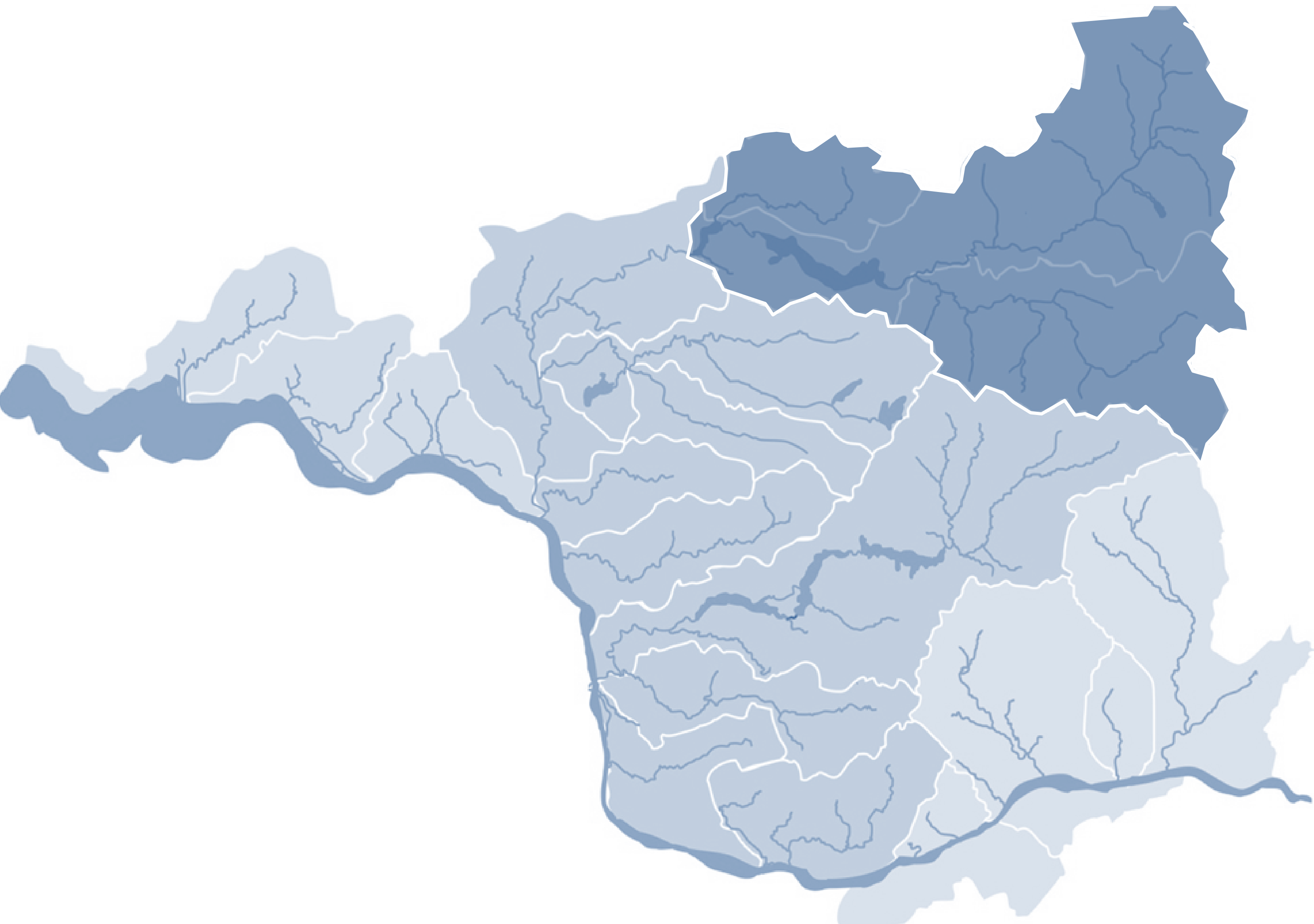
F. UPPER COWLITZ SUBBASIN



F. UPPER COWLITZ SUBBASIN

Tables

Figures

F.1. Executive Summary

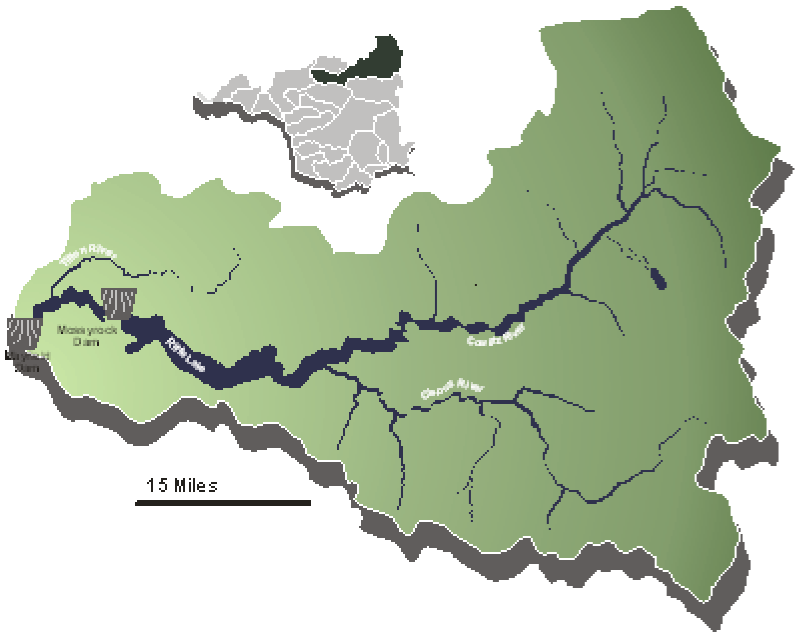


Figure F-1. Map of the Upper Cowlitz River.

This Plan describes a vision, strategy, and actions for recovery of listed salmon, steelhead, and trout species to healthy and harvestable levels, and mitigation of the effects of the Columbia River Hydro system in Washington lower Columbia River subbasins. Recovery of listed species and hydropower mitigation is accomplished at a regional scale. This plan for the Upper Cowlitz Basin describes implementation of the regional approach within this basin, as well as assessments of local fish populations, limiting factors, and ongoing activities that underlie local recovery or mitigation actions. The plan was developed in a partnership between the Lower Columbia Fish Recovery Board (LCFRB), Northwest Power and Conservation Council (NPCC), federal agencies, state agencies, tribal nations, local governments, and others.

The Cowlitz River Basin is one of twelve major NPCC subbasins in the Washington portion of the Lower Columbia Region. The upper portion of the subbasin (above Mayfield Dam) historically supported thousands of fall Chinook, spring Chinook, coho, and winter steelhead. Today, numbers of naturally spawning salmon and steelhead are limited to the adult returns associated with a program to reintroduce natural spawning salmon and steelhead above the hydrosystem. Chinook, chum, coho and steelhead have been listed as Threatened under the Endangered Species Act. The decline has occurred over decades and the reasons are many. Hydropower development and operation have altered flows, habitat, and blocked passage of salmon and steelhead to their historical habitats. Passage of salmon and steelhead around the dams and reservoirs in the Upper Cowlitz Basin will need to be sufficiently adequate to ensure viability levels that meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the basin. In portions of the basin, habitat quality has been reduced by residential development, agriculture, and forestry practices. Key habitats have been isolated or eliminated by channel modifications and through diking, filling, and draining of floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has reduced productivity. Fish are harvested in fresh and saltwater fisheries.

In recent years, agencies, local governments, and other entities have actively addressed the various threats to salmon and steelhead, but much remains to be done. One thing is clear: no single threat is responsible for the decline in these populations. All threats and limiting factors must be reduced if recovery is to be achieved. An effective recovery plan must also reflect a realistic balance within physical, technical, social, cultural and economic constraints. The decisions that govern how this balance is attained will shape the region's future in terms of watershed health, economic vitality, and quality of life.

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact Upper Cowlitz River fish populations. Specific strategies, measures, actions and priorities have been developed to address these threats and limiting factors. The specified strategies identify the best long term and short term avenues for achieving fish restoration and mitigation goals. While it is understood that data, models, and theories have their limitations and growing knowledge will certainly spawn new strategies, the LCFRB is confident that by implementation of the recommended actions in this plan, the population goals in the Upper Cowlitz River Basin can be achieved. Success will depend on implementation of these strategies at the program and project level. It remains uncertain what level of effort will need to be invested in each area of impact to ensure the desired result. The answer to the question of precisely how much is enough is currently beyond our understanding of the species and ecosystems and can only be answered through ongoing monitoring and adaptive management against the backdrop of what is socially possible.

F.1.1. Key Priorities

Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the Upper Cowlitz Basin. The following list identifies the most immediate priorities.

1. Provide Upstream and Downstream Passage Through the Cowlitz Basin Hydrosystem

The system of dams on the mainstem Cowlitz River, beginning with Mayfield Dam at River Mile 52, block all volitional access to the upper basin, consisting of up to 300 or more miles of habitat for anadromous species. Juvenile and adult fish are currently trucked around the system of dams and reservoirs. Tacoma Power and Lewis County PUD currently operate the facilities in accordance with licenses with the Federal Energy Regulatory Commission (FERC), which rely on an adaptive management approach to implementing passage improvements. Partners in the relicensing process must ensure that adequate measures are taken to restore self-sustaining natural production of ESA-listed salmonids in the Upper Cowlitz Basin.

2. Protect Intact Forests in Headwater Basins

The Cispus Basin, Upper Mainstem Cowlitz Basin, and many headwater tributaries are in National Forest Lands, with a portion of the northern basin lying within Mt. Rainier National Park. These lands are heavily forested with relatively intact landscape conditions that support functioning watershed processes. Streams are unaltered, road densities are low, and riparian areas and uplands are characterized by mature forests. Existing legal designations and management policy are expected to continue to offer protection to these lands.

3. Manage Forest Lands to Protect and Restore Watershed Processes

Much of the Tilton, reservoir tributary basins, and the lower portion of the Upper Mainstem Basin are managed for commercial timber production and have experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing sediment, and reducing riparian zones. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Habitat Conservation Plan, State Forest Practices Rules, and the Northwest Forest Plan are expected to dramatically improve conditions by restoring passage, protecting riparian conditions, reducing sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead and coho.

4. Manage Growth and Development to Protect Watershed Processes and Habitat Conditions

The human population in the basin is relatively low, but it is projected to grow by at least twenty percent in the next twenty years. Population growth will primarily occur in lower river valleys and along the major stream corridors. This growth will result in the conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions. These changes will provide a variety of risks and opportunities for preserving the rural character and local economic base while also protecting and restoring natural fish populations and habitats.

5. Restore Valley Floodplain Function and Stream Habitat Diversity

Much of the mainstem Cowlitz (between Lake Scanewa and Packwood) and the Tilton River (near Morton, WA) are used for agriculture and residential development. Dike building and bank stabilization have heavily impacted fish habitat in these areas. Removing or modifying channel control and containment structures to reconnect the stream and its floodplain where this is feasible and can be done without increasing risks of substantial flood damage will restore normal habitat-forming processes to reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing. These improvements will be particularly beneficial to spring Chinook and coho. Partially restoring normal floodplain functions will also help control catastrophic flooding and maintain wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and habitats will be protected through local land use ordinances, partnerships with landowners, and the acquisition of land, where appropriate. Restoration will be achieved by working with willing landowners, non-governmental organizations, conservation districts, and state and federal agencies.

6. Hatchery Priorities are Consistent with Conservation Objectives

Hatcheries throughout the Columbia basin historically focused on producing fish for fisheries as mitigation for hydropower development and widespread habitat degradation. Emphasis of hatchery production without regard for natural populations can pose risks to natural population viability. Hatchery priorities must be aligned to conserve natural populations, enhance natural fish recovery, and avoid impeding progress toward recovery while continuing to provide fishery mitigation benefits. The Cowlitz hatchery program will produce and/or acclimate spring Chinook, coho and winter steelhead for use in the Upper Cowlitz Basin. Hatchery fish will be used to supplement natural production in appropriate areas of the basin and adjacent tributary streams, develop a local broodstock to reestablish historical diversity and life history characteristics, and also to provide fishery mitigation in a manner that does not pose significant risk to natural population rebuilding efforts. Fall Chinook releases in the upper Cowlitz have been discontinued as not to interfere with spring Chinook re-introduction efforts

7. Manage Fishery Impacts so they do not Impede Progress Toward Recovery

This near-term strategy involves limiting fishery impacts on natural populations to ameliorate extinction risks until a combination of measures can restore fishable natural populations. There is no directed Columbia River or tributary harvest of ESA-listed Cowlitz River salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some upper Cowlitz River salmon and steelhead are incidentally taken in mainstem Columbia River and ocean mixed stock fisheries for strong wild and hatchery runs of fall Chinook and coho. These fisheries will be managed with strict limits to ensure this incidental take does not threaten the recovery of wild populations including those from the Upper Cowlitz Basin. Steelhead will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Selective fisheries for marked hatchery steelhead and coho (and fall Chinook after mass marking occurs) will be a critical tool for limiting wild fish impacts. State and federal legislative bodies will be encouraged to develop funding necessary to implement mass-marking of fall Chinook, thus enabling a selective fishery with lower impacts on wild fish. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

8. Reduce Out-of-Subbasin Impacts so that the Benefits of In-Basin Actions can be Realized

Upper Cowlitz River salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the subbasin. Human impacts include drastic habitat changes in the Columbia River estuary, effects of Columbia Basin hydropower operation on mainstem, estuary, and nearshore ocean conditions, interactions with introduced animal and plant species, and altered natural predation patterns by northern pikeminnow, birds, seals, and sea lions. A variety of restoration and management actions are needed to reduce these out-of-basin effects so that the benefits of in-basin actions can be realized. To ensure equivalent sharing of the recovery and mitigation burden, impacts in each area of effect (habitat, hydropower, etc.) should be reduced in proportion to their significance to species of interest.

F.2. Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's Upper Cowlitz River Subbasin. The plan addresses subbasin elements of a regional recovery plan for Chinook salmon, chum salmon, coho salmon, steelhead, and bull trout listed as Threatened under the federal Endangered Species Act (ESA). The plan also serves as the subbasin plan for the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program to address effects of construction and operation of the Federal Columbia River Power System.

Development of this plan was led and coordinated by the Washington Lower Columbia Fish Recovery Board (LCFRB). The LCFRB was established by state statue (RCW 77.85.200) in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. It is comprised of representatives from the state legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro project operators, the environmental community, and concerned citizens. A variety of partners representing federal agencies, tribal governments, Washington state agencies, regional organizations, and local governments participated in the process through involvement on the LCFRB, a Recovery Planning Steering Committee, planning working groups, public outreach, and other coordinated efforts.

The planning process integrated four interrelated initiatives to produce a single Recovery/Subbasin Plan for Washington subbasins of the lower Columbia:

- Endangered Species Act recovery planning for listed salmon and trout.
- Northwest Power and Conservation Council (NPCC) fish and wildlife subbasin planning for eight full and three partial subbasins.
- Watershed planning pursuant to the Washington Watershed Management Act, RCW 90-82.
- Habitat protection and restoration pursuant to the Washington Salmon Recovery Act, RCW 77.85.

This integrated approach ensures consistency and compatibility of goals, objectives, strategies, priorities and actions; eliminates redundancy in the collection and analysis of data; and establishes the framework for a partnership of federal, state, tribal and local governments under which agencies can effectively and efficiently coordinate planning and implement efforts.

The plan includes an assessment of limiting factors and threats to key fish species, an inventory of related projects and programs, and a management plan to guide actions to address specific factors and threats. The assessment includes a description of the subbasin, focal fish species, current conditions, and evaluations of factors affecting focal fish species inside and outside the subbasin. This assessment forms the scientific and technical foundation for developing a subbasin vision, objectives, strategies, and measures. The inventory summarizes current and planned fish and habitat protection, restoration, and artificial production activities and programs. This inventory illustrates current management direction and existing tools for plan implementation. The management plan details biological objectives, strategies, measures, actions, and expected effects consistent with the planning process goals and the corresponding subbasin vision.

F.3. Assessment

F.3.1. Subbasin Description

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).

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.

Land Use, Ownership, and 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). The State of Washington owns, and the Washington State Department of Natural Resources (WDNR) manages the beds of all navigable waters within the subbasin. Any proposed use of those lands must be approved in advance by the DNR. A breakdown of land ownership is presented in Figure F-2. Figure F-3 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 F-2. Figure F-3 displays the pattern of land cover / land-use.

Development Trends

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). Population growth will primarily occur in lower river valleys and along the major stream corridors. This growth will result in the conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions.

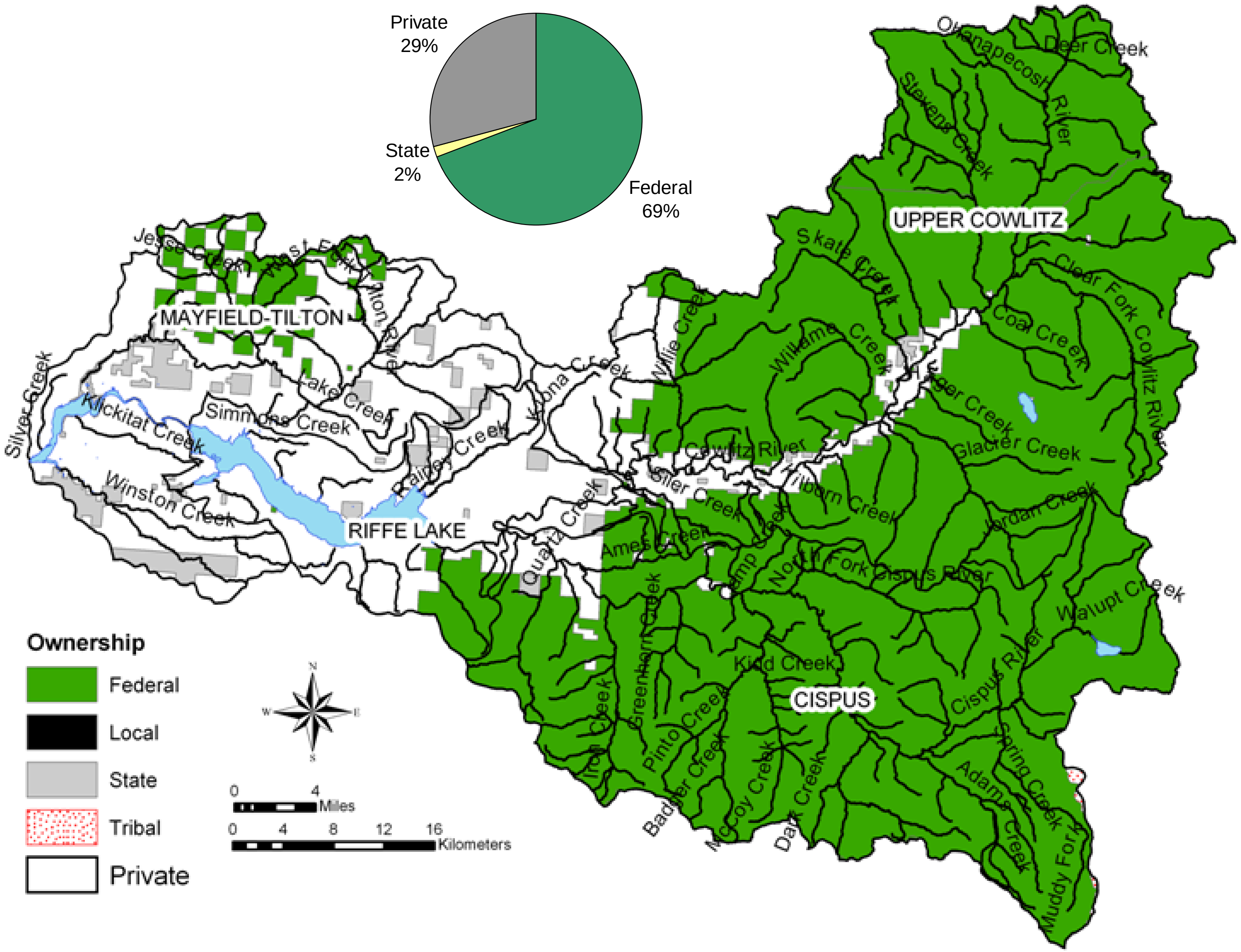


Figure F-2. **Landownership within the Upper Cowlitz basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).**

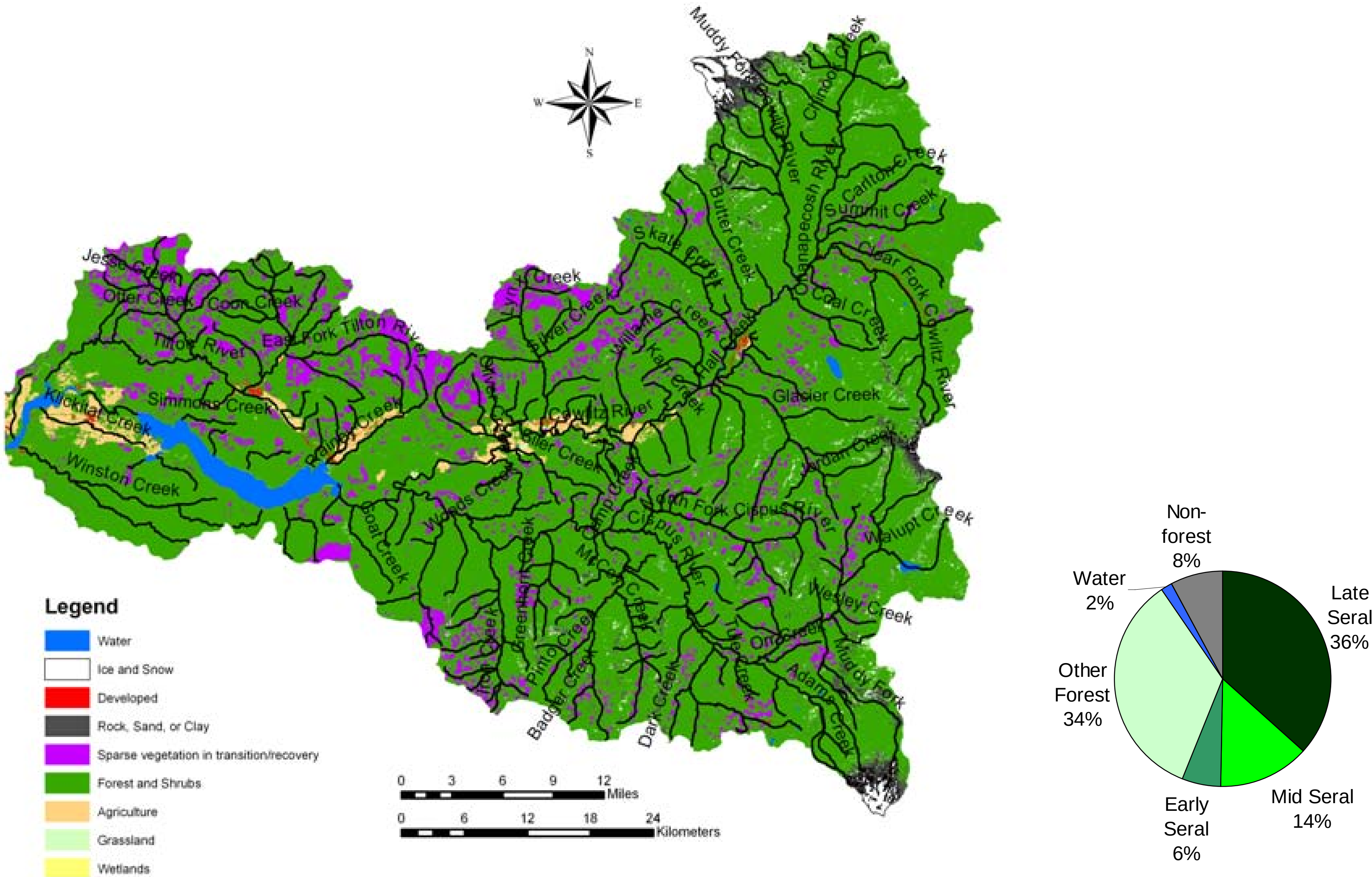


Figure F-3. Land cover within the Upper Cowlitz basin. Vegetation cover (pie chart) derived from Landsat data based on method in Lunetta et al. 1997. Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

F.3.2. Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the Upper Cowlitz Basin. Other species of interest were also identified as appropriate. Species were selected because they are listed under the U.S. Endangered Species Act or because viability or use is significantly affected by hydropower development. The upper Cowlitz ecosystem supports and depends on a wide variety of fish and wildlife in addition to designated species. A comprehensive ecosystem-based approach to salmon and steelhead recovery will provide significant benefits to other native species through restoration of landscape-level processes and habitat conditions. Other fish and wildlife species not directly addressed by this plan are subject to a variety of other Federal, State, and local planning or management activities.

Focal salmonid species in upper Cowlitz River, Cispus, and Tilton watersheds include fall Chinook, spring Chinook, coho and winter steelhead. Bull trout do not occur in the subbasin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table F-1). Extinction risks are significant for all focal species – the current health or viability of is very low for all species. Spring Chinook, coho, and winter steelhead have been reintroduced into the upper Cowlitz habitats in recent years in an effort to reestablish natural salmon and steelhead production. Returns of spring Chinook, coho and winter steelhead include both natural and hatchery produced fish.

Table F-1. Status and goals of focal salmonid and steelhead populations in the Upper Cowlitz subbasin.

		Recovery	Viability		Improve-	Abundance		
Species	Population	Priority[1]	Status[2]	Obj.[3]	Ment[4]	Historic[5]	Current[6]	Target[7]
Fall Chinook (Tule)	U. Cowlitz	Stabilizing	VL	VL	--	28,000	0	--
Spring Chinook	U. Cowlitz	Primary	VL	H+	>500%	22,000	300	1,800
Winter Steelhead	U. Cowlitz	Primary	VL	H	>500%	1,400	<50	500
Coho	U. Cowlitz	Primary	VL	H	>500%	18,000	<50	2,000
Spring Chinook	Cispus	Primary	VL	H+	>500%	7,800	150	1,800
Winter Steelhead	Cispus	Primary	VL	H	>500%	1,500	<50	500
Coho	Cispus	Primary	VL	H	>500%	8,000	<50	2,000
Spring Chinook	Tilton	Stabilizing	VL	VL	0%[8]	5,400	100	--
Winter Steelhead	Tilton	Contributing	VL	L	>500%	1,700	<50	200
Coho	Tilton	Stabilizing	VL	VL	0%[8]	5,600	<50	--

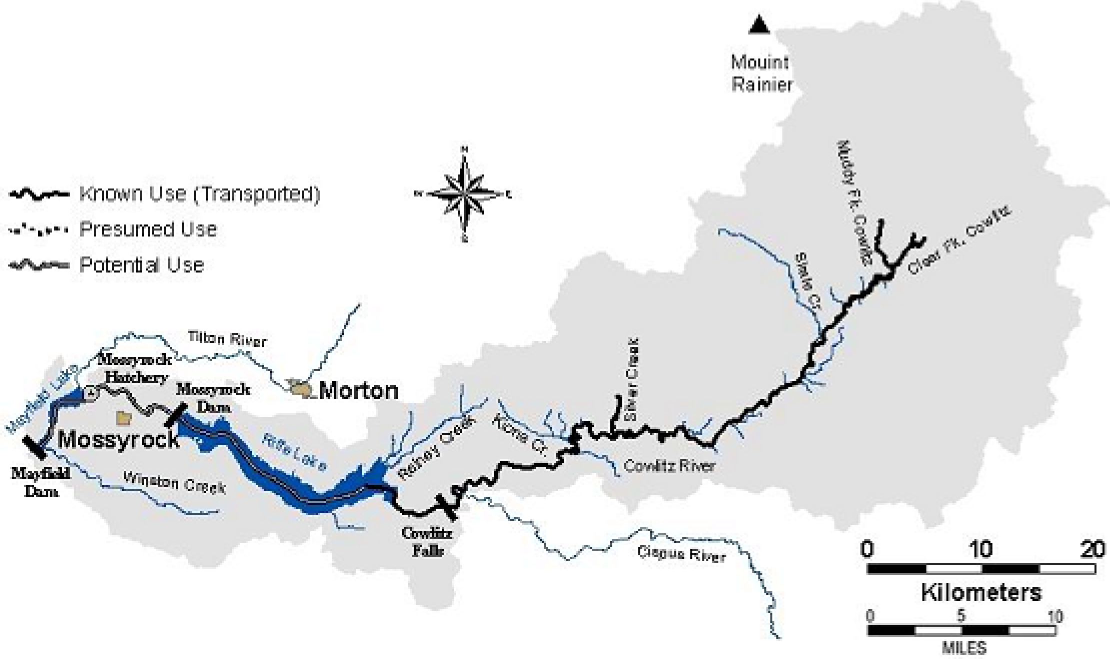
[1] Primary, Contributing, and Stabilizing designations reflect the relative contribution of a population to major population group recovery goals.
[2] Baseline viability is based on Technical Recovery Team viability rating approach.
[3] Viability objective is based on the scenario contribution.
[4] Improvement is the relative increase in population production required to reach the prescribed viability goal
[5] Historical population size inferred from presumed habitat conditions using EDT Model and NMFS back-of-envelope calculations.
[6] Approximate current annual range in number of naturally-produced fish returning to the watershed.
[7] Abundance targets were estimated by population viability simulations based on viability goals.
[8] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.

