper Cowlitz

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9.0 Cowlitz Subbasin—Upper Cowlitz

9.1 Subbasin Description

9.1.1 Topography & Geology

For the purposes of this assessment, the Upper Cowlitz basin is the watershed area contributing to Mayfield Dam. The basin encompasses 1,390 square miles in portions of Lewis, Skamania, Pierce, and Yakima Counties. The basin is within WRIA 26 of Washington State. Major tributaries include the Cispus, Clear Fork, Ohanapecosh, and Tilton.

Headwater streams consist of high gradient canyons in the steep, heavily timbered mountainous areas surrounding Mounts Rainier, Adams, St. Helens, and the Goat Rocks Wilderness. The high point in the basin is the summit of Mt. Rainier at 14,410 feet. An upper alluvial valley extends from the junction of the Muddy Fork and the Ohanapecosh Rivers (near Packwood, Washington) to Cowlitz Falls Reservoir (RM 99.5).

Cowlitz Falls Dam (RM 88.5) was constructed in 1994, creating a long, narrow 11-mile reservoir. Below the Cowlitz Falls Dam, the river enters Riffe Lake, a 23.5 mile long reservoir created by the 606-foot high Mossyrock Dam (RM 66), completed in 1968. Riffe Lake is operated as a storage reservoir by Tacoma Power for flood control and hydropower production. Due to characteristics of the dam and reservoir, no fish passage facilities have been constructed at Mossyrock Dam. A few miles below the dam, the river enters Mayfield Lake, a 13.5 mile long reservoir created by the construction of Mayfield Dam (RM 52) in 1962. Historically, the portion of the stream inundated by the three reservoirs was made up of a series of deep canyons. The salmon hatchery Barrier Dam (RM 49.5) located below Mayfield Dam is a collection facility for trapping and hauling fish into the upper basin, a practice that has been in effect since 1969.

The geology of the headwater streams consists of volcanic rocks of the Cascade Mountains. The upper basin is made up of andesite and basalt flows. The most common forest soils are Haplohumults (reddish brown lateritic soils) and the most common grassland soils are Argixerolls (prairie soils) (WDW 1990).

9.1.2 Climate

The basin has a typical northwest maritime climate. Summers are dry and warm and winters are cool, wet, and cloudy. Mean monthly precipitation ranges from 1.9 inches (July) to 19 inches (November) at Paradise on Mt. Rainier and from 1.1 inches (July) to 8.8 inches (November) at Mayfield Dam. Mean annual precipitation ranges from 56 inches at Mayfield Dam to over 116 inches at Paradise (WRCC 2003). Most precipitation occurs between October-March. Snow and freezing temperatures are common in the upper basin while rain predominates in the middle and lower elevations.

9.1.3 Land Use/Land Cover

Forestry is the dominant land use in the basin, with over 70% of the land managed as public and private commercial forestland. The Upper Cowlitz also has a substantial amount of land in non-commercial forest and reserved forest, owing primarily to the large public land holdings (Gifford Pinchot National Forest and Mt. Rainier National Park) in the basin. Much of the private land in the river valleys is agricultural and residential, with substantial impacts to riparian and floodplain areas in places. Population centers in the subbasin consist primarily of small rural towns including Morton, Randle, and Packwood, WA. Projected population change from 2000 to 2020 for unincorporated areas in WRIA 26 is 22% (LCFRB 2001). A breakdown of land ownership is presented in Figure 9-1. Figure 9-4 displays the pattern of landownership for the basin

Forests above 3,500 feet are mostly Pacific silver fir, with Douglas fir, western hemlock, mountain hemlock, and lodgepole pine as associates. Below 3,500 feet, climax species are western hemlock, Douglas fir, and western red cedar. Alder, cottonwood, maple, and willow dominate the larger stream riparian areas (WDW 1990). A breakdown of land cover is presented in Figure 9-2. Figure 9-6 displays the pattern of land cover / land-use.

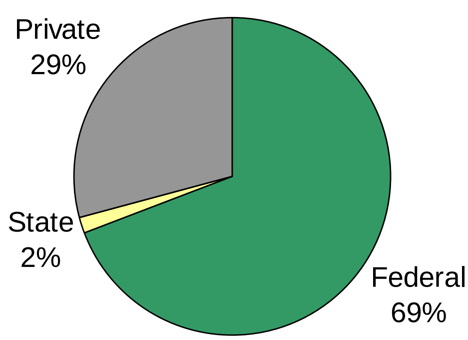


Figure 9-1. Upper Cowlitz River basin land ownership

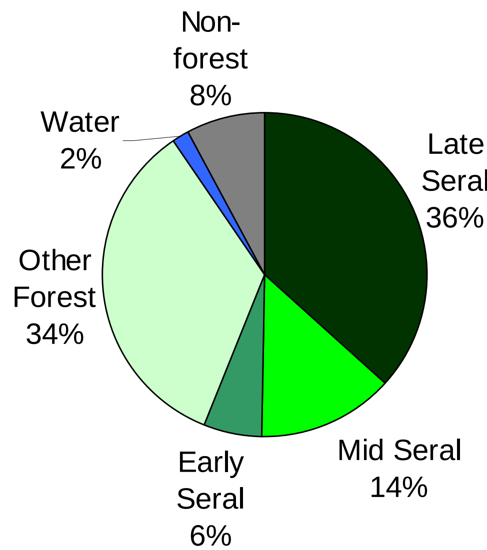


Figure 9-2. Upper Cowlitz River basin land cover

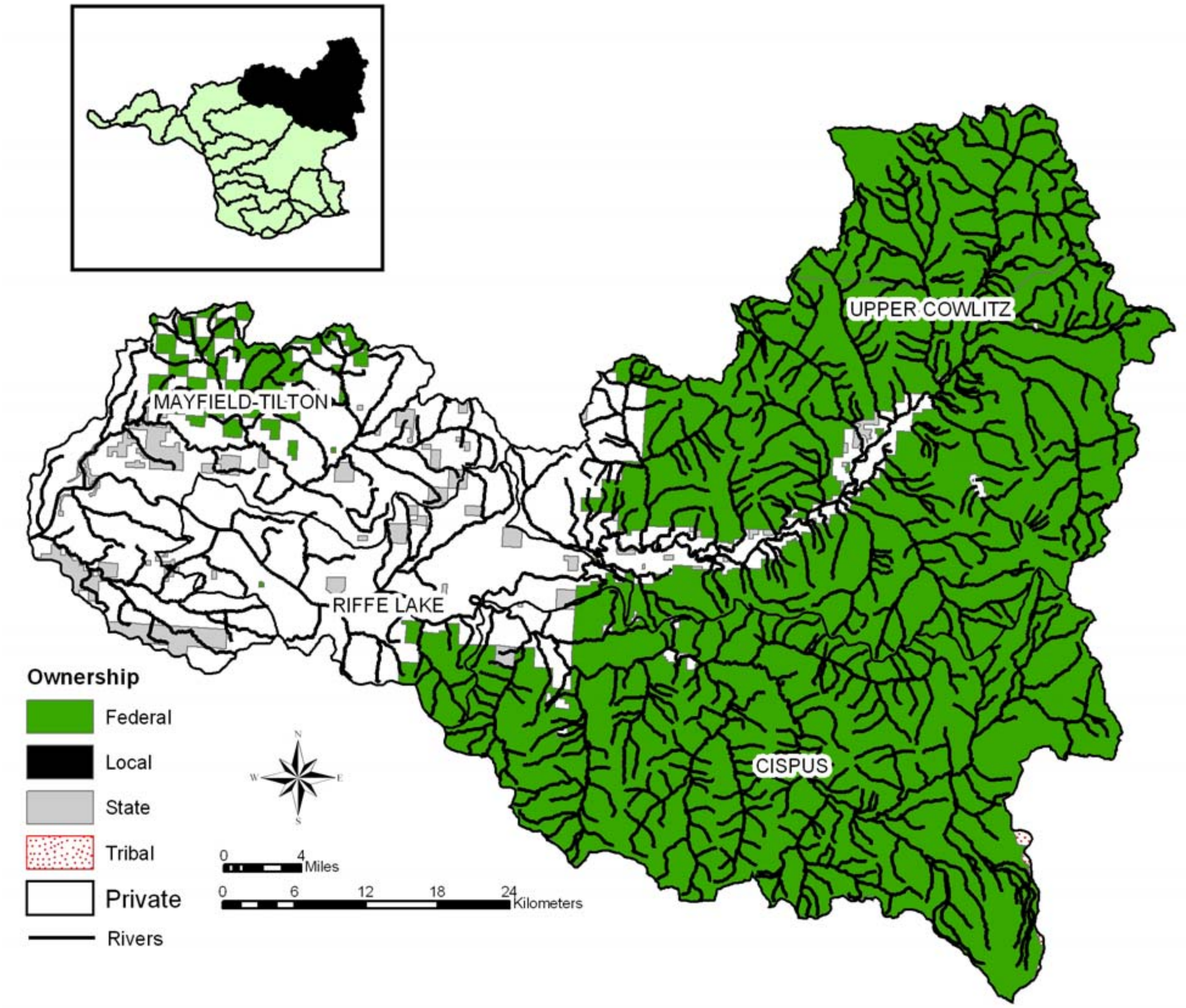


Figure 9-3. Landownership within the upper Cowlitz basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

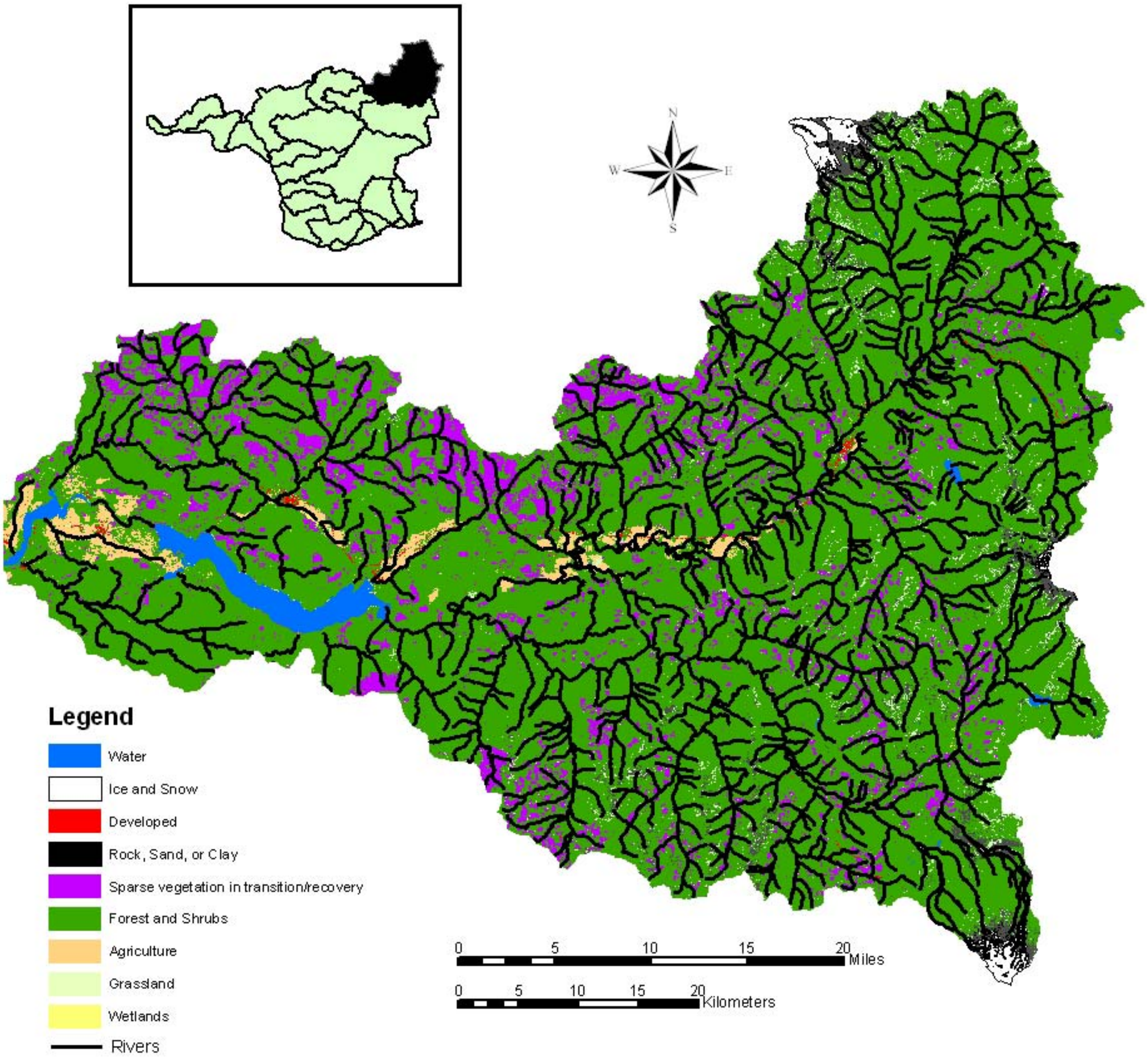
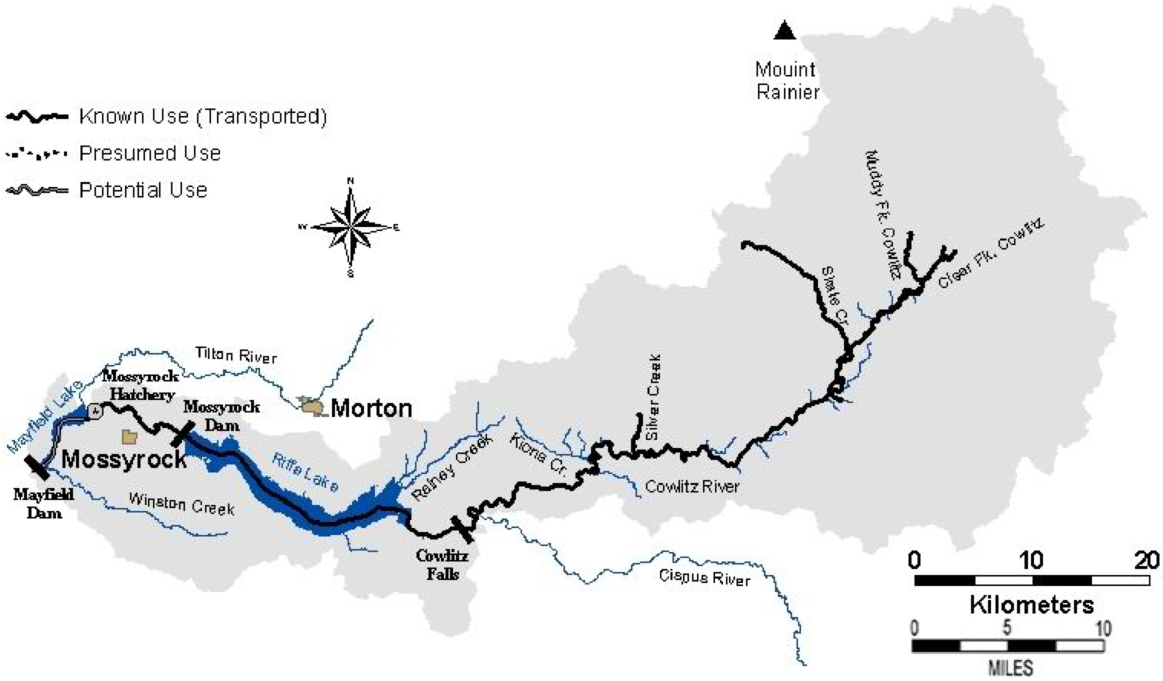


Figure 9-4. Land cover within the upper Cowliz basin. Data was obtained from the USGS National Land Cover Dataset (NLCD).

9.2 Focal Fish Species

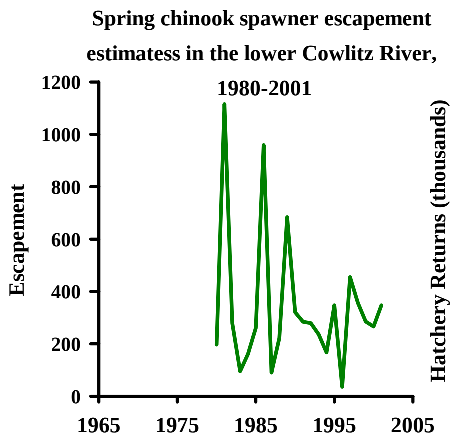
9.2.1 Spring Chinook—Cowlitz Subbasin (Upper)

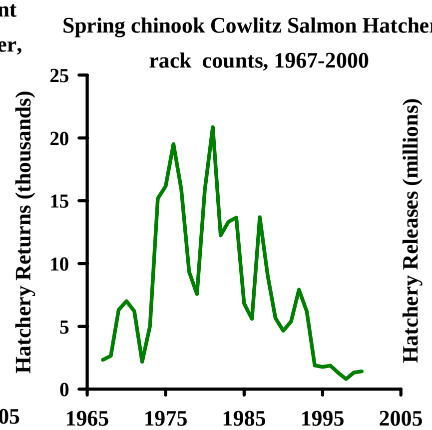
ESA: Threatened 1999	SASSI: Depressed 2002

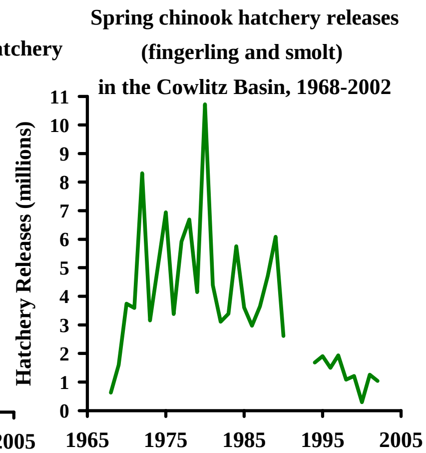


Distribution

- Historically, all spawning in the Cowlitz River occurred above the Mayfield Dam site, particularly in the mainstem Cowlitz River above Packwood and in the Cispus River between Iron and East Canyon Creeks (spring chinook were thought to have also spawned in the Tilton River, but confirmation and distribution of spawning is unknown)
- Completion of Mayfield Dam in 1962 blocked access above the dam (RM 52); fish were passed over the dam from 1962-66; from 1974-80, an average of 2,838 spring chinook were hauled to the Tilton and upper Cowlitz
- An adult trap and haul program began again in 1994 where fish were collected below Mayfield Dam and released above Cowlitz Falls Dam; spring chinook are now released in the upper Cowlitz and Cispus rivers
- A collection facility is currently operating at the Cowlitz Falls Dam to collect emigrating spring chinook smolts produced from adults released in the upper Cowlitz and Cispus rivers
- Natural spawning below Mayfield Dam is concentrated on the mainstem Cowlitz between the Cowlitz Salmon and Trout Hatcheries (~8.0 miles)







Life History

- Spring chinook enter the Cowlitz River from March through June
- Natural spawning in the Cowlitz River occurs between late August and early October; the peak is usually around mid-September
- Age ranges from 2 year-old jacks to 6 year-old adults, with 4 year-olds the dominant age class (average is 43.76%)
- Fry emerge between November and March, depending on time of egg deposition and water temperature; spring chinook fry spend one full year in fresh water, and emigrate in their second spring as age-2 smolts

Diversity

- One of four spring chinook populations in the Columbia River Evolutionarily Significant Unit (ESU)
- The Cowlitz spring chinook stock was designated based on distinct spawning distribution and early spawning timing
- Genetic analyses of Cowlitz River Hatchery spring chinook from 1982 and 1987 determined they were genetically similar to, but distinct from, Kalama Hatchery and Lewis River wild spring chinook and significantly different from other Columbia River spring chinook stocks

Abundance

- In 1948, WDF and WDG estimated that the Cowlitz River produced 32,490 adult spring chinook
- Spring chinook escapement estimates in 1951 were 10,400 in the Cowlitz basin, with 8,100 in the Cispus, 1,700 in the upper Cowlitz, 400 in the upper Toutle, and 200 in the Tilton
- From 1962-1966, an average of 9,928 spring chinook were counted annually at Mayfield Dam
- From 1978-1985 (excluding 1984), an average of 3,894 spring chinook were counted annually at Mayfield Dam
- Cowlitz River below Mayfield Dam spawning escapements from 1980-2001 ranged from 36-1,116 (average 338)
- Hatchery strays account for most spring chinook currently returning to the Cowlitz River

Productivity & Persistence

- NMFS Status Assessment for the Cowlitz River indicated a 0.03 risk of 90% decline in 25 years and a 0.25 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0
- Smolt density model predicted natural production potential for the Cowlitz River below Mayfield Dam of 329,400 smolts and 788,400 smolts for the Toutle River; above Mayfield Dam the model predicts production potential of 1,600,000 smolts
- Juvenile production from natural spawning is presumed to be low in the lower Cowlitz River

Hatchery

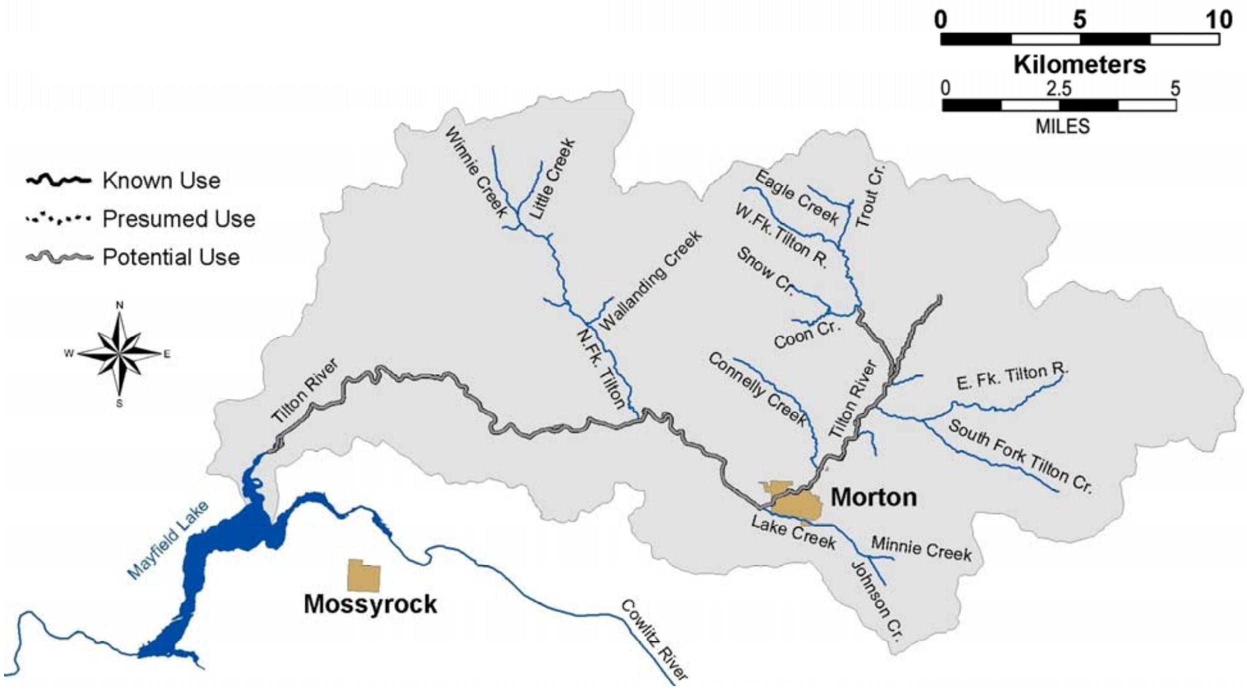
- Cowlitz River Salmon Hatchery is located about 2 miles downstream of Mayfield Dam; the hatchery was completed in 1967
- Hatchery releases of spring chinook in the Cowlitz began in the 1940s; releases from the Salmon Hatchery into the Cowlitz River averaged 3,495,517 from 1968-1990, releases into the Toutle averaged 651,369 from 1972-1984
- In 2002, the Cowlitz Salmon and Trout Hatcheries reared and released 1,131,000 spring chinook smolts: 929,000 into the lower Cowlitz, 106,600 into the Toutle and 95,900 to Deep River
- Yearling and sub-yearling spring chinook are also released above Cowlitz Falls Dam into the upper Cowlitz and Cispus rivers

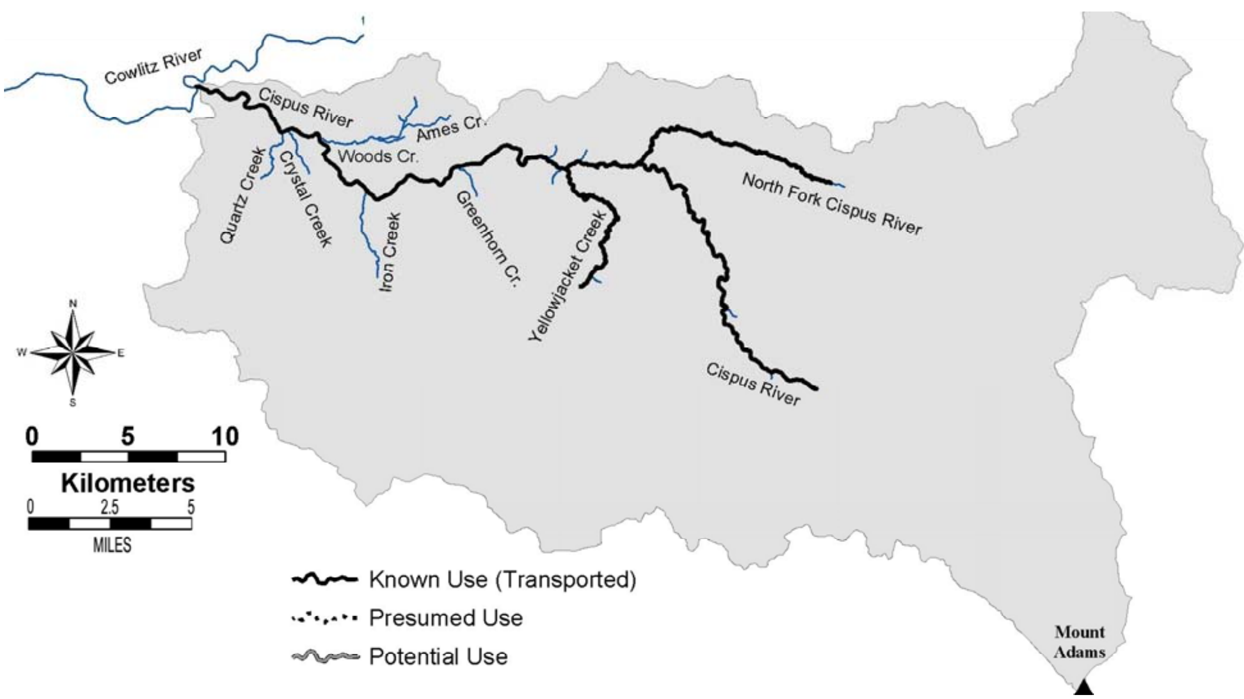
Harvest

- Cowlitz spring chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial and sport fisheries
- Coded-wire tag (CWT) data analysis of the 1989-1994 brood years indicates that 40% of the Cowlitz spring chinook were harvested and 60% escaped to spawn
- Fishery recoveries of the 1989-1994 brook Cowlitz River Hatchery spring chinook: Cowlitz sport (35%), British Columbia (29%), Washington Coast (22%), Columbia River (6%), Oregon coast (5%) and Alaska (3%)
- Mainstem Columbia River Harvest of Cowlitz spring chinook was substantially reduced and after 1977 when April and May spring chinook seasons were eliminated to protect upper Columbia and Snake wild spring chiook.
- Mainstem Columbia harvest of Cowlitz River Hatchery spring chinook increased in 2001-2002 when selective fisheries for adipose marked hatchery fish enabled mainstem spring fishing in April (and in May, 2002) again
- Sport harvest in the Cowlitz River averaged 7,100 spring chinook annually from 1980-1984, but reduced to 2,100 from 1985–94 and to only 200 from 1995–2002.
- Tributary harvest is managed to attain the Cowlitz Hatchery adult broodstock escapement goal

9.2.2 Spring Chinook—Cowlitz Subbasin (Tilton & Cispus)

ESA: Threatened	SASSI Depressed 2002





Distribution

- Historically, all spawning in the Cowlitz River occurred above the Mayfield Dam site, particularly in the mainstem Cowlitz above Packwood and in the Cispus River between Iron and East Canyon Creeks (spring chinook were thought to also have spawned in the Tilton River, but confirmation and distribution of spawning is unknown)
- Completion of Mayfield Dam in 1962 blocked access above the dam (RM 52); fish were passed over the dam from 1962-66; from 1974-80, an average of 2,838 spring chinook were hauled to the Tilton and upper Cowlitz
- An adult trap and haul program began again in 1994 where fish were collected below Mayfield Dam and released above Cowlitz Falls Dam; spring chinook are released in the upper Cowlitz and Cispus
- A collection facility is currently operating at the Cowlitz Falls Dam to collect emigrating spring chinook smolts produced from adults released in the upper Cowlitz and Cispus Rivers
- Natural spawning in the Cowlitz River below Mayfield Dam is concentrated in the mainstem between the Cowlitz Salmon and Trout Hatcheries (~8.0 miles)