Other species of interest in the Upper Cowlitz Basin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids. Brief summaries of the population characteristics and status follow. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

Fall Chinook—Cowlitz Subbasin (Upper Cowlitz)

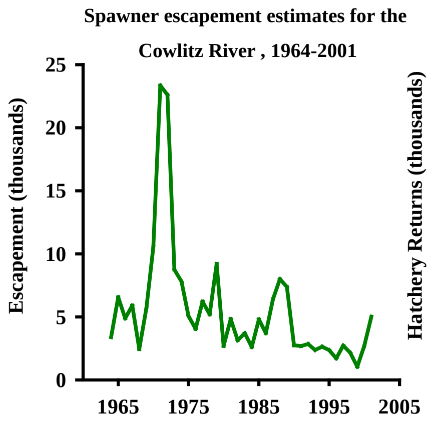
ESA: Threatened 1999	SASSI: Depressed 2002

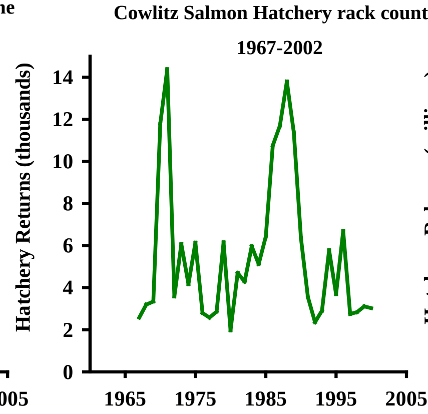
The historical upper Cowlitz adult population is estimated from 24,000-28,000 fish, where they were distributed throughout the upper basin. The natural return was blocked by Mayfield Dam in 1962. Salmon and steelhead were passed over the dam from 1962-66 and hauled to the Tilton and upper Cowlitz from 1967-80, and again beginning in 1994. Fall Chinook are not currently being hauled to the upper Cowlitz to avoid conflict with reintroduction of spring Chinook. Recovery efforts for fall Chinook are currently focused on the lower Cowlitz population.

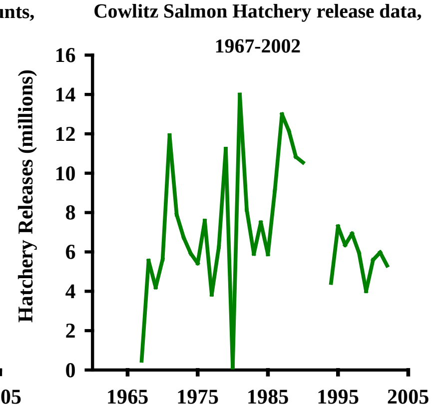


Distribution

- 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

- Baseline risk assessment determined a high to very high risk of extinction for fall Chinook in the upper Cowlitz basin
- 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

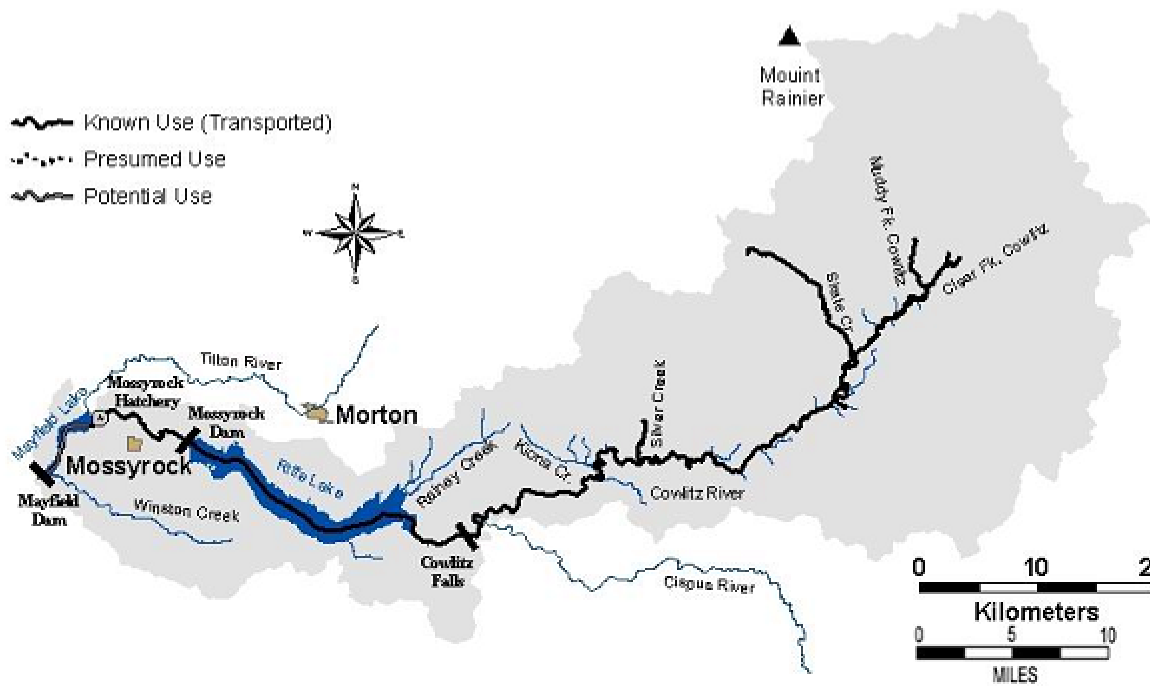
Harvest

- 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 (U.S./Canada), PFMC (U.S. 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

Spring Chinook—Cowlitz Subbasin (Tilton/Cispus)

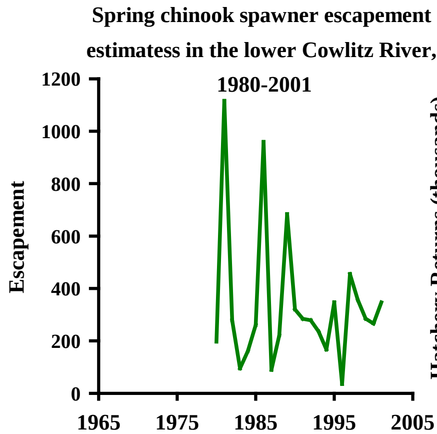
ESA: Threatened 1999	SASSI: Depressed 2002

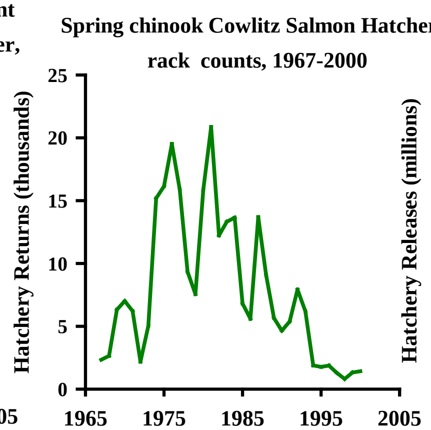
The historical upper Cowlitz adult population is estimated from 35,000-60,000 fish. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Cowlitz origin hatchery produced spring Chinook are utilized for supplementation of natural spring Chinook. Spawning primarily occurs in the mainstem upper Cowlitz above Packwood and in the Cispus River between Iron and East Canyon creeks. Natural spawning occurs between late August and early October. Juveniles typically spend a full rear rearing in the upper Cowlitz and Cispus before migrating. Juveniles are captured at the Cowlitz Falls collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz.

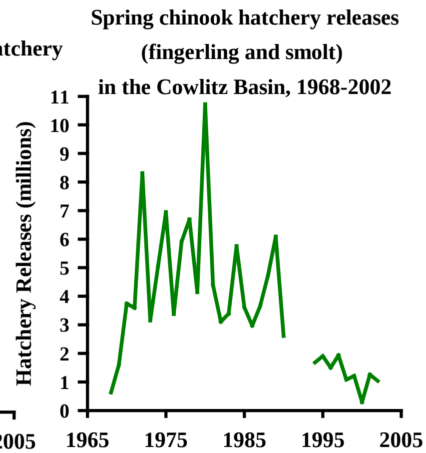


Distribution

- 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

- Baseline risk assessment determined a high to very high risk of extinction for spring Chinook in the upper Cowlitz basin

- 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
- There are an additional 300,000 sub-yearling spring Chinook released above Cowlitz Falls Dam into the upper Cowlitz and Cispus rivers as part of the reintroduction program.

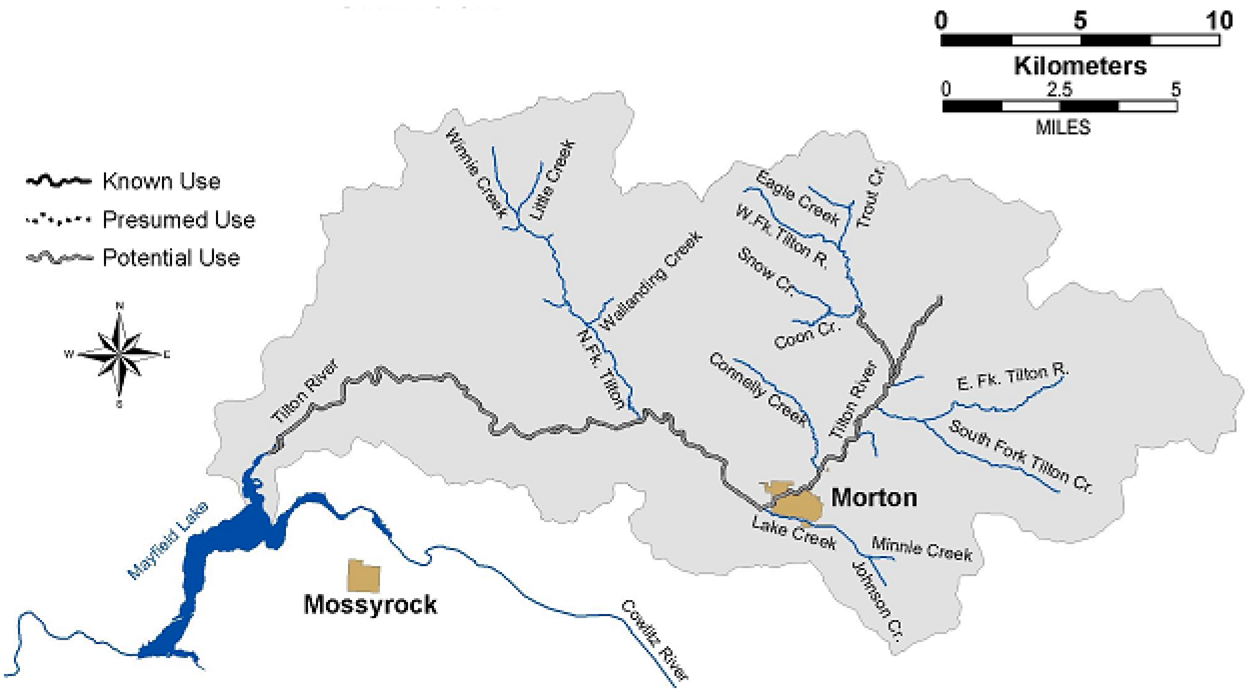
Harvest

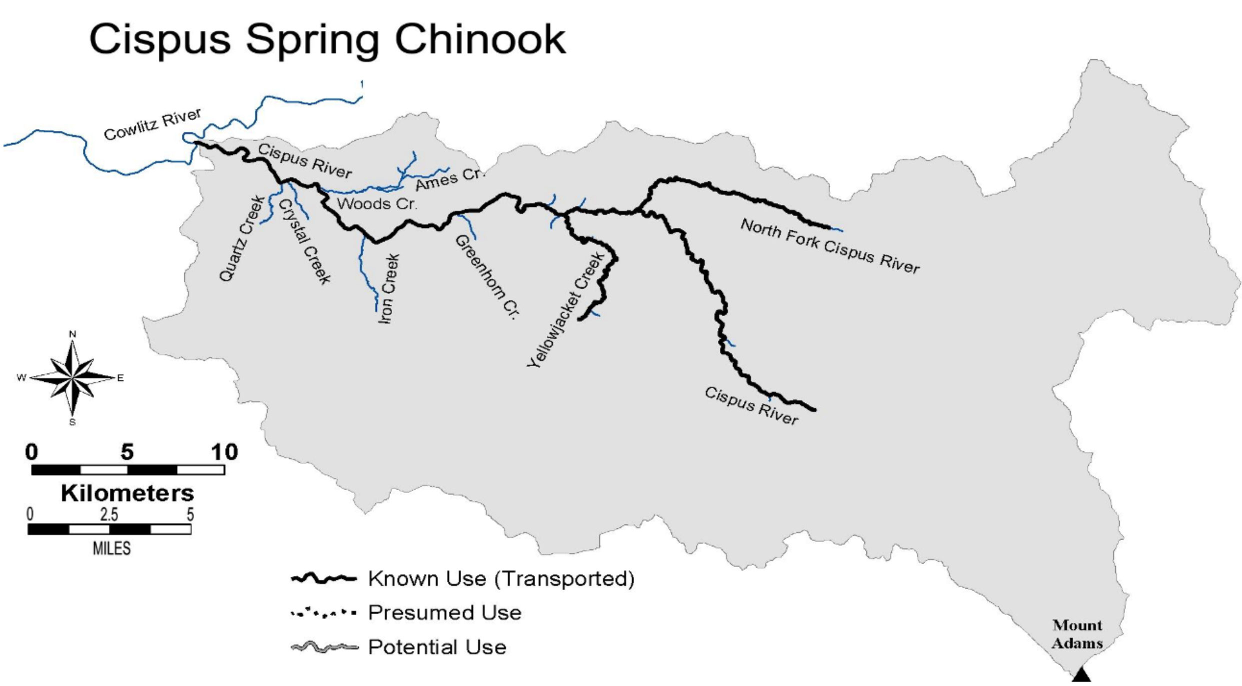
- Cowlitz spring Chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial and sport fisheries
- Coded-wire tag (CWT) data analysis of the 1989-1994 brood years indicates that 40% of the Cowlitz spring Chinook were harvested and 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 Chinook.
- 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

Spring Chinook—Cowlitz Subbasin (Upper Cowlitz)

ESA: Threatened	SASSI Depressed 2002

The historical upper Cowlitz adult population is estimated from 35,000-60,000 fish. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Cowlitz origin hatchery produced spring Chinook are utilized for supplementation of natural spring Chinook. Spawning primarily occurs in the mainstem upper Cowlitz above Packwood and in the Cispus River between Iron and East Canyon creeks. Natural spawning occurs between late August and early October. Juveniles typically spend a full rear rearing in the upper Cowlitz and Cispus before migrating. Juveniles are captured at the Cowlitz Falls collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz





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

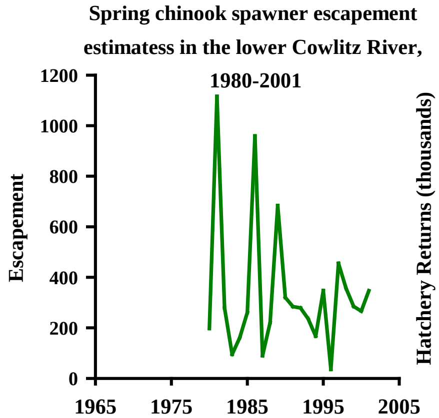
- Spring Chinook enter the Cowlitz River from March through June
- Natural spawning in the Cowlitz River occurs between late August and early October; the peak is usually around mid-September
- Age ranges from 2-year-old jacks to 6-year-old adults, with 4-year-olds the dominant age class (average is 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

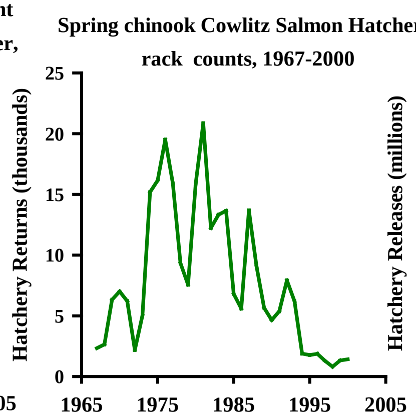
Diversity

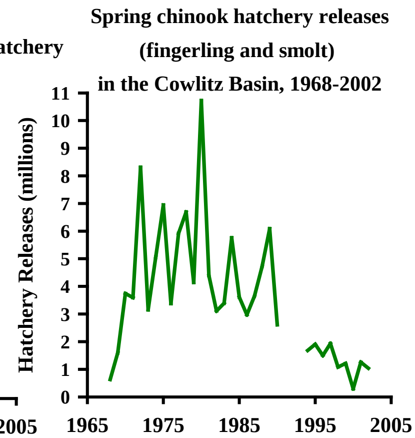
- One of four spring Chinook populations in the Columbia River Evolutionarily Significant Unit (ESU)
- The Cowlitz spring Chinook stock was designated based on distinct spawning distribution and early spawning timing
- Genetic analyses of Cowlitz River Hatchery spring Chinook from 1982 and 1987 determined 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

- Baseline risk assessment determined a high to very high risk of extinction for spring Chinook in the upper Cowlitz basin
- 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
- There are 300,000 sub-yearling spring Chinook released annually above Cowlitz Falls Dam as part of a reintroduction program

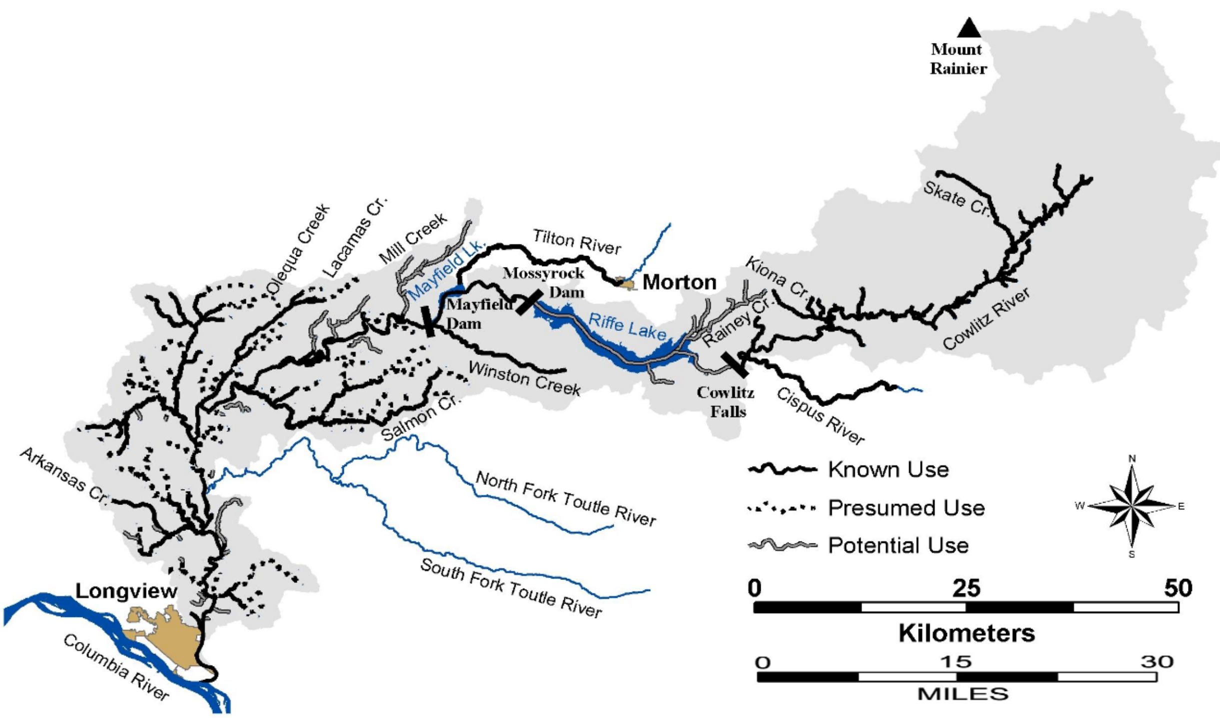
Harvest

- 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

Coho—Cowlitz Subbasin (Upper Cowlitz)

ESA: Threatened 2005	SASSI: Cowlitz—Depressed 2002;

The historical upper Cowlitz adult population is estimated from 20,000-70,000 fish with the majority of returns being late stock which spawn from late November to March. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Cowlitz origin hatchery coho are utilized for supplementation of natural coho. Natural spawning occurs in the mainstem and tributaries of the upper Cowlitz, Cispus, and Tilton rivers. Juvenile rearing occurs upstream and downstream of spawning areas. Juveniles rear for a full year in the Cowlitz Basin before migrating as yearlings in the spring. Juveniles are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz.



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

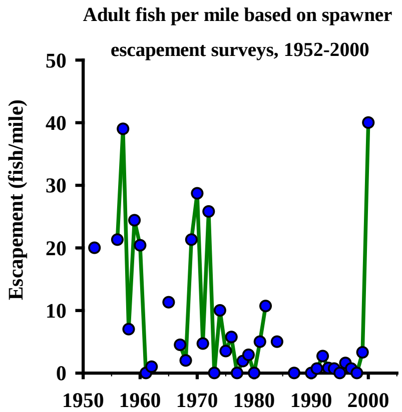
- Late stock (or Type-N) coho are informally considered synonymous with Cowlitz River stock
- Early stock (or Type-S) coho are informally considered synonymous with Toutle River stock
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar

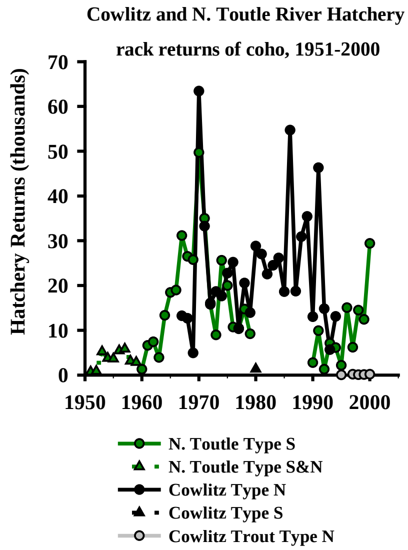
Abundance

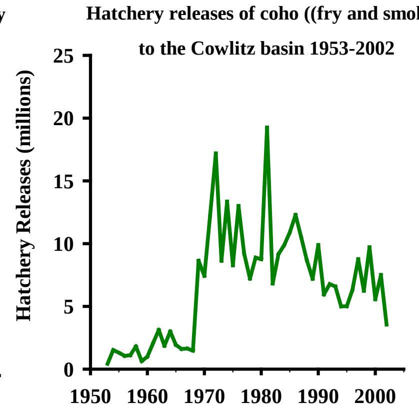
- Cowlitz River wild coho run is a fraction of its historical size
- In 1948, WDF estimated coho escapement to the basin was 77,000; in the early 1950s, escapement to the basin was estimated as 32,500 coho
- Escapement surveys on Olequa Creek from 1952-1990 established a range of 0-40 fish/mile
- Average 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
- Baseline risk assessment determined a high to very high risk of extinction for coho in the upper Cowlitz basin







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. Adult coho are released upstream of the dams to spawn naturally in the upper Cowlitz, Cispus, and Tilton rivers.
- 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

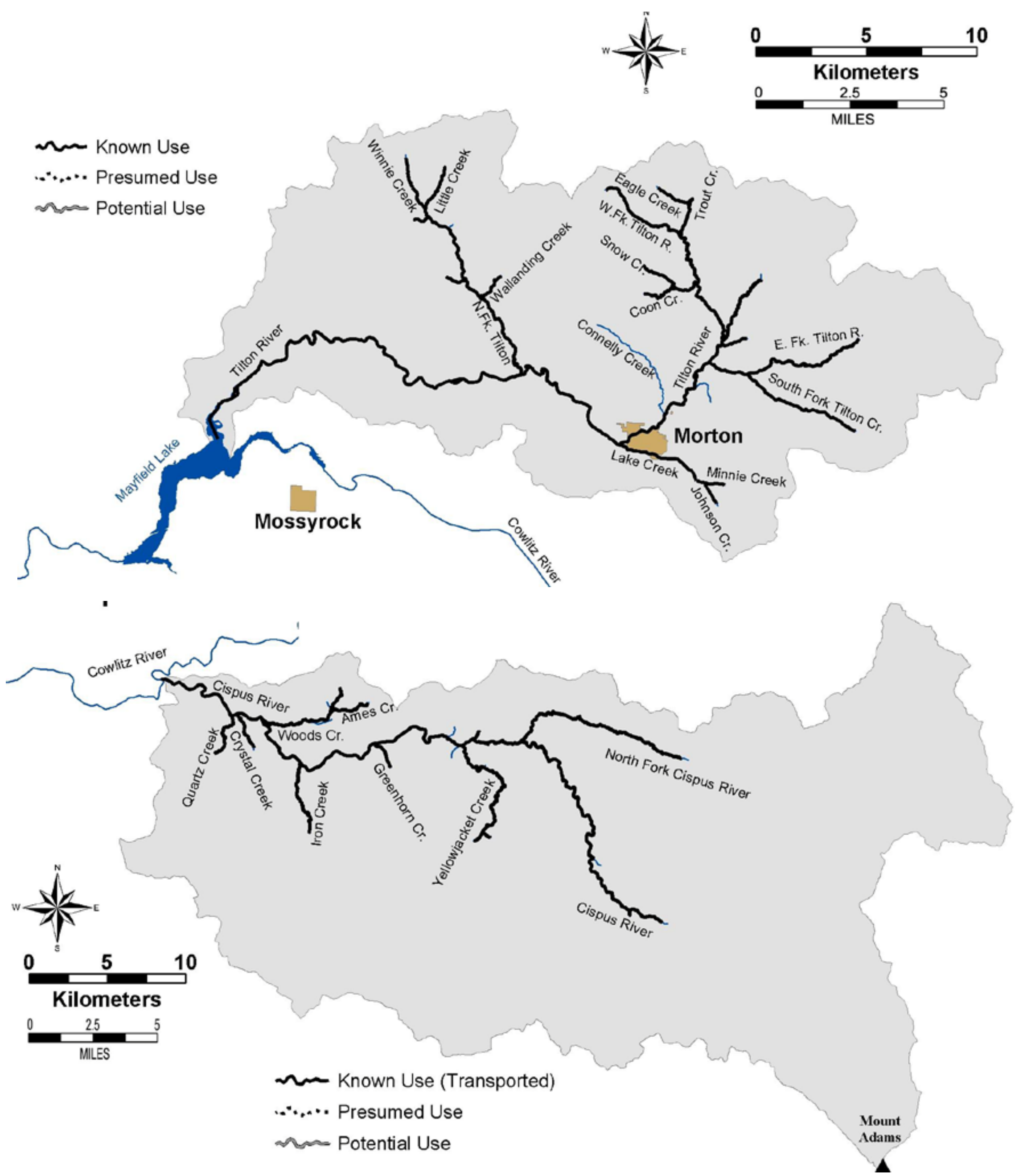
- Until recent years, natural produced coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest of Columbia produced coho ranged from 70% to over 90% from 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound 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

Winter Steelhead—Cowlitz Subbasin (Tilton and Cispus)

ESA: Threatened 1998	SASSI: Unknown 2002

The historical upper Cowlitz adult population is estimated from 2,000-17,000 fish. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Cowlitz origin hatchery produced late spawning winter steelhead are utilized for supplementation of natural winter steelhead. Spawning in the Upper Cowlitz Basin primarily occurs in the mainstem upper Cowlitz near the Muddy Fork and Clear Fork and the Ohanapecosh River, Cispus River, and Tilton River. Spawning time is generally March to June Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Cowlitz Basin in the spring. Juveniles are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz.



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
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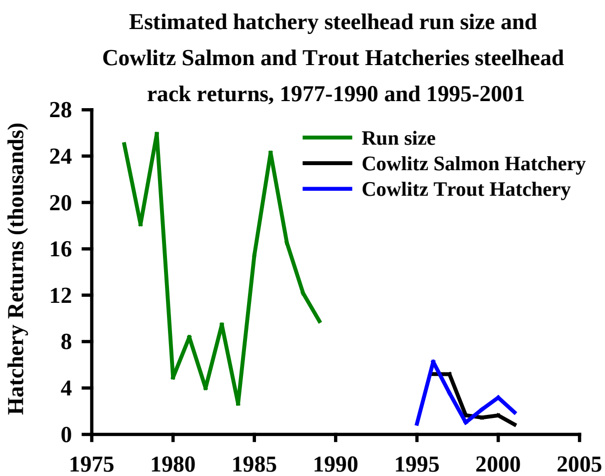
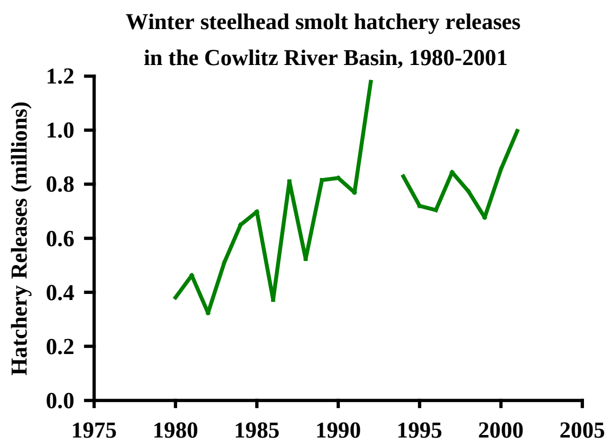




Diversity

- 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 at 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
- Baseline risk assessment determined a high to very high risk of extinction for winter steelhead in the upper Cowlitz basin

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
- There are 100,000 late stock winter steelhead juveniles planted in the Tilton and 287,500 late stock winter steelhead juveniles planted in the upper Cowlitz as part of the reintroduction program.

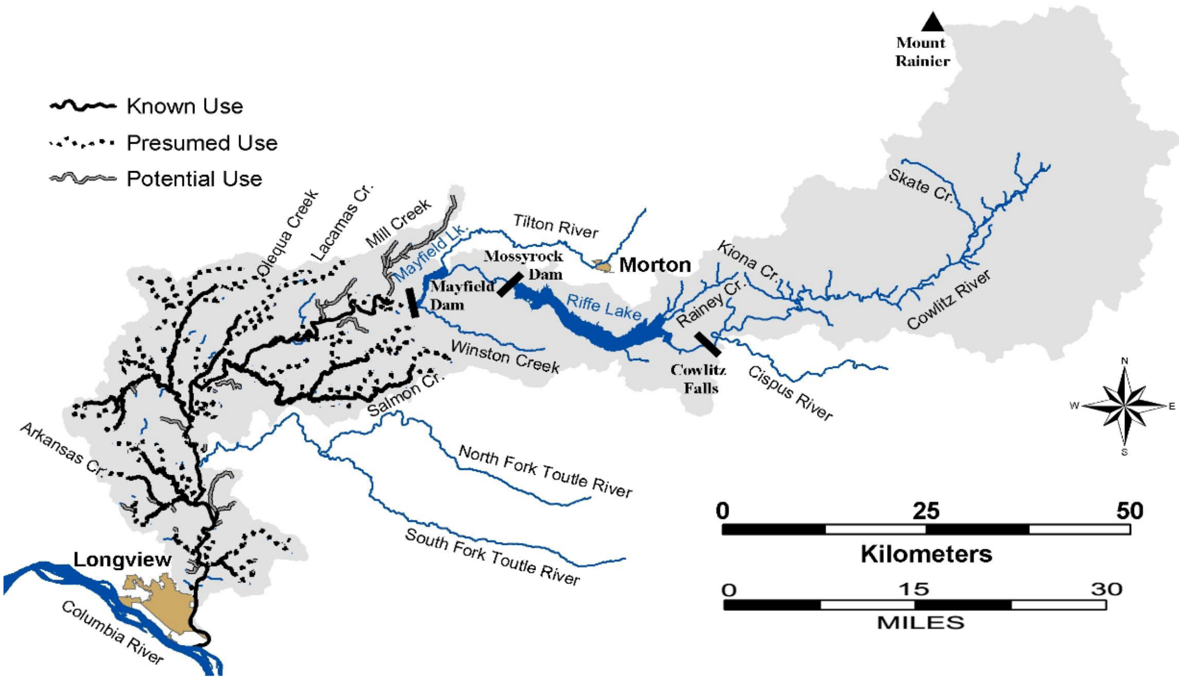
Harvest

- 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 as per the Fishery Management and Evaluation Plan submitted by WDFW to NMFS in 2003.
- 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
-

Cutthroat Trout—Cowlitz Subbasin (Upper Cowlitz)

ESA: Not Listed **SASSI: Depressed 2000**

Anadromous cutthroat counts at Mayfield Dam from 1962-96 ranged from 5,500-12,300. Outmigrant counts at the Mayfield migrant trap show a long-term declining trend. The anadromous population is considered depressed. Adfluvial forms are present in Mayfield, Riffe, and Scanewa reservoirs and resident forms are present throughout the upper Cowlitz basin. Cutthroat trout are present throughout the basin. Anadromous cutthroat enter the Cowlitz from July-October and spawn from January to April. The hatchery cutthroat spawn from November-February. Most juveniles rear 2-3 years before migrating from their natal stream.

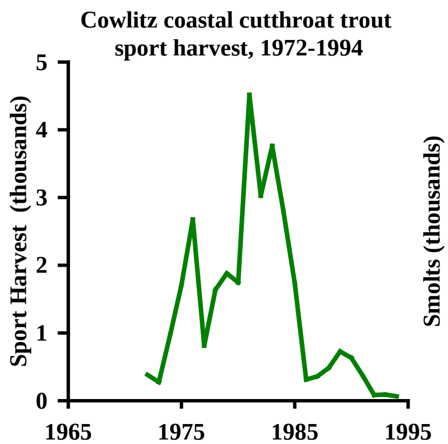


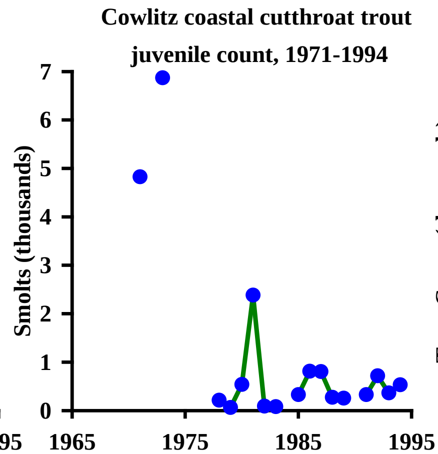
Distribution

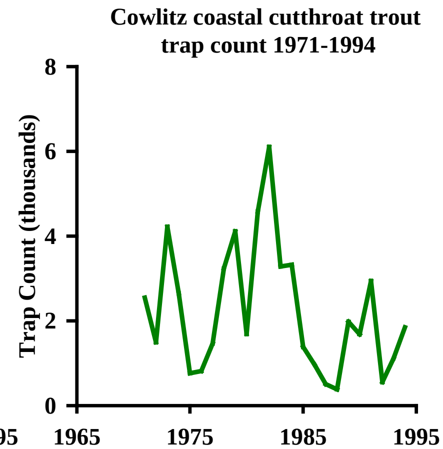
- Anadromous forms were historically present throughout the watershed, but are now limited to the area downstream of Mayfield Dam, which block passage
- Adfluvial forms are present in Mayfield, Riffe, and Scanewa Reservoirs
- Resident forms are documented throughout the system and are the only form present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

Other Species

Pacific lamprey – Information on lamprey abundance is limited and does not exist for the upper Cowlitz population. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have also declined in the upper Cowlitz. The adult lamprey return from the ocean to spawn in the spring and summer. Spawning likely occurs in the small to mid-size streams of the basins. Juveniles rear in freshwater up to 6 years before migrating to the ocean.

F.4. Subbasin Habitat Conditions

This section describes the current condition of aquatic and terrestrial habitats within the subbasin. Descriptions are included for habitat features of particular significance to focal salmonid species including watershed hydrology, passage obstructions, water quality, key habitat availability, substrate and sediment, woody debris, channel stability, riparian function, and floodplain function. These descriptions will form the basis for subsequent assessments of the effects of habitat conditions on focal salmonids and opportunities for improvement.

F.4.1. Watershed Hydrology

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 F-4 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.

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).

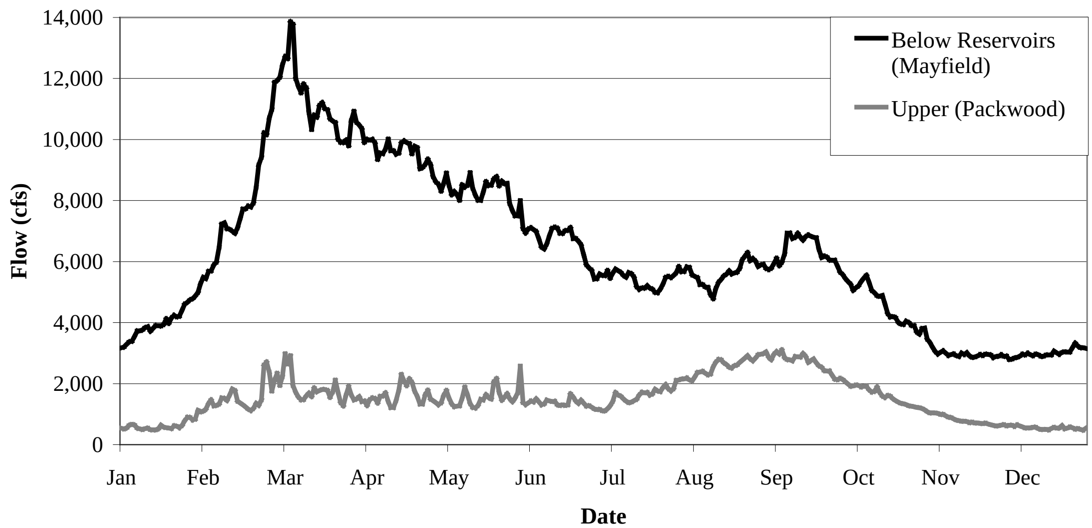


Figure F-4. Cowlitz River hydrographs (mean daily flows 1972-2001). Both stations exhibit winter peaks due to rain and rain-on-snow events. There is a rise in flows in the fall in the Cowlitz near Packwood due to late summer snowmelt from snowfield and glacial melt. The rise in flows below the reservoirs 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, WA.

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).

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.

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).

Key Habitat Availability

The three 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).

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 were 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.

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).

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).

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 (Mt. 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, 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.

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).

F.4.2. Stream Habitat Limitations

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 Lower Cowlitz River fall Chinook, coho, and steelhead. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Appendix E.

Three general categories of EDT output are discussed in this section: 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.

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.

Cowlitz and Cispus Basins

Habitat-based assessments were completed for fall Chinook, spring Chinook, coho, and winter steelhead 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 F-2). 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 F-5). 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 F-2). Diversity for winter steelhead has remained more stable, decreasing by an estimated 16% (Table F-2).

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 F-2). Smolt abundance levels have also declined for spring Chinook, fall Chinook, and winter steelhead (Table F-2). For coho, the model indicates a 16% increase in smolt abundance levels (Table F-2).

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 F-3). 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 F-6). Diversity of spring chinook, fall chinook, and coho has decreased by 50-75%, though winter steelhead diversity has only decreased by 13% (Table F-3).

Smolt productivity in the Cispus basin has declined by 55-73% from historical levels for all species (Table F-3). 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 F-3). Coho have suffered the least impact with an abundance reduction of only 18% (Table F-3).

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 F-2 and Table F-3). 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 F-2 and Table F-3). Productivity and diversity would also increase with restoration to PFC conditions.

Tilton Basin

Habitat-based assessments were completed for fall Chinook, spring Chinook, coho, and winter steelhead 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 F-4). Current abundance estimates range from only 4-22% of historical levels (Figure F-7). Diversity (as measured by the diversity index) has also declined sharply (Table F-4). 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 F-4), 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 F-4).

Model results indicate that restoration of PFC conditions would produce substantial benefits for all species (Table F-4). 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 F-4). Smolt abundance would also increase for all species (Table F-4). Benefits to smolt abundance would range from a 92% increase for fall Chinook smolts to a 669% increase for coho smolts.

Table F-2. 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)[1], and properly functioning (PFC) habitat conditions.

	Adult Abundance		Adult Productivity		Diversity Index		Smolt Abundance		Smolt Productivity	
Species	**P**	**T[1]**	**P**	**T[1]**	**P**	**T[1]**	**P**	**T[1]**	**P**	T[1]
Fall Chinook	3,097	17,613	2.5	9.1	0.60	1.00	465,080	1,779,088	237	518
Spring Chinook	3,019	21,750	2.5	15.8	0.41	1.00	175,993	1,707,591	77	270
Coho	11,039	17,654	3.0	21.4	0.57	0.92	317,625	272,111	76	316
Winter Steelhead	855	1,973	4.8	15.1	0.72	0.86	17,196	28,802	94	213

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

Table F-3. 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.

	Adult Abundance		Adult Productivity		Diversity Index		Smolt Abundance		Smolt Productivity	
Species	**P**	**T[1]**	**P**	**T[1]**	**P**	**T[1]**	**P**	**T[1]**	**P**	T[1]
Fall Chinook	934	5,792	1.8	7.2	0.49	1.00	129,631	607,842	176	426
Spring Chinook	718	7,791	1.9	14.0	0.27	1.00	52,519	790,464	79	297
Coho	3,752	8,029	4.0	22.1	0.33	0.73	98,166	120,143	90	309
Winter Steelhead	624	1,504	4.2	13.1	0.85	0.98	12,576	22,084	83	185

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

Table F-4. 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**	**T[1]**	**P**	**T[1]**	**P**	**T[1]**	**P**	**T[1]**	**P**	T[1]
Fall Chinook	1,025	4,610	2.0	8.6	0.35	0.90	137,656	337,240	211	465
Spring Chinook	868	5,436	1.9	15.1	0.20	0.93	63,454	246,459	92	251
Coho	261	5,599	2.6	24.9	0.32	0.90	8,741	82,075	72	352
Winter Steelhead	219	1,741	2.3	16.5	0.21	1.00	4,484	26,042	44	234

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

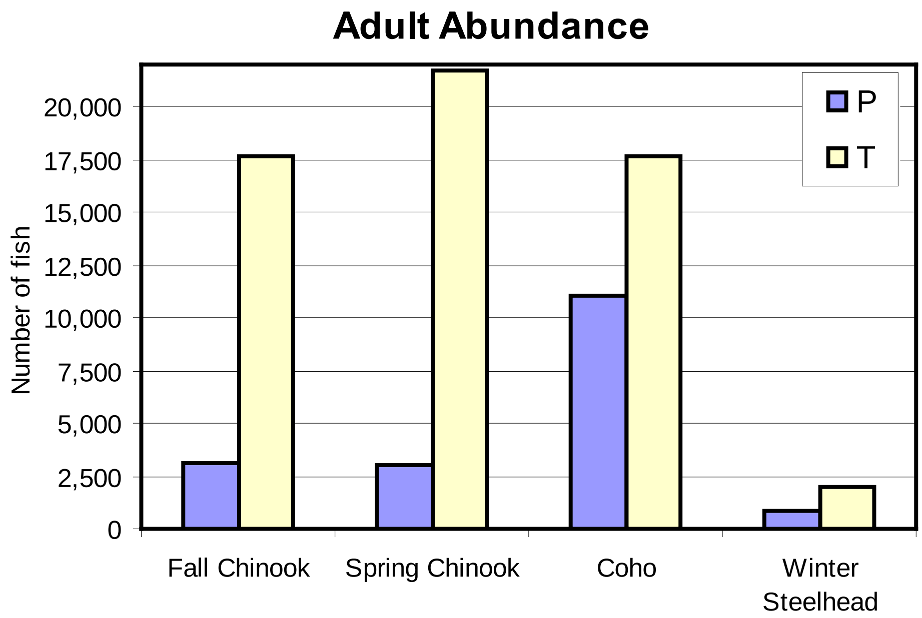


Figure F-5. **Adult abundance of Upper Cowlitz fall Chinook, spring Chinook, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.**

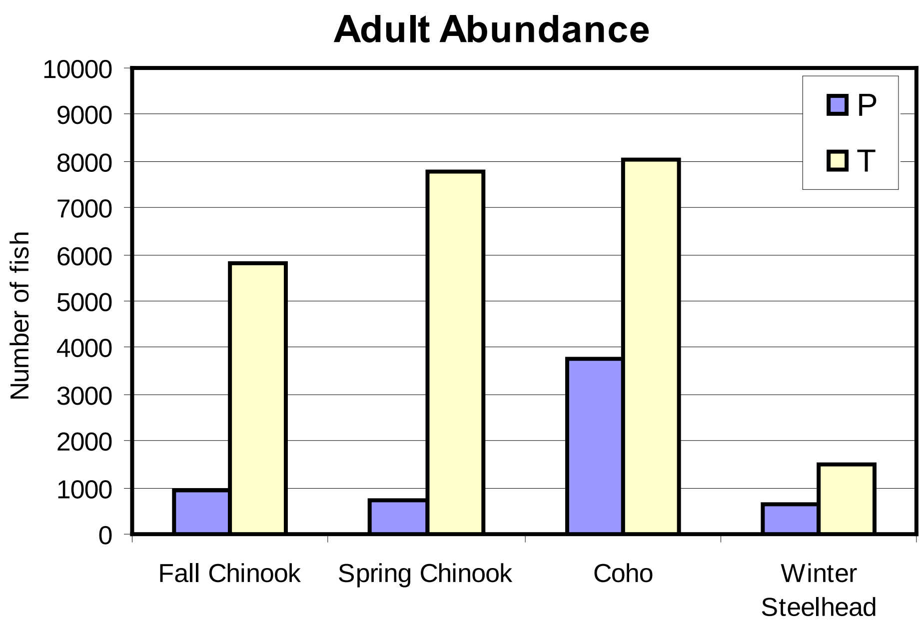


Figure F-6. **Adult abundance of Cispus fall Chinook, spring Chinook, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.**

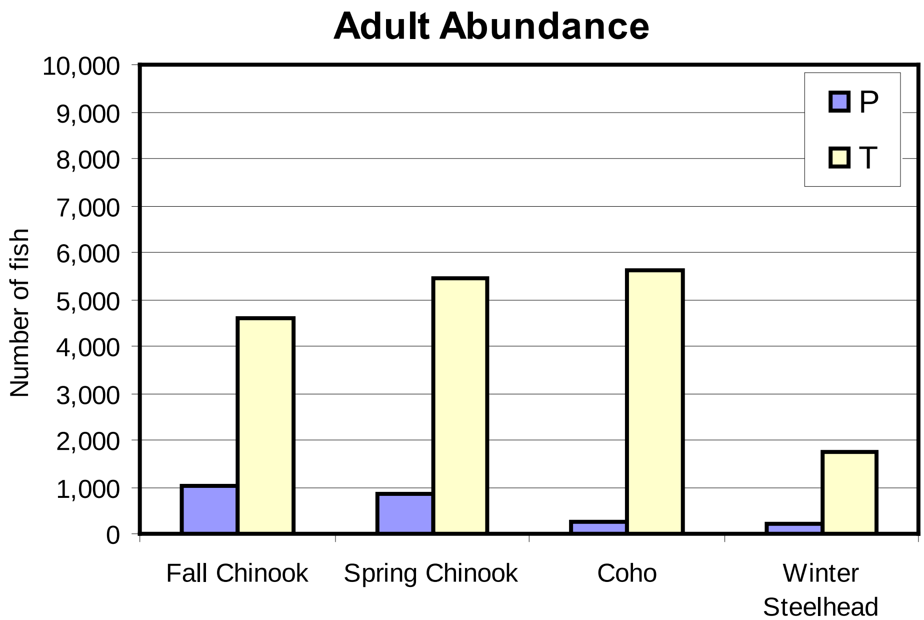


Figure F-7. Adult abundance of Tilton River fall Chinook, spring Chinook, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

Stream Reach 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 F-8 for a map of EDT reaches within the Upper Cowlitz and Cispus basins and Figure F-9 for a map of EDT reaches in the Tilton basin.

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.

Important reaches in the Upper Cowlitz and Cispus for fall Chinook (Figure F-10) 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 F-10). 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 F-11). These reaches are split with regard to recovery emphasis (Figure F-11). 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 F-12). In the Cispus, the reaches Cispus 2 and 3 are considered high priority reaches (Figure F-12). 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.

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 F-13). 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 F-13). 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.

Tilton Basin

High priority reaches are similar for fall Chinook (Figure F-14) and spring Chinook (Figure F-15), 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 emphases 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 F-8). Again, all reaches show a strong habitat restoration emphasis, with Tilton 5 having the most potential improvement due to restoration.

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 F-9). All high and medium priority reaches for winter steelhead show a restoration emphasis.

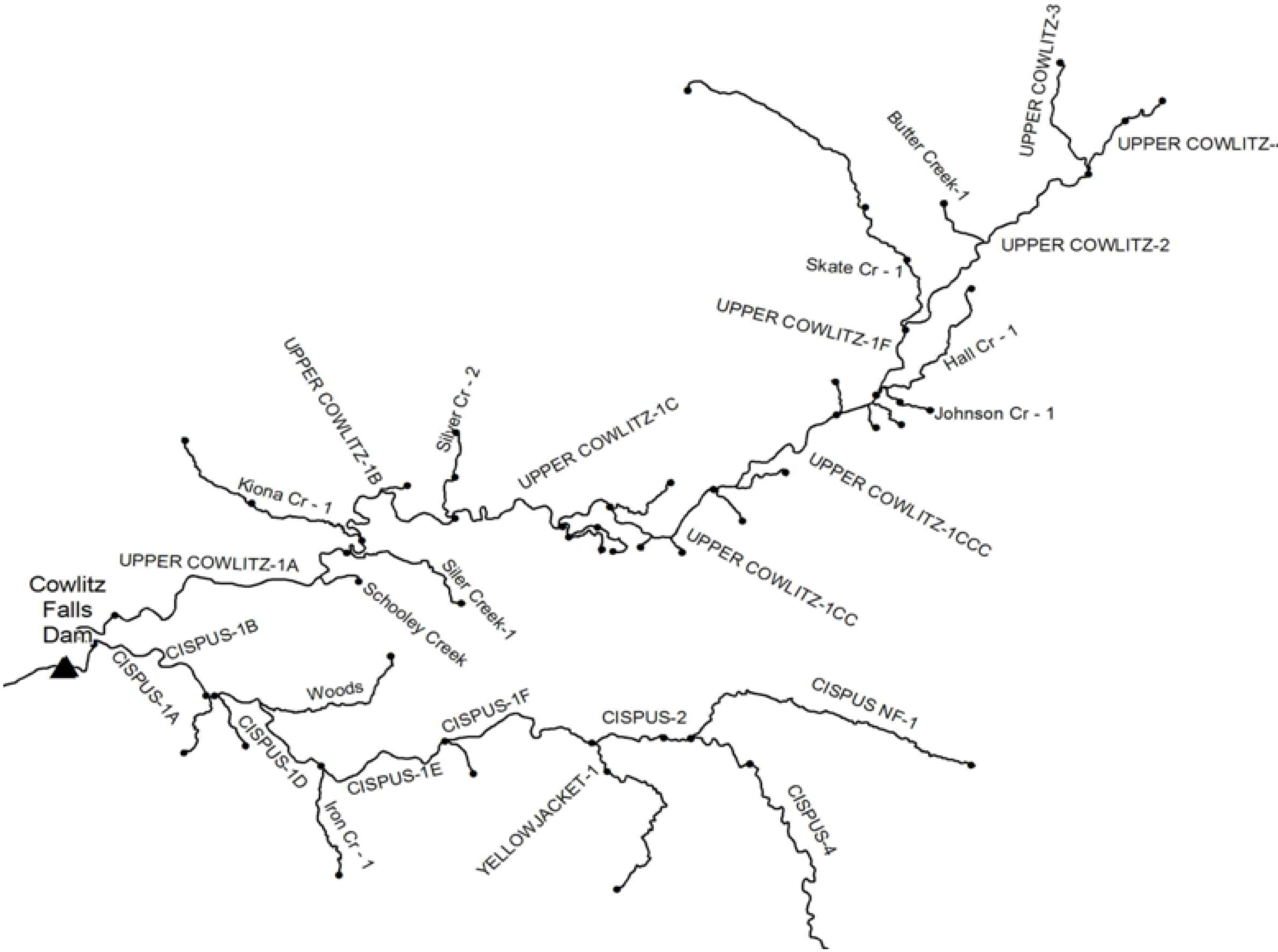


Figure F-8. Upper Cowlitz and Cispus rivers with EDT reaches identified. For readability, not all reaches are labeled.

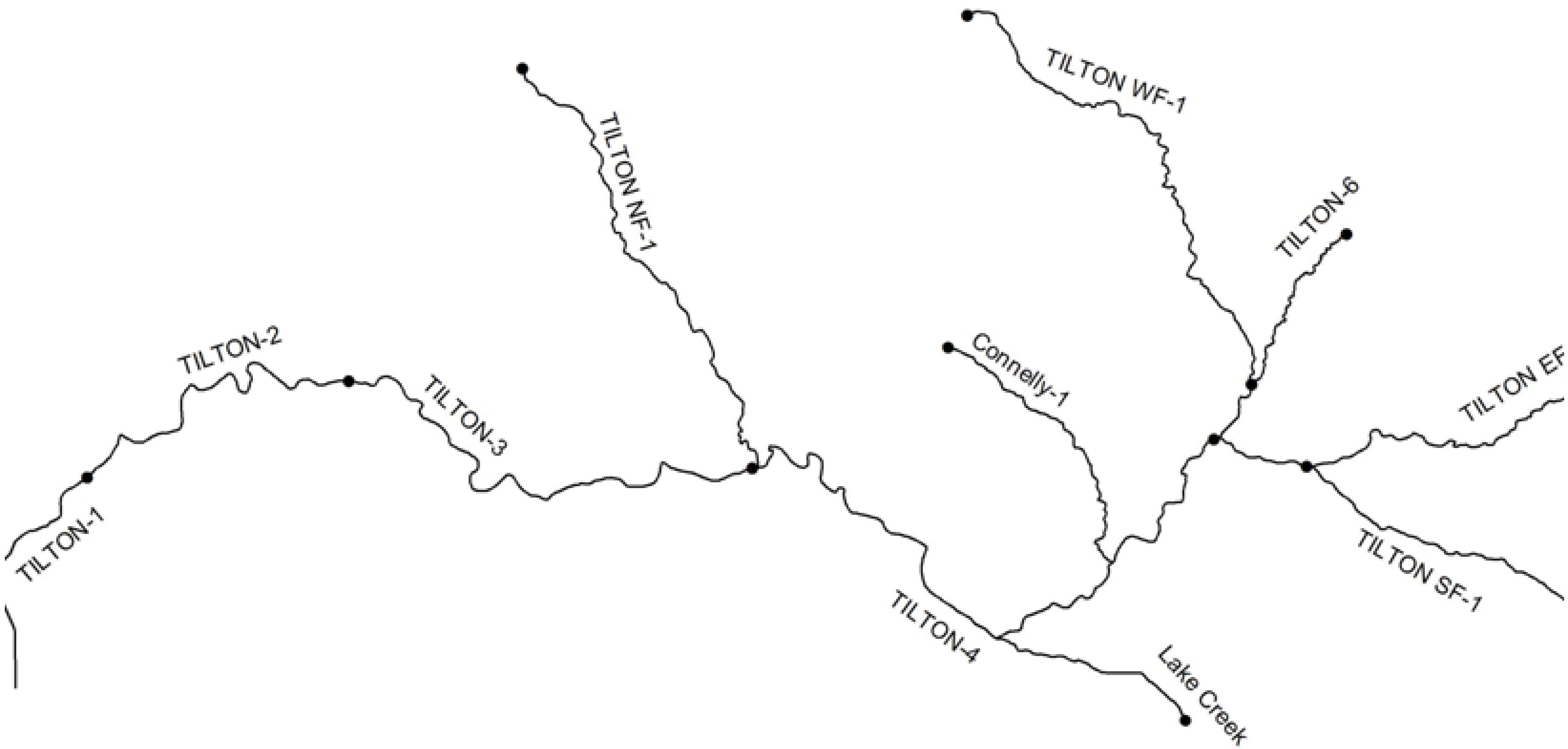


Figure F-9. Tilton River basin EDT reaches. Some reaches are not labeled for clarity.