Life History

- Spring chinook enter the Cowlitz River from March through June
- Natural spawning in the Cowlitz River occurs between late August and early October; the peak is usually around mid-September
- Age ranges from 2-year-old jacks to 6-year-old adults, with 4-year-olds the dominant age class (average is 43.76%)
- Fry emerge between November and March, depending on time of egg deposition and water temperature; spring chinook fry spend one full year in fresh water, and emigrate in their second spring as age-2 smolts

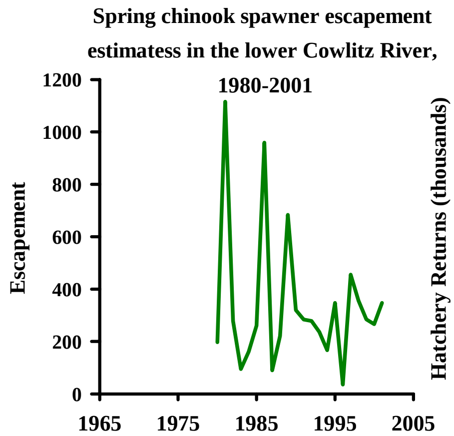
Diversity

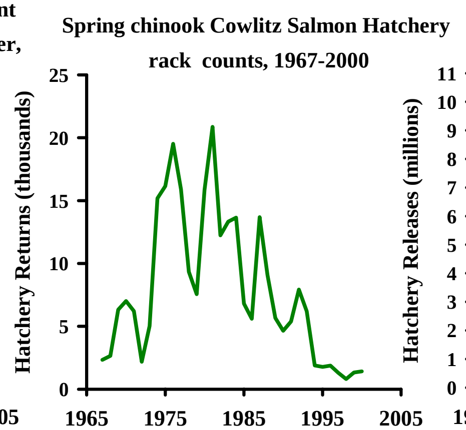
- One of four spring chinook populations in the Columbia River Evolutionarily Significant Unit (ESU)
- The Cowlitz spring chinook stock was designated based on distinct spawning distribution and early spawning timing
- Genetic analyses of Cowlitz River Hatchery spring chinook from 1982 and 1987 determined they were genetically similar to, but distinct from, Kalama Hatchery and Lewis River wild spring chinook and significantly different from other Columbia River spring chinook stocks

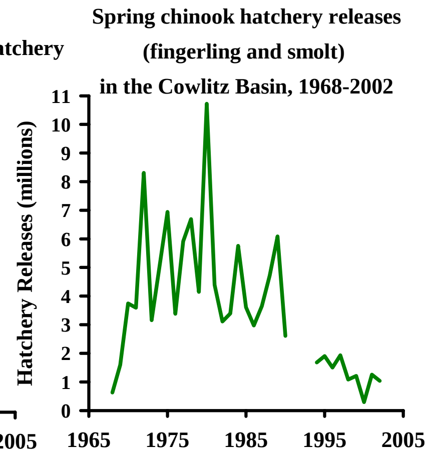
Abundance

- In 1948, WDF and WDG estimated that the Cowlitz River produced 32,490 adult spring chinook
- Spring chinook escapement estimates in 1951 were 10,400 in the Cowlitz basin, with 8,100 in the Cispus, 1,700 in the upper Cowlitz, 400 in the upper Toutle, and 200 in the Tilton
- From 1962-1966, an average of 9,928 spring chinook were counted annually at Mayfield Dam
- From 1978-1985 (excluding 1984), an average of 3,894 spring chinook were counted annually at Mayfield Dam
- Cowlitz River below Mayfield Dam spawning escapements from 1980-2001 ranged from 36 to 1,116 (average 338)

- Hatchery strays account for most spring chinook returning to the Cowlitz River







Productivity & Persistence

- NMFS Status Assessment for the Cowlitz River indicated a 0.03 risk of 90% decline in 25 years and a 0.25 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0
- Smolt density model predicted natural production potential for the Cowlitz River below Mayfield Dam of 329,400 smolts and 788,400 smolts for the Toutle River; above Mayfield Dam the model predicts production potential of 1,600,000 smolts
- Juvenile production from natural spawning is presumed to be low

Hatchery

- Cowlitz Salmon Hatchery is located about 2 miles downstream of Mayfield Dam; hatchery was completed in 1967
- Hatchery releases of spring chinook in the Cowlitz began in the 1940s; releases from the salmon hatchery into the Cowlitz River averaged 3,495,517 from 1968-1990, releases into the Toutle River averaged 651,369 from 1972-1984
- Some yearling and sub-yearling spring chinook are also released above Mayfield Dam as part of a spring chinook reintroduction program
- In 2002, the Cowlitz Salmon and Trout Hatcheries reared and released 1,131,000 spring chinook smolts: 929,000 into the lower Cowlitz, 106,600 into the Toutle River and 95,900 to Deep River

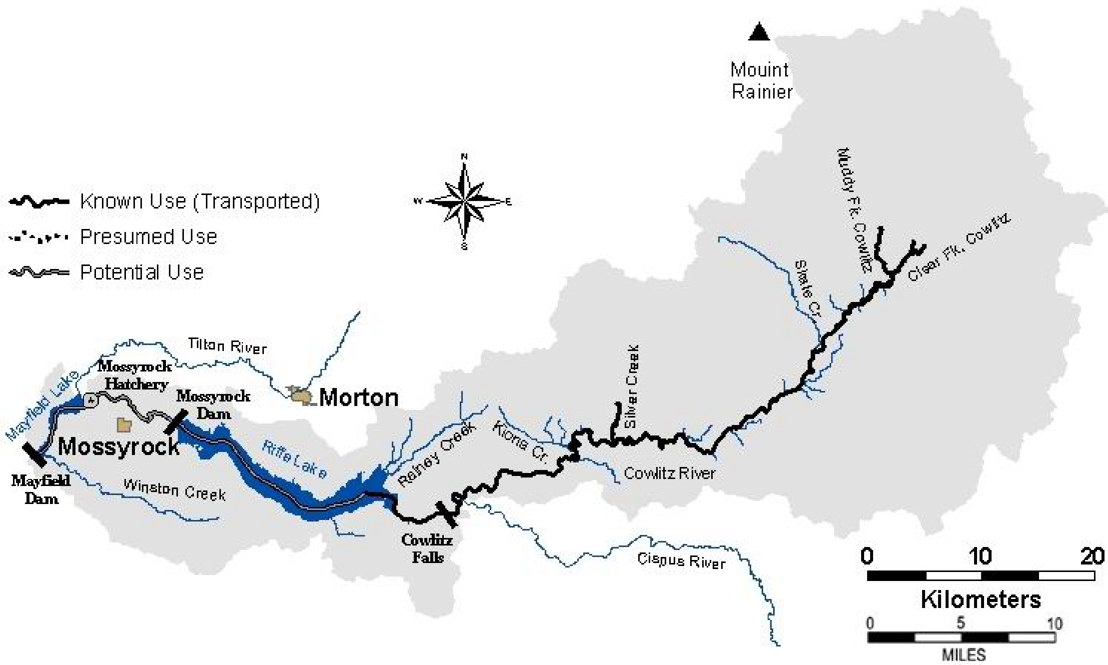
Harvest

- Cowlitz spring chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial and sport fisheries
- Coded-wire tag (CWT) data analysis of the 1989-1994 brood years indicates that 40% of the Cowlitz spring chinook were harvested and 60% escaped to spawn
- Fishery recoveries of the 1989-1994 brood Cowlitz River Hatchery spring chinook: Cowlitz sport (35%), British Columbia (29%), Washington Coast (22%), Columbia River (6%), Oregon coast (5%) and Alaska (3%)
- Mainstem Columbia River harvest of Cowlitz River spring chinook was substantially reduced after 1977 when April and May spring chinook seasons were eliminated to protect upper Columbia and Snake wild spring chinook.

- Mainstem Columbia River harvest of Cowlitz River Hatchery spring chinook increased in 2001-2002 when selective fisheries for adipose marked hatchery fish enabled mainstem spring fishing in April (and in May, 2002) again
- Sport harvest in the Cowlitz River averaged 7,100 spring chinook annually from 1980-1984, but reduced to 2,100 from 1985-1994 and only 200 from 1995-2002.
- Tributary harvest is managed to attain the Cowlitz River hatchery adult broodstock escapement goal

9.2.3 Fall Chinook—Cowlitz Subbasin (Cowlitz)

ESA: Threatened 1999	SASSI: Depressed 2002

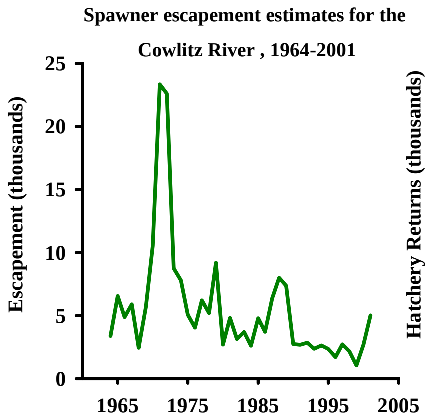


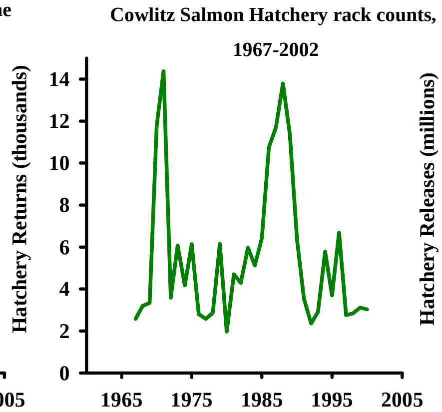
Distribution

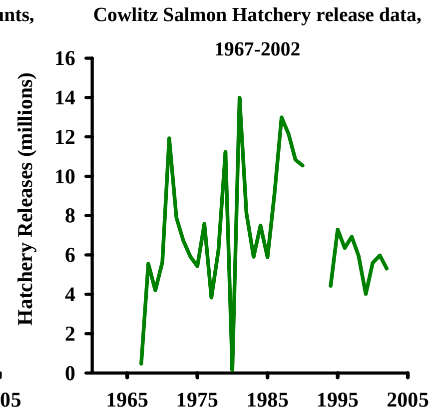
- In the Cowlitz River, spawning occurs in the mainstem between the Cowlitz River Salmon Hatchery and the Kelso Bridge (~45 miles), but is concentrated in the area between the Cowlitz Salmon and Trout Hatcheries (RM 52 and 41.3)
- Historically, Cowlitz River fall chinook were distributed from the mouth to upper tributaries such as the Ohanapecosh and Tilton Rivers and throughout the upper basin
- Completion of Mayfield Dam in 1962 blocked access above the dam (RM 52); all fish were passed over the dam from 1962–66; from 1967–80, small numbers of fall chinook were hauled to the Tilton and upper Cowlitz
- An adult trap and haul program began again in 1994 where fish were collected below Mayfield Dam and released above Cowlitz Falls Dam; fall chinook are currently released in the upper Cowlitz and Cispus Rivers

Life History

- Fall chinook enter the Cowlitz River from early September to late November
- Natural spawning in the Cowlitz River occurs between September and November, over a broader time period than most fall chinook; the peak is usually around the first week of November
- Age ranges from 2-year-old jacks to 6-year-old adults, with dominant adult age of 3, 4, and 5 (averages are 16.49%, 58.05%, and 19.31%, respectively)
- Fry emerge around March/April, depending on time of egg deposition and water temperature; fall chinook fry spend the spring in fresh water, and emigrate in the summer as sub-yearlings
- Cowlitz fall chinook display life history characteristics (spawn timing, migration patterns) that fall between tules and Lewis River late spawning wild fall chinook







Diversity

- The Cowlitz fall chinook stock is designated based on distinct spawning timing and distribution
- Genetic analysis of Cowlitz River Hatchery fall chinook from 1981, 1982, and 1988 determined they were similar to, but distinct from, Kalama Hatchery fall chinook and distinct from other Washington chinook stocks

Abundance

- Historical abundance of natural spawning fall chinook in the Cowlitz River is estimated to have once been 100,000 adults, declining to about 18,000 adults in the 1950s, 12,000 in the 1960s, and recently to less than 2,000
- In 1948, WDF and WDG estimated that the Cowlitz River produced 63,612 adult fall chinook; escapement above the Mayfield Dam site was at least 14,000 fish
- Fall chinook escapement estimates in 1951 were 10,900 in the Cowlitz and minor tributaries, 8,100 in the Cispus, and 500 in the Tilton
- From 1961–66, an average of 8,535 fall chinook were counted annually at Mayfield Dam
- Cowlitz River spawning escapement from 1964-2001 ranged from 1,045 to 23,345 (average 5,522)
- Currently hatchery production accounts for most fall chinook returning to the Cowlitz River
- Natural spawning escapement goal is 3,000 fish; the goal was not met from 1990-2000

Productivity & Persistence

- NMFS Status Assessment for the Cowlitz River indicated a 0.15 risk of 90% decline in 25 years and a 0.33 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0
- Two adult production potential estimates have been reported for the upper Cowlitz: 63,818 and 93,015
- Smolt density model predicted natural production potential for the Cowlitz River below Mayfield Dam of 2,183,000 smolts; above Mayfield Dam the model predicts production potential of 357,000 smolts from the Tilton River and 4,058,000 smolts above Cowlitz Falls
- Current juvenile production from natural spawning is presumed to be low

Hatchery

- Cowlitz River Salmon Hatchery is located about 2 miles downstream of Mayfield Dam; hatchery was completed in 1967; broodstock is primarily native Cowlitz fall chinook

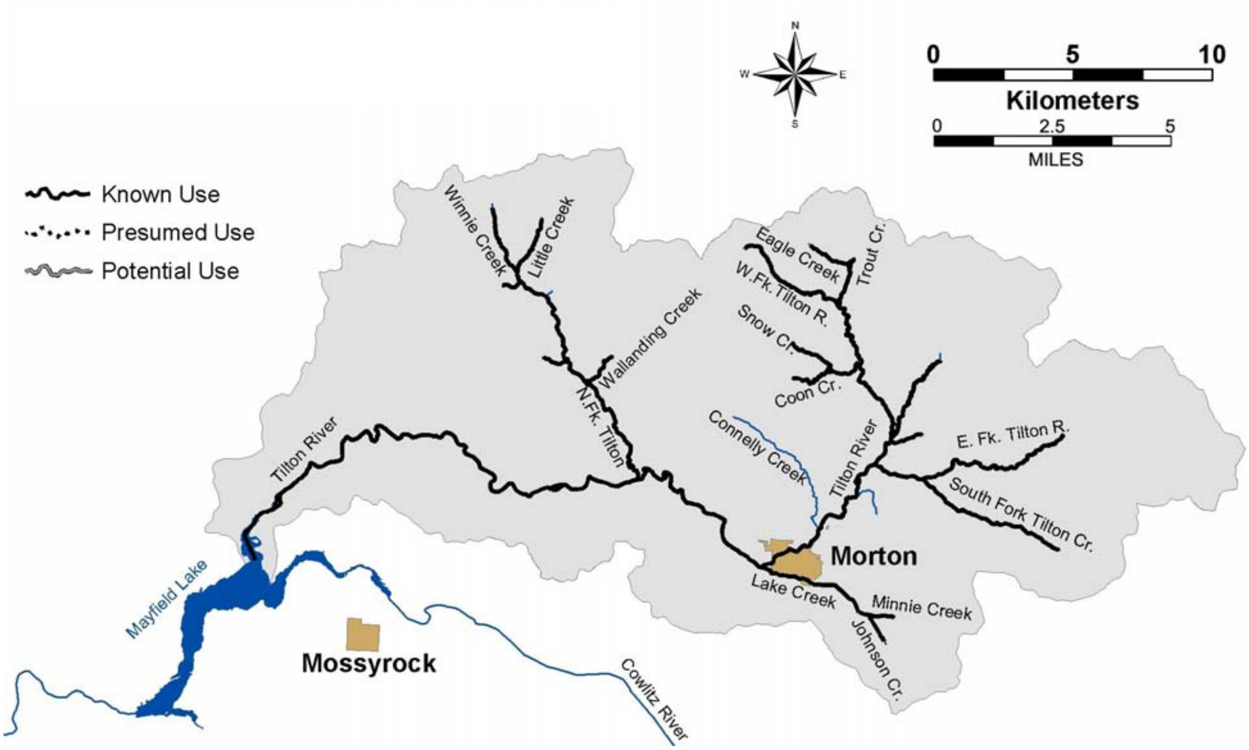
- Hatchery releases of fall chinook in the Cowlitz River began in 1952; hatchery release data are displayed for 1967-2002
- The current hatchery program goal is 5 million fall chinook juveniles released annually

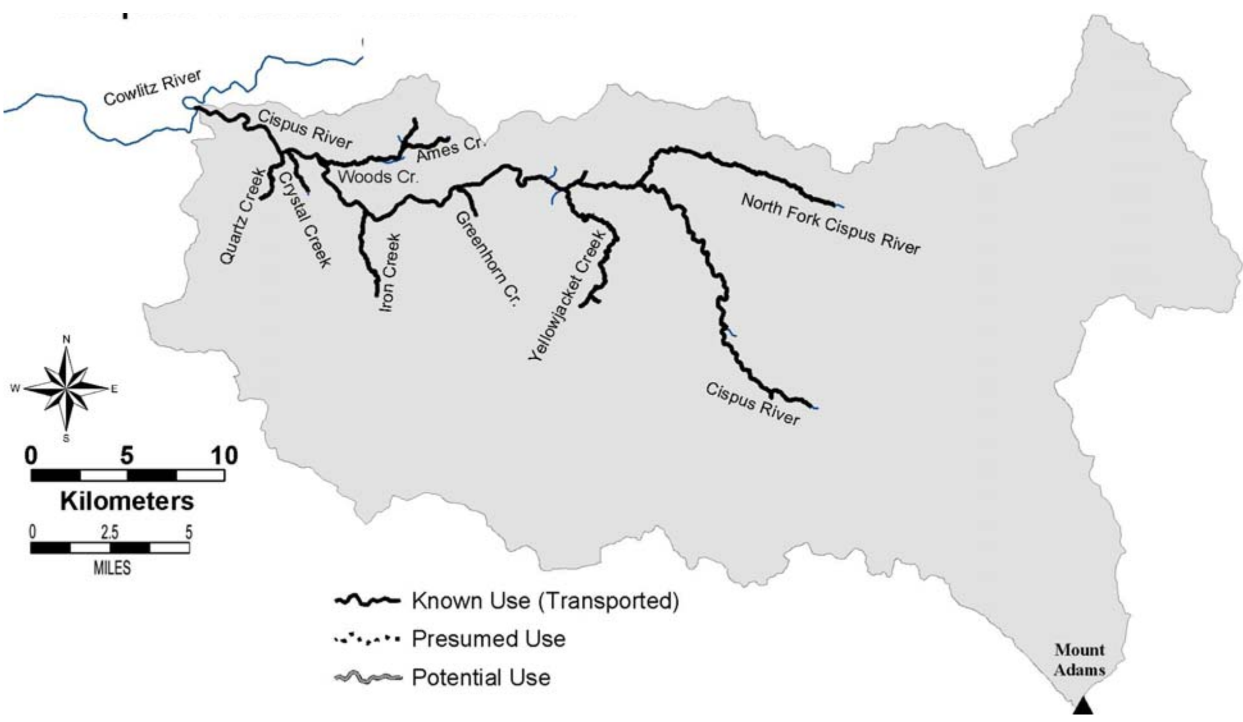
Harvest

- Fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, and in Columbia River commercial and sport fisheries
- Ocean and mainstem Columbia River fisheries are managed for Snake and Coweeman River wild fall chinook ESA harvest rate limits which limits the harvest of Cowlitz fall chinook
- Cowlitz fall chinook are important contributors to Washington ocean sport and troll fisheries and to the Columbia River estuary sport (Buoy 10) fishery
- CWT data analysis of the 1989–94 brood years indicates a total Cowlitz Hatchery fall chinook harvest rate of 33% with 67% accounted for in escapement
- The majority of fishery CWT recoveries of 1989–94 brood Cowlitz Hatchery fall chinook were distributed between Washington ocean (30%), British Columbia (21%), Alaska (15%), Cowlitz River (11%), and Columbia River (8%) sampling areas
- Annual harvest is variable depending on management response to annual abundance in PSC (US/Canada), PFMC (US ocean), and Columbia River Compact Forums
- Sport harvest in the Cowlitz River averaged 2,672 fall chinook annually from 1977–86
- Freshwater sport fisheries in the Cowlitz River are managed to achieve adult fall chinook hatchery escapement goals

9.2.4 Winter Steelhead—Cowlitz Subbasin (Tilton and Cispus)

ESA: Threatened 1998 **SASSI: Unknown 2002**





Distribution

- Winter steelhead are distributed throughout the mainstem Cowlitz River below Mayfield Dam; natural spawning occurs in Olequa, Ostrander, Salmon, Arkansas, Delameter, Stillwater and Whittle Creeks
- Historically, winter steelhead were distributed throughout the upper Cowlitz, Cispus, and Tilton Rivers; known spawning areas include the mainstem Cowlitz near Riffle and the reach between the Muddy Fork and the Clear Fork and the lower Ohanapecosh River
- Construction of Mayfield Dam in 1963 blocked winter steelhead access to the upper watershed; approximately 80% of the spawning and rearing habitat are not accessible
- In 1994, a trap and haul program began to reintroduce anadromous salmonids to the watershed above Cowlitz Falls Dam; adult winter steelhead are collected at the Cowlitz hatcheries and released in the upper Cowlitz, Cispus, and Tilton basins; smolts resulting from natural production in the upper watershed are collected at the Cowlitz Falls Fish Collection Facility, acclimated at the Cowlitz Salmon Hatchery, and released in the mainstem Cowlitz

Life History

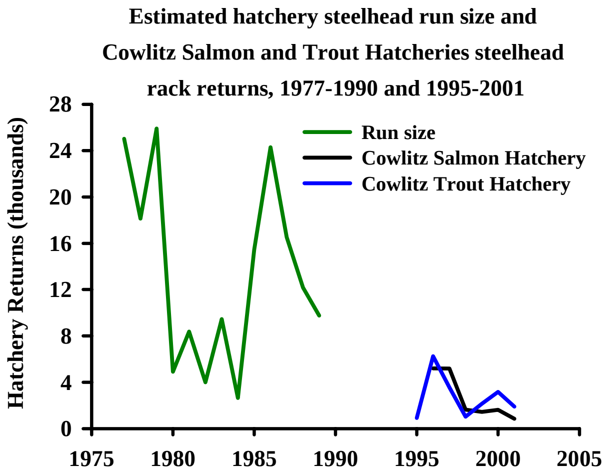
- Adult migration timing for Cowliltz winter steelhead is from December through April
- Spawning timing on the Cowlitz is generally from early March to early June
- Limited age composition data for Cowlitz River winter steelhead indicate that the dominant age classes are 2.2 and 2.3 (54.2% and 32.2 %, respectively)
- Wild steelhead fry emerge from March through May; juveniles generally rear in fresh water for two years; juvenile emigration occurs from April to May, with peak migration in early May

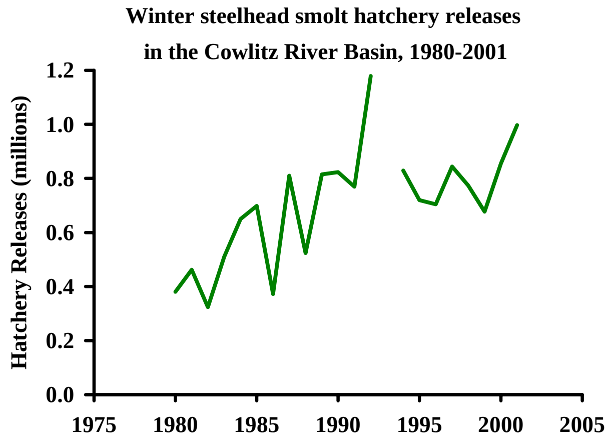
Diversity

- Cowlitz winter steelhead stock designated based on distinct spawning distribution
- Concern with wild stock interbreeding with hatchery brood stock from Chambers Creek and the Cowlitz River (Cowlitz and late Cowlitz stock)
- Allele frequency analysis of Cowlitz Hatchery late winter steelhead in 1996 was unable to determine the distinctiveness of the stock compared to other lower Columbia steelhead stocks

Abundance

- Historically, annual wild winter steelhead runs to the Cowlitz River were estimated at 20,000 fish; escapement was estimated as 11,000 fish
- In 1936, steelhead were observed in the Cispus River and reported in the Tilton River during escapement surveys
- Between 1961 and 1966, an average of 11,081 adult steelhead were collected annually at the Mayfield Dam Fish Passage Facility
- In the late 1970s and 1980s, wild winter steelhead annual average run size in the Cowlitz River was estimated to be 309 fish
- From 1983–95, the annual escapement of Cowlitz River winter steelhead ranged from 4,067-30,200 (average 16,240)





Productivity & Persistence

- In the late 1970s and 1980s, wild winter steelhead contribution to the annual winter steelhead return was estimated to be 1.7%
- Estimated potential winter steelhead smolt production for the Cowlitz River is 63,399

Hatchery

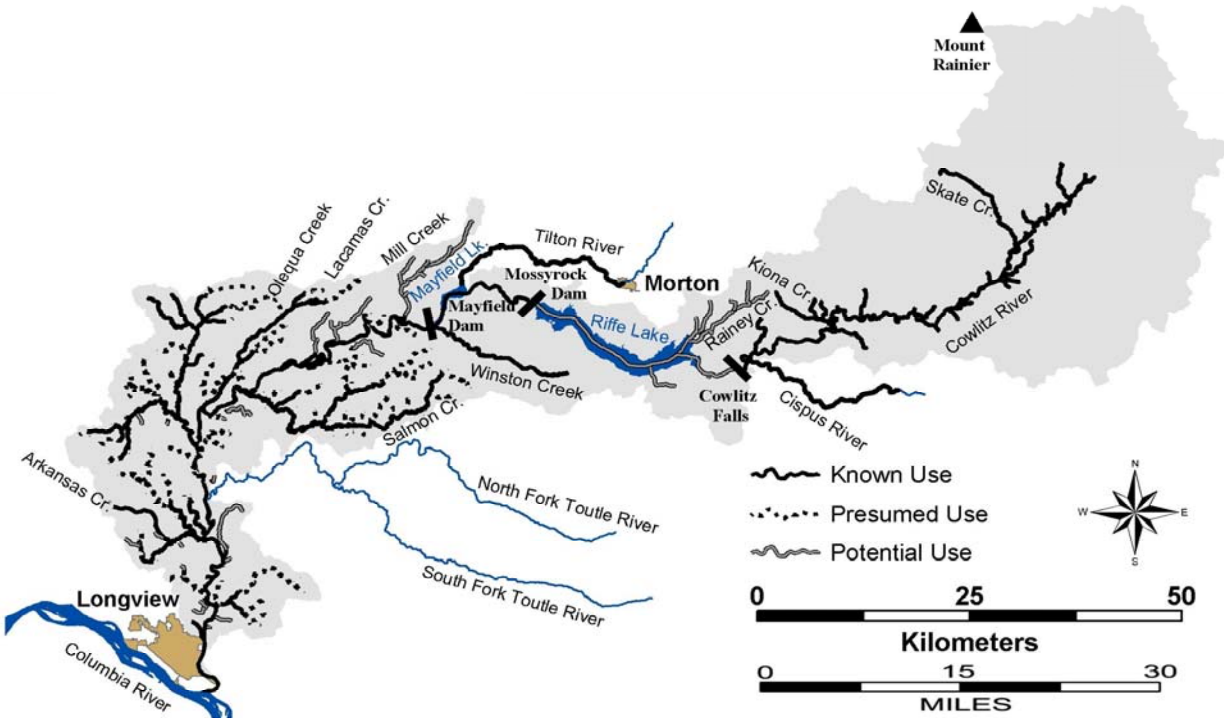
- The Cowlitz Trout Hatchery, located on the mainstem Cowlitz at RM 42, is the only hatchery in the Cowlitz basin producing winter steelhead
- Hatchery winter steelhead have been planted in the Cowlitz River basin since 1957; broodstock from the Cowlitz River and Chambers Creek have been used; an annual average of 180,000 hatchery winter steelhead smolts were released in the Cowlitz River from 1967–94; smolt release data are displayed from 1980–2001
- Hatchery fish account for the majority of the winter steelhead run to the Cowlitz River basin

Harvest

- No directed commercial or tribal fisheries target Cowlitz winter steelhead; incidental mortality currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Steelhead sport fisheries in the Columbia must release wild winter steelhead which are not marked with an adipose fin clip
- ESA limits fishery impact of wild winter steelhead in the mainstem Columbia and in the Cowlitz basin
- Approximately 6.2% of returning Cowlitz River steelhead are harvested in the Columbia River sport fishery
- Wild winter steelhead sport harvest in the Cowlitz River from in the late 1970s and early 1980s ranged from 102-336; wild winter steelhead contribution to the total annual sport harvest was less than 2%
- The Cowlitz River may be the most intensely-fished basin in the Washington sport fisheries; the Cowlitz has been the top winter steelhead river in Washington

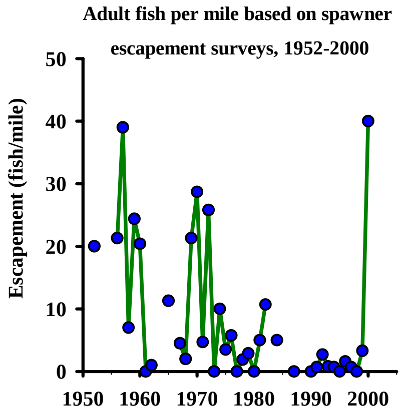
9.2.5 Coho—Cowlitz Subbasin

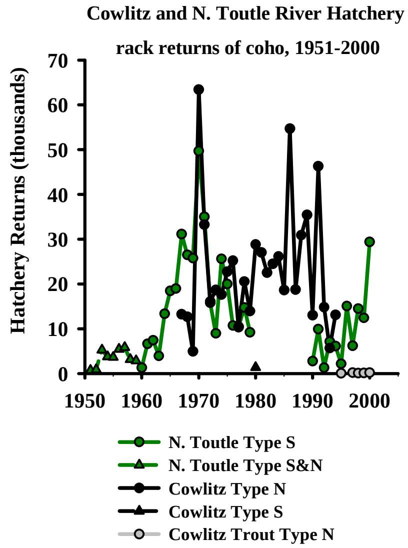
ESA: Candidate 1995	SASSI: Cowlitz—Depressed 2002;

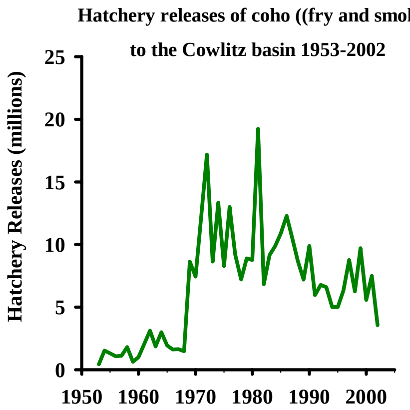


Distribution

- Managers refer to early stock coho as Type S due to their ocean distribution generally south of the Columbia River and late stock coho as Type N due to their ocean distribution generally north of the Columbia River
- Natural spawning is thought to occur in most areas accessible to coho, including the Toutle, SF Toutle, Coweeman, and Green Rivers and all accessible tributaries
- Natural spawning in lower Cowlitz tributaries occurs primarily in Olequa, Lacamas, Brights, Ostrander, Blue, Otter, Mill, Arkansas, Foster, Stillwater, Campbell, and Hill Creeks
- Natural spawning in the Coweeman River basin is primarily in tributaries downstream of the confluence of Mulholland Creek
- The post Mt. St. Helens eruption Toutle River system includes tributaries at various stages of recovery and some tributaries (primarily on the Green and South Toutle) with minor effects of the eruption. Bear, Hoffstadt, Johnson, Alder, Devils, and Herrington Creeks are examples of tributaries important to coho; coho adults are collected and passed to tributaries above the North Toutle Sediment Retention Dam
- Completion of Mayfield Dam in 1962 blocked access above the dam; a returning adult trap and haul program began in 1994 where fish were collected below Mayfield Dam and released above Cowlitz Falls Dam, restoring some access to the upper watershed.