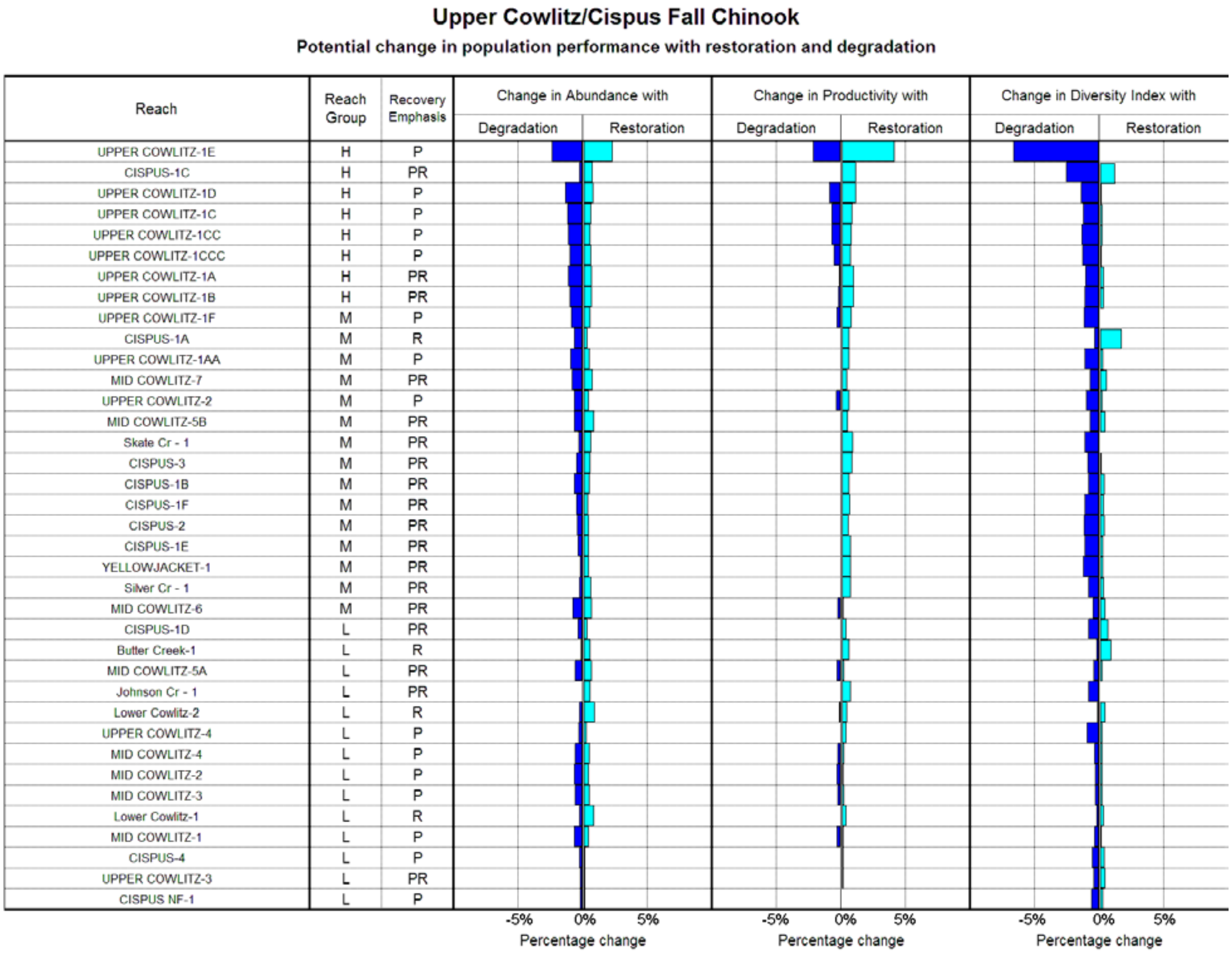


Figure F-10. Upper Cowlitz and Cispus fall Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

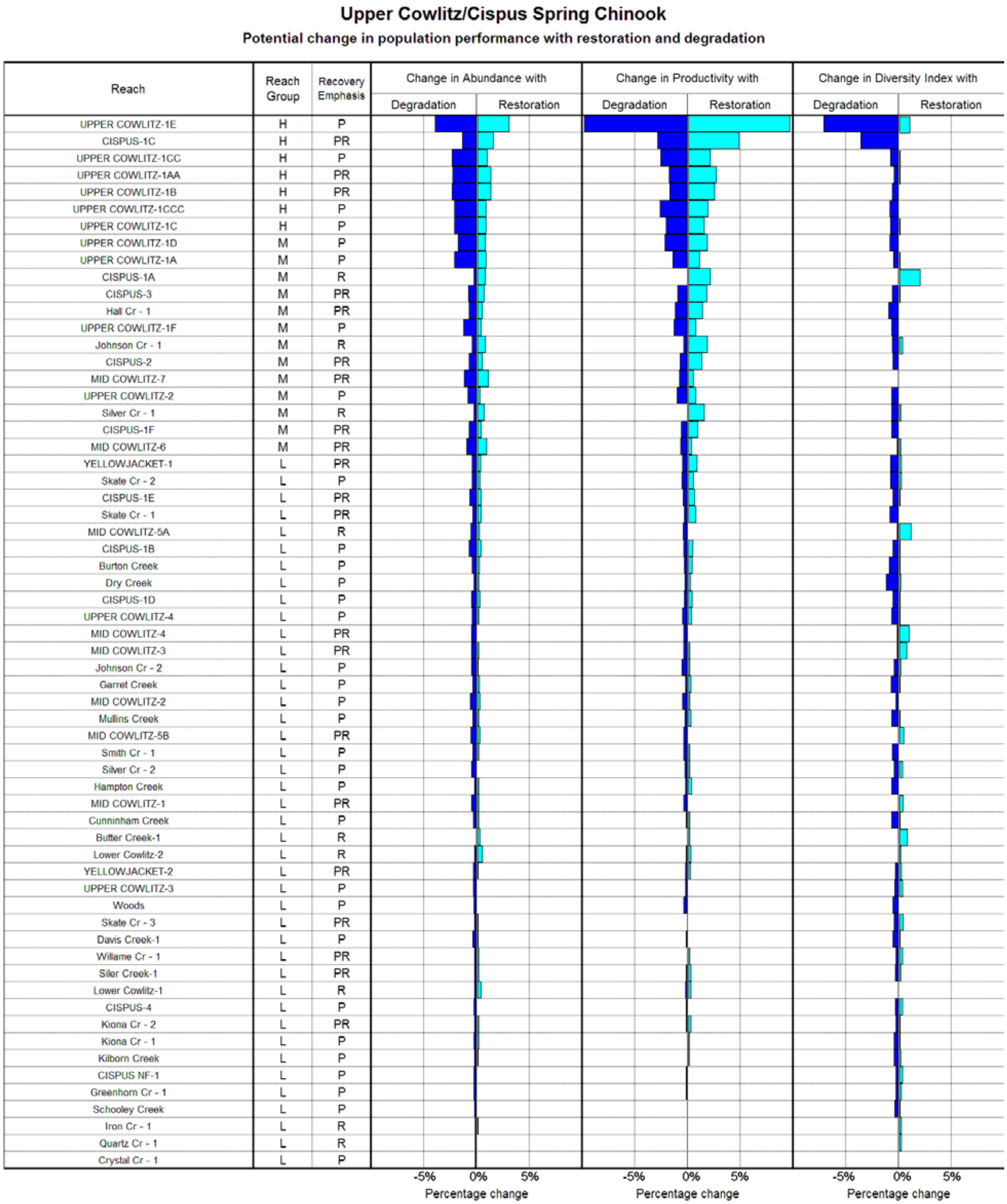


Figure F-11. Upper Cowlitz and Cispus spring Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

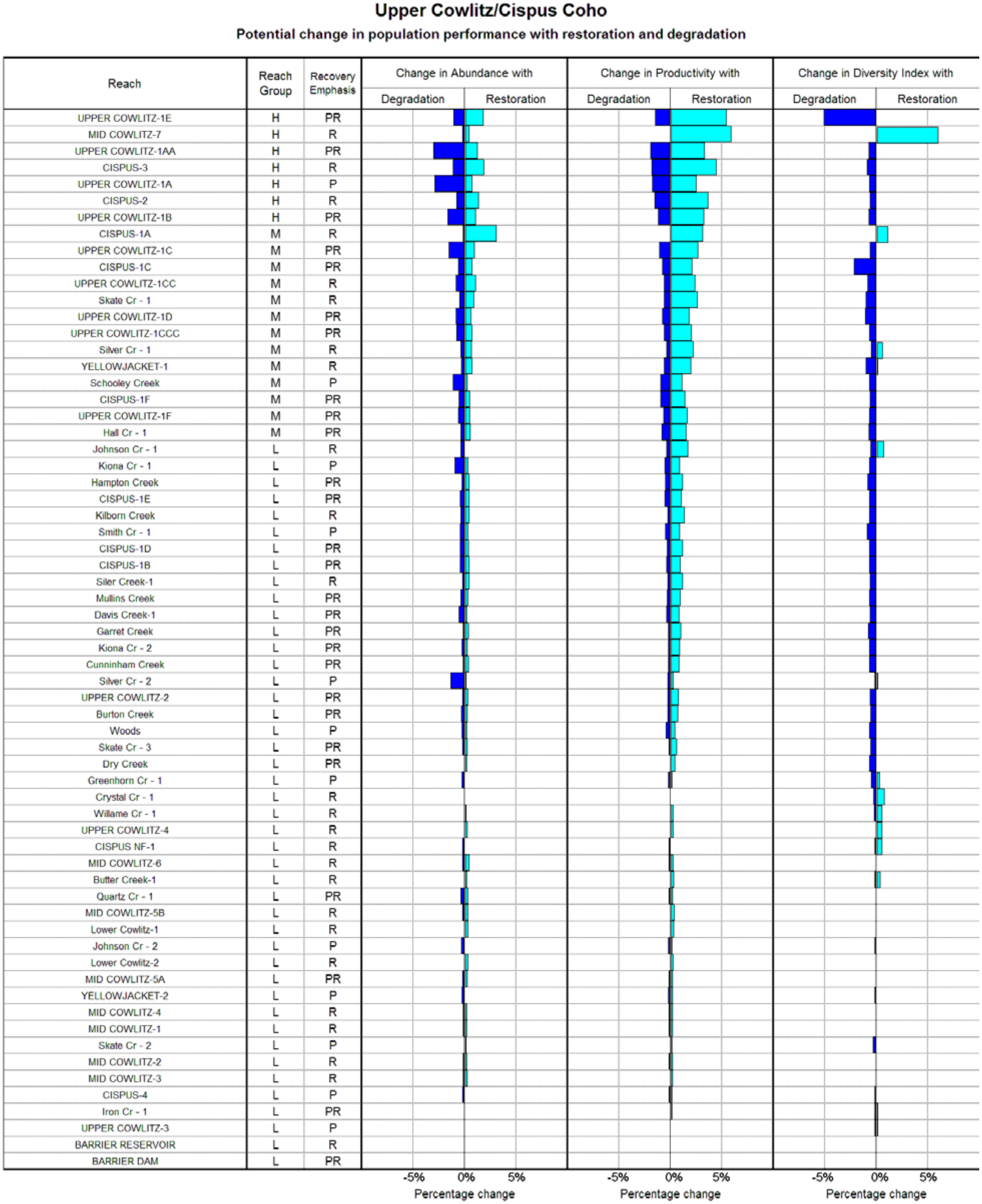


Figure F-12. Upper Cowlitz and Cispus coho ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

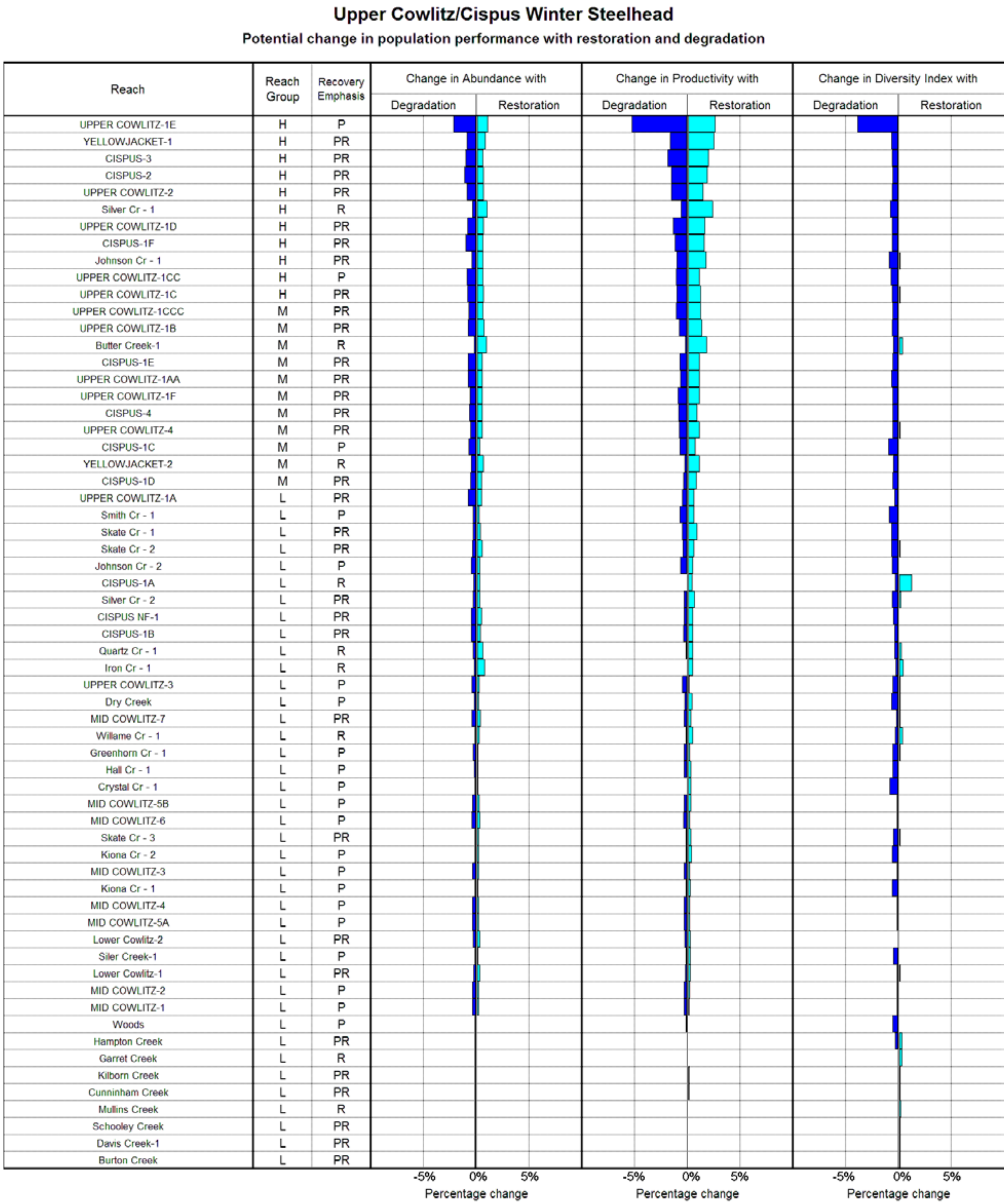


Figure F-13. Upper Cowlitz and Cispus winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

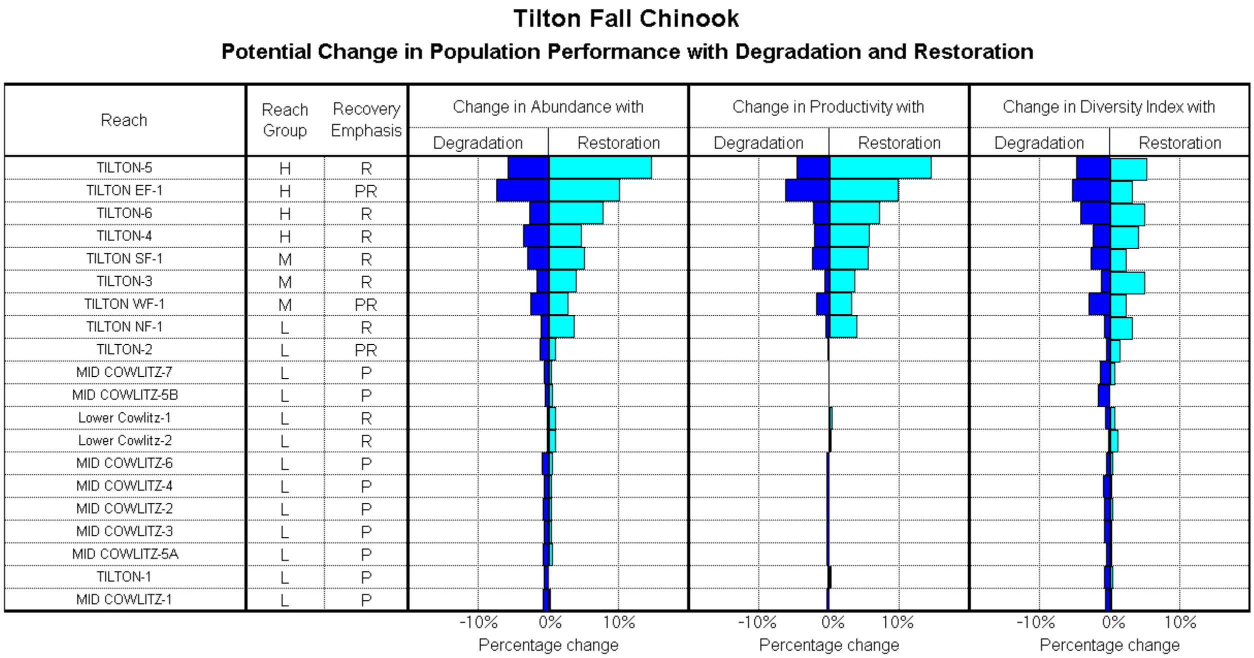


Figure F-14. Tilton fall Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

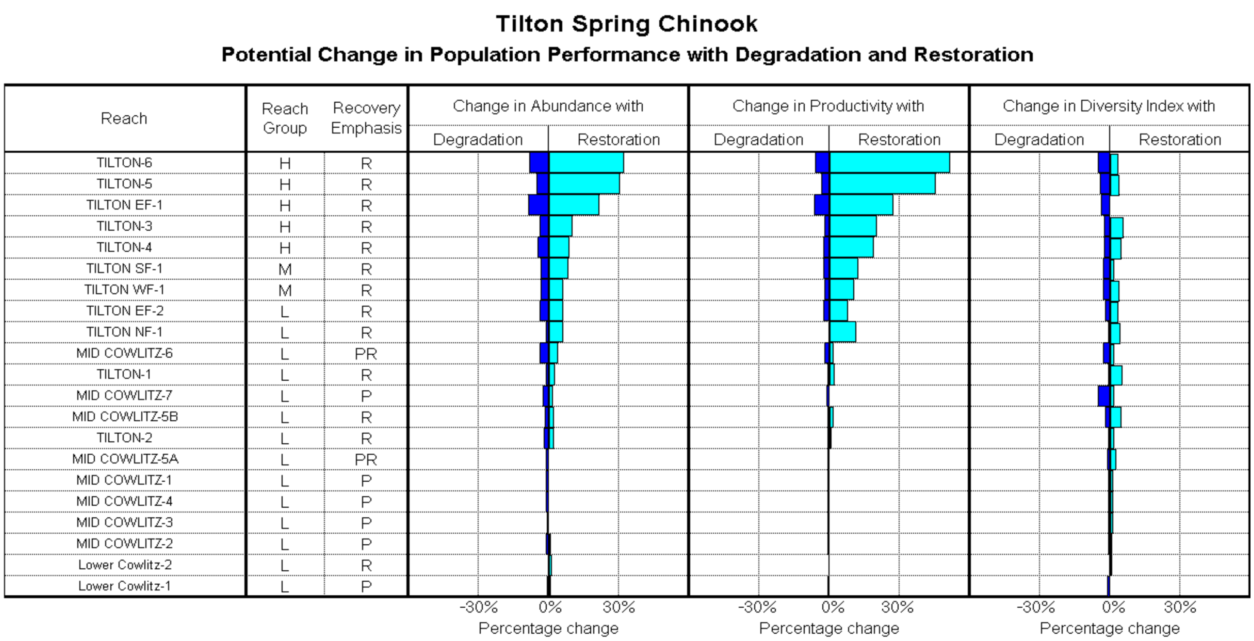


Figure F-15. Tilton spring Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

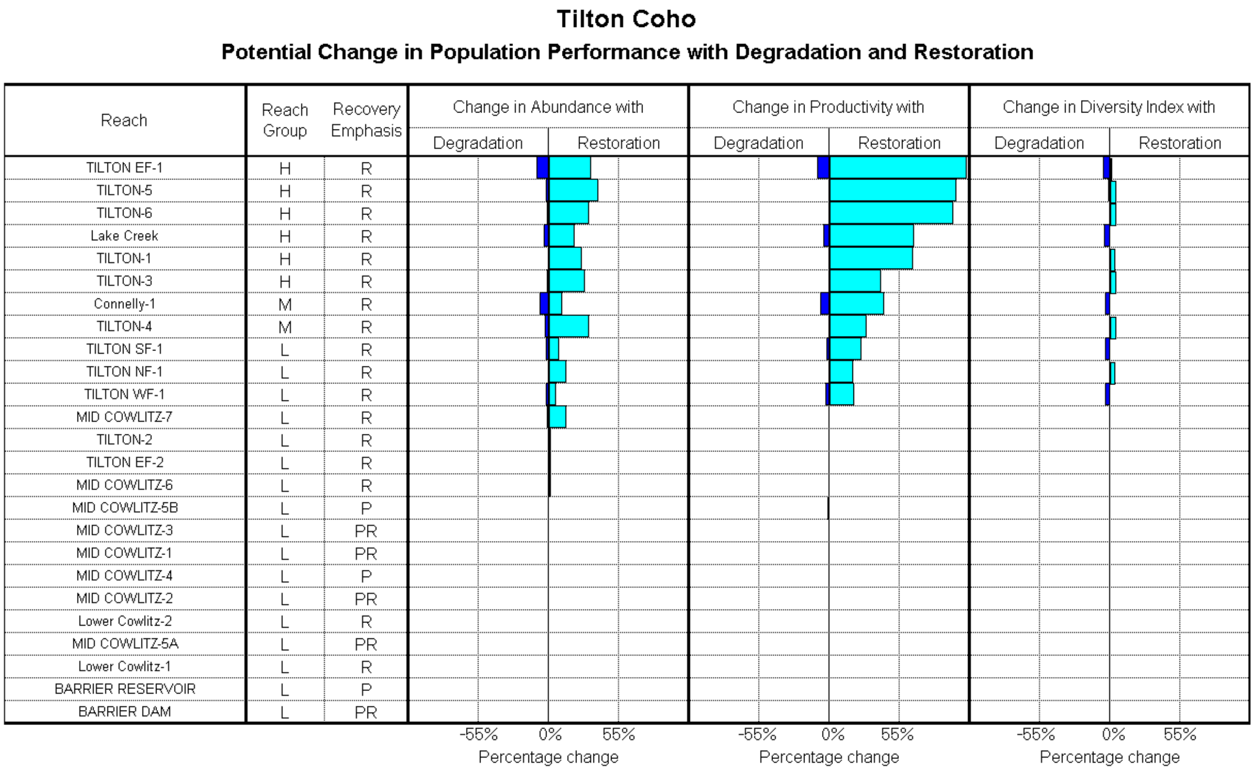


Figure F-16. Tilton coho ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

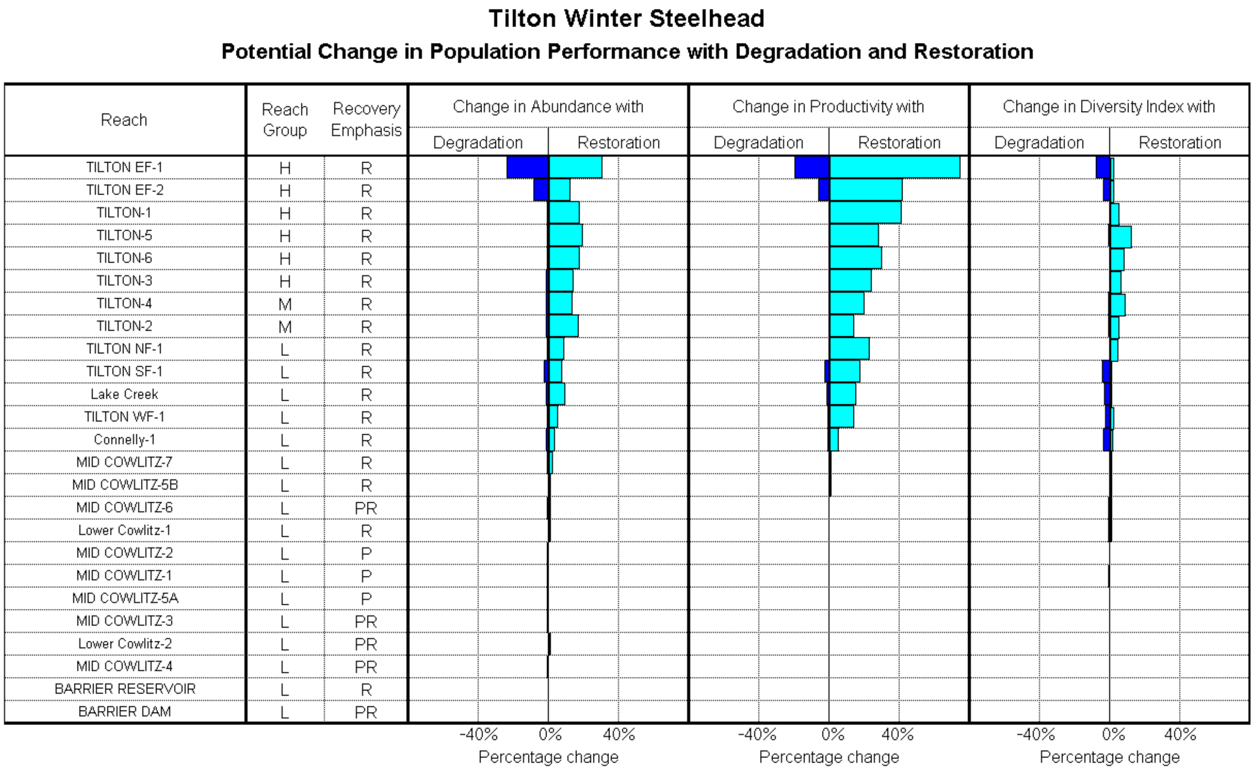


Figure F-17. Tilton River winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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 Appendix E Chapter 6 for more information on EDT ladder diagrams

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 habitat factor analysis compares current/patient and historical/template habitat conditions. For each reach, EDT generates what is referred to as a "consumer reports diagram", which identifies the degree to which individual habitat factors are acting to suppress population performance. The effect of each habitat factor is identified for each life stage that occurs in the reach and the relative importance of each life stage is indicated. For additional information and examples of this analysis, see Appendix E. Inclusion of the consumer report diagram for each reach is beyond the scope of this document. A summary of the most critical life stages and the habitat factors affecting them are displayed for each species in the Upper Cowlitz and Cispus basins in the following tables are for species in the Tilton basin:

Table F-5. Summary of the primary limiting factors affecting life stages of focal salmonid species. Results are summarized from EDT Analysis

Species and Lifestage		*Primary factors*	*Secondary factors*	*Tertiary factors*
Upper Cowlitz/Cispus Fall Chinook				
most critical	Egg incubation	channel stability	sediment	
second	Fry colonization	habitat diversity	flow, food, channel stability	predation
third	0-age summer rearing	habitat diversity, pathogens	competition (hatchery)	channel stability, food, key habitat
Upper Cowlitz/Cispus Spring Chinook				
most critical	Egg incubation	channel stability, sediment		
second	0-age summer rearing	competition (hatchery), food, habitat diversity, pathogens		
third	0-age winter rearing	channel stability, flow, food, habitat diversity		
Upper Cowlitz Coho				
most critical	Egg incubation	channel stability, sediment		
second	0-age summer rearing	habitat diversity	competition (hatchery), food, predation, key habitat	pathogens
third	0-age winter rearing	habitat diversity	flow, key habitat	channel stability, food
Upper Cowlitz/Cispus Winter Steelhead				
most critical	1-age summer rearing	competition (hatchery), flow, pathogens	habitat diversity, predation	channel stability
second	0-age summer rearing	competition (hatchery), pathogens	habitat diversity	food, flow
third	Egg incubation	sediment	channel stability, temperature	oxygen, pathogens, key habitat

Table F-6. Summary of the primary limiting factors affecting life stages of focal salmonid species. Results are summarized from EDT Analysis

Species and Lifestage		*Primary factors*	*Secondary factors*	*Tertiary factors*
Tilton Fall Chinook				
most critical	Egg incubation	channel stability, sediment	flow, temperature	
second	Fry colonization	habitat diversity, food, sediment	flow, channel stability, predation	
third	Spawning	sediment	temperature, habitat diversity	predation, pathogens
Tilton Spring Chinook				
most critical	Egg incubation	channel stability, sediment	Temperature,	flow
second	Prespawning holding	flow	habitat diversity, temperature	pathogens, harassment, key habitat
third	Fry colonization	habitat diversity, sediment	flow	food
Tilton Coho				
most critical	0-age winter	habitat diversity, flow, sediment	channel stability, key habitat	food, predation
second	Egg incubation	channel stability, sediment	habitat diversity	flow, temperature
third	Prespawning holding	sediment	habitat diversity	
Tilton Winter Steelhead				
most critical	Egg incubation	sediment, temperature	pathogens, flow	channel stability, key habitat
second	0,1-age winter rearing	flow	habitat diversity, sediment	flood, channel stability, predation
third	0-age summer rearing	flow	competition (hatchery), habitat diversity, pathogens, temperature	food, predation, key habitat

The consumer reports diagrams have also been summarized to show the relative importance of habitat factors by reach. The summary figures are referred to as habitat factor analysis diagrams and are displayed for each species below. 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.

Upper Cowlitz and Cispus Basins

Almost all of the key fall Chinook (Figure F-18) and spring Chinook (Figure F-19) 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 F-20). The cause of these impacts is the same as described earlier for winter steelhead reaches.

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 F-21). 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.

Tilton Basin

Important reaches for both fall Chinook (Figure F-22) and spring Chinook (Figure F-23) are located in the mainstem, EF, SF, and WF 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. 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.

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 F-24). The causes of these impacts are the same as those discussed above for fall Chinook and spring Chinook.

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 primarily impacted by sediment, habitat diversity, flow, temperature, and channel stability. The causes of these impacts are the same as those discussed above for fall Chinook and spring Chinook.

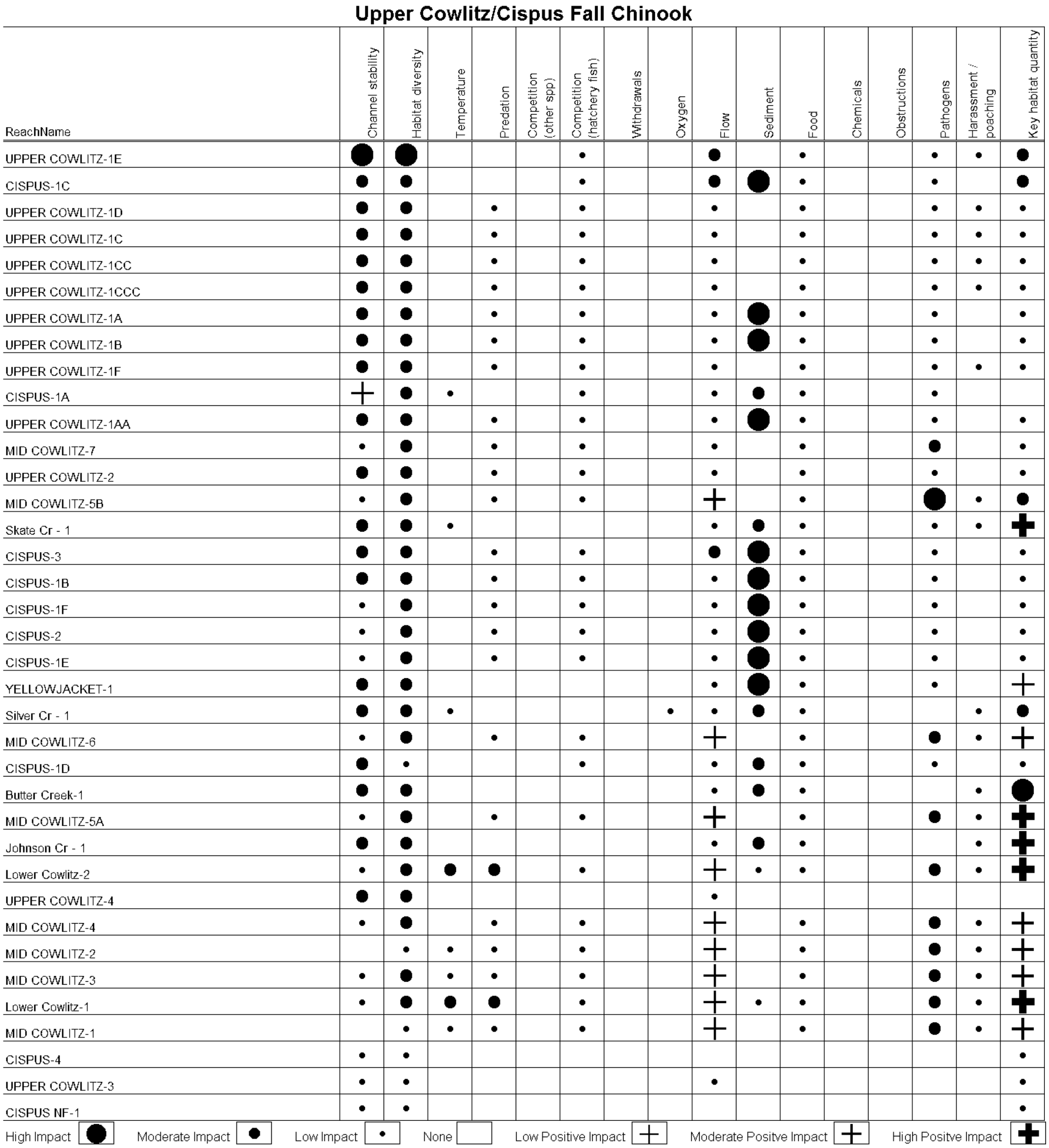


Figure F-18. Upper Cowlitz and Cispus fall Chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

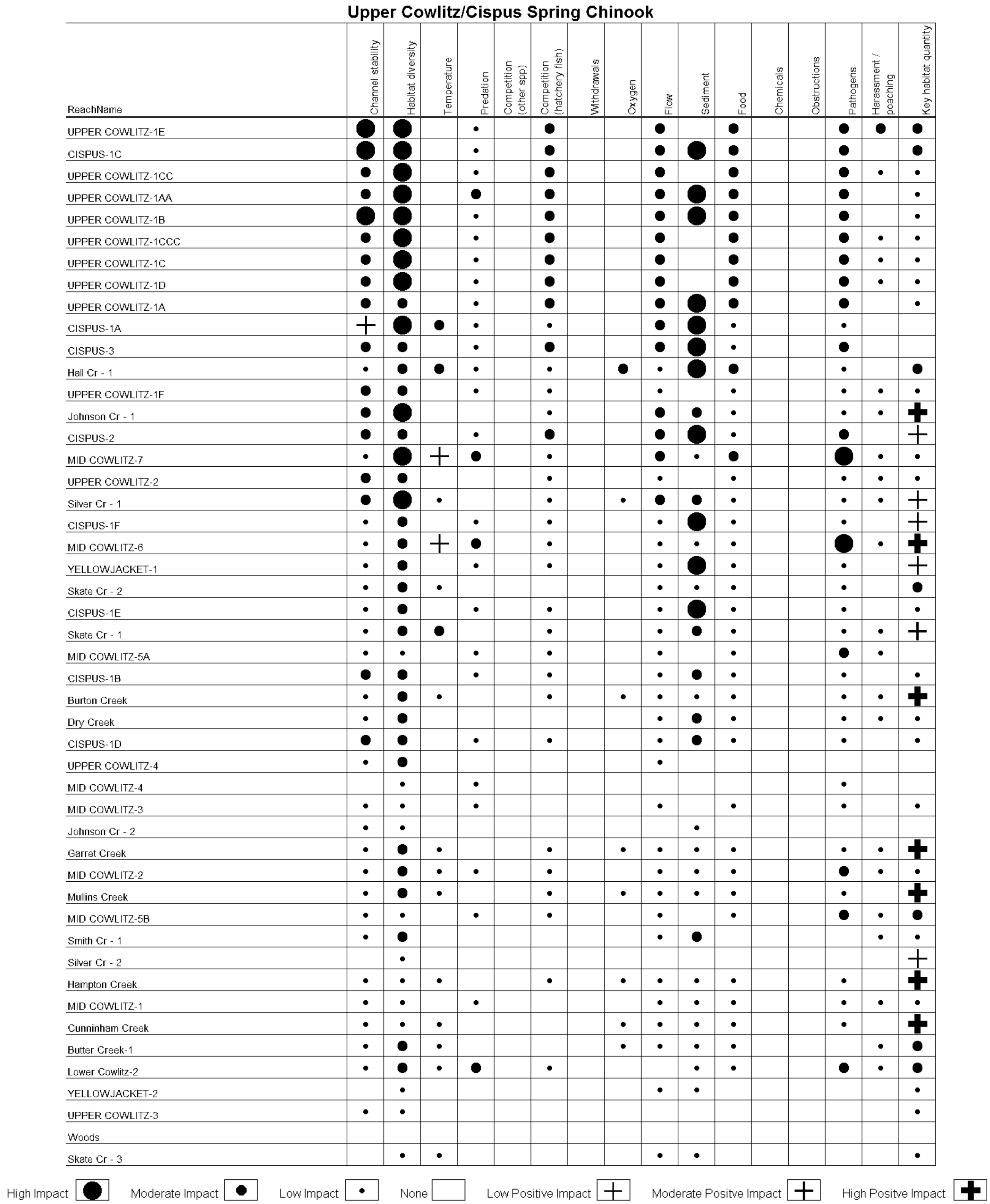


Figure F-19. Upper Cowlitz and Cispus spring chinook habitat factor analysis. Some low priority reaches are not included for display purposes. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

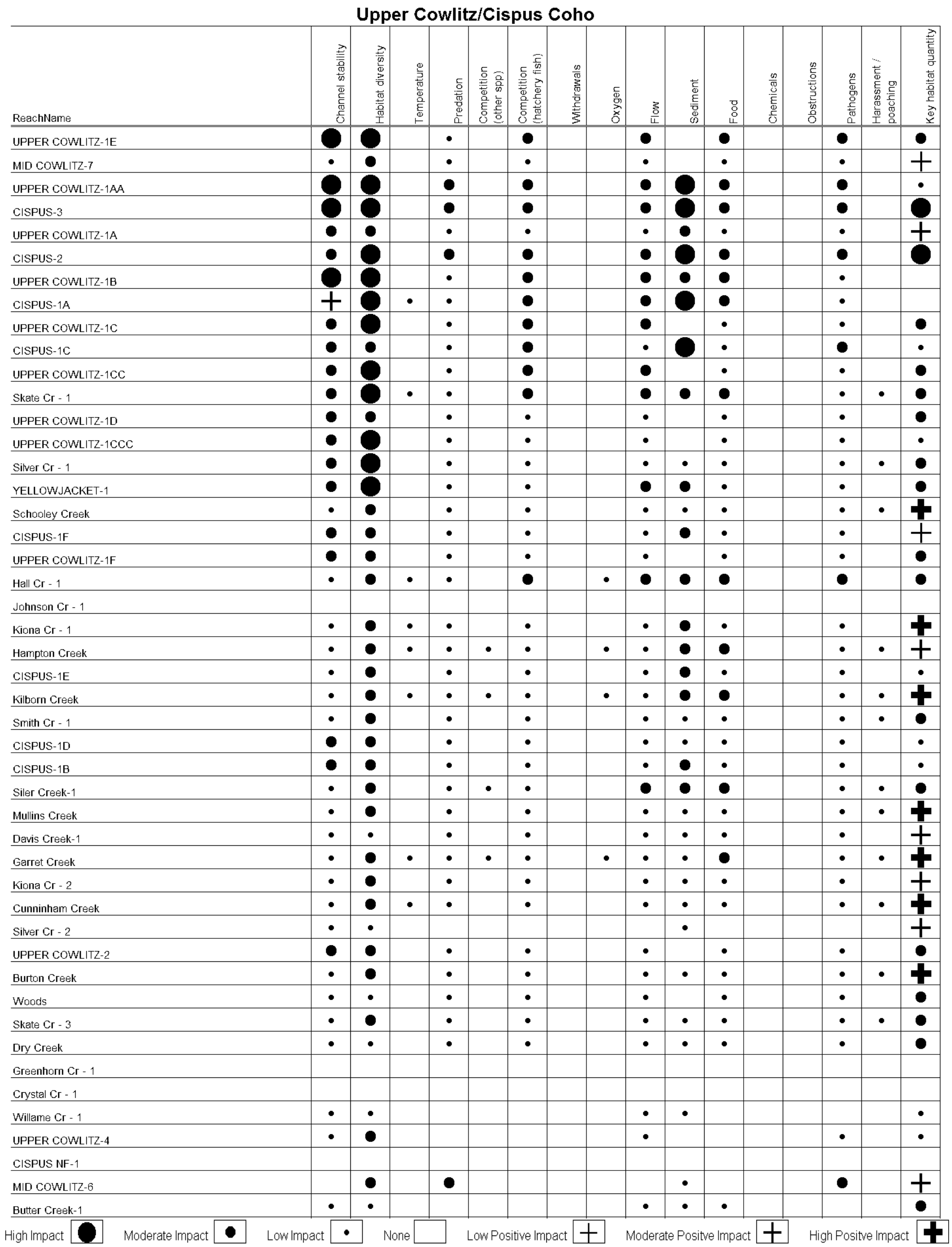


Figure F-20. Upper Cowlitz and Cispus coho habitat factor analysis. Some low priority reaches are not included for display purposes. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

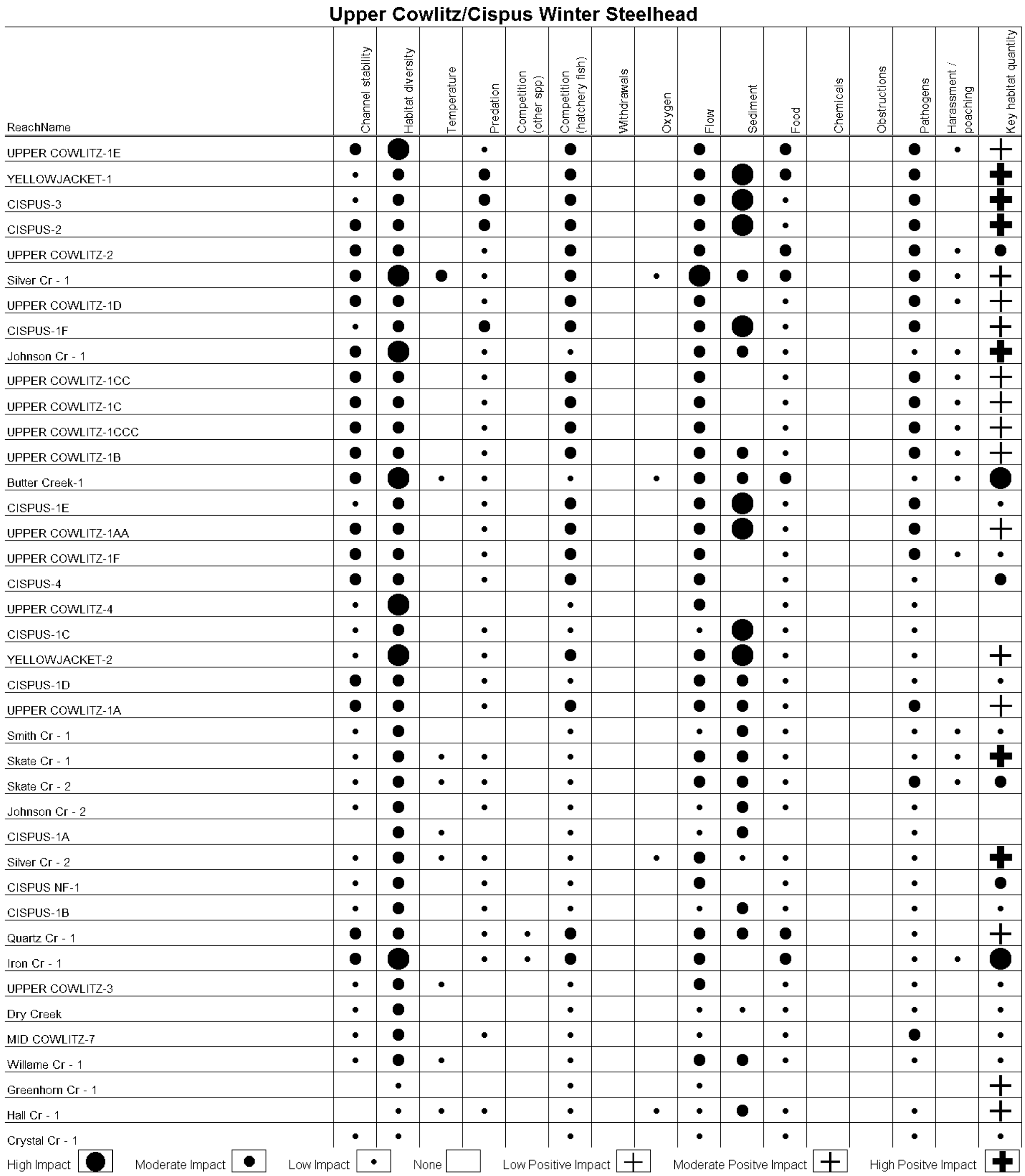


Figure F-21. Upper Cowlitz and Cispus winter steelhead habitat factor analysis. Some low priority reaches are not included for display purposes. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

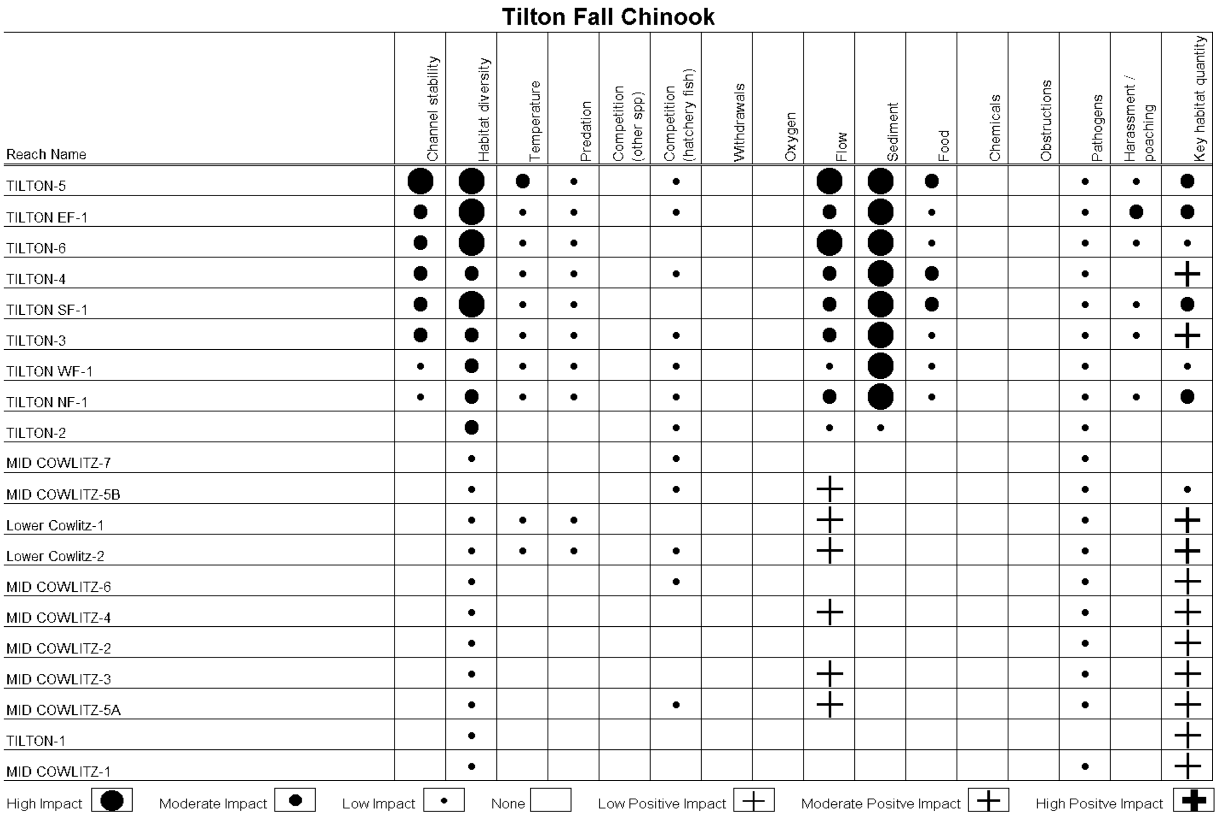


Figure F-22. Tilton fall Chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

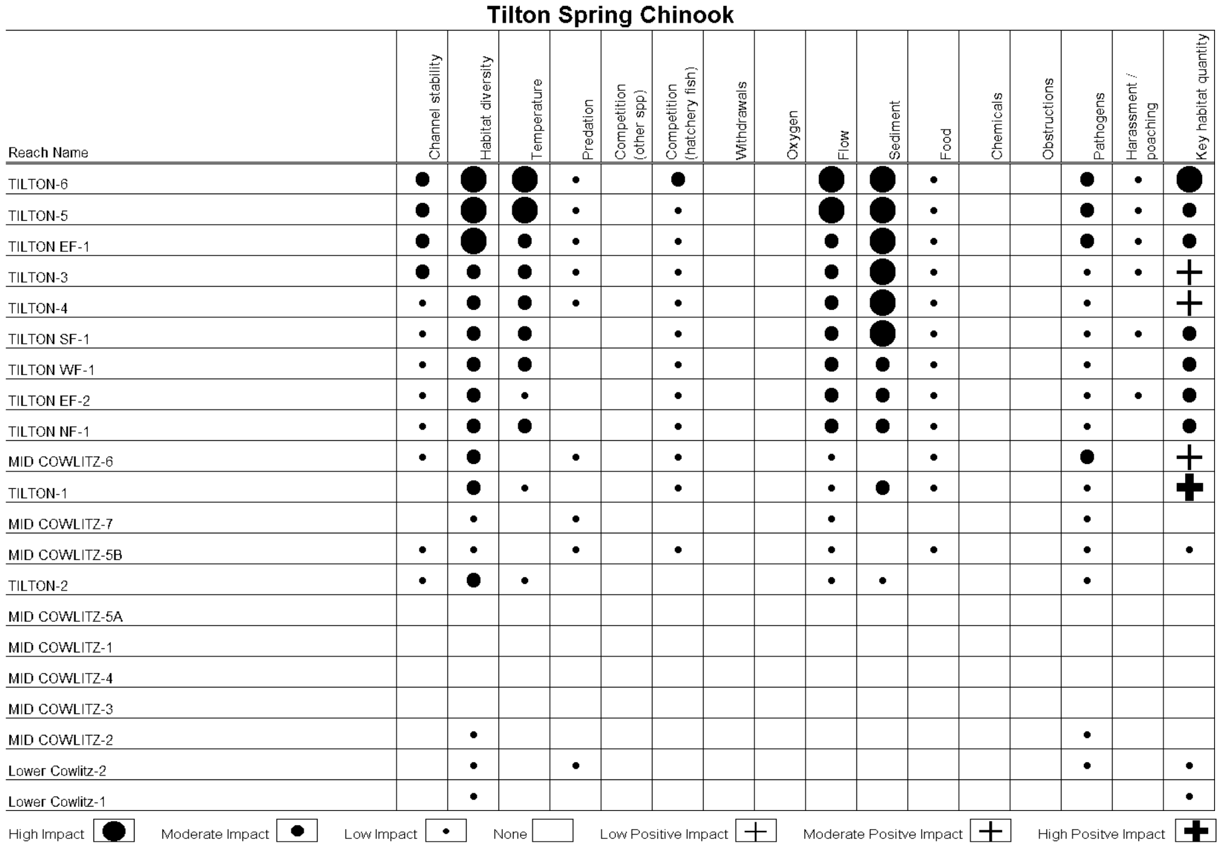


Figure F-23. Tilton spring chinook habitat factor analysis. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

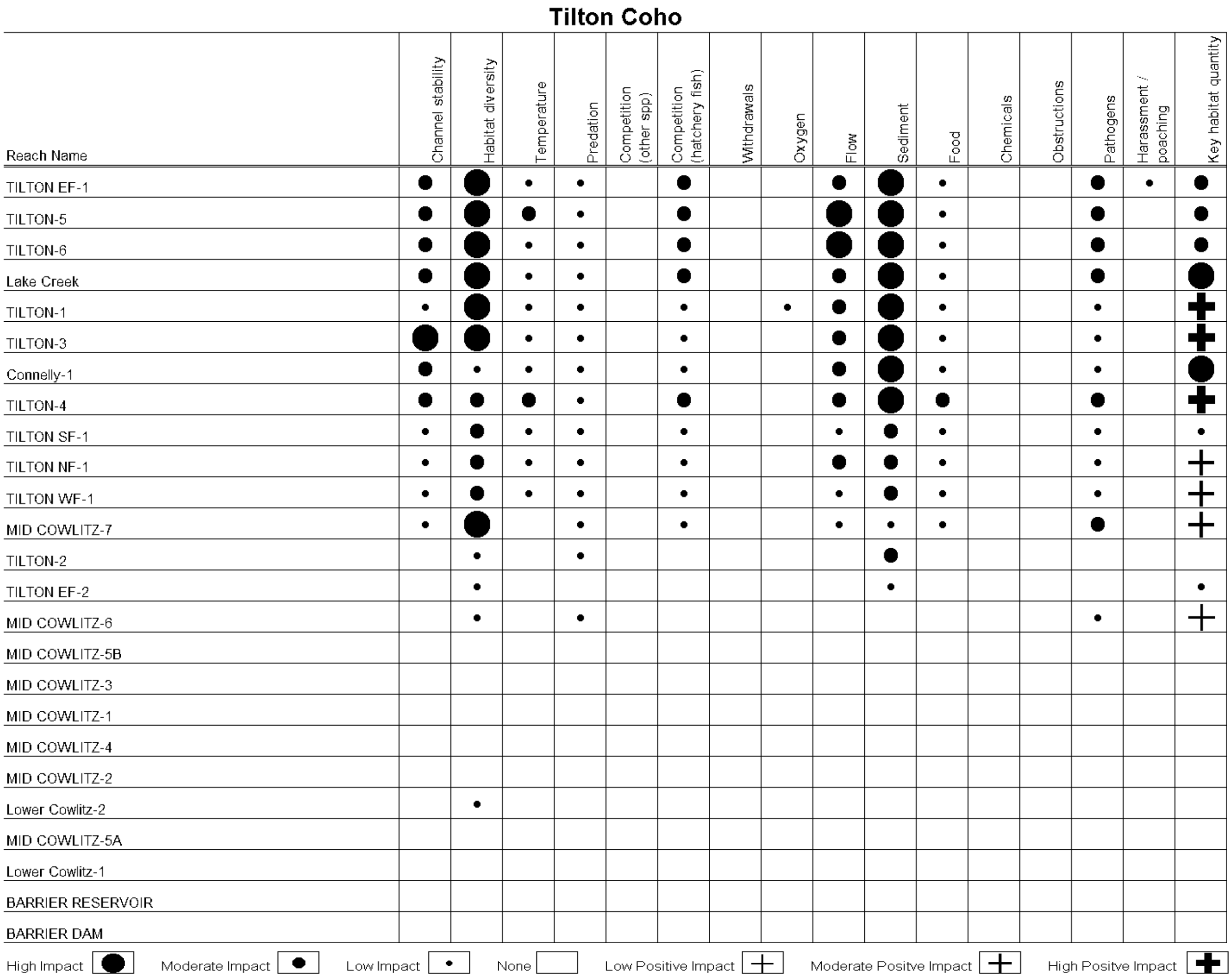


Figure F-24. Tilton coho habitat factor analysis. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

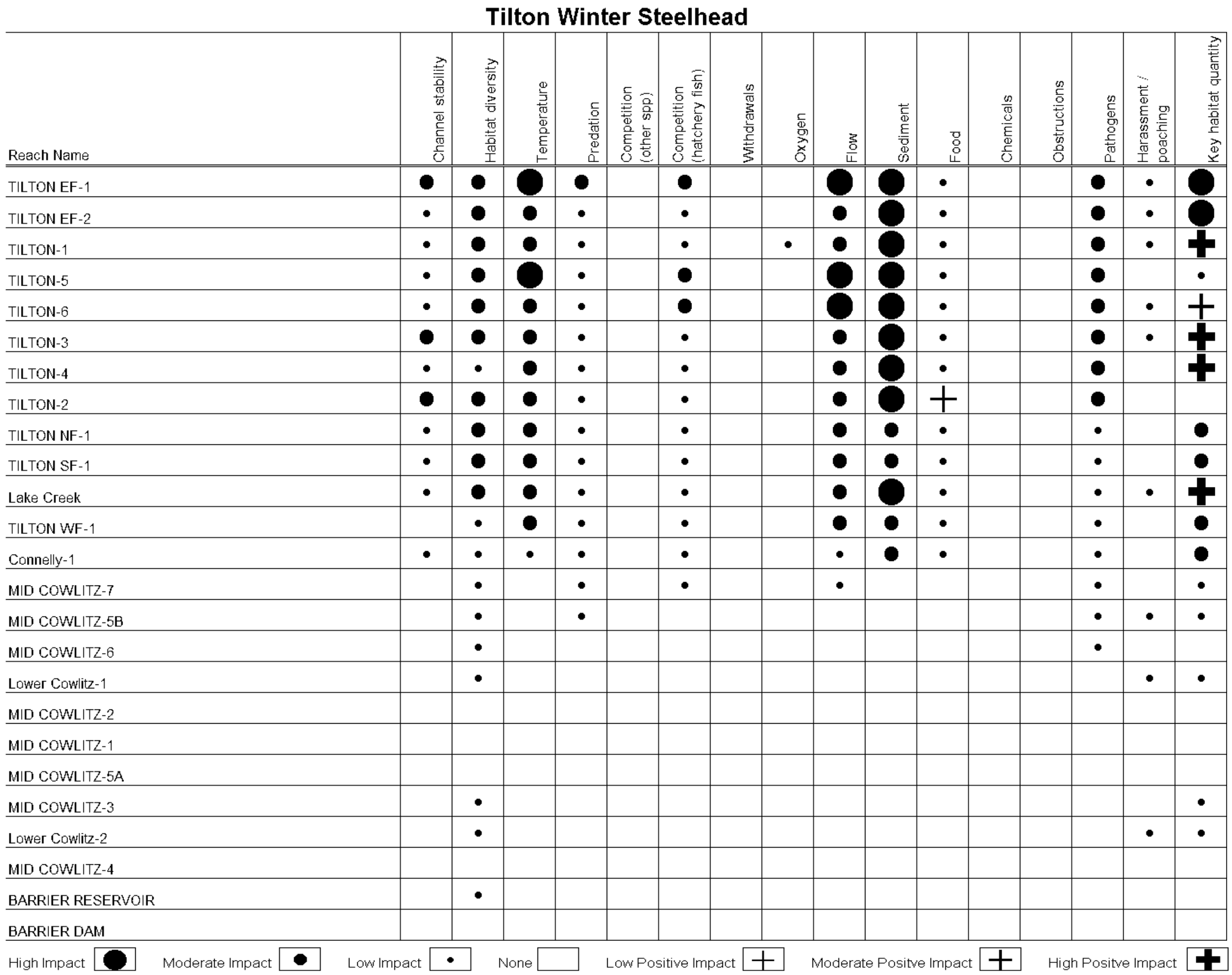


Figure F-25. Tilton winter steelhead habitat factor analysis. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

F.4.3. Watershed Process Limitations

This section describes watershed process limitations that contribute to stream habitat conditions significant to focal fish species. Reach level stream habitat conditions are influenced by systemic watershed processes. Limiting factors such as temperature, high and low flows, sediment input, and large woody debris recruitment are often affected by upstream conditions and by contributing landscape factors. Accordingly, restoration of degraded channel habitat may require action outside the targeted reach, often extending into riparian and hillslope (upland) areas that are believed to influence the condition of aquatic habitats.

Watershed process impairments that affect stream habitat conditions were evaluated using a watershed process screening tool termed the Integrated Watershed Assessment (IWA). The IWA is a GIS-based assessment that evaluates watershed impairments at the subwatershed scale (3,000 to 12,000 acres). The tool uses landscape conditions (i.e. road density, impervious surfaces, vegetation, soil erodability, and topography) to identify the level of impairment of 1) riparian function, 2) sediment supply conditions, and 3) hydrology (runoff) conditions. For sediment and hydrology, the level of impairment is determined for local conditions (i.e. within subwatersheds, not including upstream drainage area) and at the watershed level (i.e. integrating the entire drainage area upstream of each subwatershed). See Appendix E for additional information on the IWA.

The IWA 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.

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). IWA results for the Mayfield-Tilton watershed are shown in Table F-7. A reference map showing the location of each subwatershed in the basin is presented in Figure F-26. Maps of the distribution of local and watershed level IWA results are displayed in Figure F-27.