Life History

- Adults enter the Columbia River from August through January (early stock primarily from mid-August through September and late stock primarily from late September to October)
- Peak spawning occurs in late October for early stock and December to early January for late stock
- Adults return as 2-year-old jacks (age 1.1) or 3-year-old adults (age 1.2)
- Fry emerge from January through April on the Cowlitz, depending on water temperature
- Coho spend one year in fresh water, and emigrate as age-1 smolts in the spring

Diversity

- Late stock (or Type-N) coho are informally considered synonymous with Cowlitz River stock
- Early stock(or Type-S) coho are informally considered synonymous with Toutle River stock
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar

Abundance

- Cowlitz River wild coho run is a fraction of its historical size
- In 1948, WDF estimated coho escapement to the basin was 77,000; in the early 1950s, escapement to the basin was estimated as 32,500 coho
- Escapement surveys on Olequa Creek from 1952-1990 established a range of 0-40 fish/mile
- Average total escapement of natural coho to the Toutle River was estimated as 1,743 for the years 1972-1979, prior to the 1980 eruption of Mt. St. Helens
- In 1985, an estimated 5,229 coho naturally spawned in lower Cowlitz River tributaries (excluding the Coweeman and Toutle systems), but the majority of spawners were fish originating from the Cowlitz Hatchery
- Hatchery production accounts for most coho returning to the Cowlitz River

Productivity & Persistence

- Natural coho production is presumed to be very low in the lower Cowlitz basin with Olequa Creek the most productive
- The Toutle River system likely provided the most productive habitat in the basin in the 1960s and 1970s, but was greatly reduced after the 1980 Mt. St. Helens eruption
- Reintroduction efforts in the upper Cowlitz River basin have demonstrated good production capabilities in tributaries above the dams, but efforts are challenged in passing juvenile production through the system
- Smolt density model natural production potential estimates were made on various sections of the Cowlitz River basin: 123,123 smolts for the lower Cowlitz River, 131,318 smolts for the Tilton River and Winston Creek, 155,018 smolts above Cowlitz Falls, 142,234 smolts for the Toutle River, and 37,797 smolts for the Coweeman River

Hatchery

- The Tilton River Hatchery released coho in the Cowlitz basin from 1915-1921
- A salmon hatchery operated in the upper Cowlitz River near the mouth of the Clear Fork until 1949
- The Cowlitz Salmon Hatchery is located about 2 miles downstream of Mayfield Dam; hatchery was completed in 1967; the hatchery is programmed for an annual release of 4.2 million late coho smolts
- Cowlitz Hatchery coho are important to the reintroduction effort in the upper basin
- The North Toutle Hatchery is located on the Green River less than a mile upstream of the confluence with the North Fork Toutle River; the hatchery is programmed for an annual release of 1 million early coho smolts

Harvest

- Until recent years, natural produced coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest of Columbia produced coho ranged from 70% to over 90% from 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho stocks
- Columbia River commercial coho fisheries in November were eliminated in the 1990s to reduce harvest of late Clackamas River wild coho
- Since 1999, Columbia River hatchery fish have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon State listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho is constrained by fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early hatchery coho, but late coho harvest can also be substantial
- An average of 1,494 coho (1986-1990) were harvested annually in the Cowlitz River sport fishery

- The Toutle River sport fishery was closed in 1982 after the eruption of Mt. St. Helens; the Green River sport fishery was closed from 1981 to 1988 after the eruption of Mt. St. Helens and was reopened in 1989
- CWT data analysis of the 1995-97 North Toutle Hatchery early coho indicates 34% were captured in fisheries and 66% were accounted for in escapement
- CWT data analysis of the 1994 and 1997 brood Cowlitz Hatchery late coho indicates 64% were captured in fisheries and 36% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 Toutle coho were distributed between Columbia River (47%), Washington ocean (37%), and Oregon ocean (15%) sampling areas
- Fishery CWT recoveries of 1994 and 1997 brood Cowlitz coho were distributed between Columbia River (55%), Washington ocean (30%), and Oregon ocean (15%) sampling areas

9.2.6 Cutthroat Trout—Cowlitz River Subbasin

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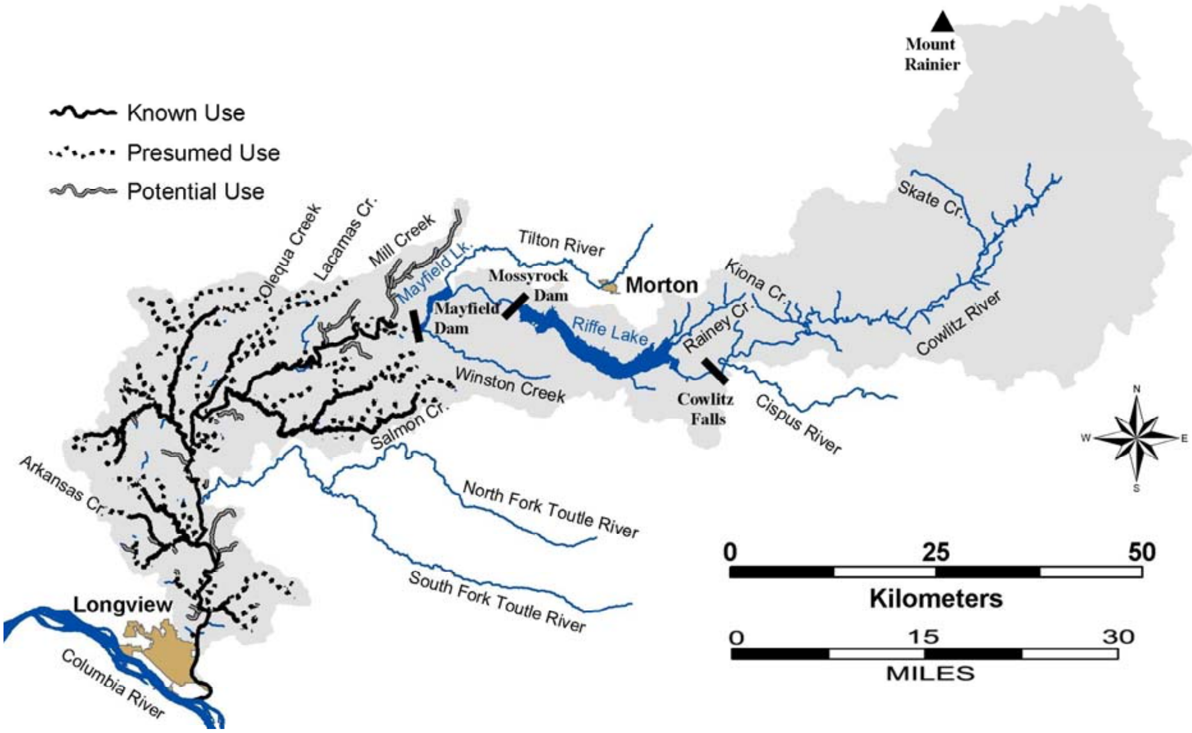
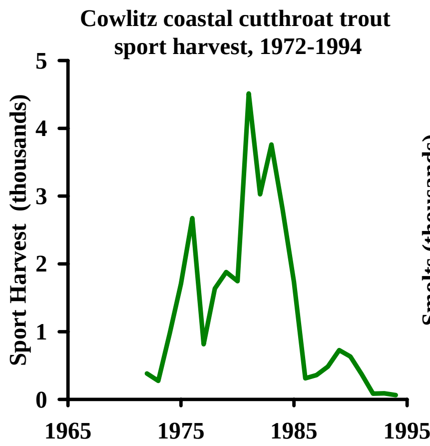


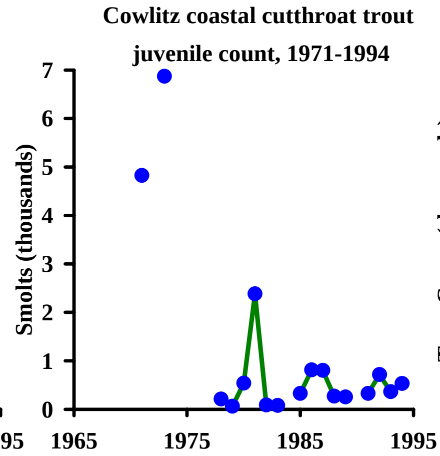
Distribution

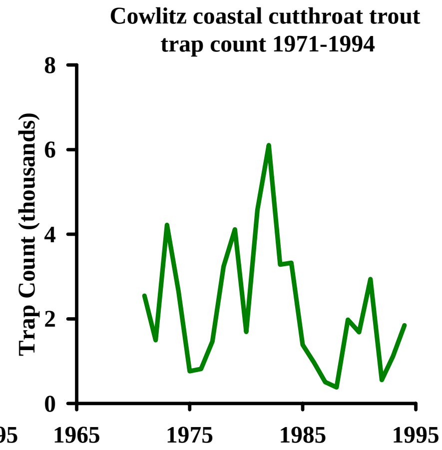
- Anadromous forms were historically present throughout the watershed, but are now limited to the area downstream of Mayfield Dam, which block passage
- Adfluvial forms are present in Mayfield, Riffe, and Scanewa Reservoirs
- Resident forms are documented throughout the system and are the only form present upstream of Mayfield Dam

Life History

- Anadromous, adfluvial, fluvial and resident forms are present
- Anadromous river entry is from July through October, with peak entry in August and September
- Anadromous spawning occurs from January through mid-April
- Fluvial and resident spawn timing is not documented but is believed to be similar to anadromous timing
- Spawn timing at higher elevations is likely later, and may occur as late as June
- Hatchery cutthroat spawn from November to February, due to artificial selection for early spawn timing
- Smolt migration occurs in the spring after juveniles have spend 2 to 3 years in fresh water







Diversity

- Distinct stock based on geographic distribution of spawning areas
- Genetic sampling of ten groups within the Cowlitz system showed little difference among the groups
- Cowlitz collections were significantly different from other lower Columbia samples, except for Elochoman/Skamakowa Creek.

Abundance

- Anadromous counts at Mayfield Dam from 1962 to 1996 ranged from 5458 to 12,324 fish, and averaged 8698
- Outmigrant trapping at Mayfield migrant trap shows a long term declining trend
- Recent years' counts average about 10% of outmigrant counts when sampling began in the early 60s
- Smolt counts have been under 1000 every year since 1978, with the exception of 1982
- No population size data for resident forms

Hatchery

- Cowlitz Trout Hatchery began producing anadromous cutthroat in 1968
- The goal is 115,000 smolts larger than 210 mm to produce a return to the hatchery of 5000 adults

Harvest

- Not harvested in ocean commercial or recreational fisheries
- Angler harvest for adipose fin clipped hatchery fish occurs in mainstem Columbia River summer fisheries downstream of the Cowlitz River
- Cowlitz River sport harvest for hatchery cutthroat can be significant in year of large adult returns.
- Wild cutthroat (unmarked fish) must be released

9.3 Potentially Manageable Impacts

In Volume I of this Technical Foundation, we evaluated factors currently limiting Washington lower Columbia River salmon and steelhead populations based on a simple index of potentially manageable impacts. The index incorporated human-caused increases in fish mortality, changes in habitat capacity, and other natural factors of interest (e.g. predation) that might be managed to affect salmon productivity and numbers. The index was intended to inventory key factors and place them in perspective relative to each other, thereby providing general guidance for technical and policy level recovery decisions. In popular parlance, the factors for salmon declines have come to be known as the 4-H's: hydropower, habitat, harvest, and hatcheries. The index of potentially manageable mortality factors has been presented here to prioritize impacts within each subbasin.

- Fall chinook, spring chinook, winter steelhead and coho in the Upper Cowlitz, Cispus and Tilton suffer the greatest loss from hydrosystem impacts of all impact factors.
- Loss of tributary and estuary habitat quality and quantity has significant impacts on all four populations. Losses are greatest for fall and spring chinook.
- Coho, spring chinook and fall chinook sustain moderate losses from harvest impacts. Impacts to winter steelhead are relatively minor.
- Hatchery impacts are moderately important to winter steelhead, but are relatively minor for spring and fall chinook and coho.
- Predation impacts in the upper Cowlitz, Tilton and Cispus are relatively minor for all four populations.

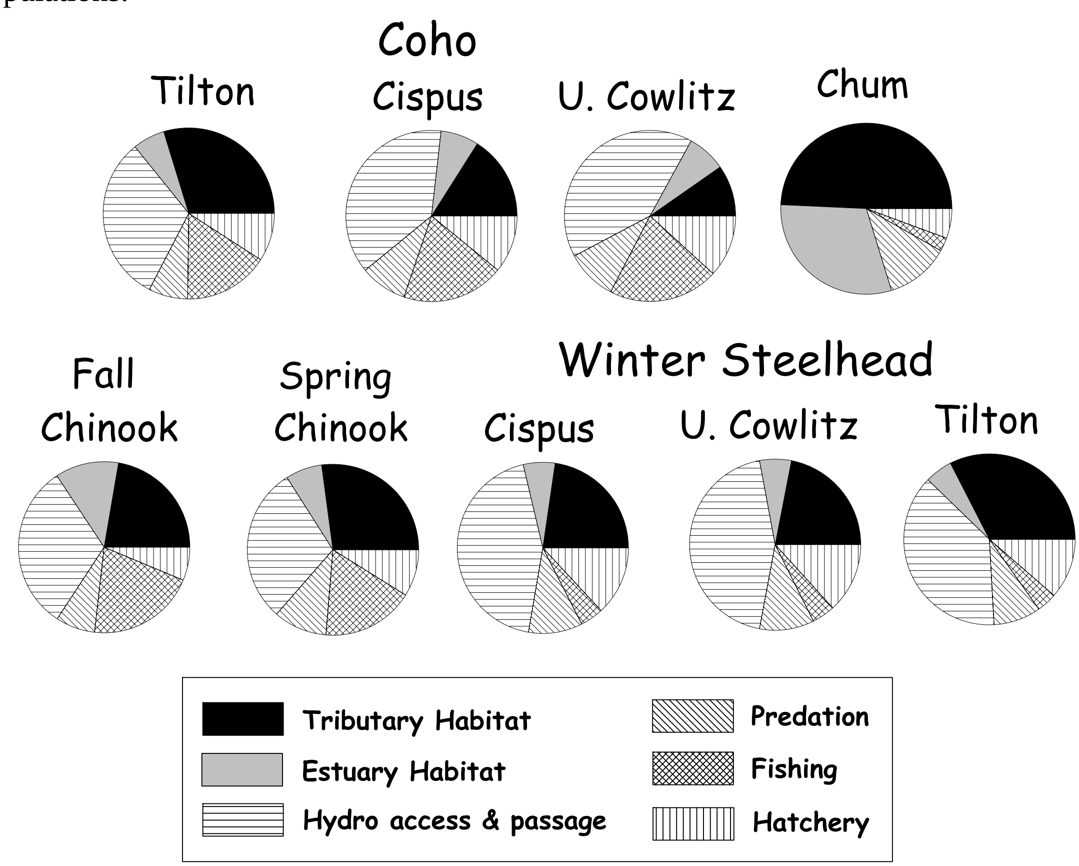


Figure 9-5. Relative index of potentially manageable mortality factors for each species in the Upper Cowlitz subbasin.

9.4 Hatchery Programs

Vol II, Chapter 7.4 cotains a discussion of the hatcheries in the Cowlitz basin

9.5 Fish Habitat Conditions

9.5.1 Passage Obstructions

The hydropower system is the primary factor for decline in the upper Cowlitz basin. Historically, spawning grounds in the upper basin produced 20% of the fall chinook and 38% of the steelhead in the Cowlitz basin (Mobrand Biometrics 1999). The hydropower facilities impede volitional access to upstream habitats. Furthermore, over 48 miles of stream habitat was flooded by the Mayfield, Mossyrock, and Cowlitz Falls Dams.

The Barrier Dam and Mayfield Dam prevent all volitional passage of anadromous fish above RM 52. A facililty at the Barrier Dam (RM 49) collects coho, winter steelhead, and coastal cutthroat, which are hauled upstream of the Cowlitz Falls Dam. Outmigrating smolts are collected at the Cowlitz Falls Fish Collection Facility (CFFCF) above Cowlitz Falls Dam and are hauled below the Barrier Dam. Some fish may avoid collection at the CFFCF and pass through the Cowlitz Falls Dam turbines or through the dam spill. Passage of juvenile migrants through Riffe Lake is a major problem for maintaining sustainable anadromous fish runs in the upper basin. A 1999 study revealed that only 63% of radio tagged steelhead smolts traveled successfully from the Cowlitz Falls Dam tailrace to a collection facility at Mossyrock Dam. None of the tagged coho and chinook were detected at Mossyrock. This study revealed potential problems with migration through the reservoir as well as problems with smolt collection at Mossyrock Dam (Harza 2000). Currently, there is no regular juvenile collection at Mossyrock Dam. Regular collection of downstream migrants was discontinued in 1974. The 606 foot tall Mossyrock Dam prevents access to several Riffe Lake tributaries, including Rainey Creek, which is believed to have a substantial amount of potentially productive habitat (Wade 2000). Radio-telemetry studies of coho and steelhead revealed a low (<50%) survival rate of juvenile migrants negotiating Mayfield Lake. Results could be due to predation, water quality, flow, or monitoring error (Harza 1999 as cited in Wade 2000).

Apart from the mainstem Cowlitz dams, passage problems in the Mayfield Lake basin include numerous culverts and road crossings in the Winston Creek, Connelly Creek, East Fork Tilton, South Fork Tilton, and West Fork Tilton basins. A full description is given in Wade (2000). Passage problems in the Cispus include subsurface flows in Copper Creek, Crystal Creek, and Camp Creek. A culvert in Woods Creek blocks approximately 1 mile of potential anadromous habitat. Subsurface and/or low flow conditions related to excessive sediment aggradation are believed to create passage problems in some areas of the upper Cowlitz basin. Ten such barriers are identified by the USFS (1997a and 1997b). The USFS has also identified several artificial barriers including culverts and other features.

9.5.2 Stream Flow

Runoff is predominantly generated by rainfall, with a portion of spring flows coming from snowmelt in the upper elevations and occasional winter peaks related to rain-on-snow events. A few upper tributaries drain glaciers and contribute meltwater during dry summer months. Most of the lower elevation streamflows are controlled by winter rainfall.

Flow in the mainstem is regulated in large part by the hydropower system. See Figure 9-6 for a comparison of flows upstream and downstream of the reservoirs:

- Cowlitz Falls Dam is the uppermost hydropower project (RM 88.5). It is owned and operated by Lewis County Public Utility District (PUD) No. 1 and is a run-of-the-river facility (no significant storage) that creates daily fluctuations related to power production.
- Mossyrock Dam (RM 66) is operated by Tacoma Power and provides 1,686,000 acre-feet of storage in Riffe Lake. The lake's levels are raised in the spring and drawn down in the fall in preparation for winter flows.
- Mayfield Dam (RM 52) is also operated by Tacoma Power and has a relatively small 133,764 acre-foot capacity. Behind Mayfield Dam, Mayfield Lake provides little flood storage capacity and flows from Mayfield Dam are largely in response to the regulation of flows through Mossyrock Dam.
- The Barrier Dam and salmon hatchery at RM 49.5 also are operated by Tacoma Power.

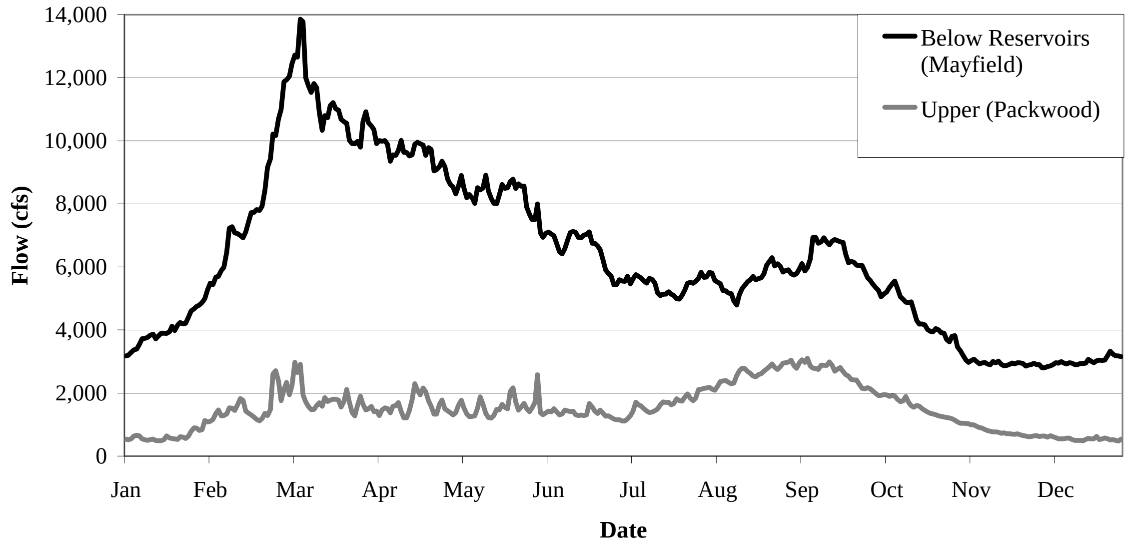


Figure 9-6. Cowlitz River hydrographs (mean daily flows 1972-2001). Both stations exhibit winter peaks due to rain and rain-on-snow events. There is a rise in flows in the fall in the Cowlitz near Packwood due to late summer snowmelt from snowfield and glacial melt. The rise in flows below the reservoirs is due partly to snowmelt flows and partly to flow releases at the dams in preparation for winter rains. USGS Gage #14238000; Cowlitz River below Mayfield Dam, Wash, and USGS Gage #14226500; Cowlitz River at Packwood, Wash.

Runoff conditions may be impaired in portions of the basin as a result of forest and road conditions. The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that approximately 30% of the upper Cowlitz basin is 'impaired' with regards to runoff properties. These impaired areas are located primarily in subwatersheds in the Tilton, Mayfield Lake, Rainey Creek, and the upper Cowlitz mainstem just above the reservoirs; areas with high road densities, immature forest vegetation, and developed land. About 27% of the basin is rated as 'moderately impaired'. These areas are located primarily in the northern portion of the upper Cowlitz mainstem watershed, the lower Cispus watershed, and scattered subwatersheds throughout the basin. Approximately 43% of the basin is rated as 'functional' according to the IWA. Hydrologically functional subwatersheds have mature forest cover and low road densities and are located primarily in the upper elevation areas in the upper Cowlitz mainstem and Cispus watersheds.

Impaired runoff conditions identified by the IWA in the Tilton and Mayfield Lake basins are supported by reports of extreme high and low flows in Mayfield Lake tributaries, which are believed to be the result of extensive timber harvesting (Mobrand Biometrics 1999, Wade 2000). Elevated winter peaks in the Tilton risk flushing out juveniles and scouring spawning gravels (Wade 2000). Average peak flow increases of 10%, 22%, 20%, and 17% were estimated for Tilton tributaries Connelly Creek, Lake Creek, EF Tilton, and SF Tilton, respectively (Murray Pacific 1994 and 1996a). Landslides causing dam break floods are very damaging in Connelly Creek and are associated with logging roads and clearcuts (Murray Pacific 1993). Low flows degrade habitat in the NF, SF, EF, and WF Tilton (Harza 1997).

Peak flow analyses by the USFS in the Cispus basin revealed that 14 out of 24 subbasins had a significant risk of increased peak flows as a result of impacts to vegetation structure (USFS 1996a, 1996b, and 1995). Similar analyses in the upper Cowlitz revealed that 9 out of 24 subbasins had a significant risk of increased peak flows, roughly corresponding to the IWA results.

Low and subsurface flows are a concern in many of the upper Cowlitz tributaries, generally due to excessive in-channel sediment aggradation. Flow regulation at Mossyrock Dam affects Riffe Lake levels, which can affect low flow habitat in the alluvial fan through which Riffe Lake tributaries Rainey, Stiltner, and Philips Creek flow. Low flow in this area can cause increased temperature and vulnerability to predation. There may also be low flow issues related to a private hatchery that has water rights to 50% of the flow of Rainey Creek and 100% of the flow of an unnamed tributary (Murray Pacific 1996b).

The projected 20 year increase in combined surface and groundwater demand in the upper Cowlitz basin ranges from 0.5% (Cispus) to 36.4% (Tilton). However, the presence of Mayfield and Riffe Lakes, combined with the low population of the subbasin, suggests that the impact from current or projected water withdrawals on stream flow rates will be minimal (LCFRB 2001).

9.5.3 Water Quality

Elevated water temperatures (>18ºC) in the Tilton basin have been found in Winston Creek, the mainstem Tilton, Connelly Creek, Slam Creek (EF Tilton basin), the WF Tilton, and Coon Creek (WF Tilton basin). High temperatures are attributed to low stream shade levels and low summer flows (Murray Pacific 1998 and 1994). High turbidity and low dissolved oxygen levels have been measured in Mayfield Lake and the Tilton (Wade 2000).

High temperatures in Riffe Lake have been recorded as deep as 20 meters (Harza 2000). Temperatures above state standards measured in the Rainey Creek basin were believed to be related to low canopy cover (Murray Pacific 1996b). High turbidity levels have also been measured in Rainey Creek (Harza 2000).

In the Cispus basin, the mainstem Cispus above Quartz Creek, Woods Creek, Chambers Creek, and East Canyon Creeks have exceeded the state temperature standard of 16ºC (USFS 1995). Four stream segments in the Cispus basin, including two on the mainstem, one on the North Fork, and one on Baird Creek were included on the State’s 1998 303(d) list for temperature exceedances (WDOE 1998). High turbidity was measured in Quartz Creek following the St. Helens eruption (354 NTU in 1981 and 64 NTU in 1983). High (240 NTU) turbidity was measured in the lower Cispus during the December 1995 flood, attributable to streambank erosion, road failures, and road surface erosion (USFS 1996a).

In upper mainstem Cowlitz tributaries, Silver Creek and Willame Creek were listed on the 1996 and 1998 WA State 303(d) list for exceedances of temperature standards (WDOE 1996 and 1998). State temperature standards (16ºC) have also been exceeded on Kiona Creek and tributaries (Murray Pacific 1995) and Lake Creek (USFS 1997b). Miller Creek may have water quality issues associated with sewage and garbage disposal into the creek at Randle (USFS 1997a).

Nutrient levels in all streams above the dams are assumed to be lower than in historical times due to lower current numbers of anadromous fish (Wade 2000).

9.5.4 Key Habitat

The 3 dams inundated a significant amount of pool and side channel habitat in the mainstem and in the lower reaches of tributaries. Riffe Lake may provide some refuge for fish displaced from tributaries during high flows, but in general, the reservoir does not provide favorable habitat (Murray Pacific 1996b).