Hydrology

Current Conditions— 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 truly 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.

Predicted Future Trends— 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.

Table F-7. IWA results for the Mayfield-Tilton Watershed

	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

[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.

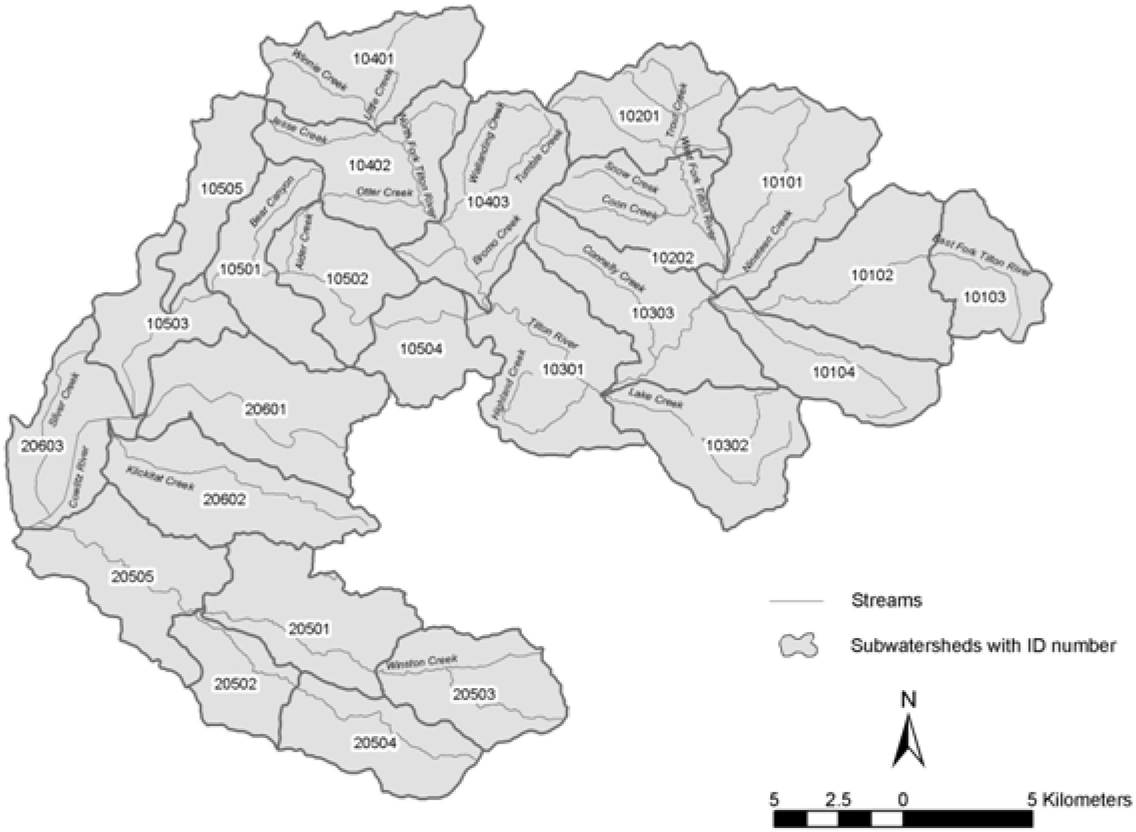


Figure F-26. Map of the Mayfield-Tilton watershed showing the location of the IWA subwatersheds

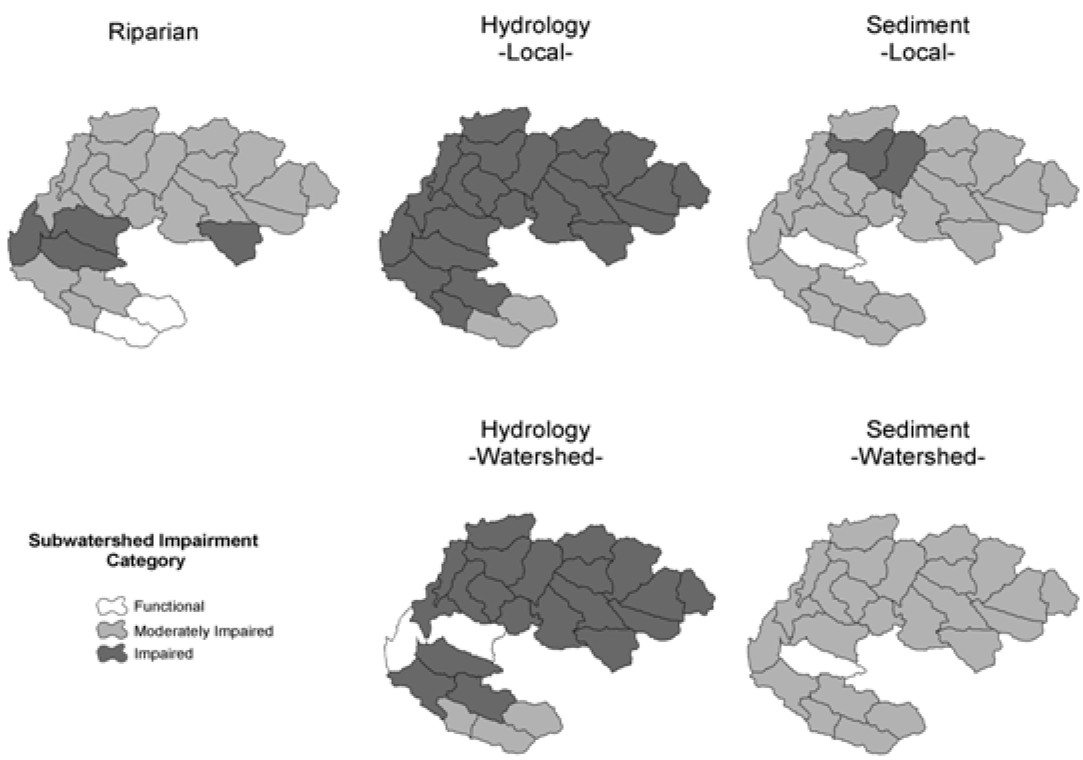


Figure F-27. IWA subwatershed impairment ratings by category for the Mayfield-Tilton basin

Sediment Supply

Current Conditions— 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.

Predicted Future Trends— 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.

Riparian Condition

Current Conditions— 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.

Predicted Future Trends— 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.

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. IWA results for the Riffe Lake watershed are shown in Table F-8. A reference map showing the location of each subwatershed in the basin is presented in Figure F-28. Maps of the distribution of local and watershed level IWA results are displayed in FigureF-29.

Hydrology

Current Conditions— 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.

Predicted Future Trends— 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.

Table F-8. 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

[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.

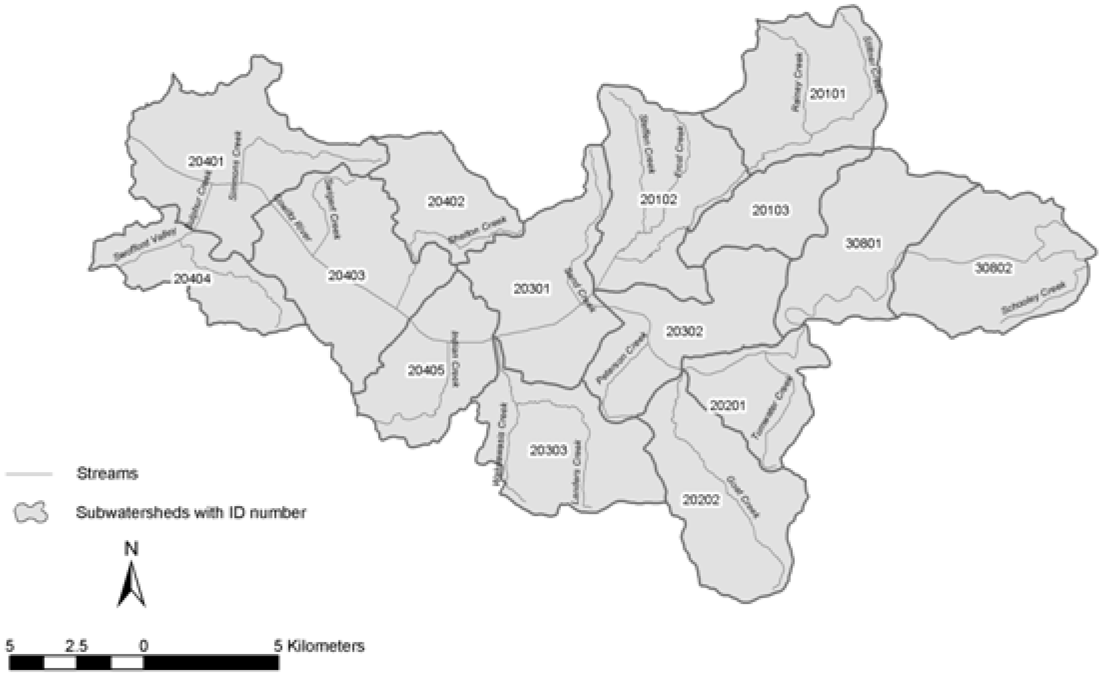
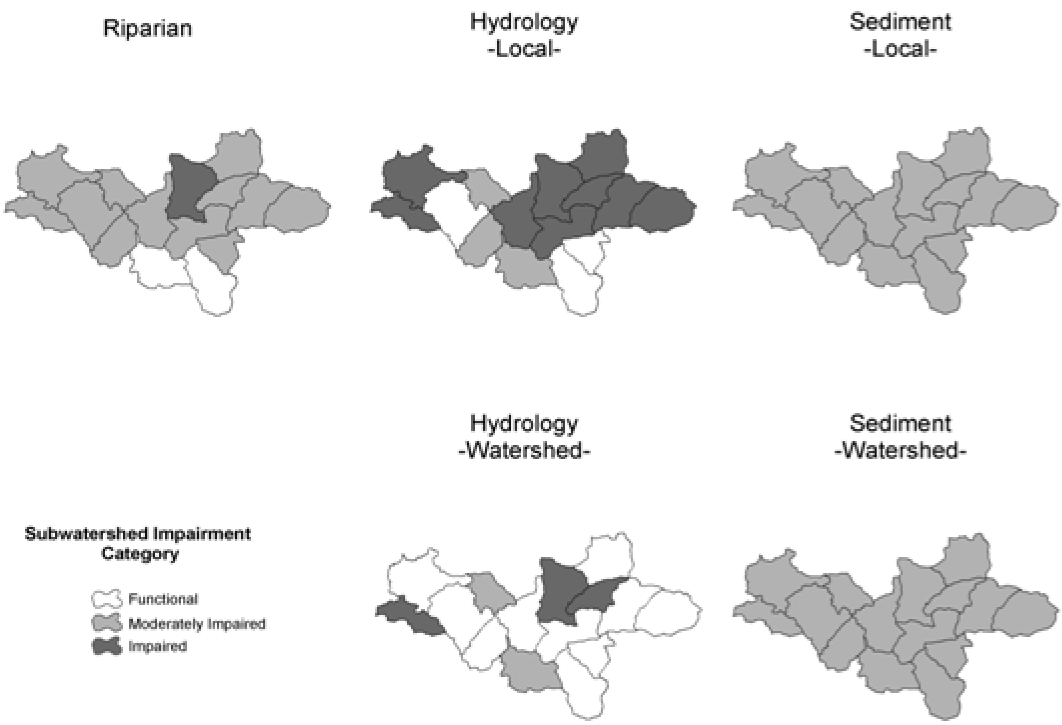


Figure F-28. Map of the Riffe Lake watershed showing the location of the IWA subwatersheds



FigureF-29. IWA subwatershed impairment ratings by category for the Riffe Lake watershed.

Sediment Supply

Current Conditions—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.

Predicted Future Trends— 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.

Riparian Condition

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

Predicted Future Trends— 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.

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). IWA results for the Cispus River watershed are shown in Table F-9. A reference map showing the location of each subwatershed in the basin is presented in Figure F-30. Maps of the distribution of local and watershed level IWA results are displayed in Figure F-31.

Hydrology

Current Conditions— 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 F-31, 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.

Predicted Future Trends— 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.

Table F-9. 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

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
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
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

[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 F-30. Map of the Cispus watershed showing the location of the IWA subwatersheds.

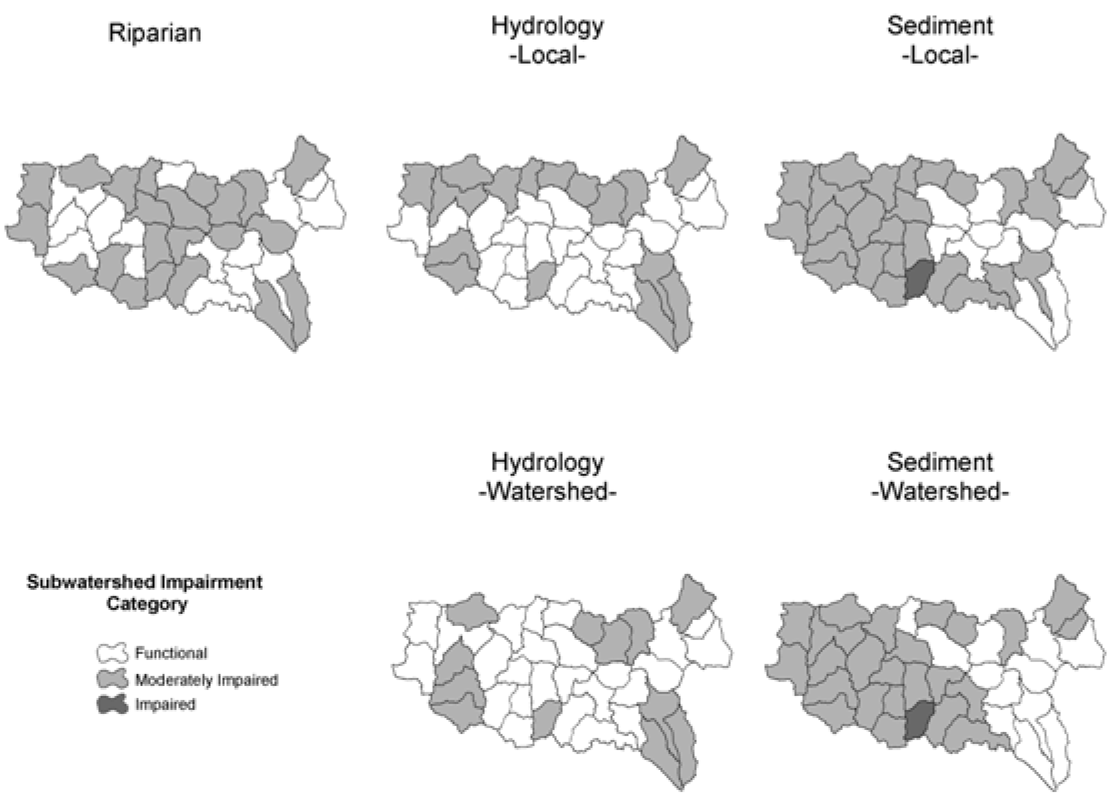


Figure F-31. IWA subwatershed impairment ratings by category for the Cispus watershed.

Sediment Supply

Current Conditions— 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.

Predicted Future Trends— 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

Riparian Condition

Current Conditions— 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.

Predicted Future Trends— 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.

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). IWA results for the Upper Cowlitz River watershed are shown in Table F-10. A reference map showing the location of each subwatershed in the basin is presented in Figure F-32. Maps of the distribution of local and watershed level IWA results are displayed in Figure F-33.

Hydrology

Current Conditions— 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.

Predicted Future Trends— 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.

Table F-10. 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

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
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
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
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

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
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

[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 F-32. Map of the upper Cowlitz basin showing the location of the IWA subwatersheds

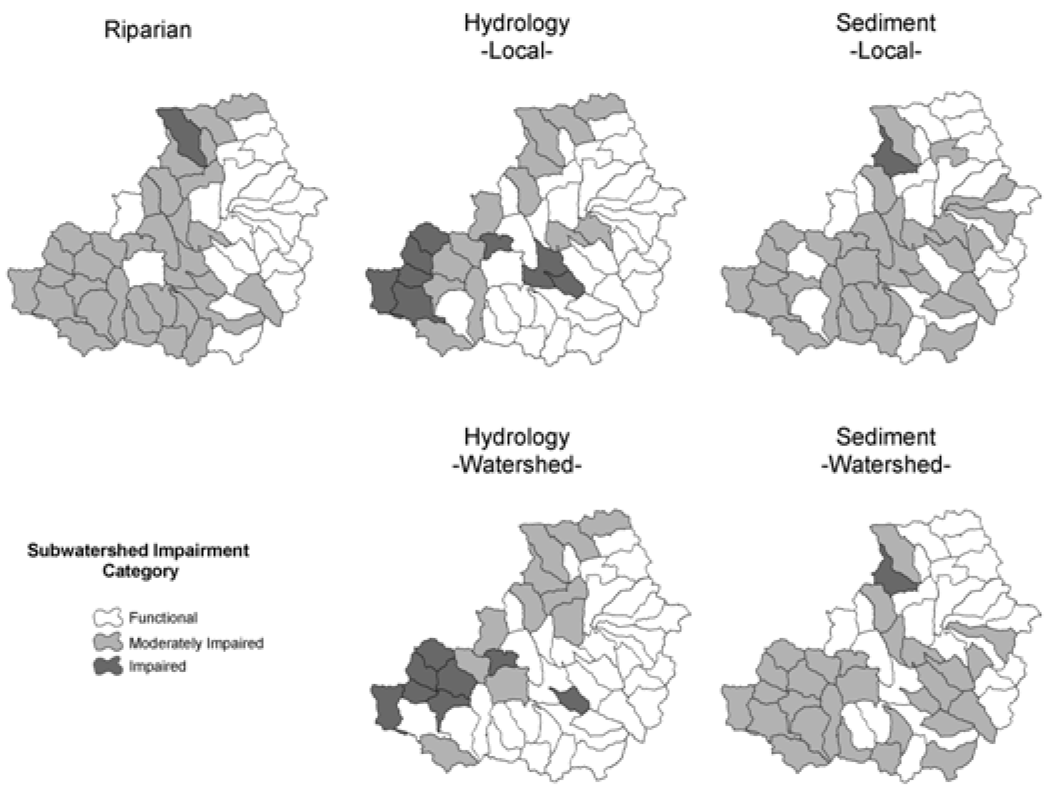


Figure F-33. IWA subwatershed impairment ratings by category for the Upper Cowlitz basin

Sediment Supply

Current Conditions— 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.

Predicted Future Trends— 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.

Riparian Condition

Current Conditions— 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.

Predicted Future Trends— 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.

F.4.4. Other Factors and Limitations

Hatcheries

Hatcheries currently release over 50 million salmon and steelhead per year in Washington lower Columbia River subbasins. Many of these fish are released to mitigate for loss of habitat. Hatcheries can provide valuable mitigation and conservation benefits may also cause significant adverse impacts if not prudently and properly employed. Risks to wild fish include genetic deterioration, reduced fitness and survival, ecological effects such as competition or predation, facility effects on passage and water quality, mixed stock fishery effects, and confounding the accuracy of wild population status estimates. This section describes hatchery programs in the upper Cowlitz subbasin and discusses their potential effects.

There are no salmon or steelhead hatcheries operating in the upper Cowlitz basin. Mossyrock Hatchery produces trout for regional plants into Southwest Washington lakes and the Tilton River. The Cowlitz Salmon Hatchery and Cowlitz Trout Hatchery in the lower Cowlitz produce spring Chinook and late-timed winter steelhead fingerlings for reintroduction into the upper Cowlitz and Tilton basins. There are no juvenile coho released into the upper basin, but adult coho are collected at the salmon hatchery and transported to the upper basin to spawn. The main threats from hatchery steelhead and salmon are ecological interactions between upper Cowlitz natural juveniles and hatchery released juveniles.

Table F-11. Upper Cowlitz Basin hatchery production.

Hatchery	Release Location	Spring Chinook	Winter Steelhead
Cowlitz Salmon	Upper Cowlitz	300,000	
Cowlitz Trout	Upper Cowlitz		287,500
Cowlitz Trout	Tilton		100,000

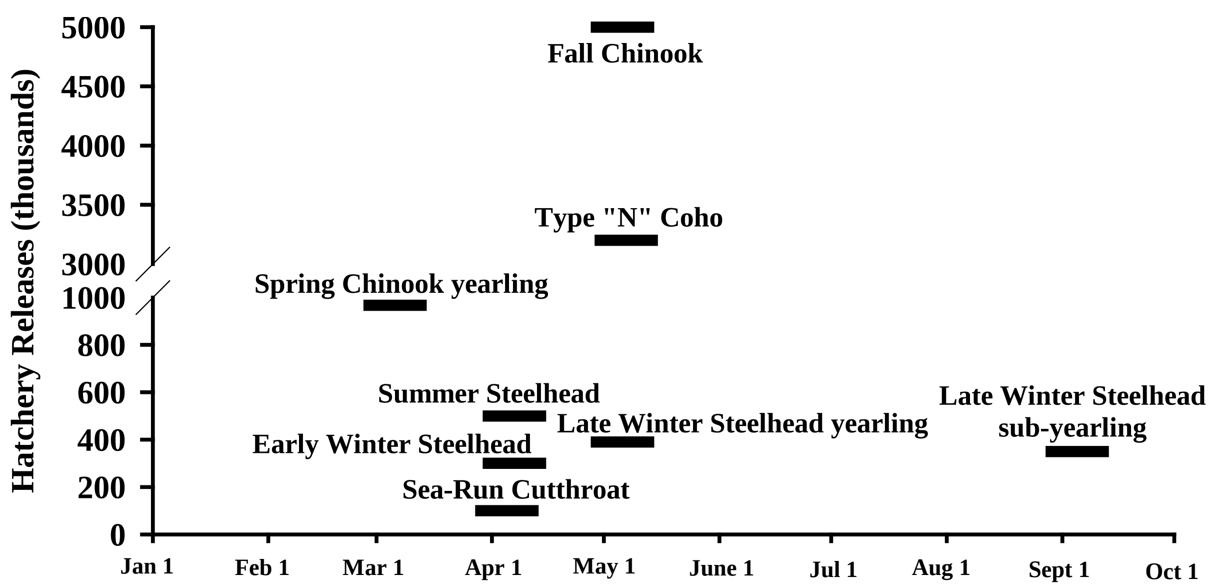


Figure F-34. Magnitude and timing of hatchery releases in the Cowlitz basin by species, based on 2003 brood production goals.

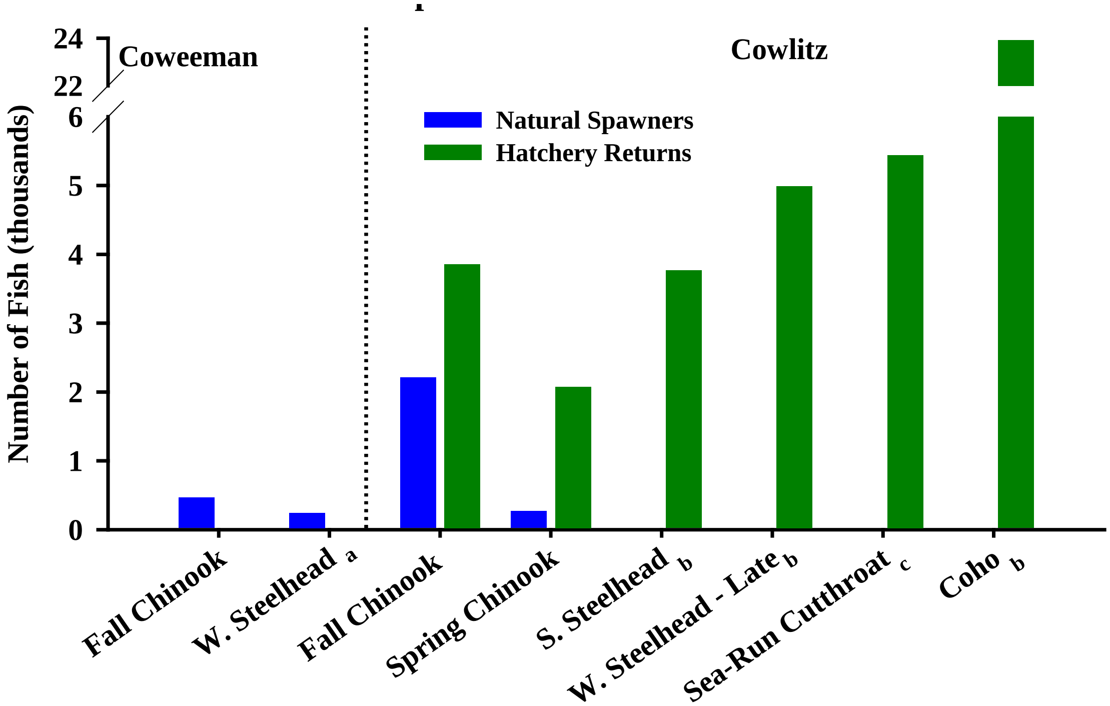


Figure F-35. Recent average hatchery returns and estimates of natural spawning escapement in the Cowlitz basin by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from the period 1992 to the present. Calculation of each average utilized a minimum of 5 years of data.

Biological Risk Assessment: The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC related plans on the Cowlitz River and Lewis River; 4) the federally mandated Artificial Production Review and Evaluation (APRE) process, and 5) the congressionally mandated, Hatchery Scientific Review Group (HSRG) review of all state, tribal and federal hatchery programs in Puget Sound and Coastal Washington, and in the Columbia River Basin. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program.

WDFW completed a Benefit-Risk Assessment Procedure (BRAP) in 2004 to provide a framework for considerations of hatchery reforms consistent with the Recovery Plan. The BRAP evaluates hatchery programs in the ecological context of the watershed, with integrated assessment and decisions for hatcheries, harvest, and habitat. The risk assessment procedure consists of five basic steps, grouped into two blocks. A policy framework assesses population status of wild populations, develops risk tolerance profiles for all stock conditions, and assign risk tolerance profiles to all stocks. A risk assessment characterizes risk assessments for each hatchery program and identifies appropriate management actions to reduce risk.

Table F-12 identifies hazards levels associated with risks involved with hatchery programs in the Grays River / Columbia Estuary Tributaries Basins. Table F-13 identifies preliminary strategies proposed to address risks identified in the BRAP for the same populations. The BRAP risk assessments and strategies to reduce risk have been key in providing the biological context to develop the hatchery recovery measures for lower Columbia River sub-basins.

Table F-12. Preliminary BRAP for hatchery programs affecting populations in the Upper Cowlitz, Cispus and Tilton Basins.

Symbol	Description
○	Risk of hazard consistent with current risk tolerance profile.
?	Magnitude of risk associated with hazard unknown.
●	Risk of hazard exceeds current risk tolerance profile.
(shaded)	Hazard not relevant to population

Upper Cowlitz Population	Hatchery Program: Name	Release (millions)	Genetic: Effective Population Size	Genetic: Domestication	Genetic: Diversity	Ecological: Predation	Ecological: Competition	Ecological: Disease	Demographic: Survival Rate	Demographic: Reproductive Success	Facility: Catastrophic Loss	Facility: Passage	Facility: Screening	Facility: Water Quality
Fall Chinook	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912				?	?	○				○	○	○
	Cowlitz Sp. Chinook 0+	0.300				○	?	○				○	○	○
	Friends of the Cowlitz Sp. Chinook 1+	0.055				?	?	○				○	○	○
	Cowlitz Early W. Steelhead 1+	0.300				?	?	○				○	○	○
	Cowlitz Late W. Steelhead 1+	0.390				?	?	○				○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○
Spring Chinook	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912	○	○	○	?	?	○	○	?	○	○	○	○
	Cowlitz Sp. Chinook 0+	0.300	○	○	○	○	?	○	○	?	○	○	○	○
	Friends of the Cowlitz Sp. Chinook 1+	0.055	○	○	○	?	?	○	○	?	○	○	○	○
	Cowlitz Early W. Steelhead 1+	0.300				?	?	○				○	○	○
	Cowlitz Late W. Steelhead 1+	0.390				?	?	○				○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○
Winter Steelhead	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912				?	?	○				○	○	○
	Cowlitz Sp. Chinook 0+	0.300				○	?	○				○	○	○
	Friends of the Cowlitz Sp. Chinook 1+	0.055	○	○	?	?	?	○				○	○	○
	Cowlitz Early W. Steelhead 1+	0.300	○	○	?	?	?	○	○	?	○	○	○	○
	Cowlitz Late W. Steelhead 1+	0.390	○	○	?	?	?	○	○	?	○	○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○

	Hatchery Program		Genetic			Ecological			Demographic		Facility			
Cispus Population	Name	Release (millions)	Effective Population Size	Domestication	Diversity	Predation	Competition	Disease	Survival Rate	Reproductive Success	Catastrophic Loss	Passage	Screening	Water Quality
Spring Chinook	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912	○	○	○	?	?	○	○	?	○	○	○	○
	Cowlitz Sp. Chinook 0+	0.300	○	○	○	○	?	○	○	?	○	○	○	○
	Friends of the Cowlitz Sp. Chinook 1	0.055	○	○	○	?	?	○	○	?	○	○	○	○
	Cowlitz Early W. Steelhead 1+	0.300				?	?	○				○	○	○
	Cowlitz Late W. Steelhead 1+	0.390				?	?	○				○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Per	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○
Winter Steelhead	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912				?	?	○				○	○	○
	Cowlitz Sp. Chinook 0+	0.300				○	?	○				○	○	○
	Friends of the Cowlitz Sp. Chinook 1	0.055	○	○	?	?	?	○				○	○	○
	Cowlitz Early W. Steelhead 1+	0.300	○	○	?	?	?	○	○	?	○	○	○	○
	Cowlitz Late W. Steelhead 1+	0.390	○	○	?	?	?	○	○	?	○	○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Per	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○

	Hatchery Program		Genetic			Ecological			Demographic		Facility			
Tilton Population	Name	Release (millions)	Effective Population Size	Domestication	Diversity	Predation	Competition	Disease	Survival Rate	Reproductive Success	Catastrophic Loss	Passage	Screening	Water Quality
Spring Chinook	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912	○	○	○	?	?	○	○	?	○	○	○	○
	Cowlitz Sp. Chinook 0+	0.300	○	○	○	○	?	○	○	?	○	○	○	○
	Friends of the Cowlitz Sp. Chinook 1	0.055	○	○	○	?	?	○	○	?	○	○	○	○
	Cowlitz Early W. Steelhead 1+	0.300				?	?	○				○	○	○
	Cowlitz Late W. Steelhead 1+	0.390				?	?	○				○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Per	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○
Winter Steelhead	Cowlitz Fall Chinook	5.000				○	?	○				○	○	○
	Cowlitz Coho 1+	3.200				?	?	○				○	○	○
	Cowlitz Coho Eggs	0.181				?	?	○				○	○	○
	Cowlitz Sp. Chinook 1+	0.912				?	?	○				○	○	○
	Cowlitz Sp. Chinook 0+	0.300				○	?	○				○	○	○
	Friends of the Cowlitz Sp. Chinook 1	0.055	○	○	?	?	?	○				○	○	○
	Cowlitz Early W. Steelhead 1+	0.300	○	○	?	?	?	○	○	?	○	○	○	○
	Cowlitz Late W. Steelhead 1+	0.390	○	○	?	?	?	○	○	?	○	○	○	○
	Colwitz Late W. Steelhead 0+	0.200				?	?	○				○	○	○
	Cowlitz S. Steelhead	0.450				?	?	○				○	○	○
	Friends of the Cowlitz S. Steelhead 1	0.100				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+ Net Per	0.010				?	?	○				○	○	○
	Cowlitz Sea-run Cutthroat 1+	0.150				?	?	○				○	○	○

Table F-13. Preliminary strategies proposed to address risks identified in the BRAP for Upper Cowlitz, Cispus and Tilton Basins populations.

	Hatchery Program		Risk Assessment of Hazards														
			Address Genetic Risks					Address Ecological Risks				Address Demographic Risks		Address Facility Risks			
Upper Cowlitz Population	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abatement
Fall Chinook	Cowlitz Fall Chinook	5.000		●	●	●							●				
	Cowlitz Coho 1+	3.200						●	●		●						
	Cowlitz Coho Eggs	0.181						●	●		●						
	Cowlitz Sp. Chinook 1+	0.912						●	●		●						
	Cowlitz Sp. Chinook 0+	0.300															
	Friends of the Cowlitz Sp. Ch. 1+	0.055						●	●		●						
	Cowlitz Early W. Steelhead 1+	0.300						●	●		●						
	Cowlitz Late W. Steelhead 1+	0.390						●	●		●						
	Cowlitz Late W. Steelhead 0+	0.200						●	●		●						
	Cowlitz S. Steelhead 1+	0.450						●	●		●						
	Friends of the Cowlitz S. Steelhead 1+	0.100						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.150						●	●		●						
Spring Chinook	Cowlitz Fall Chinook	5.000															
	Cowlitz Coho 1+	3.200						●	●		●						
	Cowlitz Coho Eggs	0.181						●	●		●						
	Cowlitz Sp. Chinook 1+	0.912		●	●	●		●	●		●		●				
	Cowlitz Sp. Chinook 0+	0.300		●	●	●		●	●		●		●				
	Friends of the Cowlitz Sp. Ch. 1+	0.055		●	●	●		●	●		●		●				
	Cowlitz Early W. Steelhead 1+	0.300						●	●		●						
	Cowlitz Late W. Steelhead 1+	0.390						●	●		●						
	Cowlitz Late W. Steelhead 0+	0.200						●	●		●						
	Cowlitz S. Steelhead 1+	0.450						●	●		●						
	Friends of the Cowlitz S. Steelhead 1+	0.100						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.150						●	●		●						

	Hatchery Program		Risk Assessment of Hazards														
			Address Genetic Risks					Address Ecological Risks				Address		Address Facility Risks			
Cispus Population	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abatement
Spring Chinook	Cowlitz Fall Chinook	5.000															
	Cowlitz Coho 1+	3.200						●	●		●						
	Cowlitz Coho Eggs	0.181						●	●		●						
	Cowlitz Sp. Chinook 1+	0.912		●	●	●		●	●		●		●				
	Cowlitz Sp. Chinook 0+	0.300		●	●	●		●	●		●		●				
	Friends of the Cowlitz Sp. Ch. 1+	0.055		●	●	●		●	●		●		●				
	Cowlitz Early W. Steelhead 1+	0.300						●	●		●						
	Cowlitz Late W. Steelhead 1+	0.390						●	●		●						
	Cowlitz Late W. Steelhead 0+	0.200						●	●		●						
	Cowlitz S. Steelhead 1+	0.450						●	●		●						
	Friends of the Cowlitz S. Steelhead 1+	0.100						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.150						●	●		●						

	Hatchery Program		Risk Assessment of Hazards														
			Address Genetic Risks					Address Ecological Risks				Address		Address Facility Risks			
Tilton Population	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abatement
Spring Chinook	Cowlitz Fall Chinook	5.000															
	Cowlitz Coho 1+	3.200						●	●		●						
	Cowlitz Coho Eggs	0.181						●	●		●						
	Cowlitz Sp. Chinook 1+	0.912		●	●	●		●	●		●		●				
	Cowlitz Sp. Chinook 0+	0.300		●	●	●		●	●		●		●				
	Friends of the Cowlitz Sp. Ch. 1+	0.055		●	●	●		●	●		●		●				
	Cowlitz Early W. Steelhead 1+	0.300						●	●		●						
	Cowlitz Late W. Steelhead 1+	0.390						●	●		●						
	Cowlitz Late W. Steelhead 0+	0.200						●	●		●						
	Cowlitz S. Steelhead 1+	0.450						●	●		●						
	Friends of the Cowlitz S. Steelhead 1+	0.100						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.010						●	●		●						
	Cowlitz Sea-run Cutthroat 1+ Net Pen	0.150						●	●		●						

The regional Hatchery Scientific Review Group (HSRG) completed an assessment of lower Columbia River hatcheries in 2009 (http://www.hatcheryreform.us/mfs/welcome_show.action). The HSRG is the independent scientific review panel of the Pacific Northwest Hatchery Reform Project established by Congress in 2000 in recognition that while hatcheries play a legitimate role in meeting harvest and conservation goals for Pacific Northwest salmon and steelhead, the hatchery system was in need of comprehensive reform. The HSRG has reviewed all state, tribal and federal hatchery programs in Puget Sound, Coastal Washington, and the Columbia River Basin. The HSRG concluded that hatcheries play an important role in the management of salmon and steelhead populations in the Columbia River Basin but that hatchery programs must be viewed not as surrogates or replacements for lost habitat, but as tools that can be managed as part of a coordinated strategy to meet watershed or regional resource goals, in concert with actions affecting habitat, harvest rates, water allocation and other important components of the human environment. The HSRG reached several critical, overarching conclusions regarding areas where current hatchery and harvest practices need to be reformed. Recommendation included:

- Manage hatchery broodstocks to achieve proper genetic integration with, or segregation from, natural populations;
- Promote of local adaptation of natural and hatchery populations;
- Minimize adverse ecological interactions between hatchery- and natural-origin fish;
- Minimize effects of hatchery facilities on the ecosystem in which they operate; and
- Maximize the survival of hatchery fish.

The HSRG developed a series of criteria for evaluating hatchery influence on wild populations based on Population Viability objectives identified in the Recovery Plan. Criteria are based on the proportion of effective hatchery-origin spawners (pHOS), the proportion of natural-origin adults in the broodstock (pNOB), and the proportionate natural influences (PNI) which is a product of pHOS and pNOB.

For Primary populations:

- pHOS should be less than 5% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, pNOB should exceed pHOS by at least a factor of two, corresponding to a PNI (proportionate natural influence) value of 0.67 or greater and pHOS should be less than 0.30.

For Contributing populations:

- The proportion of effective hatchery-origin spawners (pHOS) should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, pNOB should exceed pHOS, corresponding to a PNI value of 0.50 or greater and pHOS should be less than 0.30.

For Stabilizing populations:

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for proportion of effective hatchery-origin spawners (pHOS) or PNI.

Evaluations of current hatchery programs relative to population recovery objectives and hatchery criteria led the HSRG to provide detailed recommendations for reform of specific hatchery programs for each species and programs. General recommendations are summarized below for each species. More specific recommendations for each hatchery program are detailed, along with analyses of alternatives, in the HSRG report (http://www.hatcheryreform.us/mfs/welcome_show.action). These recommendations inform the hatchery actions identified for this subbasin and hatchery reform implementation planning reflected in WDFW's Conservation and Sustainable Fisheries plans under current development.

For Chinook, the HSRG concluded that a major concern with these programs is the effect hatchery strays have on the long-term fitness of naturally spawning populations. Although programs provide significant harvest benefits, and in some cases, help preserve genetic resources in the ESU, there are many poorly segregated and poorly integrated programs. HSRG recommendations for Chinook hatchery reform included:

- In segregated programs, improve the ability to control hatchery fish on the spawning grounds so that harvest benefits can be maintained while improving natural-origin spawning abundance and productivity for instance, by installing weirs in specific drainages where straying limits the ability to meet conservation goals.
- Move production from some tributaries into larger segregated harvest programs in Select Area Fishery Evaluation areas, where excess hatchery fish can be removed by applying higher harvest rates.
- Reduce reliance of some programs on imported out-of-basin broodstock or rearing to improve homing and increase productivity.
- For integrated programs, increase the proportion of natural-origin fish used in hatchery broodstock and control the contribution of hatchery-origin fish to natural spawning areas. In some cases, meeting the criteria for the population designation requires reducing program size.

For coho, the HSRG concluded that a major concern with these programs is the effect hatchery strays have on the long-term fitness of naturally spawning populations. These programs provide significant harvest benefits, and in some cases, help preserve genetic resources in the ESU. However, the ESU is dominated by many poorly segregated and a few poorly integrated programs. HSRG recommendations for coho hatchery reform included:

- In segregated programs, improve the ability to control hatchery fish on the spawning grounds so that harvest benefits can be maintained while improving natural-origin spawning abundance and productivity for instance, by installing weirs in specific drainages where straying limits the ability to meet conservation goals.
- Move production from some tributaries into larger segregated harvest programs in Select Area Fishery Evaluation areas, where excess hatchery fish can be removed by applying higher harvest rates.
- For integrated programs, increase the proportion of natural-origin fish used in hatchery broodstock and control the contribution of hatchery-origin fish to natural spawning areas. In some cases, meeting the criteria for the population designation requires reducing program size.
- In some cases, harvest benefits could be maintained and conservation improved by developing highly integrated conservation programs with associated segregated harvest programs (stepping-stone programs).
- More emphasis on monitoring and evaluation programs to accurately estimate straying is also recommended.

For chum, the HSRG concluded that hatchery intervention can reduce demographic risk by boosting abundance and additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk. The HSRG had no recommendations to improve on single existing chum program (Grays River) and recommends its continued operation as an important safety net in the lower Columbia.

For steelhead, the HSRG concluded that all populations in this DPS meet or exceed the HSRG criteria for their population designation. No recommendations to change programs were made by the HSRG. However, due to uncertainty about the number of unharvested hatchery-origin fish from segregated programs that remain in the natural environment, the HSRG identified a need for additional monitoring to further clarify these values and to aid in assessing the ecological impacts to the natural populations.

Subbasin Specific Recommendations: The HSRG provided subbasin and population specific advice. For the Cowlitz River, the following recommendations were made:

Cowlitz River – Fall Chinook

The HSRG observed that historically this was an important population and can contribute to recovery. The HSRG recommends:

- Consider designating this as a Primary population, given its available habitat and genetic legacy
- Develop the capability to meet the challenges of managing spawning composition and collecting natural-origin broodstock, including a monitoring program to estimate composition on the spawning grounds
- Implement a Bacterial-Kidney Disease (BKD) control strategy

Cowlitz River – Spring Chinook

The HSRG recognizes that this population can make a contribution to recovery, although downstream survival at Cowlitz Falls continues to be a problem. The HSRG recommends:

- Continue current program in the lower river (managing as a segregated program) and ongoing planned reintroduction in the upper river
- Implement a BKD control strategy for the hatchery programs

Cowlitz River – Coho

The HSRG noted the challenge of accessing broodstock needed for an integrated program in the lower river as well as to monitor and control composition on the spawning grounds, although WDFW has submitted a proposal to develop and test non-lethal methods for live capture. Recommendations include:

- Consider designating the upper watershed as a Primary population and the lower watershed component as a Contributing population
- Consider operating an integrated program and a related segregated program consistent with a Contributing population designation
- Fund and implement projects for live capture of adults
- Expand spawning ground surveys in lower river tributaries to better estimate spawner abundance, distribution, and composition

Cowlitz River – Chum

There are no hatchery releases in the Cowlitz River. The HSRG recommends that managers monitor the abundance of natural-origin chum.

Cowlitz River – Winter Steelhead (lower river)

The HSRG observed that to meet the standards for a Contributing population, the total smolt release from each of the harvest programs would need to be reduced by half. If the population were designated as Stabilizing, then current programs could be retained, continuing the transition of the late winter integrated program. A settlement agreement with Tacoma Power includes the reintroduction of the late winter component into the upper watershed.

Cowlitz River – Winter Steelhead (upper river)

The HSRG noted that the re-introduction program is being successful and the population may be able to sustain itself. Recommendations include:

- If the population is achieving levels of productivity and fish passage can lead to sustainability, then hatchery programs should be suspended and testing for self-sustainability should begin.
- If those conditions are not met, the HSRF recommends modifying the current program to an integrated conservation program. Approximately 100,000 smolts would be released below the barrier dam to improve survival and upon return, all adults would be transported to the upper watershed and allowed to spawn naturally.

Impacts: Impacts of hatchery fish on local wild populations are estimated in this plan, for the purposes of comparison with the relative magnitude of other factors, based on hatchery fractions and assumed fitness effects estimated by the HSRG. Detailed explanations of these impact estimates may be found in Volume I, Chapter 3 of this Recovery Plan.

Harvest

Fishing generally affects salmon populations through directed and incidental harvest, catch and release mortality, and size, age, and run timing alterations because of uneven fishing on different run components. From a population biology perspective, this results in fewer spawners and can alter age, size, run timing, fecundity, and genetic characteristics. Fewer spawners result in fewer eggs for future generations and diminish marine-derived nutrients delivered via dying adults, now known to be significant to the growth and survival of juvenile salmon in aquatic ecosystems. The degree to which harvest-related limiting factors influence productivity varies by species and location.

Most harvest of wild Columbia River salmon and steelhead occurs incidental to the harvest of hatchery fish and healthy wild stocks in the Columbia estuary, mainstem, and ocean. Fish are caught in the Canada/Alaska ocean, U.S. West Coast ocean, lower Columbia River commercial and recreational, tributary recreational, and in-river treaty Indian (including commercial, ceremonial, and subsistence) fisheries. Total exploitation rates have decreased for lower Columbia salmon and steelhead, especially since the 1970s as increasingly stringent protection measures were adopted for declining natural populations.

At the time of interim plan completion, fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table F-14). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced spring Chinook, coho, and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

Table F-14. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Spring Chinook	13	5	1	1	2	**22**	53	65
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Coho	<1	9	6	2	1	**18**	51	85
Steelhead	0	<1	3	0.5	5	**8.5**	70	75

Columbia River fall Chinook are subject to freshwater and ocean fisheries from Alaska to their rivers of origin in fisheries targeting abundant Chinook stocks originating from Alaska, Canada, Washington, Oregon, and California. Columbia tule fall Chinook harvest is constrained by a Recovery Exploitation Rate (RER) developed by NMFS for management of Coweeman naturally-spawning fall Chinook. Some In-basin sport fisheries are closed to the retention of fall chinook to protect naturally spawning populations. Harvest of lower Columbia bright wild fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Harvest of upper Cowlitz coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River as well as recreational fisheries in the Lower Cowlitz Basin. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish.

Steelhead are not encountered by ocean fisheries and non-Indian commercial steelhead fisheries are prohibited in the Columbia River. Incidental mortality of steelhead occurs in freshwater commercial fisheries directed at Chinook and coho and freshwater sport fisheries directed at hatchery steelhead and salmon. All recreational fisheries are managed to selectively harvest fin-marked hatchery steelhead and commercial fisheries cannot retain hatchery or wild steelhead.

Access to harvestable surpluses of strong stocks in the Columbia River and ocean is regulated by impact limits on weak populations mixed with the strong. Weak stock management of Columbia River fisheries became increasingly prevalent in the 1960s and 1970s in response to continuing declines of upriver runs affected by mainstem dam construction. In the 1980s coordinated ocean and freshwater weak stock management commenced. More fishery restrictions followed ESA listings in the 1990s. Each fishery is controlled by a series of regulating factors. Many of the regulating factors that affect harvest impacts on Columbia River stocks are associated with treaties, laws, policies, or guidelines established for the management of other stocks or combined stocks, but indirectly control impacts of Columbia River fish as well. Listed fish generally comprise a small percentage of the total fish caught by any fishery. Every listed fish may correspond to tens, hundreds, or thousands of other stocks in the total catch. As a result of weak stock constraints, surpluses of hatchery and strong naturally-spawning runs often go unharvested. Small reductions in fishing rates on listed populations can translate to large reductions in catch of other stocks and recreational trips to communities which provide access to fishing, with significant economic consequences.

Selective fisheries for adipose fin-clipped hatchery spring Chinook (since 2001), coho (since 1999), and steelhead (since 1984) have substantially reduced fishing mortality rates for naturally-spawning populations and allowed concentration of fisheries on abundant hatchery fish. Selective fisheries occur in the Columbia River and tributaries, for spring Chinook and steelhead, and in the ocean, Columbia River, and tributaries for coho. Columbia River hatchery fall Chinook are not marked for selective fisheries, but likely will be in the future because of recent legislation enacted by Congress.

Mainstem and Estuary Habitat

Conditions in the Columbia River mainstem, estuary, and plume affect all anadromous salmonid populations within the Columbia Basin. Juvenile and adult salmon may be found in the mainstem and estuary at all times of the year, as different species, life history strategies and size classes continually rear or move through these waters. A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals.

Effects on salmonids of habitat changes in the mainstem and estuary are complex and poorly understood. Effects are similar for upper Cowlitz populations to those of most other subbasin salmonid populations. Effects are likely to be greater for fall Chinook which rear for extended periods in the mainstem and estuary than for steelhead and coho which move through more quickly. Estimates of the impacts of human-caused changes in mainstem and estuary habitat conditions are available based on changes in river flow, temperature, and predation as represented by EDT analyses for the NPCC Multispecies Framework Approach (Marcot et al. 2002). These estimates generally translate into a 10-60% reduction in salmonid productivity depending on species (Appendix E). Estuary effects are described more fully in the estuary subbasin volume of this plan (Volume II-A).

Hydropower Construction and Operation

The hydropower system is the primary factor for decline in the upper Cowlitz basin. Mayfield Dam (RM 52), built in 1962, blocks anadromous passage to the upper Cowlitz, Tilton, and Cispus river watersheds. In addition, two more dams, Mossyrock (RM 66), and Cowlitz Falls Dam (RM 88.5) impound the upper watershed. 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.

Upper Cowlitz species are also affected by changes in the Columbia River mainstem and estuary related to Columbia basin hydropower development and operation. The mainstem Columbia River and estuary provide important habitats for anadromous species during juvenile and adult migrations between spawning and rearing streams and the ocean where they grow and mature. These habitats are particularly important for fall Chinook which rear extensively in the Columbia mainstem and estuary. Aquatic habitats have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control.

The hydropower infrastructure and flow regulation affects adult migration, juvenile migration, mainstem spawning success, estuarine rearing, water temperature, water clarity, gas supersaturation, and predation. Dams block or impede passage of anadromous juveniles and adults. Columbia River spring flows are greatly reduced from historical levels as water is stored for power generation and irrigation, while summer and winter flows have increased. These flow changes affect juvenile and adult migration, and have radically altered habitat forming processes. Flow regulation and reservoir construction have increased average water temperature in the Columbia River mainstem and summer temperatures regularly exceed optimums for salmon. Supersaturation of water with atmospheric gases, primarily nitrogen, when water is spilled over high dams causes gas bubble disease. Predation by fish, bird, and marine mammals has been exacerbated by habitat changes. The net effect of these direct and indirect effects is difficult to quantify but is expected to be less significant for populations originating from lower Columbia River subbasins than for upriver salmonid populations. Additional information on hydropower effects can be found in Volume I.

Ecological Interactions

Ecological interactions focus on how salmon and steelhead, other fish species, and wildlife interact with each other and the subbasin ecosystem. Salmon and steelhead are affected throughout their lifecycle by ecological interactions with non native species, food web components, and predators. Each of these factors can be exacerbated by human activities either by direct actions or indirect effects of habitat alternation. Effects of non-native species on salmon, effects of salmon on system productivity, and effects of native predators on salmon are difficult to quantify. Strong evidence exists in the scientific literature on the potential for significant interactions but effects are often context- or case-specific.

Predation is one interaction where effects can be estimated although interpretation can be complicated. In the lower Columbia River, northern pikeminnow, Caspian tern, and marine mammal predation on salmon has been estimated at approximately 5%, 10-30%, and 3-12%, respectively of total salmon numbers (see Appendix E for additional details). Predation has always been a source of salmon mortality but predation rates by some species have been exacerbated by human activities.

Ocean Conditions

Salmonid numbers and survival rates in the ocean vary with ocean conditions and low productivity periods increase extinction risks of populations stressed by human impacts. The ocean is subject to annual and longer-term climate cycles just as the land is subject to periodic droughts and floods. The El Niño weather pattern produces warm ocean temperatures and warm, dry conditions throughout the Pacific Northwest. The La Niña weather patterns are typified by cool ocean temperatures and cool/wet weather patterns on land. Recent history is dominated by a high frequency of warm dry years, along with some of the largest El Niños on record—particularly in 1982-83 and 1997-98. In contrast, the 1960s and early 1970s were dominated by a cool, wet regime. Many climatologists suspect that the conditions observed since 1998 may herald a return to the cool wet regime that prevailed during the 1960s and early 1970s.

Abrupt declines in salmon populations throughout the Pacific Northwest coincided with a regime shift to predominantly warm dry conditions from 1975 to 1998 (Beamish and Bouillon 1993, Hare et al 1999, McKinnell et al. 2001, Pyper et al. 2001). Warm dry regimes result in generally lower survival rates and abundance, and they also increase variability in survival and wide swings in salmon abundance. Some of the largest Columbia River fish runs in recorded history occurred during 1985–1987 and 2001–2002 after strong El Niño conditions in 1982–83 and 1997–98 were followed by several years of cool wet conditions.

The reduced productivity that accompanied an extended series of warm dry conditions after 1975 has, together with numerous anthropogenic impacts, brought many weak Pacific Northwest salmon stocks to the brink of extinction and precipitated widespread ESA listings. Salmon numbers naturally ebb and flow as ocean conditions vary. Healthy salmon populations are productive enough to withstand these natural fluctuations. Weak salmon populations may disappear or lose the genetic diversity needed to withstand the next cycle of low ocean productivity (Lawson 1993).

Recent improvements in ocean survival may portend a regime shift to generally more favorable conditions for salmon. The large spike in recent runs and a cool, wet climate would provide a respite for many salmon populations driven to critical low levels by recent conditions. The National Research Council (1996) concluded: *"Any favorable changes in ocean conditions—which could occur and could increase the productivity of some salmon populations for a time—should be regarded as opportunities for improving management techniques. They should not be regarded as reasons to abandon or reduce rehabilitation efforts, because conditions will change again".* Additional details on the nature and effects of variable ocean conditions on salmonids can be found in Volume I.

F.4.5. Summary of Human Impacts on Salmon and Steelhead

Stream habitat, estuary/mainstem habitat, harvest, hatchery and ecological interactions have all contributed to reductions in productivity, numbers, and population viability. Pie charts in Figure 36 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Toutle Basin salmon and steelhead. Impact values were developed for a base period corresponding to species listing dates. This depiction is useful for identifying which factors are most significant for each species and where improvements might be expected to provide substantial benefits. Larger pie slices indicate greater significance and scope for improvement in an impact for a given species. These numbers also serve as a working hypothesis for factors limiting salmonid numbers and viability.

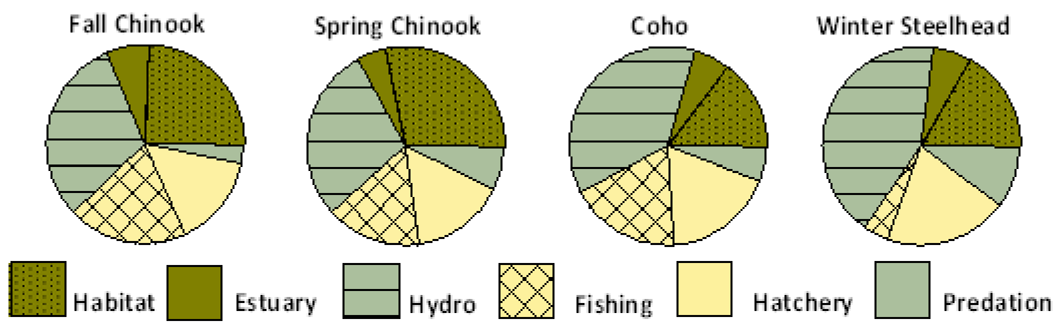


Figure F-36. Relative contribution of potentially manageable impacts on upper Cowlitz River salmonid populations.

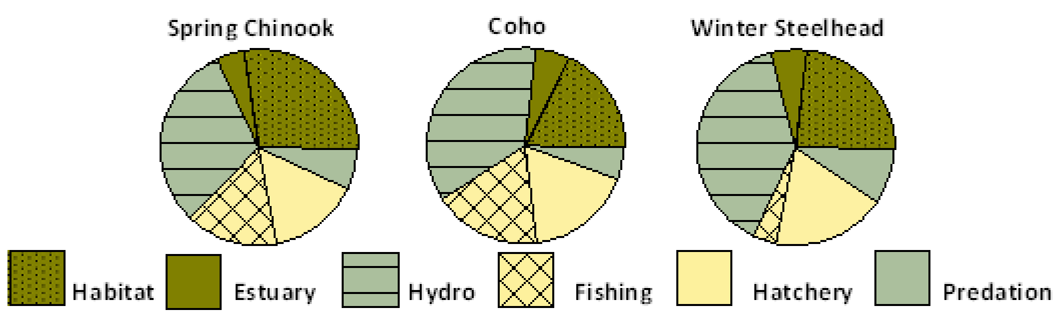


Figure F-37. Relative contribution of potentially manageable impacts on Cispus River salmonid populations.

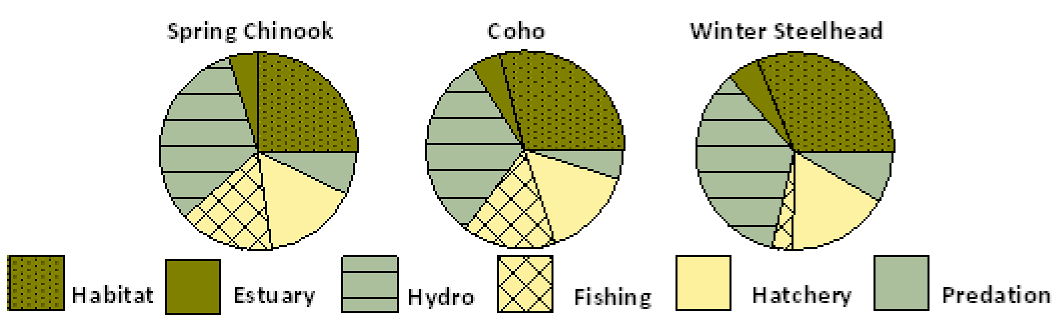


Figure F-38. Relative contribution of potentially manageable impacts on Tilton River salmonid populations.

This assessment indicates that current salmonid status is the result of large impacts distributed among several factors. No single factor accounts for a majority of effects on all species. Thus, substantial improvements in salmonid numbers and viability will require significant improvements in several factors. Hydrosystem impacts account for the largest relative impact on all species in the Upper Cowlitz Subbasin. Loss of tributary habitat quality and quantity is also relatively important for all species. Fishing harvest has a sizeable effect on fall and spring Chinook and coho but is relatively minor for winter steelhead. Hatchery impacts are moderate for coho, and relatively low for winter steelhead, fall Chinook and spring Chinook. Loss of estuary habitat quantity and quality as well as predation impacts are moderate for all species.

Impacts were defined as the proportional reduction in average numbers or productivity associated with each effect. Tributary and estuary habitat impacts are the differences between the pre-development historical baseline and current conditions. Hydro impacts identify the percentage of historical habitat blocked by impassable dams and the mortality associated with juvenile and adult passage of other dams. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries. Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in its relative significance. Methods and data for these analyses are detailed in Appendix E.