Pool frequency and quality in the Mayfield Lake basin is low. This is largely attributed to low LWD concentrations. Streams containing LWD had 15 times the amount of pools than streams without LWD (EA 1998). Of 5 creeks surveyed (Tilton, EF Tilton, SF Tilton, Lake Creek, Winston Creek), 4 of them had low (<35% pool area) pool frequency (Harza 1997). In the WF Tilton, mass wasting between 1974 and 1996 reduced pool frequency and quality (Murray Pacific 1998). Pool frequency was generally low in reaches surveyed in the Rainey Creek (Riffe Lake tributary) basin. Fifty percent of the pools were associated with LWD.

Pool frequency and quality in the Cispus basin is low due in part to channel widening, sediment aggradation, and low LWD quantities (USFS 1995). The Cispus mainstem has a low amount of pool habitat in places but conditions are expected to improve as forest practices improve. Pools in Crystal Creek are of poor quality but are also expected to improve (USFS 1996a). Side channel habitat in the Cispus basin is assumed to be lacking due to roads and other activities that have blocked historical flood channels and have disconnected floodplains, however, a few decent off-channel habitats conducive to coho rearing are available in some places (USFS 1995).

Pool frequency and quality in the upper Cowlitz mainstem basin is low. Width-to-depth ratios are high, sediment pulses often fill existing pools, and pools lack adequate cover (USFS 1997a and 1997b). Excessive sediment deposits and lack of LWD are thought to be responsible for poor pool quality and frequency in most of the smaller tributaries (Wade 2000). The channel between RM 100 and RM 115 on the Cowlitz may have experienced side channel loss due to downcutting following the 1996 flood (USFS 1997b). Side channel habitats have been lost on the lower reaches of most of the smaller tributaries due to residential, agricultural, and industrial development (Wade 2000).

9.5.5 Substrate & Sediment

A 1996 study found that over half of the surveyed habitat units in the SF Tilton, Lake Creek, and Winston Creek basins had greater than 35% embeddedness (Harza 1997). Connelly Creek has experienced an increase in fines (7% in 1993 to 18% in 1996) due to mass wasting associated with large storms and logging activities on steep slopes (Murray Pacific 1996a). Fines are a problem in the WF Tilton from the Coon Creek confluence to the mouth. Mass wasting is a concern due to high harvest levels in this basin (Murray Pacific 1998). There are also concerns with mass wasting and fine sediment input between Nineteen Creek and the falls on the mainstem Tilton. A lack of good spawning sized substrate may be due to transport capacity exceeding input in the EF Tilton and in Coal Creek (Murray Pacific 1994). Poor gravel quality due to excessive fines (>20% fine sediment) was identified for 3 of 7 survey locations in the Rainey Creek basin (Murray Pacific 1996b).

Excessive stream sedimentation occurs in the Cispus basin due to mass wasting and erosion from roads, concentrated overland runoff, and harvest-related mass wasting (USFS 1995). Excessive fine sediments are considered a major problem in the upper mainstem Cowlitz. Increased sediment delivery from floodplain development, riparian impacts, channelization, and lack of LWD has increased channel migration, raised width-to-depth ratios, and reduced pool quality (USFS 1997b, Lanigan et al. 1998). Erosion and sedimentation in many of the upper Cowlitz tributaries are believed to be impacting fish production. In some cases, sediment accumulations have created subsurface flow conditions, eliminating anadromous habitat (USFS 1997a).

Sediment supply conditions from hillslopes was evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results indicate that only 4 of 131 subwatershed are ‘impaired’ with regards to sediment supply, however, 95 of the 131 (73%) subwatersheds were rated as ‘moderately impaired’. The remainder, which are located primarily in the upper Cispus and upper Cowlitz mainstem basins, were rated as ‘functional’. Sediment supply impairments are related to the high number of forest roads and unstable slopes in some areas.

Sediment production from private forest roads is expected to decline over the next 15 years as roads are updated to meet the new forest practices standards, which include ditchline disconnect from streams and culvert upgrades. The frequency of mass wasting events should also decline due to the new regulations, which require geotechnical review and mitigation measures to minimize the impact of forest practices activities on unstable slopes.

9.5.6 Woody Debris

LWD levels in the Tilton watershed have been reduced since historical times due to channel cleaning, timber harvest in riparian zones, debris torrents, dam-break floods, and increased peak flows (EA 1998). It is believed that large wood was present in channels throughout the watershed in historical times (Mobrand Biometrics 1999). Low LWD levels also exist in Winston Creek (Wade 2000). Approximately 97% of the fish-bearing streams in the Rainey Creek basin contain below target levels of LWD. Near term recruitment of LWD is considered “high” on only 3% of the fish-bearing streams (Murray Pacific 1996b).

Adequate LWD is lacking in the Cispus basin due to channel clearing and timber harvest. Lower Iron Creek and the NF Cispus have particularly low levels of instream LWD (USFS 1996a). The upper Cowlitz mainstem historically had abundant LWD but now has very little (Mobrand Biometrics 1999, USFS 1997a). LWD was removed from the floodplains and harvested from riparian areas. Low LWD levels in nearly all of the tributary streams have been attributed to debris flows, riparian cleaning, active removal, loss of recruitment, natural decay, and attrition (Murray Pacific 1995).

9.5.7 Channel Stability

There are bank stability concerns in the lower NF Tilton due to glacial till parent material. There are also bank stability concerns in the lower mainstem Tilton, Winston Creek, WF Tilton, and Otter and Tumble Creeks (NF Tilton tributaries) (EA 1998).

A total of 210 slides have occurred in the Rainey Creek basin between 1937 and 1996; an estimated 80% are associated with forestry activities. Major debris torrents and channel avulsions occurred on Rainey and Stiltner Creeks during floods in 1995 and 1996. Other areas of bank instability are related to logging and grazing impacts on riparian vegetation (Murray Pacific 1996b).

Increased sediment deposition, combined with increased peak flow associated with upslope vegetation removal, has contributed to channel widening and bank erosion in the Cispus basin. Numerous incidences of bank instability and channel widening are described in the limiting factors analysis (Wade 2000).

Bank instability is a problem in the upper mainstem Cowlitz due to excessive sediment accumulations causing channel widening. Bank stability has also been compromised as a result of farming and grazing practices (USFS 1997b). Specific bank stability problem areas are identified in Wade (2000).

9.5.8 Riparian Function

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, riparian conditions are ‘impaired’ in 6 of the 131 upper Cowlitz subwatersheds (5%) , ‘moderately impaired’ in 85 of the 131 subwatersheds (65%), and ‘functional’ in 40 of the subwatersheds (30%). The greatest impairments are in the Mayfield Lake and Rainey Creek basins. Functional riparian conditions are located primarily along higher elevation streams in the upper Cispus and upper Cowlitz mainstem basins.

These results are supported by an analysis by Lewis County GIS (2000), which revealed that over 87% of riparian corridors in the Mayfield / Tilton basin are clearly lacking vegetation or have early-seral riparian conditions. Stream surveys revealed that the mainstem Tilton, EF Tilton, SF Tilton, and Lake Creek all had greater than 60% of surveyed habitat units with only 0-20% canopy cover (Harza 1997). Wade (2000), however, identifies several areas where good riparian conditions exist in the Tilton basin.

Small and medium-sized hardwoods make up 68% of riparian areas along fish bearing streams in the Rainey Creek basin. This is attributed to soil types, conversion to agriculture, and logging (Murray Pacific 1996b). In the entire Riffe Lake basin only 17.4% of the basin has riparian areas with greater than 70% mature coniferous cover (Lewis County GIS 2000).

In the Cispus basin, areas of concern for poor riparian conditions include upper Quartz Creek (Mount St. Helens eruption impacts), Crystal Creek, Iron Creek, Camp Creek, McCoy Creek, East Canyon Creek, and private lands on the mainstem Cispus. Lower Quartz Creek and the NF Cispus have some of the best conditions (USFS 1996a, 1999b, and 1995). Throughout the entire Cispus basin, 70% of riparian areas are in early seral structural stages (Lewis County GIS 2000, Wade 2000).

The bulk of the mature riparian forest cover on the upper mainstem Cowlitz and on the lower reaches of most upper mainstem tributaries has been removed by agriculture, timber harvest, and development (Harza 1997). Kiona Creek in particular is in bad shape, with 100% of the riparian areas in either grass/pole or small tree (9” to 20.9” diameter) vegetation structures (USFS 1997a). In the entire upper Cowlitz basin, over 72% of the riparian areas are either in early-seral stand structures or are clearly lacking vegetation (Lewis County GIS 2000, Wade 2000).

Riparian function is expected to improve over time on private forestlands. This is due to the requirements under the Washington State Forest Practices Rules (Washington Administrative Code Chapter 222). Riparian protection has increased dramatically today compared to past regulations and practices.

9.5.9 Floodplain Function

The 23.5 miles of stream inundated by Mossyrock Dam was historically a braided, alluvial channel that provided abundant salmon habitat (Mobrand Biometrics 1999). Cowlitz Falls Dam inundated approximately 11 miles of stream also in an unconfined alluvial valley bottom.

Most of the smaller streams in the Mayfield Lake basin have little potential for floodplain habitat. Many of the floodplains that do exist are likely affected by roads since 33% of anadromous streams in the basin have stream-adjacent roads (Lewis County GIS 2000). The WRIA 26 Limiting Factors Analysis (Wade 2000) describes several areas where stream-adjacent roads, railroads, and road crossings impact floodplain function. Channelization has occurred along the Rainey Creek (Riffe Lake tributary) alluvial fan due to diking and at the mouths of several Rainey Creek tributaries (Murray Pacific 1996b).

Wetlands and floodplains have been altered in the Cispus basin due to roads and manipulation of channel locations (USFS 1996b). Twenty-one percent of anadromous streams in the Cispus basin have stream-adjacent roads (Lewis County GIS 2000). Floodplains along the mainstem Cispus, Iron Creek, Camp Creek, and Yellowjacket Creek have all been affected by channelization, roads, or timber salvage (USFS 1996a and 1996b).

The mainstem Cowlitz above Scanewa Lake (created by Cowlitz Falls Dam) has lost floodplain habitat due to encroachment of agricultural uses. Most tributaries to the upper Cowlitz mainstem have been affected by diking, dredging, bank hardening, straightening, road building, and/or floodplain structures associated with residential, commercial, and industrial development (Wade 2000).

9.6 Fish/Habitat Assessments

The previous descriptions of fish habitat conditions can help identify general problems but do not provide sufficient detail to determine the magnitude of change needed to affect recovery or to prioritize specific habitat restoration activities. A systematic link between habitat conditions and salmonid population performance is needed to identify the net effect of habitat changes, specific stream sections where problems occur, and specific habitat conditions that account for the problems in each stream reach. In order to help identify the links between fish and habitat conditions, the Ecosystem Diagnosis and Treatment (EDT) model was applied to Upper Cowlitz spring chinook, fall chinook, winter steelhead, and coho populations. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Volume VI. Model results are discussed in separate sections for the Upper Cowlitz/Cispus and for the Tilton.

Three general categories of EDT output are discussed in the following sections: population analysis, reach analysis, and habitat factor analysis. Population analysis has the broadest scope of all model outputs. It is useful for evaluating the reasonableness of results, assessing broad trends in population performance, comparing among populations, and for comparing past, present, and desired conditions against recovery planning objectives. Reach analysis provides a greater level of detail. Reach analysis rates specific reaches according to how degradation or restoration within the reach affects overall population performance. This level of output is useful for identifying general categories of management (i.e. preservation and/or restoration), and for focusing recovery strategies in appropriate portions of a subbasin. The habitat factor analysis section provides the greatest level of detail. Reach specific habitat attributes are rated according to their relative degree of impact on population performance. This level of output is most useful for practitioners who will be developing and implementing specific recovery actions.

9.6.1 Upper Cowlitz - Cispus

9.6.1.1 Population Analysis

Population assessments under different habitat conditions are useful for comparing fish trends and establishing recovery goals. Fish population levels under current and potential habitat conditions were inferred using the EDT model based on habitat characteristics of each stream reach and a synthesis of habitat effects on fish life cycle processes.

Habitat-based assessments were completed for spring chinook, fall chinook, winter steelhead and coho in the upper Cowlitz and Cispus basins. Model results indicate adult productivity in the upper Cowlitz has been reduced to 15-30% of historical levels for all species (Table 9-1). Adult abundance of both spring chinook and fall chinook has declined by more than 80% from historical levels, while winter steelhead and coho abundance has declined by 57% and 37%, respectively (Figure 9-7). Diversity (as measured by the diversity index) is estimated to have declined by 40%, 60%, and 38% for fall chinook, spring chinook, and coho, respectively (Table 9-1). Diversity for winter steelhead has remained more stable, decreasing by an estimated 16% (Table 9-1).

Smolt productivity has also decreased sharply for all species in the upper Cowlitz basin. Smolt productivity for fall chinook and winter steelhead has declined by 54% and 56%, respectively, while spring chinook and coho smolt productivities have declined by 72% and

76%, respectively (Table 9-1). Smolt abundance levels have also declined for spring chinook, fall chinook, and winter steelhead (Table 9-1). For coho, the model indicates a 16% increase in smolt abundance levels (Table 9-1).

Declines in adult productivity in the Cispus basin are similar to those in the upper Cowlitz. Adult productivity in the Cispus is estimated to have declined by 68-87% for all species (Table 9-2). Adult abundance of spring and fall chinook has fallen to 10-15% of historical levels, and winter steelhead and coho runs are estimated at less than half of historical levels (Figure 9-8). Diversity of spring chinook, fall chinook, and coho has decreased by 50-75%, though winter steelhead diversity has only decreased by 13% (Table 9-2).

Smolt productivity in the Cispus basin has declined by 55-73% from historical levels for all species (Table 9-2). These declines have been greater for spring chinook and coho than for fall chinook and winter steelhead. Smolt abundance has been reduced for all species as well, however fall and spring chinook have been impacted the most, with current abundance levels only 21% and 7% of the historical levels, respectively (Table 9-2). Coho have suffered the least impact with an abundance reduction of only 18% (Table 9-2).

Model results indicate that restoration of PFC conditions in both of the basins would produce substantial benefits. Adult returns to the upper Cowlitz and the Cispus would increase by 40-150%, with the greatest benefits for spring and fall chinook (Table 9-1 and Table 9-2). Similarly, smolt abundance levels would increase by 30-260% with the spring chinook gaining the most production in both the upper Cowlitz and Cispus (Table 9-1 and Table 9-2). Productivity and diversity would also increase with restoration to PFC conditions.

Table 9-1. Upper Cowlitz River— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

Species	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]
Fall Chinook	3,097	6,516	17,613	2.5	3.6	9.1	0.60	0.70	1.00	465,080	818,516	1,779,088	237	274	518
Spring Chinook	3,019	6,426	21,750	2.5	4.5	15.8	0.41	0.45	1.00	175,993	384,052	1,707,591	77	115	270
Coho	11,039	23,633	17,654	3.0	7.3	21.4	0.57	0.61	0.92	317,625	644,219	272,111	76	157	316
Winter Steelhead	855	1,402	1,973	4.8	9.3	15.1	0.72	0.78	0.86	17,196	25,080	28,802	94	163	213

[1] Estimate represents historical conditions in the basin and current conditions in the mainstem and estuary.

Table 9-2. Cispus River— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

Species	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]
Fall Chinook	934	2,055	5,792	1.8	2.9	7.2	0.49	0.70	1.00	129,631	282,394	607,842	176	245	426
Spring Chinook	718	1,803	7,791	1.9	3.5	14.0	0.27	0.37	1.00	52,519	191,009	790,464	79	141	297
Coho	3,752	5,351	8,029	4.0	7.5	22.1	0.33	0.37	0.73	98,166	124,684	120,143	90	153	309
Winter Steelhead	624	1,001	1,504	4.2	7.4	13.1	0.85	0.94	0.98	12,576	18,112	22,084	83	131	185

[1] Estimate represents historical conditions in the basin and current conditions in the mainstem and estuary.

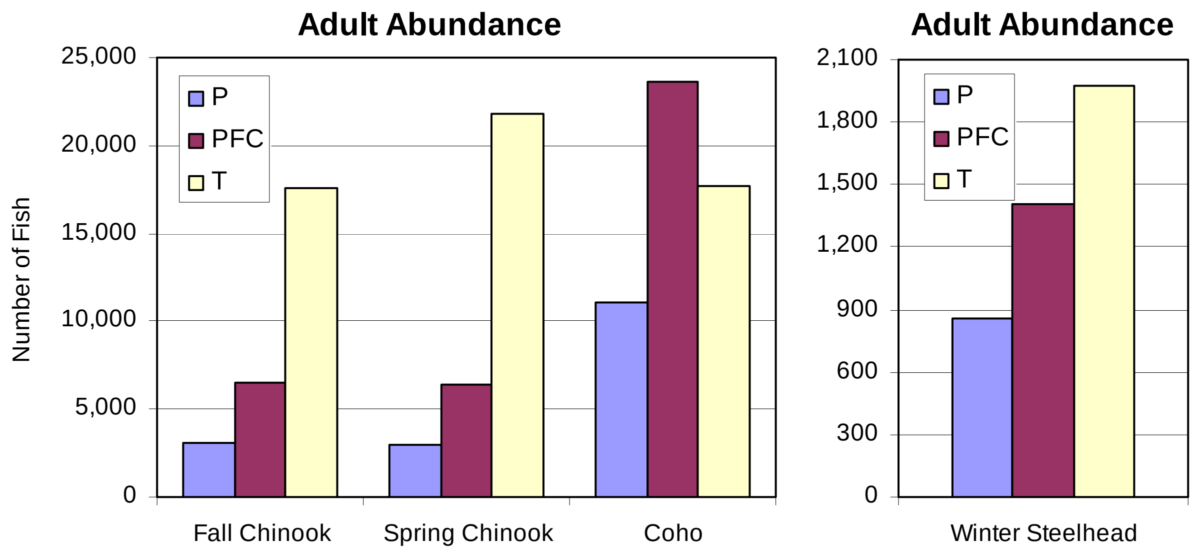


Figure 9-7. Adult abundance of Upper Cowlitz fall chinook, spring chinook, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

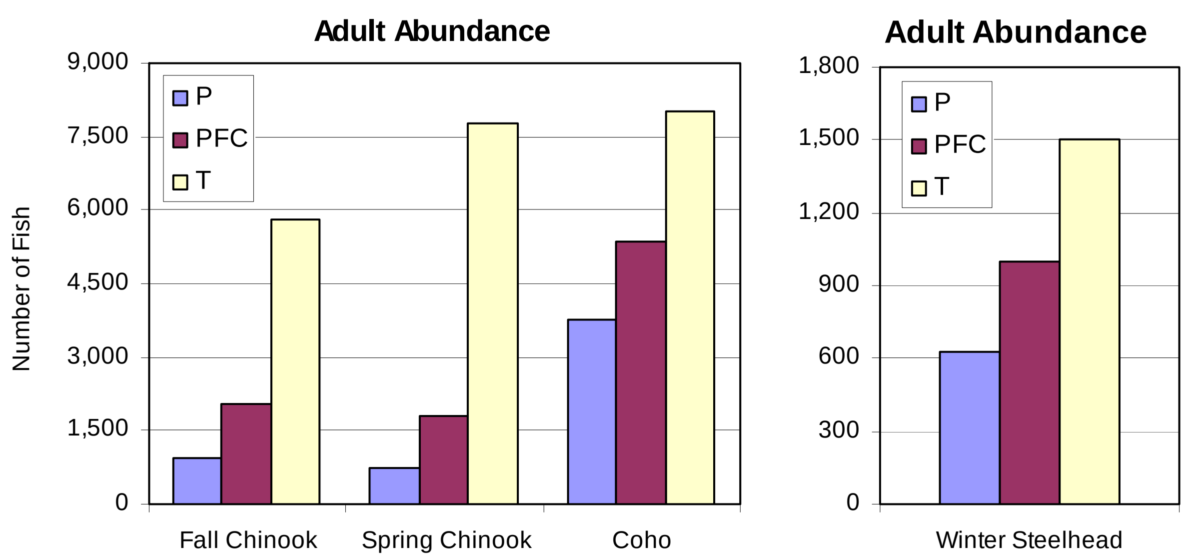


Figure 9-8. Adult abundance of Cispus fall chinook, spring chinook, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

9.6.1.2 Restoration and Preservation Analysis

Habitat conditions and suitability for fish are better in some portions of a subbasin than in others. The reach analysis of the EDT model uses estimates of the difference in projected population performance between current/patient and historical/template habitat conditions to identify core and degraded fish production areas. Core production areas, where habitat degradation would have a large negative impact on the population, are assigned a high value for preservation. Likewise, currently degraded areas that provide significant potential for restoration are assigned a high value for restoration. Collectively, these values are used to prioritize the reaches within a given basin. For this reach analysis, the Upper Cowlitz and Cispus basins were combined for EDT modeling purposes. See Figure 9-9 for a map of EDT reaches within the Upper Cowlitz and Cispus basins.

Winter steelhead, spring chinook, and fall chinook are transported above the hydropower system and make extensive use of mainstem habitat in the upper Cowlitz and Cispus basins. Winter steelhead and spring chinook make use of mainstem tributaries to a greater degree than fall chinook. Coho primarily use mainstem tributaries for spawning and rearing.

High priority areas for winter steelhead in the Upper Cowlitz and Cispus include the mainstem reaches Upper Cowlitz 1C, 1D, 1E and 1CC, as well as Cispus 2, 3, and 1F (Figure 9-10). The tributary reaches Yellowjacket 1, Silver Cr 1, and Johnson Cr 1 are also key areas. The majority of high priority reaces for winter steelhead show a combined preservation and restoration recovery emphasis (Figure 9-10). Silver Cr 1 is the only high priority reach with a restoration emphasis. Upper Cowlitz 1E shows the highest preservation rating of any winter steelhead reach.

Important reaches in the Upper Cowlitz and Cispus for fall chinook (Figure 9-11) include primarily the upper mainstem reaches of the Cowlitz (Upper Cowlitz 1A-1E, and Upper Cowlitz 1CC and 1CCC). Only one reach in the Cispus, Cispus 1C, was considered high priority for fall chinook. The majority of these reaches show a preservation recovery emphasis (Figure 9-11). Only the reaches of Cispus 1C and Upper Cowlitz 1A and 1B show a combined preservation and restoration recovery emphasis. The reach Upper Cowlitz 1E shows the highest preservation rating of any fall chinook reach.

For spring chinook in the Upper Cowlitz and Cispus, high priority reaches are concentrated in the mainstem Cowlitz, with only one high priority reach located in the Cispus (Figure 9-12). These reaches are split with regard to recovery emphasis (Figure 9-12). Three reaches, Upper Cowlitz 1AA and 1B, and Cispus 1C, show a combined preservation and restoration recovery emphasis. All other reaches show a preservation emphasis only. Reach Upper Cowlitz 1E shows the highest preservation rating of any spring chinook reach.

High priority areas for coho in the Cowlitz include the reaches Upper Cowlitz 1A, 1AA, 1B and 1E (Figure 9-13). In the Cispus, the reaches Cispus 2 and 3 are considered high priority reaches (Figure 9-13). As with spring chinook, these reaches are split with regard to recovery emphasis. Again, reach Upper Cowlitz 1E is ranked as the highest priority reach.

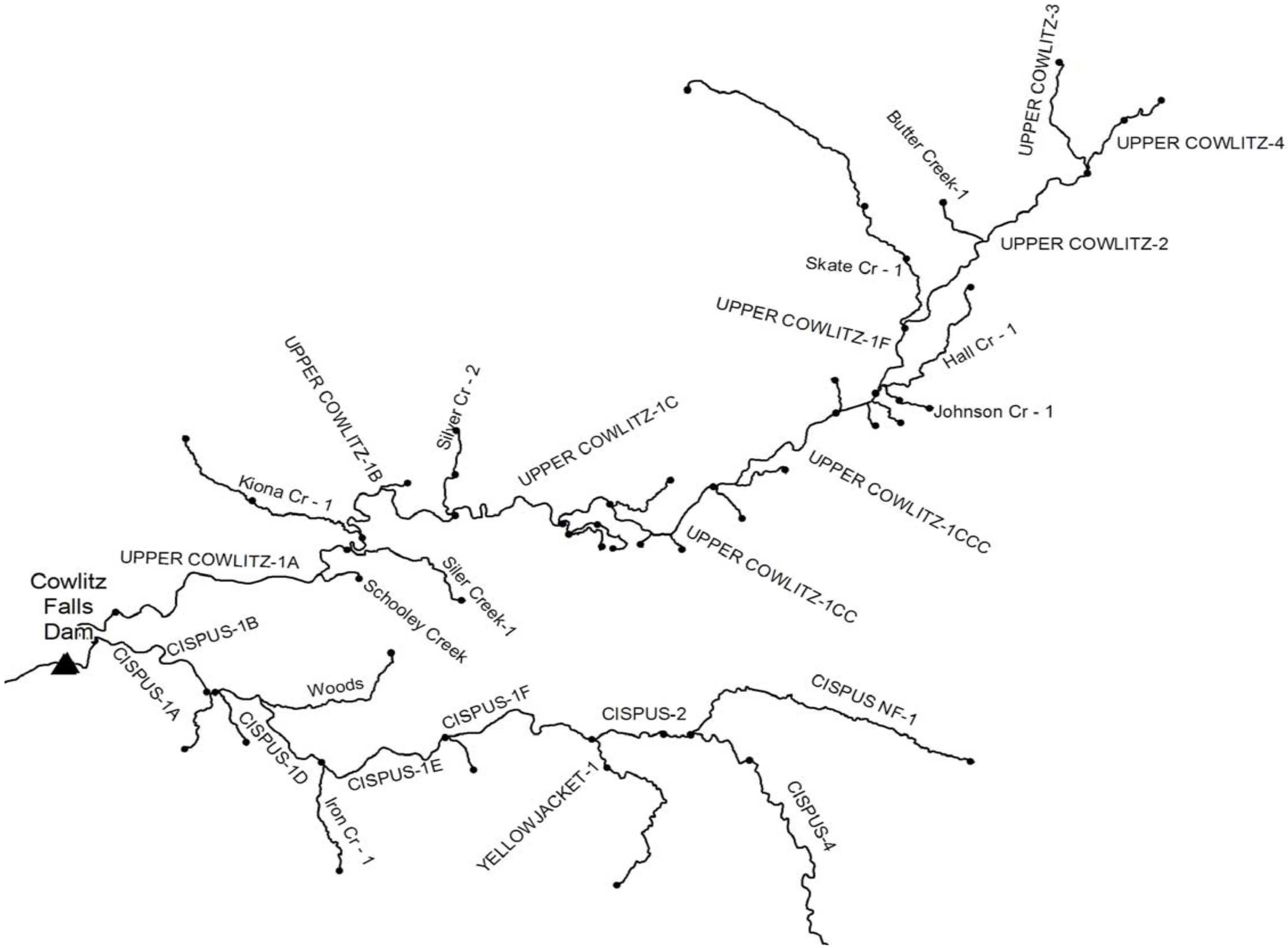


Figure 9-9. Upper Cowlitz and Cispus subbasin EDT reaches. Some reaches not labeled for clarity.

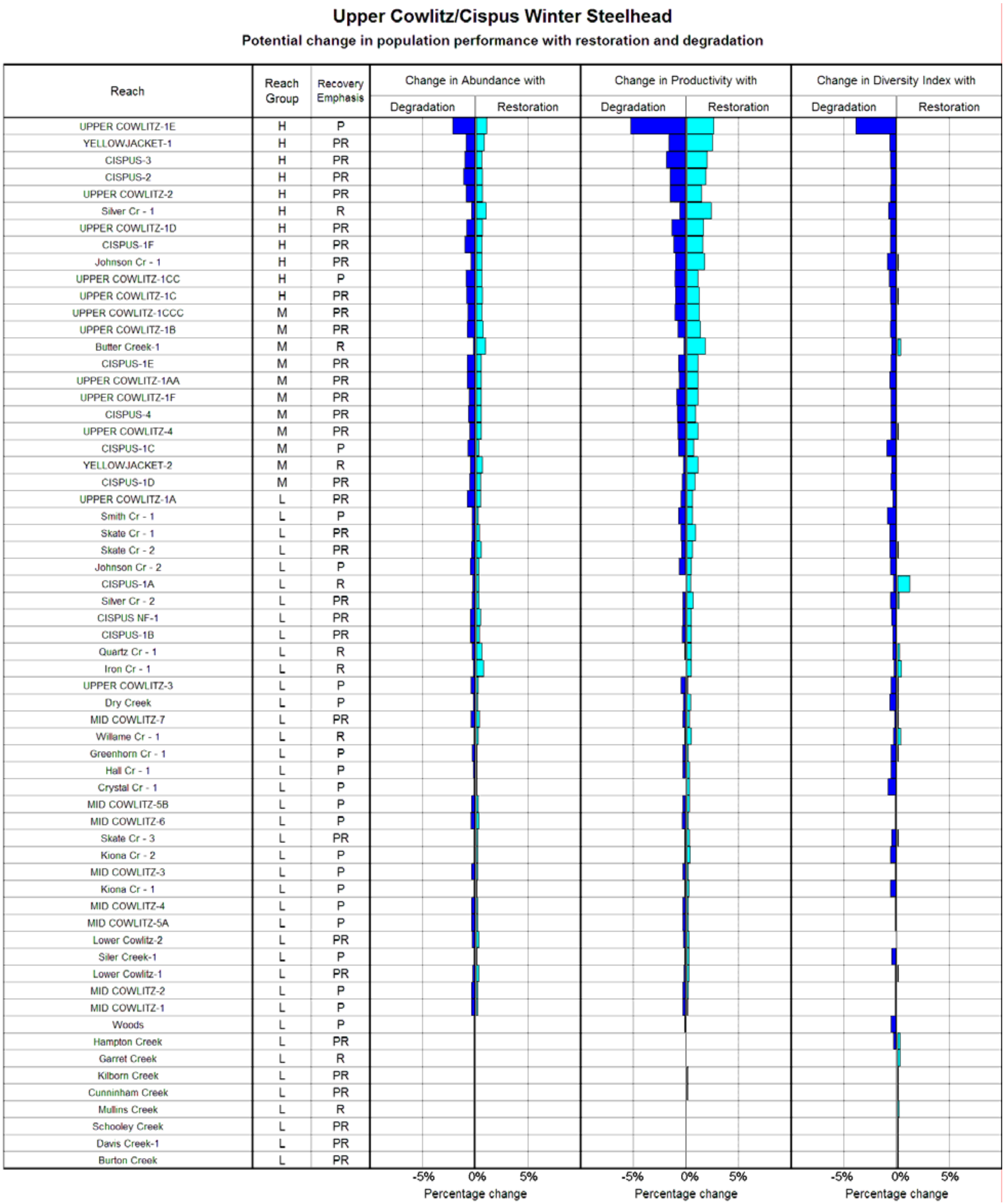


Figure 9-10. Upper Cowlitz and Cispus winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Volume VI for more information on EDT ladder diagrams.

Upper Cowlitz/Cispus Fall Chinook

Potential change in population performance with restoration and degradation

Reach	Reach Group	Recovery Emphasis
UPPER COWLITZ-1E	H	P
CISPUS-1C	H	PR
UPPER COWLITZ-1D	H	P
UPPER COWLITZ-1C	H	P
UPPER COWLITZ-1CC	H	P
UPPER COWLITZ-1CCC	H	P
UPPER COWLITZ-1A	H	PR
UPPER COWLITZ-1B	H	PR
UPPER COWLITZ-1F	M	P
CISPUS-1A	M	R
UPPER COWLITZ-1AA	M	P
MID COWLITZ-7	M	PR
UPPER COWLITZ-2	M	P
MID COWLITZ-5B	M	PR
Skate Cr - 1	M	PR
CISPUS-3	M	PR
CISPUS-1B	M	PR
CISPUS-1F	M	PR
CISPUS-2	M	PR
CISPUS-1E	M	PR
YELLOWJACKET-1	M	PR
Silver Cr - 1	M	PR
MID COWLITZ-6	M	PR
CISPUS-1D	L	PR
Butter Creek-1	L	R
MID COWLITZ-5A	L	PR
Johnson Cr - 1	L	PR
Lower Cowlitz-2	L	R
UPPER COWLITZ-4	L	P
MID COWLITZ-4	L	P
MID COWLITZ-2	L	P
MID COWLITZ-3	L	P
Lower Cowlitz-1	L	R
MID COWLITZ-1	L	P
CISPUS-4	L	P
UPPER COWLITZ-3	L	PR
CISPUS NF-1	L	P

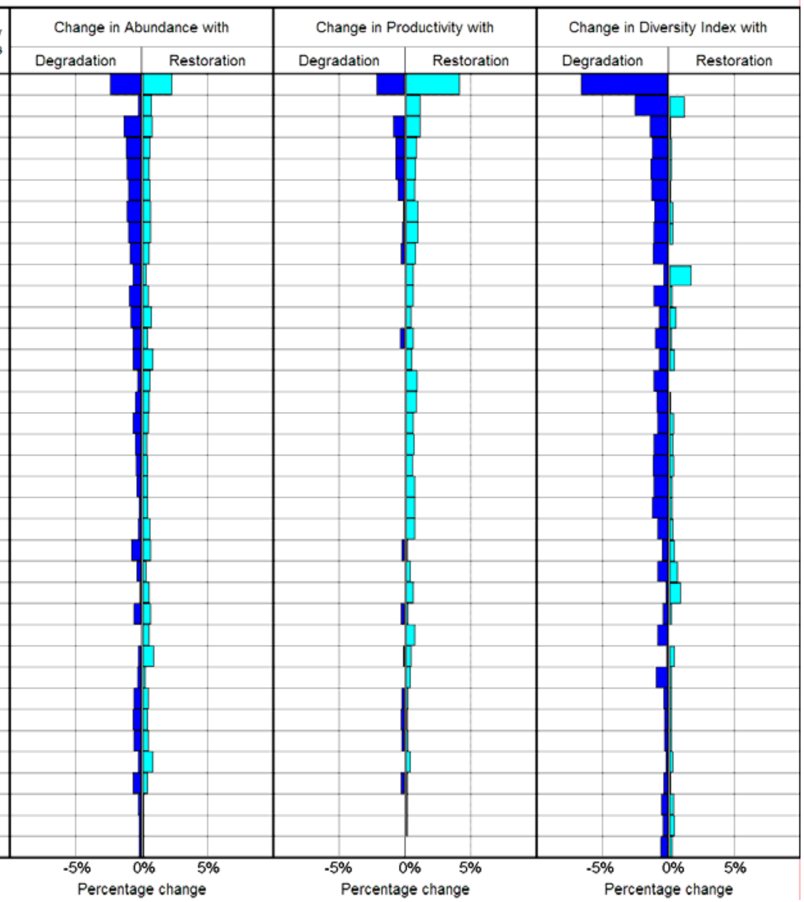


Figure 9-11. Upper Cowlitz and Cispus fall chinook ladder diagram.

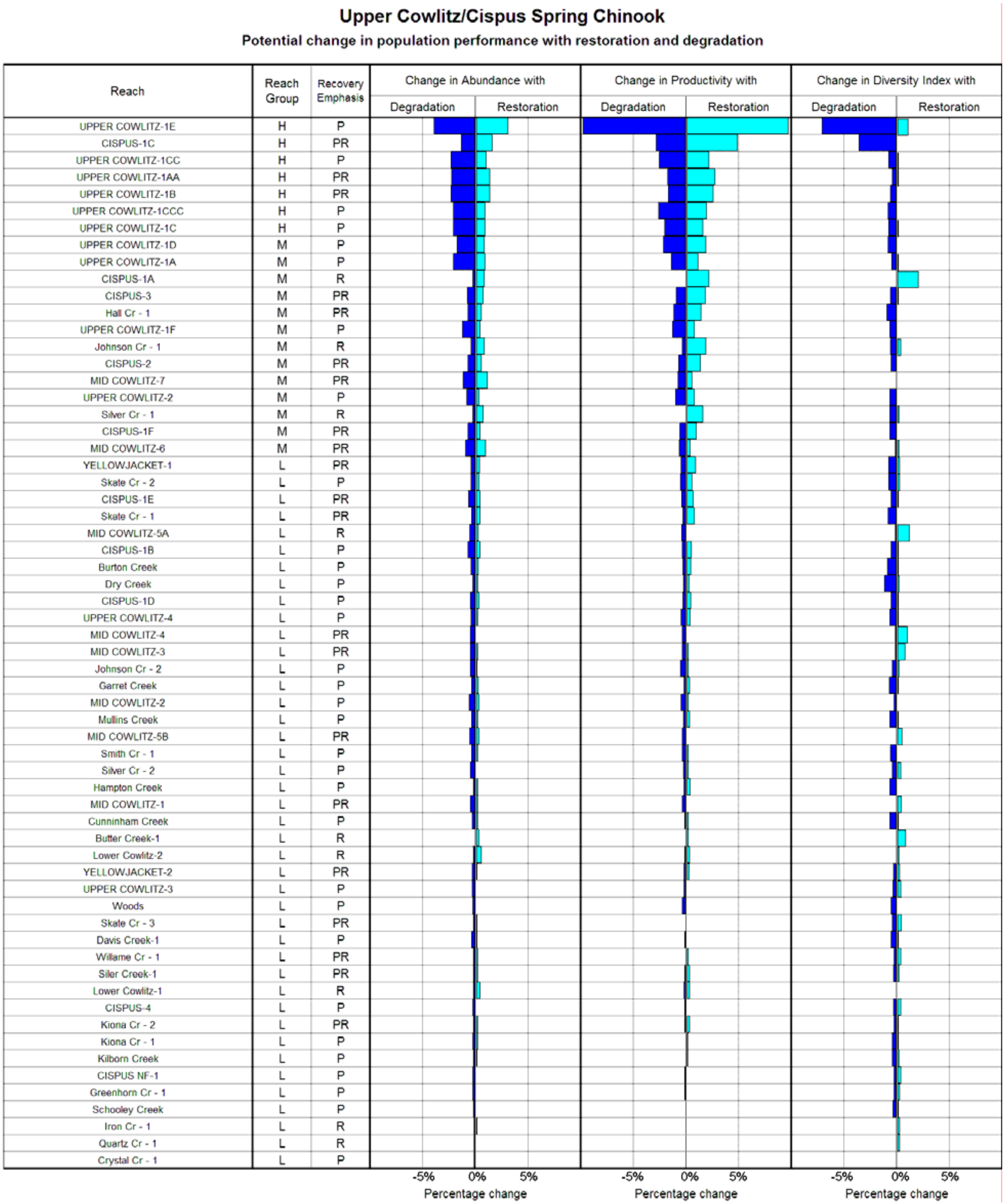


Figure 9-12. Upper Cowlitz and Cispus spring chinook ladder diagram.

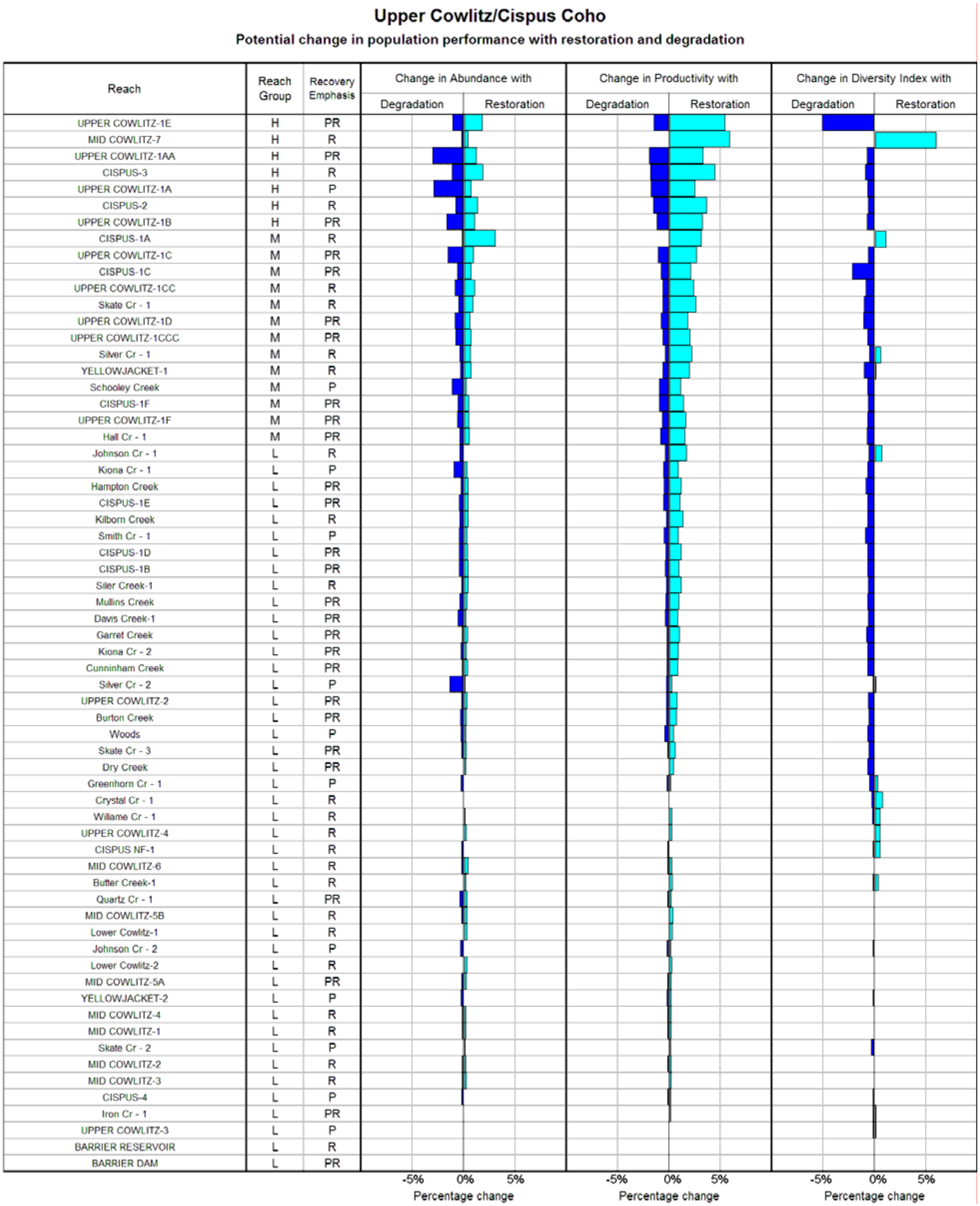


Figure 9-13. Upper Cowlitz and Cispus coho ladder diagram.

9.6.1.3 Habitat Factor Analysis

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the reach analysis compares current/patient and historical/template habitat conditions. The figures generated by habitat factor analysis display the relative impact of habitat factors in specific reaches. The reaches are ordered according to their combined restoration and preservation rank. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to historical conditions.

Key winter steelhead restoration reaches are in both mainstem and tributary locations. These reaches are most negatively influenced by low habitat diversity, sediment, poor channel stability, altered flow regimes, competition with hatchery fish, and pathogens (Figure 9-14). Low habitat diversity is a result of loss of side channel habitat in these mainstem reaches. Historically, these reaches had abundant LWD, but now have very little (Mobrand Biometrics 1999, USFS 1997a). LWD was removed from the floodplains and harvested from riparian areas. The loss of LWD has contributed to the loss of habitat diversity and channel stability. Bank stability is a problem due to excessive sediment accumulations causing channel widening. Sediment problems arise because of mass wasting, road erosion, and concentrated overland runoff associated with land use throughout the basin. Disease and competition concerns arise because of the extensive hatchery influence in the basin.

Almost all of the key fall chinook (Figure 9-15) and spring chinook (Figure 9-16) restoration reaches within the upper Cowlitz and Cispus watersheds are in the mainstem Cowlitz (only one high priority reach in the Cispus). These reaches are primarily affected by loss of habitat diversity, decreased channel stability, and excessive fine sediment, and in the case of spring chinook, by competition and pathogens. The causes of these impacts are the same as those described for winter steelhead restoration reaches.

Key coho restoration reaches exist in both the upper Cowlitz and Cispus watersheds. The habitat impacts affecting these areas are loss of habitat diversity, loss of channel stability, increased sediments, and loss of key habitat (Figure 9-17). The cause of these impacts is the same as described earlier for winter steelhead reaches.

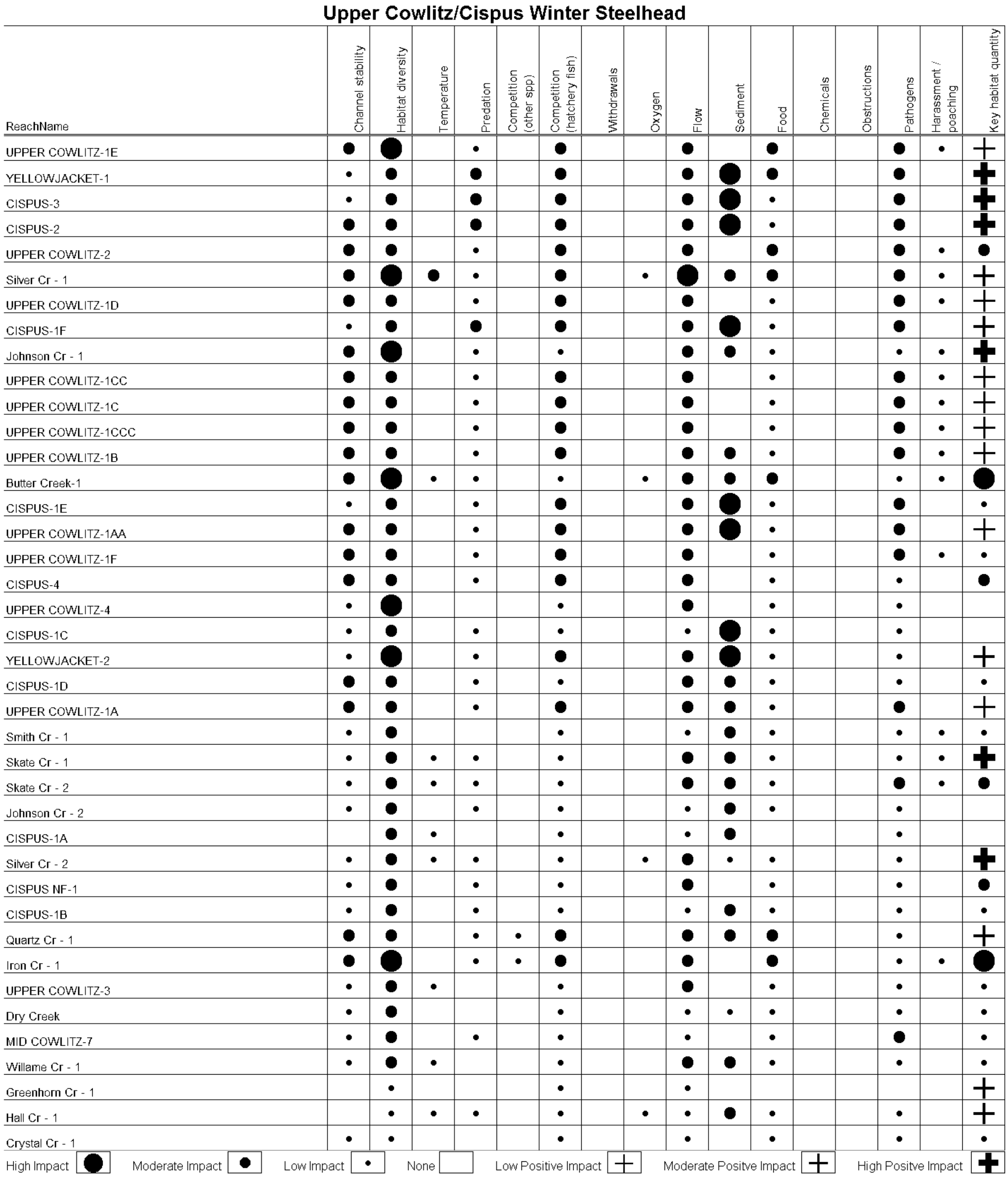


Figure 9-14. Upper Cowlitz and Cispus winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Volume VI for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

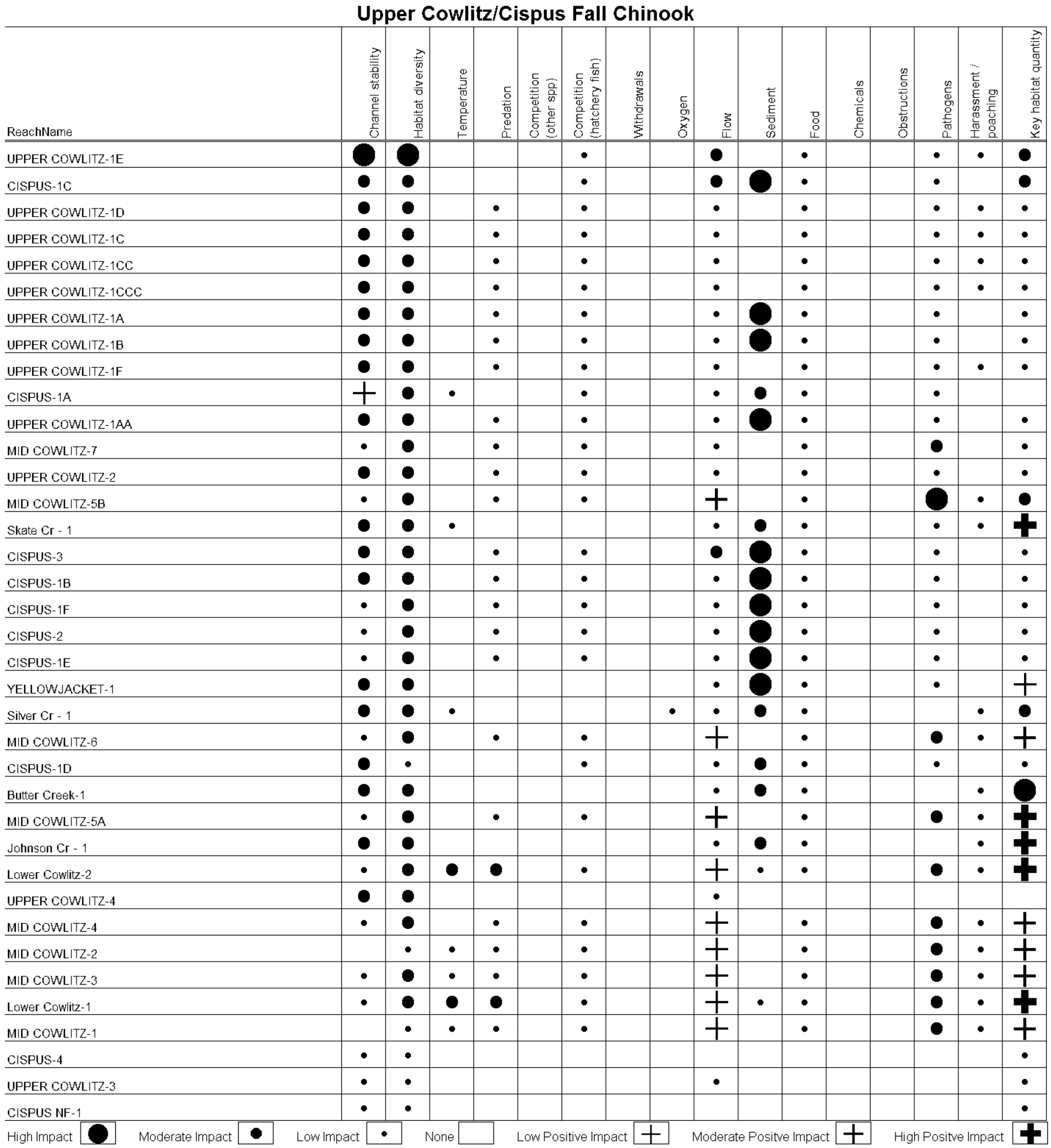


Figure 9-15. Upper Cowlitz and Cispus fall chinook habitat factor analysis.

Upper Cowlitz/Cispus Spring Chinook

ReachName	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
UPPER COWLITZ-1E	●	●		·		•			•		•			•	•	•
CISPUS-1C	●	●		·		•			•	●	•			•		•
UPPER COWLITZ-1CC	•	●		·		•			•		•			•	·	·
UPPER COWLITZ-1AA	•	●		•		•			•	●	•			•		·
UPPER COWLITZ-1B	●	●		·		•			•	●	•			•		·
UPPER COWLITZ-1CCC	•	●		·		•			•		•			•	·	·
UPPER COWLITZ-1C	•	●		·		•			•		•			•	·	·
UPPER COWLITZ-1D	•	●		·		•			•		•			•	·	·
UPPER COWLITZ-1A	•	•		·		•			•	●	•			•		·
CISPUS-1A	+	●	•	·		·			•	●	·			·		
CISPUS-3	•	•		·		•			•	●	·			•		
Hall Cr - 1	·	•	•	·		·		•	·	●	•			·		•
UPPER COWLITZ-1F	•	•		·		·			·		·			·	·	·
Johnson Cr - 1	•	●				·			•	•	·			·	·	✚
CISPUS-2	•	•		·		•			•	●	·			•		+
MID COWLITZ-7	·	●	+	•		·			•	·	•			●	·	·
UPPER COWLITZ-2	•	•				·			·		·			·	·	·
Silver Cr - 1	•	●	·			·		·	•	•	·			·	·	+
CISPUS-1F	·	•		·		·			·	●	·			·		+
MID COWLITZ-6	·	•	+	•		·			·	·	·			●	·	✚
YELLOWJACKET-1	·	•		·		·			·	●	·			·		+
Skate Cr - 2	·	•	·						·	·	·			·		•
CISPUS-1E	·	•		·		·			·	●	·			·		·
Skate Cr - 1	·	•	•			·			·	•	·			·	·	+
MID COWLITZ-5A	·	·		·		·			·		·			•	·	
CISPUS-1B	•	•		·		·			·	•	·			·		·
Burton Creek	·	•	·			·		·	·	·	·			·	·	✚
Dry Creek	·	•							·	•	·			·	·	·
CISPUS-1D	•	•		·		·			·	•	·			·		·
UPPER COWLITZ-4	·	•							·							
MID COWLITZ-4		·		·										·		
MID COWLITZ-3	·	·		·					·		·			·		·
Johnson Cr - 2	·	·								·						
Garret Creek	·	•	·			·		·	·	·	·			·	·	✚
MID COWLITZ-2	·	•	·	·		·			·	·	·			•	·	·
Mullins Creek	·	•	·			·		·	·	·	·			·		✚
MID COWLITZ-5B	·	·		·		·			·		·			•	·	•
Smith Cr - 1	·	•							·	•					·	·
Silver Cr - 2		·														+
Hampton Creek	·	·	·			·		·	·	·	·			·		✚
MID COWLITZ-1	·	·		·					·	·	·			·	·	·
Cunninham Creek	·	·	·					·	·	·	·			·		✚
Butter Creek-1	·	•	·					·	·	·	·				·	•
Lower Cowlitz-2	·	•	·	•		·				·	·			•	·	•
YELLOWJACKET-2		·							·	·						·
UPPER COWLITZ-3	·	·														·
Woods																
Skate Cr - 3		·	·						·	·						·

High Impact ● Moderate Impact • Low Impact · None Low Positive Impact + Moderate Positve Impact High Positve Impact ✚

Figure 9-16. Upper Cowlitz and Cispus spring chinook habitat factor analysis. Some low priority reaches are not included for display purposes.

Upper Cowlitz/Cispus Coho

ReachName	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
UPPER COWLITZ-1E	⬤	⬤		•		●			●		●			●		●
MID COWLITZ-7	•	●		•		•			•		•			•		+
UPPER COWLITZ-1AA	⬤	⬤		●		●			●	⬤	●			●		•
CISPUS-3	⬤	⬤		●		●			●	⬤	●			●		⬤
UPPER COWLITZ-1A	●	●		•		•			•	●	•			•		+
CISPUS-2	●	⬤		●		●			●	⬤	●			●		⬤
UPPER COWLITZ-1B	⬤	⬤		•		●			●	●	●			•		
CISPUS-1A	+	⬤	•	•		●			●	⬤	●			•		
UPPER COWLITZ-1C	●	⬤		•		●			●		•			•		●
CISPUS-1C	●	●		•		●			•	⬤	•			●		•
UPPER COWLITZ-1CC	●	⬤		•		●			●		•			•		●
Skate Cr - 1	●	⬤	•	•		●			●	●	●			•	•	●
UPPER COWLITZ-1D	●	●		•		•			•		•			•		●
UPPER COWLITZ-1CCC	●	⬤		•		•			•		•			•		•
Silver Cr - 1	●	⬤		•		•			•	•	•			•	•	●
YELLOWJACKET-1	●	⬤		•		•			●	●	•			•		●
Schooley Creek	•	●		•		•			•	•	•			•	•	✚
CISPUS-1F	●	●		•		•			•	●	•			•		+
UPPER COWLITZ-1F	●	●		•		•			•		•			•		●
Hall Cr - 1	•	●	•	•		●		•	●	●	●			●		●
Johnson Cr - 1																
Kiona Cr - 1	•	●	•	•		•			•	●	•			•		✚
Hampton Creek	•	●	•	•	•	•		•	•	●	●			•	•	+
CISPUS-1E	•	●		•		•			•	●	•			•		•
Kilborn Creek	•	●	•	•	•	•		•	•	●	●			•	•	✚
Smith Cr - 1	•	●		•		•			•	•	•			•	•	●
CISPUS-1D	●	●		•		•			•	•	•			•		•
CISPUS-1B	●	●		•		•			•	●	•			•		•
Siler Creek-1	•	●		•	•	•			●	●	●			•	•	●
Mullins Creek	•	●		•		•			•	•	•			•	•	✚
Davis Creek-1	•	•		•		•			•	•	•			•		+
Garret Creek	•	●	•	•	•	•		•	•	•	●			•	•	✚
Kiona Cr - 2	•	●		•		•			•	•	•			•		+
Cunninham Creek	•	●	•	•		•			•	•	•			•	•	✚
Silver Cr - 2	•	•								•						+
UPPER COWLITZ-2	●	●		•		•			•		•			•		●
Burton Creek	•	●		•		•			•	•	•			•	•	✚
Woods	•	•		•		•			•		•			•		●
Skate Cr - 3	•	●		•		•			•	•	•			•	•	●
Dry Creek	•	•		•		•			•	•	•			•		●
Greenhorn Cr - 1																
Crystal Cr - 1																
Willame Cr - 1	•	•							•	•						•
UPPER COWLITZ-4	•	●							•					•		•
CISPUS NF-1																
MID COWLITZ-6		●		●						•				●		+
Butter Creek-1	•	•							•	•	•					●

High Impact ⬤ Moderate Impact ● Low Impact • None Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Figure 9-17. Upper Cowlitz and Cispus coho habitat factor analysis. Some low priority reaches are not included for display purposes.

9.6.2 Tilton

9.6.2.1 Population Analysis

Population assessments under different habitat conditions are useful for comparing fish trends and establishing recovery goals. Fish population levels under current and potential habitat conditions were inferred using the EDT model based on habitat characteristics of each stream reach and a synthesis of habitat effects on fish life cycle processes.

Habitat-based assessments were completed for spring chinook, fall chinook, winter steelhead and coho in the Tilton watershed. Model results indicate that both adult productivity and adult abundance have been severely reduced. Current productivity estimates range from only 10-24% of historical levels (Table 9-3). Current abundance estimates range from only 4-22% of historical levels (Figure 9-18). Diversity (as measured by the diversity index) has also declined sharply (Table 9-3). Fall chinook and coho diversity is estimated at only 39% and 36% of historical levels, respectively. Spring chinook and winter steelhead diversity has declined by 78% and 79%, respectively.

Smolt productivity in the Tilton has also declined (Table 9-3), though losses have not been as great as for adult productivity, suggesting that out of basin factors may be contributing to losses in adult productivity. Relative declines in smolt abundance have been greatest for coho and winter steelhead, but similar losses have also occurred for spring chinook and fall chinook (Table 9-3).

Model results indicate that restoration of PFC conditions would produce substantial benefits for all species (Table 9-3). Adult abundance for coho would benefit the most, with runs increasing to approximately 12 times current levels. Similarly, returns of fall chinook, spring chinook, and winter steelhead all would increase by 140- 400% (Table 9-3). Smolt abundance would also increase for all species (Table 9-3). Benefits to smolt abundance would range from a 92% increase for fall chinook smolts to a 669% increase for coho smolts.

Table 9-3. Tilton River — Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	1,025	2,475	4,610	2.0	4.5	8.6	0.35	0.90	0.90	137,656	264,812	337,240	211	359	465
Spring Chinook	868	3,176	5,436	1.9	7.2	15.1	0.20	0.78	0.93	63,454	195,918	246,459	92	188	251
Coho	261	3,233	5,599	2.6	12.6	24.9	0.32	0.84	0.90	8,741	67,197	82,075	72	256	352
Winter Steelhead	219	1,093	1,741	2.3	9.7	16.5	0.21	0.91	1.00	4,484	19,991	26,042	44	170	234

[1] Estimate represents historical conditions in the basin and current conditions in the mainstem and estuary.

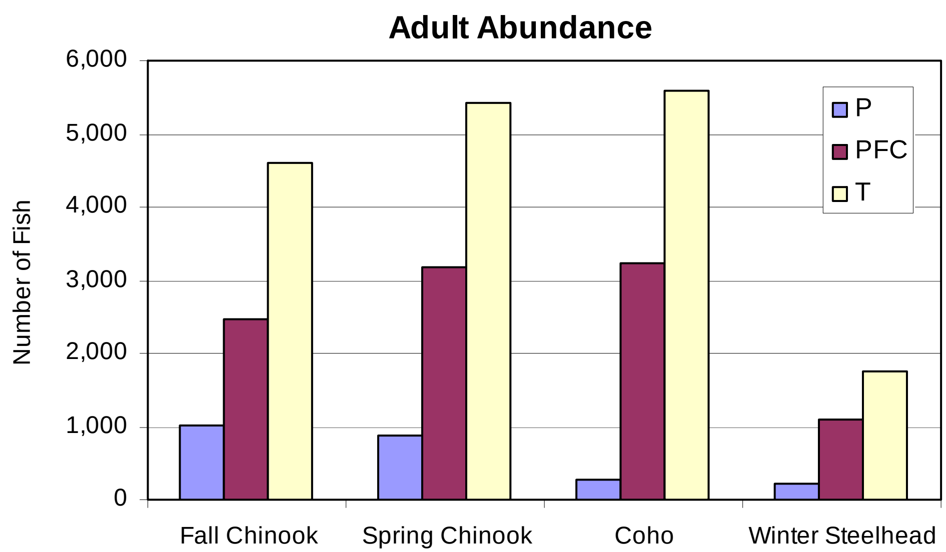


Figure 9-18. Adult abundance of Tilton River fall chinook, spring chinook, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

9.6.2.2 Restoration and Preservation Analysis

Habitat conditions and suitability for fish are better in some portions of a subbasin than in others. The reach analysis of the EDT model uses estimates of the difference in projected population performance between current/patient and historical/template habitat conditions to identify core and degraded fish production areas. Core production areas, where habitat degradation would have a large negative impact on the population, are assigned a high value for preservation. Likewise, currently degraded areas that provide significant potential for restoration are assigned a high value for restoration. Collectively, these values are used to prioritize the reaches within a given subbasin. See Figure 9-19 for a map of EDT reaches in the Tilton basin.

High priority reaches for winter steelhead include the lower sections of the EF Tilton (Tilton EF1 and Tilton EF2) as well as mainstem sections of the Tilton (Tilton 1, 3, 5 and 6) (Figure 9-20). All high and medium priority reaches for winter steelhead show a restoration emphasis.

For fall chinook (Figure 9-21) and spring chinook (Figure 9-22), the high priority locations are similar and include mainstem reaches from Bear Canyon to the EF Tilton and sections in the EF Tilton. In these reaches, as in the reaches for winter steelhead, all high and medium priority reaches show a restoration emphasis. Reaches Tilton 5 and Tilton 6 show one of the strongest restoration emphasis for both fall and spring chinook in the Tilton.

Important sections for coho include mainstem reaches (Tilton1, 3, 5 and 6), the lower EF Tilton (Tilton EF1), and Lake Creek (Figure 9-23). Again, all reaches show a strong habitat restoration emphasis, with Tilton 5 having the most potential improvement due to restoration.

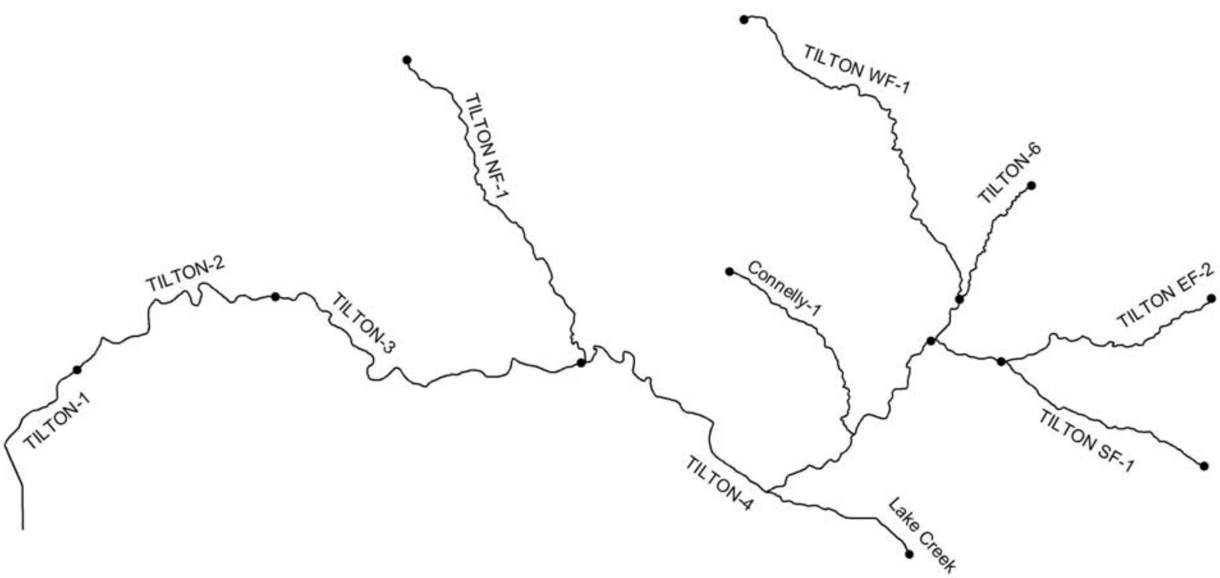


Figure 9-19. Tilton River basin EDT reaches. Some reaches are not labeled for clarity.

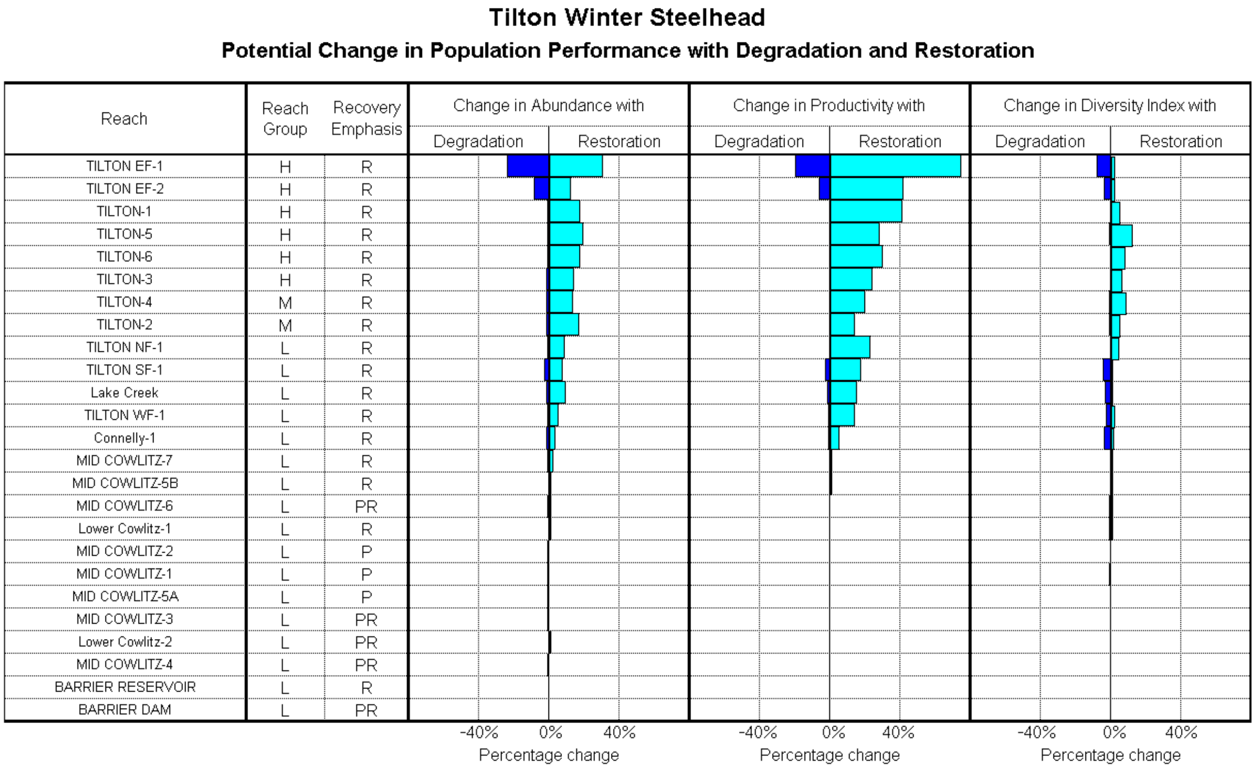


Figure 9-20. Tilton River winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Volume VI for more information on EDT ladder diagrams.

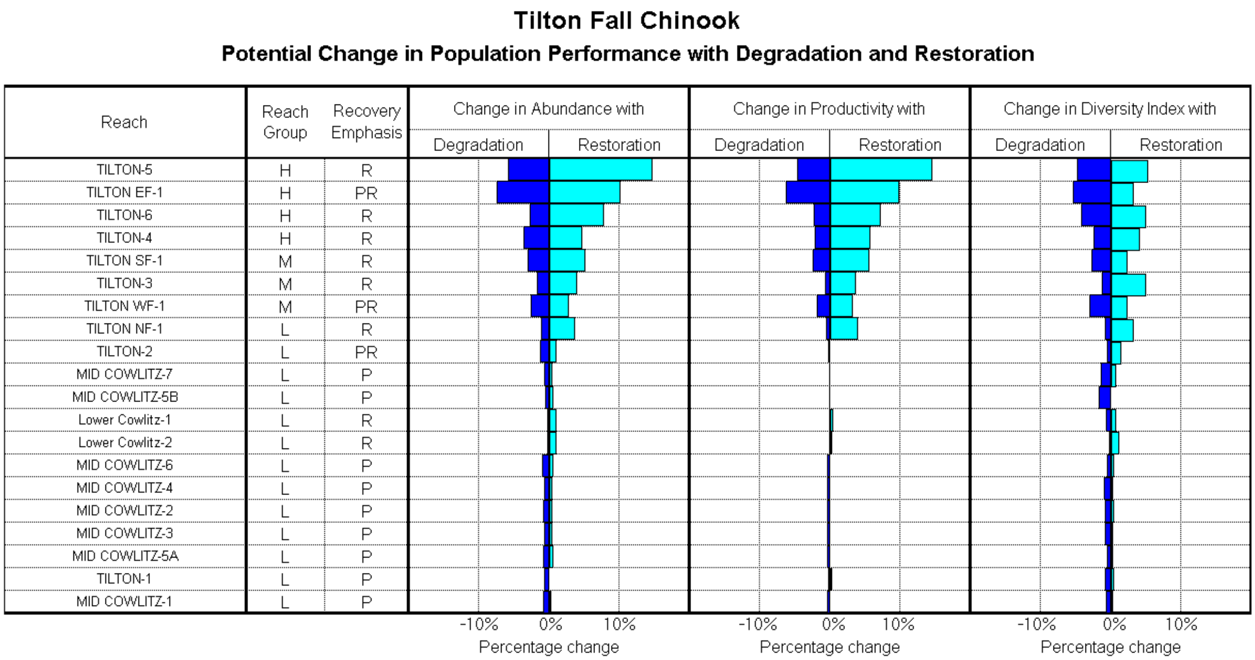


Figure 9-21. Tilton fall chinook ladder diagram.

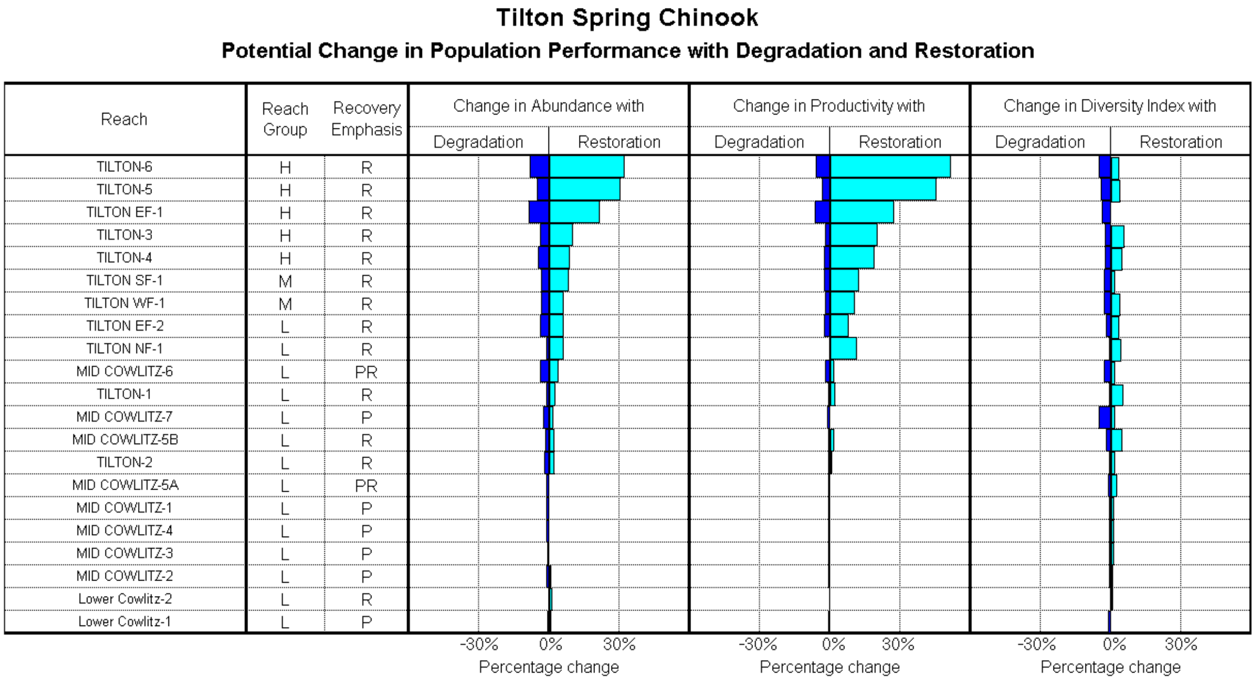


Figure 9-22. Tilton spring chinook ladder diagram.

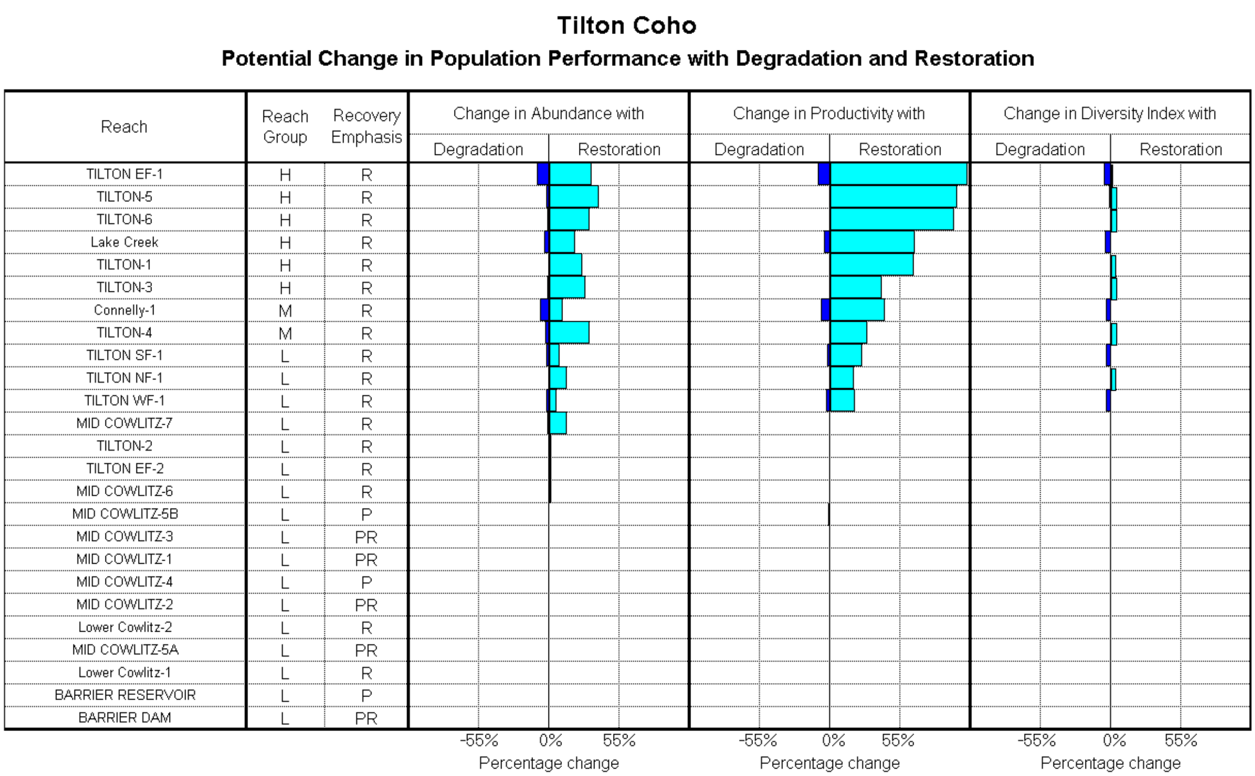


Figure 9-23. Tilton coho ladder diagram.

9.6.2.3 Habitat Factor Analysis

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the reach analysis compares current/patient and historical/template habitat conditions. The figures generated by habitat factor analysis display the relative impact of habitat factors in specific reaches. The reaches are ordered according to their combined restoration and preservation rank. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to historical conditions.

Key winter steelhead reaches in the Tilton include the mainstem Tilton from Bear Canyon to the East Fork Tilton, and in the East Fork Tilton. These reaches have been most negatively impacted by sediment, flow alterations, and temperature regime changes, with lesser impacts from decreased habitat diversity, pathogens, and loss of key habitat (Figure 9-24). There is an increased peak flow risk due to high road densities and reductions in forest cover throughout the basin. Low flows have also been cited as a problem (Harza 1997 as cited in Wade 2000). High road densities have also been implicated in increased fine sediment delivery rates within the basin. Habitat diversity has been reduced due to LWD reductions related to channel cleaning, timber harvest in riparian zones, debris torrents, dam break floods, and increased peak flows (EA 1998 as cited in Wade 2000). Temperature regimes have been influenced by changes in riparian vegetation. Over 87% of riparian corridors in the Mayfield/Tilton basin lack riparian vegetation or have early-seral stage riparian conditions. Pathogenic and competition concerns arise from the extensive distribution of hatchery fish in the Cowlitz basin.

Important reaches for both fall chinook (Figure 9-25) and spring chinook (Figure 9-26) are located in the mainstem, EF, SF, and WF Tilton. These reaches have been primarily impacted by sediment, habitat diversity, flow, temperature, and channel stability. The causes of these impacts are the same as those discussed above for winter steelhead.

For coho, important reaches include mainstem reaches, the lower EF Tilton, and Lake and Connelly Creeks. These reaches have been degraded in the form increased sediment, lost habitat diversity, altered flow regimes, decreased channel stability, and loss of key habitat (Figure 9-27). The causes of these impacts are the same as those discussed above for winter steelhead.

Tilton Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
TILTON EF-1	Moderate	Moderate	High	Moderate		Moderate			High	High	Low			Moderate	Low	High
TILTON EF-2	Low	Moderate	Moderate	Low		Low			Moderate	High	Low			Moderate	Low	High
TILTON-1	Low	Moderate	Moderate	Low		Low		Low	Moderate	High	Low			Moderate	Low	High Positive
TILTON-5	Low	Moderate	High	Low		Moderate			High	High	Low			Moderate		Low
TILTON-6	Low	Moderate	Moderate	Low		Moderate			High	High	Low			Moderate	Low	+
TILTON-3	Moderate	Moderate	Moderate	Low		Low			Moderate	High	Low			Moderate	Low	High Positive
TILTON-4	Low	Low	Moderate	Low		Low			Moderate	High	Low			Moderate		High Positive
TILTON-2	Moderate	Moderate	Moderate	Low		Low			Moderate	High	+			Moderate		
TILTON NF-1	Low	Moderate	Moderate	Low		Low			Moderate	Moderate	Low			Low		Moderate
TILTON SF-1	Low	Moderate	Moderate	Low		Low			Moderate	Moderate	Low			Low		Moderate
Lake Creek	Low	Moderate	Moderate	Low		Low			Moderate	High	Low			Low	Low	High Positive
TILTON WF-1		Low	Moderate	Low		Low			Moderate	Moderate	Low			Low		Moderate
Connelly-1	Low	Low	Low	Low		Low			Low	Moderate	Low			Low		Moderate
MID COWLITZ-7		Low		Low		Low			Low					Low		Low
MID COWLITZ-5B		Low		Low										Low	Low	Low
MID COWLITZ-6		Low												Low		
Lower Cowlitz-1		Low													Low	Low
MID COWLITZ-2																
MID COWLITZ-1																
MID COWLITZ-5A																
MID COWLITZ-3		Low														Low
Lower Cowlitz-2		Low													Low	Low
MID COWLITZ-4																
BARRIER RESERVOIR		Low														
BARRIER DAM																

High Impact Moderate Impact Low Impact None Low Positive Impact Moderate Positve Impact High Positve Impact

Figure 9-24. Tilton winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Volume VI for more information on habitat factor analysis diagrams.

Tilton Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
TILTON-5	High	High	Moderate	Low		Low			High	High	Moderate			Low	Low	Moderate
TILTON EF-1	Moderate	High	Low	Low		Low			Moderate	High	Low			Low	Moderate	Moderate
TILTON-6	Moderate	High	Low	Low					High	High	Low			Low	Low	Low
TILTON-4	Moderate	Moderate	Low	Low		Low			Moderate	High	Moderate			Low		+
TILTON SF-1	Moderate	High	Low	Low					Moderate	High	Moderate			Low	Low	Moderate
TILTON-3	Moderate	Moderate	Low	Low		Low			Moderate	High	Low			Low	Low	+
TILTON WF-1	Low	Moderate	Low	Low		Low			Low	High	Low			Low		Low
TILTON NF-1	Low	Moderate	Low	Low		Low			Moderate	High	Low			Low	Low	Moderate
TILTON-2		Moderate				Low			Low	Low				Low		
MID COWLITZ-7		Low				Low								Low		
MID COWLITZ-5B		Low				Low			+					Low		Low
Lower Cowlitz-1		Low	Low	Low					+					Low		+
Lower Cowlitz-2		Low	Low	Low		Low			+					Low		+
MID COWLITZ-6		Low				Low								Low		+
MID COWLITZ-4		Low							+					Low		+
MID COWLITZ-2		Low												Low		+
MID COWLITZ-3		Low							+					Low		+
MID COWLITZ-5A		Low				Low			+					Low		+
TILTON-1		Low														+
MID COWLITZ-1		Low												Low		+

High Impact ● Moderate Impact ● Low Impact • None Low Positive Impact + Moderate Positve Impact + High Positve Impact +

Figure 9-25. Tilton fall chinook habitat factor analysis.

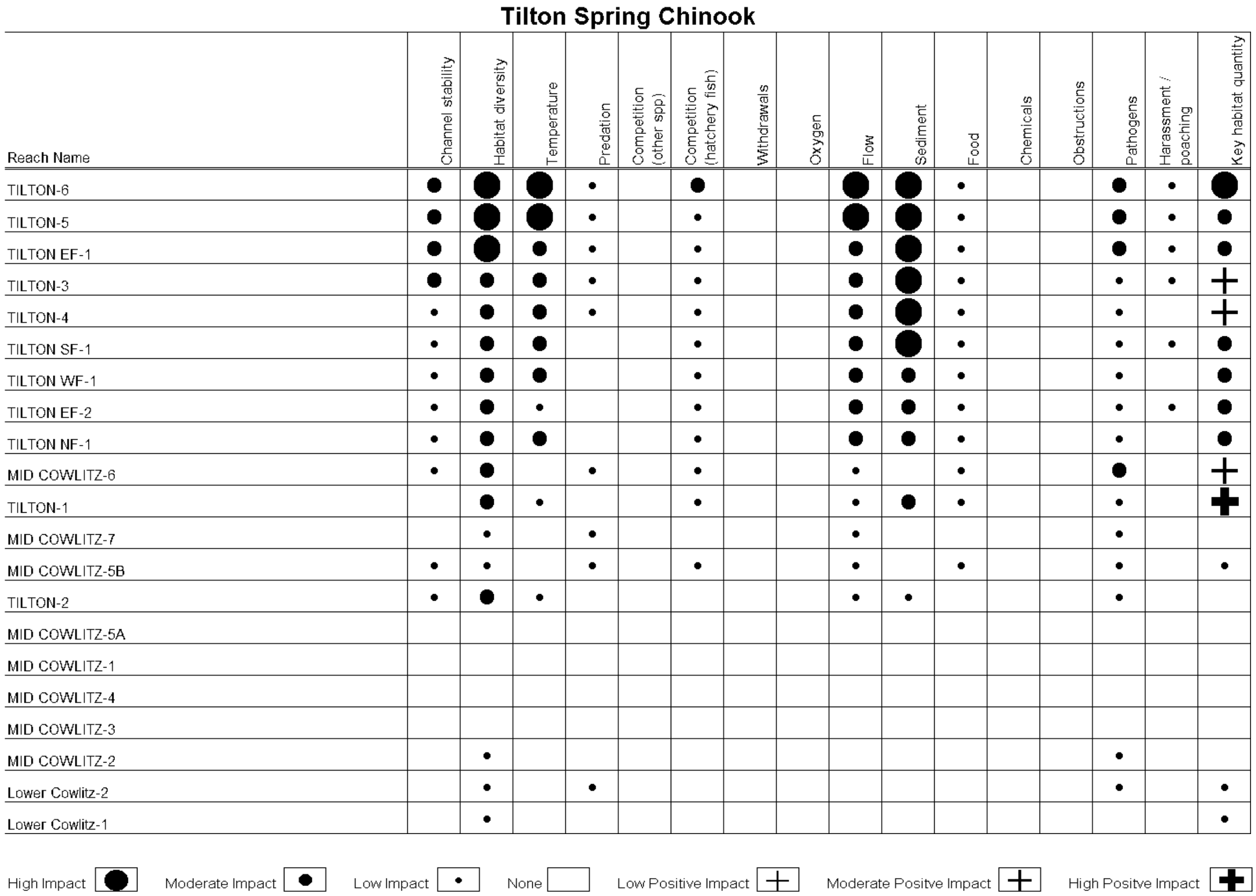


Figure 9-26. Tilton spring chinook habitat factor analysis.

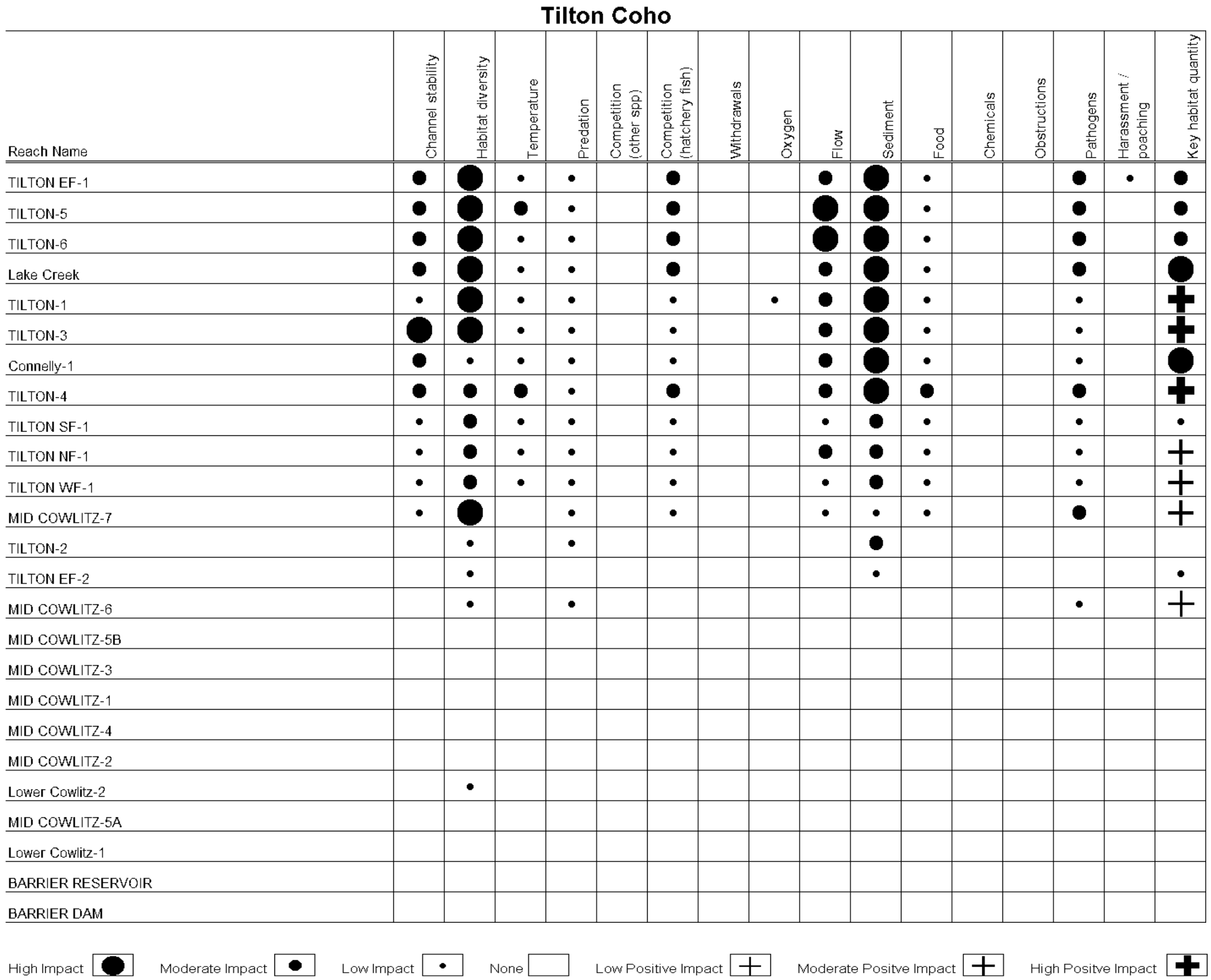


Figure 9-27. Tilton coho habitat factor analysis.

9.7 Integrated Watershed Assessments (IWA)

The Integrated Watershed Assessment analysis was performed independently for the Mayfield-Tilton, Riffe Lake, Cispus River and Upper Cowlitz River Watersheds which collectively make up the upper Cowlitz River basin. These watersheds were analyzed separately because the upper Cowlitz basin is dissected by dams and storage reservoirs which interrupt watershed processes at the basin level. The results of IWA analyses for each watershed are described below.

9.7.1 Mayfield-Tilton

The Mayfield-Tilton watershed is located in the north-central portion of WRIA 26, and in the northwestern portion of the upper Cowlitz basin. For the purpose of recovery planning, the watershed is divided into 25 planning subwatersheds covering a total of approximately 154,000 acres (240 sq mi). In addition to the mainstem Cowlitz River, principal tributaries in the watershed include the Tilton River, the North, South, and WF Tilton River, and Winston Creek. Historically, this watershed supported miles of productive habitat for anadromous species. Today anadromous migration in the drainage is impeded by Mayfield Dam, which blocks all natural upstream passage and inhibits downstream migration. Mayfield Lake Reservoir has inundated the once productive spawning and rearing habitats in the portions of the mainstem Cowlitz River within the watershed. Primary land uses in this watershed include agriculture, timber harvest, and recreation centered on public lands and large reservoirs. Private timber land is the predominant form of private land ownership. The northern portion of the watershed is within the GPNF, while state lands cover between 20% and 50% of total area in five subwatersheds. Population centers in the watershed include the towns of Morton and Mossy Rock.

The Mayfield-Tilton River watershed is primarily a high elevation system, with approximately 40% of the watershed lying in the rain-on-snow zone. The streams comprising the watershed flow mostly through Cascade volcanic and granitic rocks, and therefore, natural erodability within the watershed is low. Twelve of the 25 subwatersheds are higher elevation headwaters and tributary subwatersheds. Seven subwatersheds are defined by moderate-size, mainstem rivers, including the Tilton and the lower reaches of the North Tilton. The Cowlitz River flows through two subwatersheds, in what were historically large mainstem type reaches fed by significant drainage area. The majority of this historical channel is inundated under the Mayfield Lake Reservoir, with only a short stretch of hydrologically modified mainstem channel remaining between the impoundment and Mossy Rock Dam upstream. Finally, lower stretches of Winton Creek are characterized by small to medium, low elevation, rain-dominated, streams and rivers.

9.7.1.1 Results and Discussion

IWA results were calculated for all subwatersheds in the Mayfield-Tilton watershed. IWA results are calculated at the local level (i.e., within subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). IWA results for each subwatershed are presented in Table 9-4. A reference map showing the location of each subwatershed in the basin is presented in Figure 9-28. Maps of the distribution of local and watershed level IWA results are displayed in Figure 9-29. The majority of subwatersheds are rated moderately impaired to impaired at the local level for all three watershed processes, although two are rated functional with respect to riparian conditions, and one is rated functional for sediment. The results are similar at the watershed level. IWA results are described in more detail by process category below.

Table 9-4. Summary of IWA results for the Mayfield-Tilton River watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
10101	I	M	M	I	M	none
10102	I	M	M	I	M	10103
10103	I	M	M	I	M	none
10104	I	M	M	I	M	10102, 10103
10201	I	M	M	I	M	none
10202	I	M	M	I	M	10201
10301	I	M	M	I	M	10101, 10102, 10103, 10104, 10201, 10202, 10302, 10303, 10401, 10402, 10403
10302	I	M	I	I	M	none
10303	I	M	M	I	M	10101, 10102, 10103, 10104, 10201, 10202
10401	I	M	M	I	M	none
10402	I	I	M	I	M	10401
10403	I	I	M	I	M	10401, 10402
10501	I	M	M	I	M	10101, 10102, 10103, 10104, 10201, 10202, 10301, 10302, 10303, 10401, 10402, 10403, 10502, 10504
10502	I	M	M	I	M	10101, 10102, 10103, 10104, 10201, 10202, 10301, 10302, 10303, 10401, 10402, 10403, 10504
10503	I	M	M	I	M	10101, 10102, 10103, 10104, 10201, 10202, 10301, 10302, 10303, 10401, 10402, 10403, 10501, 10502, 10504, 10505
10504	I	M	M	I	M	10101, 10102, 10103, 10104, 10201, 10202, 10301, 10302, 10303, 10401, 10402, 10403
10505	I	M	M	I	M	none
20501	I	M	M	I	M	20503
20502	I	M	M	M	M	20504
20503	M	M	F	M	M	none
20504	M	M	F	M	M	none
20505	I	M	M	I	M	20501, 20502, 20503, 20504
20601	I	M	I	F	M	none
20602	I	F	I	I	F	none
20603	I	M	I	F	M	10101, 10102, 10103, 10104, 10201, 10202, 10301, 10302, 10303, 10401, 10402, 10403, 10501, 10502, 10503, 10504, 10505, 20501, 20502, 20503, 20504, 20505, 20601, 20602

Notes:

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800040#####.

[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional

M: Moderately impaired

I: Impaired

[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.

[d] Subwatersheds upstream from this subwatershed.

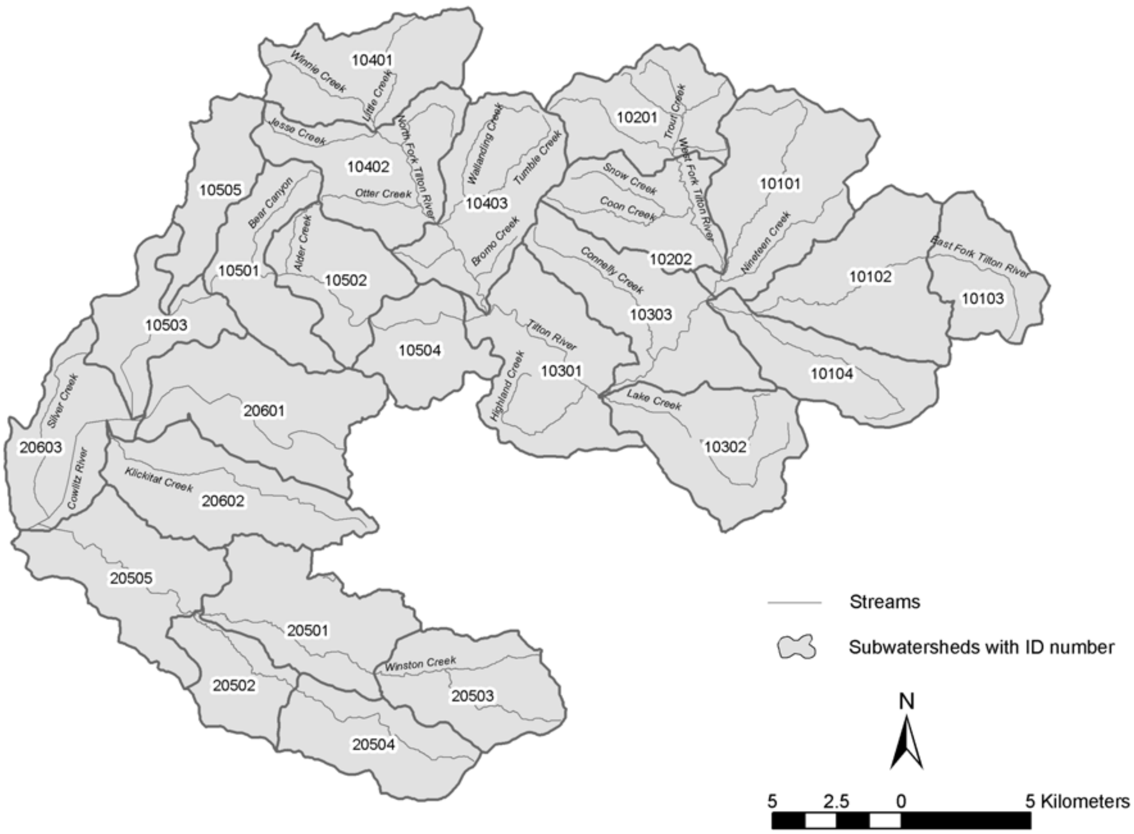


Figure 9-28. Map of the Mayfield-Tilton watershed showing the location of the IWA subwatersheds

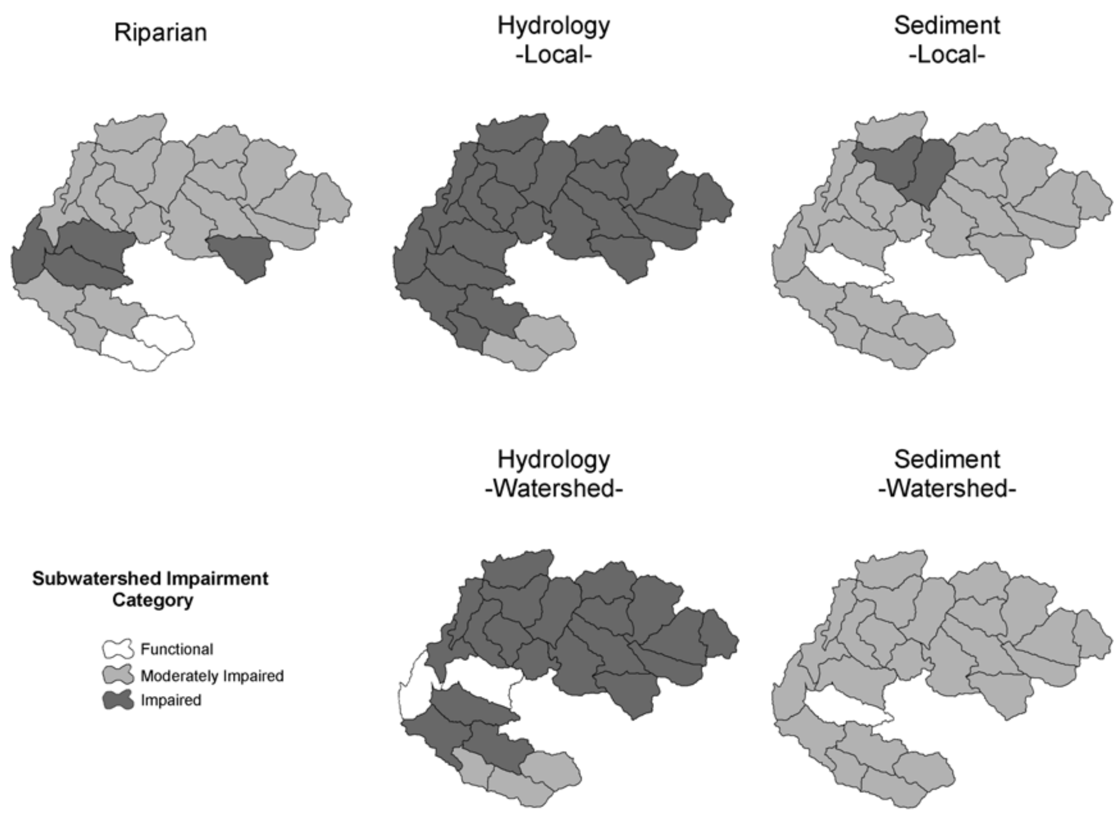


Figure 9-29. IWA subwatershed impairment ratings by category for the Mayfield-Tilton basin

9.7.1.1.1 *Hydrology*

Hydrologic conditions across the Mayfield-Tilton River watershed are generally rated as impaired. Moderately impaired subwatersheds occurring in the upper area of the Winston Creek drainage (20502-20504) make up the exceptions. Most of the land north of the Tilton River is within the Gifford Pinchot National Forest, but land around the lake is primarily under state and private ownership. Wetland area in the uplands of the Mayfield-Tilton River watershed is limited, and the percentage of watershed lying in the rain-on-snow zone is 35%. The low percentage of buffering wetlands, and the moderately high percentage of area in the rain-on-snow zone suggest a relatively high potential for adverse hydrologic impacts on channel conditions.

Hydrologic conditions within the subwatersheds along the Cowlitz (20602, 20603) are considered functional at the watershed level by the IWA analysis. This condition is an artifact of the influence of Mossyrock Dam and the Riffe Lake watershed situated directly upstream. However, hydrologic conditions along the mainstem Cowlitz within the watershed are impacted by Mayfield Dam, and therefore cannot be considered truelly functional. In most cases, upstream impairments in the Mayfield-Tilton watershed are muted by the reservoir, and therefore, they have little effect on downstream subwatersheds.

9.7.1.1.2 *Sediment*

Sediment conditions in the Mayfield-Tilton watershed range from functional to impaired at the local level. The middle and lower subwatersheds of the NF Tilton drainage (10402, 10403) are rated as impaired for sediment. In contrast, functional sediment conditions are found in Klickitat Creek (20602). The remainder of the watershed is rated as moderately impaired for sediment at the local level. Conditions are generally similar at the watershed level. However, sediment conditions in the NF Tilton drainage (10402, 10403) become moderately impaired at the local level, reflecting a buffering influence by only moderately impaired conditions in the Tilton headwaters (10401). All of the subwatersheds in the Mayfield-Tilton watershed have low to moderate natural erodability ratings, based on geology type and slope class, averaging 20 on a scale of 0-126. Mature vegetation cover is relatively low within the watershed, and road densities and road crossing densities are relatively high.

Sediment conditions along the Cowlitz mainstem (20601, 20603) are rated as moderately impaired at the watershed level. However, these ratings do not fully reflect the modified sediment regime of this portion of the watershed. The mainstem Cowlitz in these subwatersheds is inundated under storage reservoirs, and sediment transport to these reaches from upstream areas of the basin is disconnected by dams. Therefore, these ratings best reflect the influence of local subwatershed level sediment inputs.

9.7.1.1.3 *Riparian*

Riparian condition ratings for the Mayfield-Tilton watershed range from functional to impaired. Riparian conditions in the upper subwatersheds of Winston Creek (20503, 20504) are rated as functional, while subwatersheds along the Cowlitz mainstem (20602, 20603) and Klickitat Creek (20602) are rated as impaired. The remaining subwatersheds are rated as moderately impaired for riparian conditions.

9.7.1.2 Predicted Future Trends

9.7.1.2.1 Hydrology

Subwatersheds with a high percentage of public lands (10401-10403, 20504) are predicted to trend towards gradual improvement in hydrologic conditions as vegetation slowly matures and the influence of improved forestry and road management practices is manifest. Subwatersheds located on private timber lands are predicted to trend stable, given the likelihood of ongoing timber harvest rotations and high forest road densities, offset by improved forestry and road management practices. Hydrologic conditions on private lands not in large commercial forestry operations may continue to degrade if timber harvest continues and commercial and residential development expands.

A.1.1.1.1 Sediment

In subwatersheds with high percentage public land ownership (10401-10403), sediment conditions are predicted to trend towards gradual improvement over the next 20 years as improved road management practices and vegetation recovery mitigate the impacts of high forest road densities. Sediment supply conditions in the other subwatersheds, which are mostly comprised of private timber lands, are expected to trend stable or slightly improve due to new forest practices regulations that govern timber harvest and road building/maintenance practices.

9.7.1.2.2 Riparian Condition

The predicted trend for riparian conditions is for general improvement over the next 20 years due to riparian buffer timber harvest protections. The exceptions are private lands in the southern portion of the watershed that are at risk of increased residential development.

9.7.2 Riffe Lake

The Riffe Lake watershed is located in the center of WRIA 26, in the north-central portion of the region. The watershed is comprised of 15 subwatersheds covering a total of approximately 92,200 acres. Principal tributaries in the watershed include the Cowlitz River mainstem, Rainey Creek, and Goat Creek. Mossyrock Dam forms a 23-mile long lake in the center of the watershed, and together, the dam and reservoir (Riffe Lake) act as a complete barrier to both upstream and downstream fish passage. The land area in these subwatersheds is primarily under private ownership, with much of the uplands being utilized for timber production and lowlands being used for development, recreation, and timber. Wetland area along the reservoir is high, but it decreases dramatically along the upland tributaries. Mature forest cover in these subwatersheds averages only 30%. The average road density is moderately high, at 3.7 mi/sq mi, and so is the average stream crossing density at 3.2 crossings per mile.

The Riffe Lake watershed is primarily a high elevation system, supporting a large mainstem river, the Cowlitz. Eight of 15 subwatersheds are dominated by the mainstem Cowlitz. The tributary subwatersheds are characterized by small, high elevation streams feeding the reservoir (six subwatersheds), except Rainey-Frost Creek subwatershed (20502), which is a medium sized, high elevation subwatershed. Over 20% of the watershed is in the rain-on-snow zone, and between 32% and 64% of the southern watersheds lie in this zone. The rain-on-snow events cause local impacts; however, the reservoir mutes their effects downstream. Natural erodability within the watershed is low to moderate.

9.7.2.1 Results and Discussion

IWA results were calculated for all subwatersheds in the Riffe Lake watershed. IWA results are calculated at the local level (i.e., within subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). IWA results for each subwatershed are presented in Table 9-5. A reference map showing the location of each subwatershed in the basin is presented in Figure 9-30. Maps of the distribution of local and watershed level IWA results are displayed in Figure 9-31. The majority of subwatersheds are impaired at the local level for hydrologic processes, and moderately impaired for sediment and riparian conditions. Although eight are impaired with respect to hydrology, only one is impaired for sediment and one is impaired with respect to riparian conditions. Local level conditions differ considerably from watershed level conditions for hydrology, but remain similar with respect to sediment supply.

Table 9-5. IWA results for the Riffe Lake watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
30801	I	M	M	F	M	30802
30802	I	M	M	F	M	none
20101	I	M	M	F	M	none
20102	I	M	I	I	M	20101
20103	I	M	M	I	M	none
20201	F	M	M	F	M	30801, 30802
20202	F	M	F	F	M	none
20301	I	M	M	F	M	30801, 30802, 20101, 20102, 20103, 20201, 20202, 20302
20302	I	M	M	F	M	30801, 30802, 20201, 20202
20303	M	M	F	M	M	none
20401	I	M	M	F	M	30801, 30802, 20101, 20102, 20103, 20201, 20202, 20301, 20302, 20303, 20401, 20402, 20403, 20404, 20405
20402	M	M	M	M	M	none
20403	F	M	M	F	M	30801, 30802, 20101, 20102, 20103, 20201, 20202, 20301, 20302, 20303, 20403, 20405
20404	I	M	M	I	M	none
20405	M	M	M	F	M	30801, 30802, 20101, 20102, 20103, 20201, 20202, 20301, 20302, 20303

Notes:

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800040#####.

[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional

M: Moderately impaired

I: Impaired

[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.

[d] Subwatersheds upstream from this subwatershed.

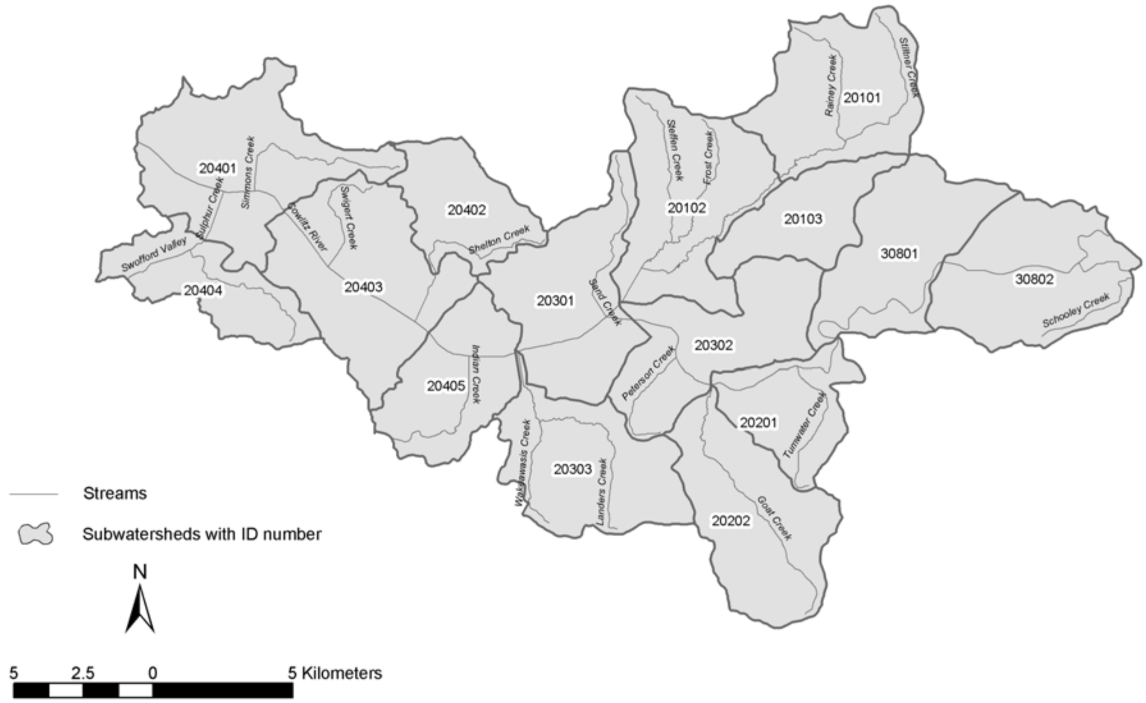


Figure 9-30. Map of the Riffe Lake watershed showing the location of the IWA subwatersheds

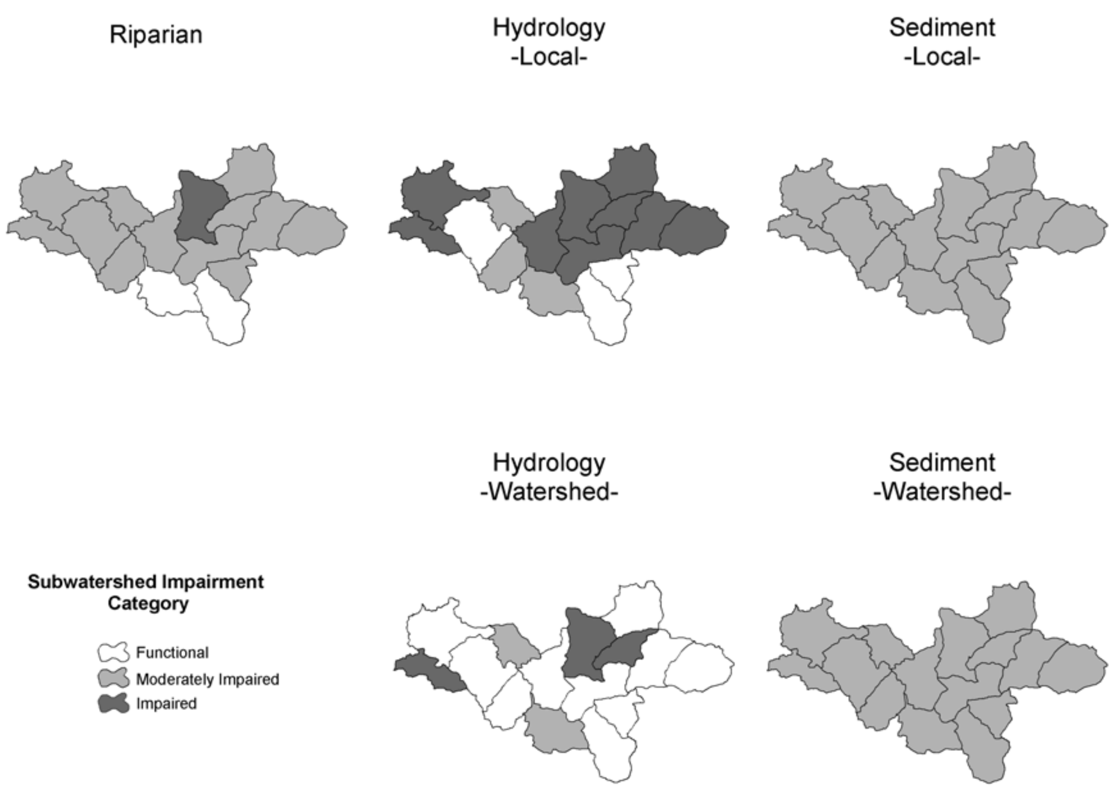


Figure 9-31. IWA subwatershed impairment ratings by category for the Riffe Lake watershed.

9.7.2.1.1 Hydrology

Local hydrologic conditions across the Riffe Lake watershed range from functional to impaired, with subwatersheds rated as functional located in most headwaters areas and along the mainstem of the upper Cowlitz River. Functional hydrologic conditions are located in the southwest portion of the watershed, including Tumwater Creek (20203) and Goat Creek (20202), which lies partly in Mt. St. Helens National Monument. Moderately impaired hydrologic conditions are in the central part of the watershed, including Landers (20303), Shelton (20402), and Indian Creeks (20405). Impaired conditions lie along the Cowlitz mainstem at the west and east ends, and in the Rainey Creek drainage (20101, 20102). Most of these impaired conditions are buffered by the reservoir and therefore do not impact downstream conditions greatly. Potentially important subwatersheds for reintroduction of anadromous fish in this watershed are located along the Cowlitz (10303-10307), which are partially inundated by the storage reservoirs.

The situation for hydrology changes drastically when looking at watershed level conditions, reflecting the influence of conditions in upstream subwatersheds on the IWA analysis. The number of subwatersheds with functional ratings increases from 3 to 10, and the number with impaired ratings drops from 9 to 3.

9.7.2.1.2 Sediment

According to IWA model results, all of the subwatersheds within the Riffe Lake watershed possess moderately impaired sediment process conditions at both the local and watershed levels. These conditions are probably driven by both local and upstream problems. Most of the local sediment condition issues are the same as the hydrology condition issues: low mature vegetation cover, moderately high road densities, and moderately high stream crossing densities. As with hydrology, the downstream effects are minimal due to the reservoir.

Watershed level sediment ratings in subwatersheds along the mainstem Cowlitz do not fully reflect the influence of dams and storage reservoirs on sediment dynamics. These ratings more accurately reflect the influence of local subwatershed level conditions on sediment delivery to the reservoir.

9.7.2.1.3 Riparian

Riparian conditions are primarily moderately impaired throughout the Riffe Lake watershed, with impaired conditions in the Frost-Rainey Creek subwatershed (20502).

9.7.2.2 Predicted Future Trends

9.7.2.2.1 Hydrology

The high percentage of private land ownership, coupled with the amount of logging, development around the reservoir, and road density, indicates that the watershed conditions will either trend stable or gradually degrade over the next 20 years. As long as the dams are in place, protection of the intact hydrologic process will probably only improve local conditions for resident fish and the few fish that reach the reservoir.

9.7.2.2.2 Sediment

Given that most of this area will be actively managed as timberland, the trend in sediment conditions is expected to remain relatively constant over the next 20 years.

9.7.2.2.3 Riparian Condition

Riparian conditions are predicted to remain stable, with a gradual trend towards improvement as improved forestry and road management practices are more broadly implemented on private timber lands.

9.7.3 Cispus River Watershed

The Cispus River watershed is located in the eastern half of WRIA 26, in the northeast portion of the region. The Cispus River originates on the flanks of Mt. Adams and the higher peaks along the Cascade Crest. The watershed is comprised of 37 subwatersheds covering a total of approximately 278,800 acres (436 sq mi). Principal tributaries in the watershed include the mainstem Cispus River, and the NF Cispus River. The entire drainage is located upstream of the Cowlitz Falls Dam. Currently, the system of dams blocks all natural upstream passage and downstream migration. Migrants are captured at the Cowlitz Falls Dam and transported around the dams. The vast majority of the watershed lies within the GPNF, with significant portions of the headwaters in the Mt. Adams and Goat Rocks Wilderness Areas.

The Cispus River watershed is primarily a high elevation, snow dominated system. Only 13% lies in the rain-on-snow zone, with the remainder at higher elevation. Natural erodability within the watershed is low. Twenty-one subwatersheds are higher elevation headwaters subwatersheds. Twelve subwatersheds are defined by moderate size mainstem rivers flowing through higher elevation granitic rocks with low/moderate erodability levels. Three subwatersheds are characterized by large mainstem rivers with low/moderate natural erodability levels, and one subwatershed is classified as a lowland, rain-dominated system.

9.7.3.1 Results and Discussion

IWA results were calculated for all subwatersheds in the Cispus River watershed. IWA results are calculated at the local level (i.e., within subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). IWA results for each subwatershed are presented in Table 9-6. A reference map showing the location of each subwatershed in the basin is presented in Figure 9-32. Maps of the distribution of local and watershed level IWA results are displayed in Figure 9-33. The majority of subwatersheds are functional to moderately impaired at the local level for all three watershed processes, with only one of the subwatersheds having impaired sediment conditions, and none having impaired hydrologic or riparian conditions. Watershed level results for hydrology and sediment are generally similar to the local level results, with some locally moderately impaired subwatersheds rated functional due to the buffering effects of upstream drainage areas.

Table 9-6. Summary of IWA results for the Cispus River watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
40101	M	M	M	M	M	none
40102	F	M	F	F	M	none
40201	F	F	F	F	F	none
40301	F	M	F	F	F	40101, 40102, 40201
40302	F	F	M	F	F	40101, 40102, 40201, 40301
40401	M	M	F	M	F	40402
40402	M	F	M	M	F	none
40501	F	M	F	F	F	40502
40502	M	F	M	M	F	none
40601	F	M	M	F	M	40602
40602	F	M	F	F	M	none
40701	F	F	M	F	F	none
40702	F	F	F	F	F	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40701
40703	F	F	F	F	M	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704
40801	F	F	M	F	F	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704, 40802
40802	F	F	M	F	M	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704
40901	M	M	F	F	M	40902, 40903, 40904
40902	M	M	M	M	M	none
40903	M	M	M	M	M	40902, 40904
40904	M	F	M	M	F	40902
50101	F	M	M	F	M	50102
50102	M	I	M	M	I	none
50201	F	M	M	F	M	50101, 50102, 50202, 50203, 50204, 50205
50202	F	M	F	F	M	50203, 50204, 50205
50203	F	M	M	F	M	none
50204	F	M	F	F	M	50203, 50205
50205	F	M	M	F	M	none
50301	M	M	M	F	F	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704, 40801, 40802, 40901, 40902, 40903, 40904

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
50302	M	M	M	F	M	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704, 40801, 40802, 40901, 40902, 40903, 40904, 50101, 50102, 50201, 50202, 50203, 50204, 50205, 50301
50401	F	M	F	F	M	none
50501	F	M	F	M	M	50502, 50503
50502	M	M	F	M	M	50503
50503	M	M	M	M	M	none
50601	M	M	M	M	M	none
50602	M	M	F	F	M	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704, 40801, 40802, 40901, 40902, 40903, 40904, 50101, 50102, 50201, 50202, 50203, 50204, 50205, 50301, 50302, 50401, 50501, 50502, 50503, 50601, 50602
50701	M	M	M	F	M	40101, 40102, 40201, 40301, 40302, 40401, 40402, 40501, 40502, 40601, 40602, 40701, 40702, 40703, 40704, 40801, 40802, 40901, 40902, 40903, 40904, 50101, 50102, 50201, 50202, 50203, 50204, 50205, 50301, 50302, 50401, 50501, 50502, 50503, 50601, 50602, 50702
50702	F	M	M	F	M	none

Notes:

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800040#####.

[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional

M: Moderately impaired

I: Impaired

[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.

[d] Subwatersheds upstream from this subwatershed.

Figure 9-32. Map of the Cispus watershed showing the location of the IWA subwatersheds.

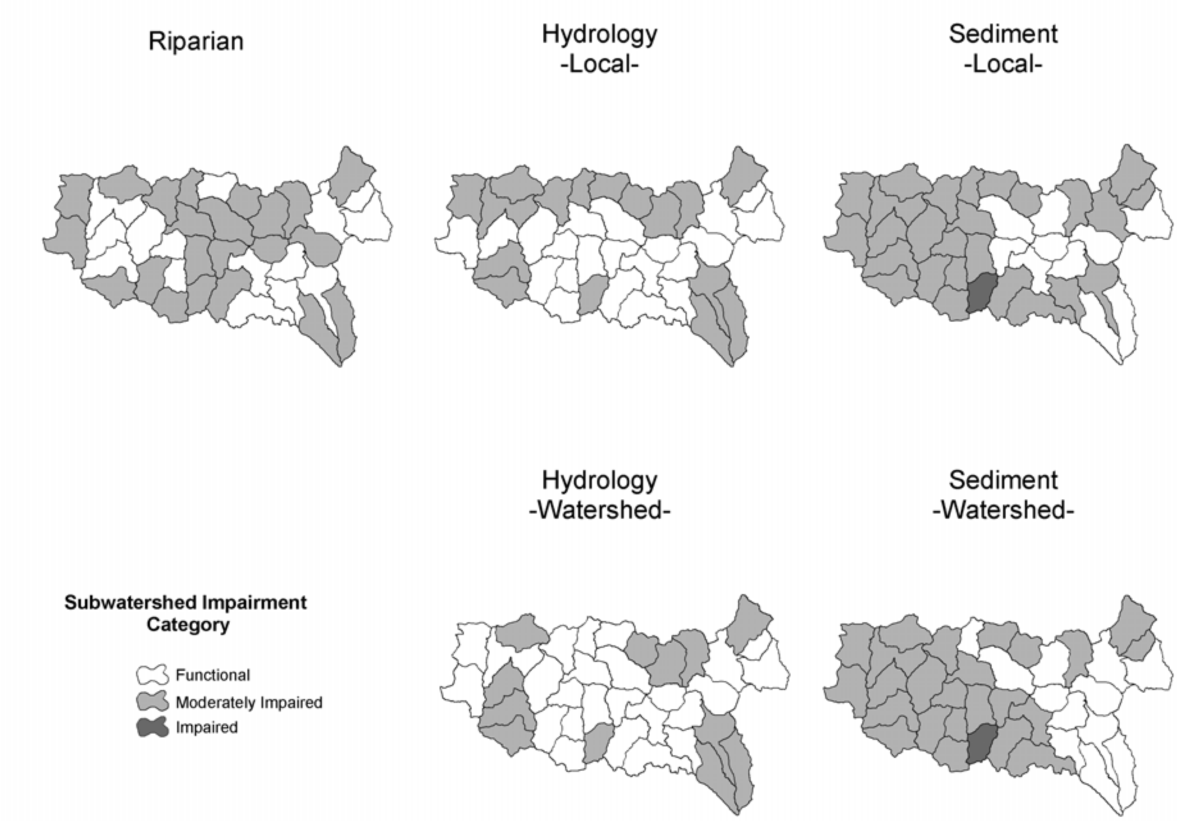


Figure 9-33. IWA subwatershed impairment ratings by category for the Cispus watershed.

9.7.3.1.1 Hydrology

Hydrologic conditions across the Cispus River watershed range from functional to moderately impaired, with functional subwatersheds located in most headwaters areas and along the mainstem of the Cispus River. Subwatersheds rated moderately impaired include the upper NF Cispus (40902-40904), Iron Creek (50501-50503), and Muddy Creek (40401, 40402), upper Adams Creek (40502) and Goat Creek (40101). The Muddy Fork, Adams Creek and Goat Creek subwatersheds are all located in Wilderness Areas, and originate in high elevation areas above the tree line. Therefore, hydrologic conditions within these subwatersheds are expected to be functional as opposed to moderately impaired. Hydrologic conditions in the Cispus and its smaller tributaries subwatersheds, including Yellowjacket Creek, are in good condition. As shown in Figure 9-33, the relatively intact hydrologic conditions in the Cispus headwaters appear to buffer hydrologic conditions in the mainstem subwatersheds and the lower areas of the NF.

9.7.3.1.2 Sediment

The majority of subwatersheds in the Cispus watershed possess moderately impaired sediment conditions. Functional sediment conditions at both the local and watershed levels can be found in headwaters subwatersheds, especially in the western portion of the watershed above the mouth of Adams Creek (40501) and Orr Creek (40702). Sediment condition ratings trend towards moderately impaired on a downstream gradient. The subwatershed encompassing the upper reaches of McCoy Creek (50102) is rated impaired for sediment conditions at the local and watershed level.

Within the NF Cispus River drainage (40901-40904), three out the four subwatersheds possess moderately impaired sediment conditions. Subwatershed 40904, which includes Timothy Creek, is functional with respect to sediment. The other subwatersheds in the drainage are moderately impaired for sediment for many of the same reasons they were moderately impaired for hydrology, moderate to high unsurfaced road densities in sensitive areas (e.g., steep slopes with erodable geology).

Except for a few headwater subwatersheds such as Camp Creek (50301), most of the middle and lower mainstem Cispus watershed is rated moderately impaired with respect to sediment. The reach between Iron Creek and the North Fork lies downstream from moderately impaired subwatersheds including the North Fork drainage, Yellowjacket Creek drainage (50201-50205, 50101-50102), Greenhorn Creek subwatershed (50401) and Woods Creek subwatershed (50601) Most of these subwatersheds have low natural erodability ratings, ranging from 1-21. Road densities in most of these subwatersheds are moderate to low, usually falling between 2-3 mi/sq mi. Stream crossings and percent of mature forest cover vary, but they also tend to be moderate to low.

9.7.3.1.3 Riparian

Riparian conditions are rated functional to moderately impaired throughout the Cispus River watershed, with headwater subwatersheds and smaller drainages containing a mix of both conditions. None of the subwatersheds are rated as impaired. It is important to note that in many subwatersheds rated as moderately impaired, stream channels originate above the treeline and limited riparian vegetation is a natural condition (e.g., the headwaters of the Muddy Fork and Adams Creek on the flanks of Mt. Adams). Many of the functional riparian subwatersheds are located in the eastern portion of the watershed in wilderness, where several subwatersheds are rated functional for all three watershed processes. Conditions become more unfavorable (moderately impaired) as you move downstream. However, even in the upper-most mainstem

Cispus (40101) and the Muddy Fork Cispus (40401, 40402), there are moderately impaired subwatersheds with respect to riparian condition.

Riparian conditions in the NF Cispus and mainstem Cispus subwatersheds (40901-40904) are primarily moderately impaired, except for the Swede-Irish Creeks subwatershed (40901), which is rated functional. Riparian ratings for the subwatersheds containing important fish habitat reaches of the mainstem Cispus River (50301, 50302, 50602) are also primarily moderately impaired.

9.7.3.2 Predicted Future Trends

9.7.3.2.1 Hydrology

Nearly all of the land area in the Cispus River watershed lies within GPNF, and is managed by the USFS. Wetland area in the uplands of the Cispus River is limited. Hydrologically mature forest cover in these subwatersheds is generally higher than in other areas of the region (averaging 60%) and road densities are low to moderate (28 subwatersheds <3 mi/sq mi). Due to the high percentage of public land ownership, forest cover within these subwatersheds is predicted to generally mature and improve. Based on this information, hydrologic conditions are predicted to trend stable or improve gradually over the next 20 years.

Other streams referred to in the LFA include Greenhorn Creek (50401), Iron Creek (50501-50503), Orr Creek (40702), and Woods Creek (50601) (Wade 2000). Orr and Greenhorn Creeks are headwaters tributaries, and are characterized by functional hydrologic conditions. The subwatersheds in the Iron Creek drainage and the Woods Creek subwatershed are characterized by moderately impaired hydrologic conditions. All of these subwatersheds have moderate to high road densities (3.0-4.4 mi/sq mi), and three out of four of these subwatersheds have moderately high stream crossing densities. Given the high road densities and the public land ownership, hydrologic conditions in these subwatersheds will probably remain constant or improve gradually over the next 20 years.

9.7.3.2.2 Sediment

Timber harvesting will continue, but due to public ownership it will be relatively modest into the foreseeable future, and impacts will be mitigated by improved forestry and road management practices. Impacts resulting from recreational uses, however, are likely to increase with growing population pressures. Considering these circumstances, the trend in sediment conditions is expected to remain relatively constant or to slightly improve over the next 20 years.

9.7.3.2.3 Riparian Condition

Given the large proportion of public land ownership throughout the Cispus River watershed, and the assumption that the trend for hydrologic recovery in these subwatersheds will also benefit riparian conditions, the predicted trend is for general improvement over the next 20 years. The generally low streamside road densities in the Cispus watershed indicate generally good potential for riparian recovery.

9.7.4 Upper Cowlitz

The Upper Cowlitz River watershed is located in the eastern half of WRIA 26, in the northeast portion of the region. The watershed is comprised of 54 subwatersheds covering a total of approximately 364,000 acres (564 sq mi). The northern portion of the watershed lies within Mt. Rainier National Park and the Tatoosh Wilderness Area, and the eastern portion comprises the Goat Rocks Wilderness. The remainder of the Upper Cowlitz River Watershed lies within the GPNF. Principal tributaries in the watershed include the Muddy and Clear Forks of the Cowlitz River, the Ohanapecosh River, Silver Creek, and Skate Creek. The entire drainage is located upstream of the Cowlitz Falls Dam. Currently, the system of dams blocks all natural upstream passage and downstream fish migration. Migrants are currently transported around the Dams.

The Upper Cowlitz River watershed is primarily a high elevation system, with only 16% lying in the rain-on-snow zone. Mature forest cover in these subwatersheds averages 70% and the average road density is moderate in general (3 mi/sq mi), although there are six subwatersheds with densities greater than 5 mi/sq mi. Natural erodability within the watershed is low. Thirty-four subwatersheds are higher elevation headwaters. Twelve subwatersheds are moderate size mainstem rivers, including the Ohanapecosh River and the lower Clear and Muddy Forks of the Cowlitz, which flow through higher elevation volcanic rocks with low natural erodability levels. Seven subwatersheds are large mainstem rivers such as the Cowlitz mainstem, with low/moderate natural erodability levels. One subwatershed, Siler Creek (30701), is classified as a lowland, rain dominated, and small tributary stream.

9.7.4.1 Results and Discussion

IWA results were calculated for all subwatersheds in the Upper Cowlitz River watershed. IWA results are calculated at the local level (i.e., within subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). IWA results for each subwatershed are presented in Table 9-7. A reference map showing the location of each subwatershed in the basin is presented in Figure 9-34. Maps of the distribution of local and watershed level IWA results are displayed in Figure 9-35. The majority of subwatersheds are functional to moderately impaired at the local level for all three watershed processes, although eight are impaired with respect to hydrology, one is impaired for sediment and one is impaired with respect to riparian conditions. Functional hydrology, sediment, and riparian conditions occur mostly in headwaters and medium-sized tributaries of the Upper Cowlitz originating in the wilderness areas and Mt. Rainier National Park, concentrated above the Cowlitz-Muddy Fork confluence (20201). Results for watershed level conditions are generally similar.

Table 9-7. IWA results for the Upper Cowlitz River watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
10101	F	F	F	F	F	none
10102	F	M	F	F	F	10101, 10103
10103	F	F	F	F	F	none
10201	M	F	M	M	F	none
10202	M	F	M	M	F	none
10203	F	F	F	F	F	10201, 10202
10204	F	F	F	F	F	none
10205	F	M	F	F	F	10201, 10202, 10203, 10204
10206	F	F	F	F	F	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205,
10301	F	M	F	F	M	none
10302	M	M	F	F	F	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10303, 10304, 10305, 10306, 10307
10303	F	F	F	F	F	10301, 10304, 10305, 10306, 10307
10304	F	F	F	F	F	none
10305	F	F	F	F	F	none
10306	F	F	F	F	F	10304, 10305
10307	F	M	F	F	M	none
10401	M	M	I	M	M	none
10402	M	I	M	M	I	none
10403	F	F	M	F	F	none
10404	F	F	M	M	F	10401, 10402, 10403
10405	F	F	F	M	F	10401, 10402, 10403, 10404
20101	F	F	F	F	M	none
20102	F	M	M	F	M	none
20201	M	M	M	F	M	20102
20202	F	M	F	F	M	none
20301	M	M	M	M	M	none
20302	F	M	M	F	M	20301
20401	F	F	M	F	F	none
20402	M	F	F	M	F	none
20403	F	M	M	F	F	20401, 20402
20501	F	F	M	F	F	20502, 20503, 20504
20502	F	M	F	F	M	none
20503	F	F	M	F	F	none
20504	F	M	F	F	M	none
20601	I	M	M	F	F	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403
20602	I	M	M	I	M	none

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
30101	F	M	M	F	M	30102
30102	F	M	M	F	M	none
30201	I	M	M	I	M	none
30202	F	M	F	M	M	30201
30301	F	M	M	F	F	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403, 20501, 20502, 20503, 20504, 20601, 20602, 30101, 30102, 30201, 30202
30302	F	M	M	F	F	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403, 20501, 20502, 20503, 20504, 20601, 20602, 30101, 30102, 30201, 30202, 30301
30303	F	M	M	F	M	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403, 20501, 20502, 20503, 20504, 20601, 20602, 30101, 30102, 30201, 30202, 30301, 30302
30401	M	M	M	F	M	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403, 20501, 20502, 20503, 20504, 20601, 20602, 30101, 30102, 30201, 30202, 30301, 30302, 30303
30402	F	F	M	F	M	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403, 20501, 20502, 20503, 20504, 20601, 20602, 30101, 30102, 30201, 30202, 30301, 30302, 30303, 30401
30501	I	M	M	I	M	none
30502	M	M	M	M	M	none
30503	I	M	M	I	M	30504

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
30504	M	F	M	I	M	30502
30505	I	M	M	I	M	none
30506	M	M	M	I	M	30501, 30502, 30503, 30504, 30505
30601	I	M	M	I	M	none
30602	I	M	M	F	M	10101, 10102, 10103, 10201, 10202, 10203, 10204, 10205, 10206, 10301, 10302, 10303, 10304, 10305, 10306, 10307, 10401, 10402, 10403, 10404, 10405, 20101, 20102, 20201, 20202, 20301, 20302, 20401, 20402, 20403, 20501, 20502, 20503, 20504, 20601, 20602, 30101, 30102, 30201, 30202, 30301, 30302, 30303, 30401, 30402, 30501, 30502, 30503, 30504, 30505, 30506, 30601, 30602, 30701,
30701	M	M	M	M	M	none

Notes:

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800040#####.

[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional

M: Moderately impaired

I: Impaired

[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.

[d] Subwatersheds upstream from this subwatershed.

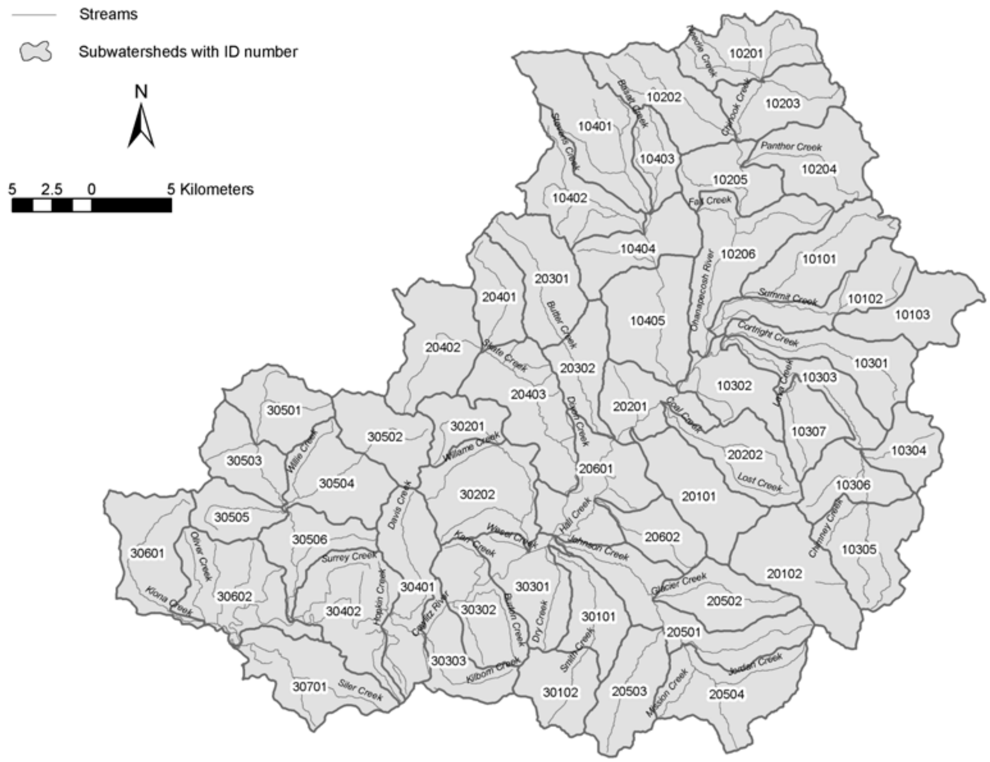


Figure 9-34. Map of the upper Cowlitz basin showing the location of the IWA subwatersheds

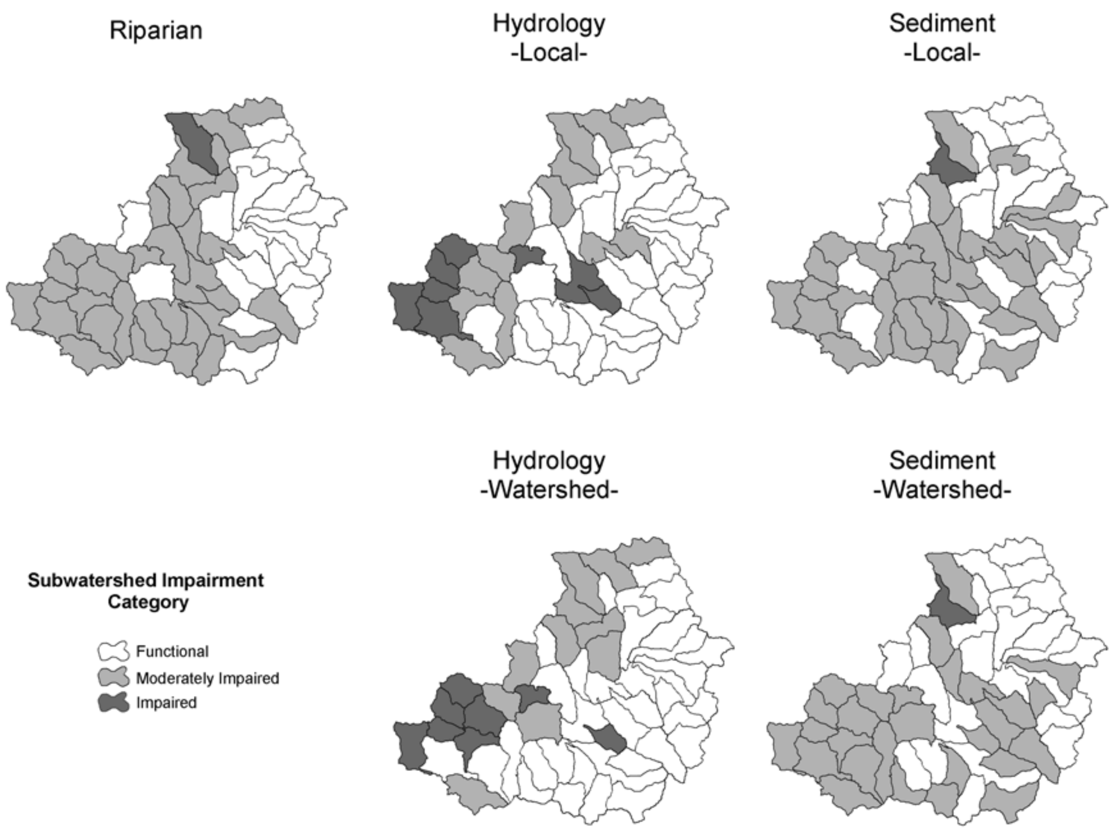


Figure 9-35. IWA subwatershed impairment ratings by category for the Upper Cowlitz basin

9.7.4.1.1 Hydrology

Almost all of the land area in the upper Cowlitz watershed lies within National Forest, National Park, or in designated wilderness area. The percentage of watershed lying in a rain-on-snow zone is low (16%), but could have some impact, especially in the higher elevation subwatersheds, such as the Ohanapecosh River.

Local hydrologic conditions across the Upper Cowlitz River watershed range from functional to impaired, with functional subwatersheds located in most headwaters areas and along the mainstem of the Upper Cowlitz River (30301-30303) downstream of and including the Smith Creek (30101, 30102) and Johnson Creek (20501-20504) drainages. Moderately impaired subwatersheds include the Muddy Fork drainage (10401-10405), Willame Creek (30201, 30202), the Cowlitz downstream of the Cowlitz-Ohanapecosh confluence (10302, 20201), and a few headwater tributary subwatersheds of the Ohanapecosh River (10201, 10202) and Skate Creek (20402). Most of these impaired conditions are buffered by headwater tributaries and by the upstream influences along the Cowlitz mainstem. Impaired areas include the Silver (30501, 30503, 30505) and Kiona Creek (30601) drainages in the southwest portion of the watershed.

The relatively intact local hydrologic conditions in the Upper Cowlitz headwaters appear to buffer hydrologic conditions in the mainstem subwatersheds at the watershed level.

9.7.4.1.2 Sediment

Functional sediment conditions at both the local and watershed levels can be found in headwaters subwatersheds, especially in the eastern portion of the watershed. However, the sediment conditions trend towards moderately impaired on a downstream gradient towards the mainstem Cowlitz at the lower end of the watershed. All of the subwatersheds in the Upper Cowlitz watershed have low natural erodability ratings, averaging 16 on a scale of 0-126. This suggests that these subwatersheds would not be large sources of sediment impacts under disturbed conditions. Except for the Silver Creek drainage, road densities and streamside road densities in these subwatersheds are also relatively low.

9.7.4.1.3 Riparian

Riparian conditions are rated functional to moderately impaired throughout the Upper Cowlitz River watershed. Most of the functional riparian subwatersheds are located in the eastern portion of the watershed, where many subwatersheds are rated functional for all three watershed processes. The majority of headwaters subwatersheds in this portion of the watershed are rated functional. Conditions become more unfavorable (moderately impaired) moving downstream. However, even in the upper-most reaches of the Ohanapecosh River (10201, 10202) and Skate Creek (20401), there are moderately impaired subwatersheds with respect to riparian condition.

9.7.4.2 Predicted Future Trends

9.7.4.2.1 Hydrology

Due to the high percentage of public land ownership, especially protected land, forest cover within these subwatersheds is predicted to generally mature and improve. Wetland area in the uplands of the upper Cowlitz River is limited. Based on this information, hydrologic conditions are predicted to trend stable or improve gradually over the next 20 years.

9.7.4.2.2 Sediment

Given the high percentage of public land ownership in these subwatersheds, and the relatively low level of current impacts, the trend in sediment conditions is expected to remain relatively constant or to slightly improve over the next 20 years.

9.7.4.2.3 Riparian Condition

Based on the assumption that the trend for hydrologic recovery in these subwatersheds will also benefit riparian conditions, the predicted trend is for general improvement over the next 20 years.

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