Potentially-manageable human impacts were estimated for each factor based on the best available scientific information. Proportions are standardized to a total of 1.0 for plotting purposes. The index is intended to illustrate order-of-magnitude rather than fine-scale differences. Only the subset of factors we can potentially manage were included in this index – natural mortality factors beyond our control (e.g. naturally-occurring ocean mortality) are excluded. Not every factor of interest is included in this index – only readily-quantifiable impacts are included.

F.5. Key Programs and Projects

This section provides brief summaries of current federal, state, local, and non-governmental programs and projects pertinent to recovery, management, and mitigation measures and actions in this basin. These descriptions provide a context for descriptions of specific actions and responsibilities in the management plan portion of this subbasin plan. More detailed descriptions of these programs and projects can be found in the Comprehensive Program Directory (Appendix C).

F.5.1. Federal Programs

NMFS

NMFS is responsible for conserving, protecting and managing pacific salmon, ground fish, halibut, marine mammals and habitats under the Endangered Species Act, the Marine Mammal Protection Act, the Magnuson-Stevens Act, and enforcement authorities. NMFS administers the ESA under Section 4 (listing requirements), Section 7 (federal actions), and Section 10 (non-federal actions).

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) is the Federal government's largest water resources development and management agency. USACE programs applicable to Lower Columbia Fish & Wildlife include: 1) Section 1135 – provides for the modification of the structure or operation of a past USACE project, 2) Section 206 – authorizes the implementation of aquatic ecosystem restoration and protection projects, 3) Hydroelectric Program – applies to the construction and operation of power facilities and their environmental impact, 4) Regulatory Program – administration of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act.

Environmental Protection Agency

The Environmental Protection Agency (EPA) is responsible for the implementation of the Clean Water Act (CWA). The broad goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. The CWA requires that water quality standards (WQS) be set for surface waters. WQS are aimed at translating the broad goals of the CWA into waterbody-specific objectives and apply only to the surface waters (rivers, lakes, estuaries, coastal waters, and wetlands) of the United States.

United States Forest Service

The United States Forest Service (USFS) manages federal forest lands within the Gifford Pinchot National Forest (GPNF) and Wilderness Areas. The GPNF operates under the Gifford Pinchot Forest Plan (GPFP). Management prescriptions within the GPFP have been guided by the 1994 Northwest Forest Plan, which calls for management of forests according to a suite of management designations including Reserves (e.g. late successional forests, riparian forests), Adaptively-Managed Areas, and Matrix Lands. Most timber harvest occurs in Matrix Lands. The GPNF implements a wide range of ecosystem restoration activities. Lands within Wilderness Areas are managed for protection and/or passive restoration of ecosystem processes.

Natural Resources Conservation Service

Formerly the Soil Conservation Service, the USDA Natural Resources Conservation Service (NRCS) works with landowners to conserve natural resources on private lands. The NRCS accomplishes this through various programs including, but not limited to, the Conservation Technical Assistance Program, Soil Survey Program, Conservation Reserve Enhancement Program, and the Wetlands Reserve Program. The NRCS works closely with local Conservation Districts; providing technical assistance and support.

National Park Service

Mt. Rainier National Park was established on March 2, 1899 and encompasses 235,625 acres, ranging in elevation from 1,610 ft to 14,410 ft above sea level. The Park is approximately 97 percent wilderness and as such, offers a high degree of protection for the headwaters of the Cowlitz subbasin.

Northwest Power and Conservation Council

The Northwest Power and Conservation Council, an interstate compact of Idaho, Montana, Oregon, and Washington, has specific responsibility in the Northwest Power Act of 1980 to mitigate the effects of the hydropower system on fish and wildlife of the Columbia River Basin. The Council does this through its Columbia River Basin Fish and Wildlife Program, which is funded by the Bonneville Power Administration. Beginning in Fiscal Year 2006, funding is guided by locally developed subbasin plans that are expected to be formally adopted in the Council's Fish and Wildlife Program in December 2004.

Federal Energy Regulatory Commission

Non-federal hydroelectric projects that meet certain criteria operate under licenses issued by the Federal Energy Regulatory Commission (FERC). A hydroelectric license prescribes operations and safety precautions, as well as environmental protection, mitigation and enhancements. The FERC relicensing process requires years of extensive planning, including environmental studies, agency consensus, and public involvement.

F.5.2. State Programs

Washington Department of Natural Resources

The Washington Department of Natural Resources governs forest practices on non-federal lands and is steward to state owned aquatic lands. Management of DNR public forest lands is governed by tenets of their proposed Habitat Conservation Plan (HCP). Management of private industrial forestlands is subject to Forest Practices regulations that include both protective and restorative measures.

Washington Department of Fish & Wildlife

WDFW's Habitat Division supports a variety of programs that address salmonids and other wildlife and resident fish species. These programs are organized around habitat conditions (Science Division, Priority Habitats and Species, and the Salmon and Steelhead Habitat Inventory and Assessment Program); habitat restoration (Landowner Incentive Program, Lead Entity Program, and the Conservation and Reinvestment Act Program, as well as technical assistance in the form of publications and technical resources); and habitat protection (Landowner Assistance, GMA, SEPA planning, Hydraulic Project Approval, and Joint Aquatic Resource Permit Applications).

Washington Department of Ecology

The Department of Ecology (Ecology) oversees: the Water Resources program to manage water resources to meet current and future needs of the natural environment and Washington's communities; the Water Quality program to restore and protect Washington's water supplies by preventing and reducing pollution; and Shoreline and the Environmental Assistance program for implementing the Shorelines Management Act, the State Environmental Protection Act, the Watershed Planning Act, and 401 Certification of USACE Permits.

Washington Department of Transportation

The Washington State Department of Transportation (WSDOT) must ensure compliance with environmental laws and statutes when designing and executing transportation projects. Programs that consider and mitigate for impacts to salmonid habitat include: the Fish Passage Barrier Removal program; the Regional Road Maintenance ESA Section 4d Program, the Integrated Vegetation Management & Roadside Development Program; Environmental Mitigation Program; the Stormwater Retrofit Program; and the Chronic Environmental Deficiency Program.

Washington Recreation and Conservation Office

Created through the enactment of the Salmon Recovery Act (Washington State Legislature, 1999), the Salmon Recovery Funding Board provides grant funds to protect or restore salmon habitat and assist related activities with local watershed groups known as lead entities. SRFB has helped finance over 500 salmon recovery projects statewide. The Aquatic Lands Enhancement Account (ALEA) was established in 1984 and is used to provide grant support for the purchase, improvement, or protection of aquatic lands for public purposes, and for providing and improving access to such lands. The Washington Wildlife and Recreation Program (WWRP), established in 1990 and administered by the RCO, provides funding assistance for a broad range of land protection, park development, preservation/conservation, and outdoor recreation facilities.

Lower Columbia Fish Recovery Board

The Lower Columbia Fish Recovery Board encompasses five counties in the Lower Columbia River Region. The 15-member board has four main programs, including habitat protection and restoration activities, watershed planning for water quantity, quality, habitat, and instream flows, facilitating the development of an integrated recovery plan for the Washington portion of the lower Columbia Evolutionarily Significant Units, and conducting public outreach activities.

F.5.3. Local Government Programs

Lewis County

Lewis County is in the process of becoming compliant with the Growth Management Act in its Comprehensive Planning process. Lewis County manages lands through a Critical Areas Ordinance, Stormwater Management, and various other programs.

Lewis Conservation District

The Lewis Conservation District provides technical assistance, cost-share assistance, and project monitoring in WRIA 26. The conservation district has developed projects in the Cowlitz subbasin, including instream work and culvert replacement projects. Lewis CD works with agricultural landowners through CREP and farm planning activities and performs limited educational activities.

Tacoma Public Utilities (Tacoma Power)

Tacoma Power is a publicly owned division of Tacoma Public Utilities that operates Mayfield and Mossyrock Dams to provide electricity to the city of Tacoma and surrounding areas. Tacoma Power operates the facilities under a license agreement with the Federal Energy Regulatory Commission (FERC).

Lewis County Public Utility District

The Lewis County Public Utility District is a non-profit, customer-owned utility that provides electricity to Lewis County in southwest Washington. The Lewis County PUD and the BPA cooperatively developed the Cowlitz Falls Project. The PUD is owner of the Project, while the BPA has purchased the annual output of the Project under a long-term contract. In exchange for receiving the output of the Project, BPA pays all costs associated with its operation and maintenance. Lewis County PUD buys its power from BPA so the power generated by the Cowlitz Falls Project helps supply the needs of Lewis County residents and businesses.

F.5.4. Non-governmental Programs

Columbia Land Trust

The Columbia Land Trust is a private, non-profit organization founded in 1990 to work exclusively with willing landowners to find ways to conserve the scenic and natural values of the land and water. Landowners donate the development rights or full ownership of their land to the Land Trust. CLT manages the land under a stewardship plan and, if necessary, will legally defend its conservation values.

Lower Columbia Fish Enhancement Group

The Washington State Legislature created the Regional Fisheries Enhancement Group Program in 1990 to involve local communities, citizen volunteers, and landowners in the state's salmon recovery efforts. RFEGs help lead their communities in successful restoration, education and monitoring projects. Every group is a separate, nonprofit organization led by their own board of directors and operational funding from a portion of commercial and recreational fishing license fees administered by the WDFW, and other sources. The mission of the Lower Columbia RFEG (LCFEG) is to restore salmon runs in the lower Columbia River region through habitat restoration, education and outreach, and developing regional and local partnerships.

F.5.5. Tribal Programs

Cowlitz Indian Tribe

The Cowlitz Indian Tribe's Natural Resources program participates in research and restoration efforts in the lower Columbia region. The focus of their fish research and restoration efforts includes salmon, steelhead, eulachon, and lamprey.

F.5.6. NPCC Fish & Wildlife Program Projects

There are no NPCC Fish & Wildlife Program Projects in the Upper Cowlitz Basin.

F.5.7. Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Restoration	Hall Creek	Upper Cowlitz
Restoration	Yellow Jacket Creek, Cispus Creek	Upper Cowlitz
Restoration	Woods Creek Fish Passage Restoration	Upper Cowlitz

F.6. Management Plan

F.6.1. Vision

Washington lower Columbia salmon, steelhead, and bull trout are recovered to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of the ecosystems upon which they depend and the implementation of supportive hatchery and harvest practices.

The health of other native fish and wildlife species in the lower Columbia will be enhanced and sustained through the protection of the ecosystems upon which they depend, the control of non-native species, and the restoration of balanced predator/prey relationships.

The Upper Cowlitz Basin will play key role in the recovery of salmon and steelhead. Natural populations of spring Chinook will be reestablished and restored to high levels of viability and coho and winter steelhead will be reestablished and restored to medium levels of viability. These objectives will be accomplished by adequate passage through the hydrosystem and significant reductions in human impacts throughout the lifecycle. Salmonid recovery efforts will provide broad ecosystem benefits to a variety of subbasin fish and wildlife species. Recovery will be accomplished through a combination of improvements in subbasin, Columbia River mainstem, and estuary habitat conditions as well as careful management of hatcheries, fisheries, and ecological interactions among species.

Habitat protection or restoration will involve a wide range of Federal, State, Local, and non-governmental programs and projects. Success will depend on effective programs as well as a dedicated commitment to salmon recovery across a broad section of society.

Some hatchery programs will be realigned to focus on protection, conservation, and recovery of native fish. The need for hatchery measures will decrease as productive natural habitats are restored. Where consistent with recovery, other hatchery programs will continue to provide fish for fishery benefits for mitigation purposes in the interim until habitat conditions are restored to levels adequate to sustain healthy, harvestable natural populations.

Directed fishing on sensitive wild populations will be eliminated and incidental impacts of mixed stock fisheries in the Columbia River and ocean will be regulated and limited consistent with wild fish recovery needs. Until recovery is achieved, fishery opportunities will be focused on hatchery fish and harvestable surpluses of healthy wild stocks.

Cowlitz Basin hydropower effects will be addressed as part of the FERC license requirements for operation of the three dams in the upper Cowlitz River. Columbia basin hydropower effects on Upper Cowlitz Subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the upper Cowlitz will also be called upon to produce fish to help mitigate for hydropower impacts on upriver stocks where compatible with wild fish recovery.

This plan uses a planning period or horizon of 25 years. The goal is to achieve recovery of the listed salmon species and the biological objectives for other fish and wildlife species of interest within this time period. It is recognized, however, that sufficient restoration of habitat conditions and watershed processes for all species of interest will likely take 75 years or more.

F.6.2. Biological Objectives

Biological objectives for upper Cowlitz subbasin salmonid populations are based on recovery criteria developed by scientists on the Willamette/Lower Columbia Technical Recovery Team convened by NMFS. Criteria involve a hierarchy of ESU, Strata (i.e. ecosystem areas within the ESU – Coast, Cascade, and Gorge), and Population standards. A recovery scenario describing population-scale biological objectives for all species in all three strata in the lower Columbia ESUs was developed through a collaborative process with stakeholders based on biological significance, expected progress as a result of existing programs, the absence of apparent impediments, and the existence of other management opportunities. Under the preferred alternative, individual populations will variously contribute to recovery according to habitat quality and the population's perceived capacity to rebuild. Criteria, objectives, and the regional recovery scenario are described in greater detail in Volume I.

Focal populations in the upper Cowlitz subbasin are targeted to improve to a level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels.

Recovery goals call for restoring salmonid populations to viability levels ranging from very low to medium and high (Table F-15).

Table F-15. Current viability status of upper Cowlitz populations and the biological objective status that is necessary to meet the recovery criteria for the Cascade strata and the lower Columbia ESU.

Species	Population	Recovery Priority[1]	Viability		Improve-ment[4]	Abundance		
			Status[2]	Obj.[3]		Historic[5]	Current[6]	Target[7]
Fall Chinook (Tule)	U. Cowlitz	Stabilizing	VL	VL	--	28,000	0	--
Spring Chinook	U. Cowlitz	Primary	VL	H+	>500%	22,000	300	1,800
Winter Steelhead	U. Cowlitz	Primary	VL	H	>500%	1,400	<50	500
Coho	U. Cowlitz	Primary	VL	H	>500%	18,000	<50	2,000
Spring Chinook	Cispus	Primary	VL	H+	>500%	7,800	150	1,800
Winter Steelhead	Cispus	Primary	VL	H	>500%	1,500	<50	500
Coho	Cispus	Primary	VL	H	>500%	8,000	<50	2,000
Spring Chinook	Tilton	Stabilizing	VL	VL	0%[8]	5,400	100	--
Winter Steelhead	Tilton	Contributing	VL	L	>500%	1,700	<50	200
Coho	Tilton	Stabilizing	VL	VL	0%[8]	5,600	<50	--

[1] Primary, contributing, and stabilizing designations reflect the relative contribution of a population to major population group recovery goals.
[2] Baseline viability is based on Technical Recovery Team viability rating approach.
[3] Viability objective is based on the scenario contribution.
[4] Improvement is the relative increase in population production required to reach the prescribed viability goal
[5] Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NMFS back-of-envelope calculations.
[6] Approximate current annual range in number of naturally-produced fish returning to the watershed.
[7] Abundance targets were estimated by population viability simulations based on viability goals.
[8] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.

The above high level for spring Chinook in the upper Cowlitz and Cispus subbasins will provide for a greater than 99% probability of population survival over 100 years and the medium level for coho and winter steelhead will provide for at least a 75% probability of survival. Fall Chinook recovery will be focused downstream of the hydrosystem in the lower Cowlitz River. Cutthroat will benefit from improvements in stream habitat conditions for anadromous species. Lamprey are also expected to benefit from habitat improvements in the estuary, Columbia River mainstem, and Upper Cowlitz Basin although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the basin.

F.6.3. Integrated Strategy

An Integrated Regional Strategy for recovery emphasizes that 1) it is feasible to recover Washington lower Columbia natural salmon and steelhead to healthy and harvestable levels; 2) substantial improvements in salmon and steelhead numbers, productivity, distribution, and diversity will be required; 3) recovery cannot be achieved based solely on improvements in any one factor; 4) existing programs are insufficient to reach recovery goals, 5) all manageable effects on fish and habitat conditions must contribute to recovery, 6) actions needed for salmon recovery will have broader ecosystem benefits for all fish and wildlife species of interest, and 7) strategies and measures likely to contribute to recovery can be identified but estimates of the incremental improvements resulting from each specific action are highly uncertain. The strategy is described in greater detail in Volume I.

The Integrated Strategy recognizes the importance of implementing measures and actions that address each limiting factor and risk category, prescribing improvements in each factor/threat category in proportion to its magnitude of contribution to salmon declines, identifying an appropriate balance of strategies and measures that address regional, upstream, and downstream threats, and focusing near term actions on species at-risk of extinction while also ensuring a long term balance with other species and the ecosystem.

Population productivity improvement increments identify proportional improvements in productivity needed to recover populations from current status to medium, high, and very high levels of population viability consistent with the role of the population in the recovery scenario. Productivity is defined as the inherent population replacement rate and is typically expressed by models as a median rate of population increase (PCC model) or a recruit per spawner rate (EDT model). Corresponding improvements in spawner numbers, juvenile outmigrants, population spatial structure, genetic and life history diversity, and habitat are implicit in productivity improvements.

Improvement targets were developed for each impact factor based on desired population productivity improvements and estimates of potentially manageable impacts (see Section 3.7). Impacts are estimates of the proportional reduction in population productivity associated with human-caused and other potentially manageable impacts from stream habitats, estuary/mainstem habitats, hydropower, harvest, hatcheries, and selected predators. Reduction targets were driven by the regional strategy of equitably allocating recovery responsibilities among the six manageable impact factors.

Table F-16. Baseline impacts for limiting factors in the the upper Cowlitz subbasin.

Species	Net increase	Per factor	Hab.	Estuary	Baseline impacts Dams	Pred.	Fishery	Hatch.
Fall Chinook	0%	0%	0.80	0.23	1.00	0.10	0.65	0.14
Spring Chinook								
Upper Cowlitz	>500%	50%	0.90	0.15	1.00	0.22	0.50	0.18
Tilton	0%	0%	0.80	0.15	1.00	0.22	0.50	0.18
Cispus	>500%	50%	1.00	0.15	0.90	0.22	0.50	0.18
Coho								
Upper Cowlitz	>500%	50%	0.40	0.16	1.00	0.15	0.50	0.30
Tilton	0%	0%	0.95	0.16	1.00	0.15	0.50	0.30
Cispus	>500%	50%	0.50	0.16	1.00	0.15	0.50	0.30
Winter Steelhead								
Upper Cowlitz	500	50	0.40	0.15	1.00	0.24	0.10	0.09
Tilton	500	50	0.90	0.15	1.00	0.24	0.10	0.09
Cispus	500	50	0.60	0.15	1.00	0.24	0.10	0.09

F.6.4. Tributary Habitat

Habitat assessment results were synthesized in order to develop specific prioritized measures and actions that are believed to offer the greatest opportunity for species recovery in the subbasin. As a first step toward measure and action development, habitat assessment results were integrated to develop a multi-species view of 1) priority areas, 2) factors limiting recovery, and 3) contributing land-use threats. For the purpose of this assessment, limiting factors are defined as the biological and physical conditions serving to suppress salmonid population performance, whereas threats are the land-use activities contributing to those factors. Limiting Factors refer to local (reach-scale) conditions believed to be directly impacting fish. Threats, on the other hand, may be local or non-local. Non-local threats may impact instream limiting factors in a number of ways, including: 1) through their effects on habitat-forming processes – such as the case of forest road impacts on reach-scale fine sediment loads, 2) due to an impact in a contributing stream reach – such as riparian degradation reducing wood recruitment to a downstream reach, or 3) by blocking fish passage to an upstream reach.

Priority areas and limiting factors were determined through the technical assessment, including primarily EDT analysis and the Integrated Watershed Assessment (IWA). As described later in this section, priority areas are also determined by the relative importance of subbasin focal fish populations to regional recovery objectives. This information allows for scaling of subbasin recovery effort in order to best accomplish recovery at the regional scale. Land-use threats were determined from a variety of sources including Washington Conservation Commission Limiting Factors Analyses, the IWA, the State 303(d) list, air photo analysis, the Barrier Assessment, personal knowledge of investigators, or known cause-effect relationships between stream conditions and land-uses.

Priority areas, limiting factors and threats were used to develop a prioritized suite of habitat measures. Measures are based solely on biological and physical conditions. For each measure, the key programs that address the measure are identified and the sufficiency of existing programs to satisfy the measure is discussed. The measures, in conjunction with the program sufficiency considerations, were then used to identify specific actions necessary to fill gaps in measure implementation. Actions differ from measures in that they address program deficiencies as well as biophysical habitat conditions. The process for developing measures and actions is illustrated in Figure F-39 and each component is presented in detail in the sections that follow.

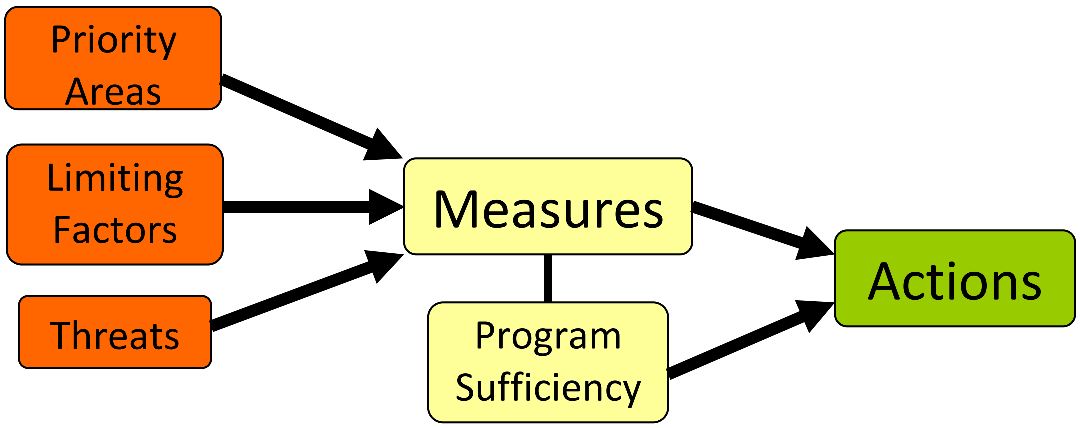


Figure F-39. Flow chart illustrating the development of measures and actions.

Priority Areas, Limiting Factors and Threats

Priority habitat areas and factors in the subbasin are discussed below in two sections. The first section contains a generalized (coarse-scale) summary of conditions throughout the basin. The second section is a more detailed summary that presents specific reach and subwatershed priorities.

Summary

Decades of human activity in the Upper Cowlitz River Basin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall Chinook, stream habitat conditions within the Upper Cowlitz Basin have a high impact on the health and viability of salmon and steelhead relative to other limiting factors. The following bullets provide a brief overview of each of the priority areas in the basin. These descriptions are a summary of the reach-scale priorities that are presented in the next section. These descriptions summarize the species most affected, the primary limiting factors, the contributing land-use threats, and the general type of measures that will be necessary for recovery. A tabular summary of the key limiting factors and land-use threats can be found in Table F-17.

- **Upper Mainstem Cowlitz & Tributaries** *(reaches Upper Cowlitz 1A-2; Silver Cr; Johnson Cr; Hall Cr)* – The upper mainstem Cowlitz reaches with the greatest current or potential production are located between Siler Creek and Hall Creek. This alluvial reach contains historically productive spawning and rearing habitat for fall Chinook, spring Chinook, coho, and winter steelhead. The reaches with the greatest current productivity, and therefore the greatest preservation value, are located between Randle and Packwood. In general, recovery emphasis should be placed primarily on preservation although many areas will also benefit from restoration measures. Effective restoration actions will involve addressing riparian and floodplain degradation related to mixed use development (agriculture, residential) along the river corridor and basin-wide watershed process restoration.

- **Cispus River & Tributaries** *(Cispus 1A, 1C, 1F-3; Yellowjacket 1)* – The Cispus supports winter steelhead, coho, and spring Chinook. The most productive reaches are located in the alluvial section from Greenhorn Creek to just upstream of the NF Cispus confluence. The basin is nearly entirely within the Gifford Pinchot National Forest. There is good preservation and restoration potential. The greatest emphasis should be placed on preservation of basin-wide watershed process conditions (runoff, sediment supply).

- **Tilton River & Tributaries** *(Tilton 1, 3-6; EF Tilton 1-2)* – The Tilton system, which contains no Tier 1 or 2 reaches, is not expected to play a prominent role in recovery planning. The basin, however, was an important component of the historical upper Cowlitz populations and contains some potentially productive habitat that is currently degraded by watershed process impairments. Limiting factors, threats, and measures have therefore been specified for Tilton basin reaches. The primary impairments are related to intensive timber harvest and road building. There are also stream corridor impairments in and around the town of Morton, WA.

Table F-17. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the upper mainstem Cowlitz and tribs (CO), the Cispus River + tribs (CI), and the Tilton + tribs (TI). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors	CO	CI	TI	Threats	CO	CI	TI
Habitat connectivity				***Hydropower operations***			
Blockages to off-channel habitats	✓		✓	Passage obstructions (dams)	✓	✓	✓
Blockages to channel habitats due to structures	✓	✓	✓	***Agriculture/grazing***			
Habitat diversity				Clearing of vegetation	✓		
Lack of stable instream woody debris	✓	✓	✓	Riparian grazing	✓		
Altered habitat unit composition	✓	✓	✓	Floodplain filling	✓		
Loss of off-channel and/or side-channel habitats	✓		✓	***Urban/rural development***			
Channel stability				Clearing of vegetation	✓		✓
Bed and bank erosion	✓	✓	✓	Floodplain filling	✓		✓
Channel down-cutting (incision)	✓	✓	✓	Roads – riparian/floodplain impacts	✓		✓
Mass wasting		✓		***Forest practices***			
Riparian function				Timber harvests –sediment supply impacts	✓	✓	✓
Reduced stream canopy cover	✓	✓	✓	Timber harvests – impacts to runoff			✓
Reduced bank/soil stability	✓	✓	✓	Riparian harvests (historical)	✓		✓
Exotic and/or noxious species	✓		✓	Forest roads – impacts to sediment supply	✓	✓	✓
Reduced wood recruitment	✓	✓	✓	Forest roads – impacts to runoff			✓
Floodplain function				***Channel manipulations***			
Altered nutrient exchange processes	✓		✓	Bank hardening	✓		✓
Reduced flood flow dampening	✓		✓	Channel straightening	✓		✓
Restricted channel migration	✓		✓	Artificial confinement	✓		✓
Disrupted hyporheic processes	✓		✓				
Water quality							
Altered stream temperature regime	✓	✓	✓				
Substrate and sediment							
Excessive fine sediment	✓	✓	✓				
Embedded substrates	✓	✓	✓				
Stream flow							
Altered magnitude, duration, or rate of change			✓				

Specific Reach and Subwatershed Priorities

Specific reaches and subwatersheds have been prioritized based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. Reaches have been placed into Tiers (1-4), with Tier 1 reaches representing the areas where recovery measures would yield the greatest benefits towards accomplishing the biological objectives. The reach tiering factors in each fish population's importance relative to regional recovery objectives, as well as the relative importance of reaches within the populations themselves. Reach tiers are most useful for identifying habitat recovery measures in channels, floodplains, and riparian areas. Reach-scale priorities were initially identified within individual populations (species) through the EDT Restoration and Preservation Analysis. This resulted in reaches grouped into categories of high, medium, and low priority for each population (see Stream Habitat Limitations section). Within a subbasin, reach rankings for all of the modeled populations were combined, using population designations as a weighting factor. Population designations for this subbasin are described in the Biological Objectives section. The population designations are 'primary', 'contributing', and 'stabilizing'; reflecting the level of emphasis that needs to be placed on population recovery in order to meet ESA recovery criteria.

Spatial priorities were also identified at the subwatershed scale. Subwatershed-scale priorities were directly determined by reach-scale priorities, such that a Group A subwatershed contains one or more Tier 1 reaches. Scaling up from reaches to the subwatershed level was done in recognition that actions to protect and restore critical reaches might need to occur in adjacent and/or upstream upland areas. For example, high sediment loads in a Tier 1 reach may originate in an upstream contributing subwatershed where sediment supply conditions are impaired because of current land use practices. Subwatershed-scale priorities can be used in conjunction with the IWA to identify watershed process restoration and preservation opportunities. The specific rules for designating reach tiers and subwatershed groups are presented in Table F-18. Reach tier designations are included in Table F-19 and Table F-20 for the Upper mainstem Cowlitz/Cispus and Tilton Basins, respectively. Reach tiers and subwatershed groups are displayed spatially in Figure F-40 and Figure F-41 for the Upper mainstem Cowlitz/Cispus and Tilton Basins, respectively.

Table F-18. Rules for designating reach tier and subwatershed group priorities. See Biological Objectives section for information on population designations.

Designation	Rule
Reaches	
Tier 1:	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2:	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary species and/or all high priority reaches for one or more contributing populations.
Tier 3:	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4:	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.
Subwatersheds	
Group A:	Includes one or more Tier 1 reaches.
Group B:	Includes one or more Tier 2 reaches, but no Tier 1 reaches.
Group C:	Includes one or more Tier 3 reaches, but no Tier 1 or 2 reaches.
Group D:	Includes only Tier 4 reaches.

Table F-19. Reach Tiers in the Upper mainstem Cowlitz / Cispus River Basin

Tier 1	Tier 2	Tier 3	Tier 4	
Cispus-1C	Upper Cowlitz -1F		Barrier Dam	Lower Cowlitz-2
Upper Cowlitz-1AA	Cispus-1A		Burton Creek	Mid Cowlitz -1
Upper Cowltiz-1B	Hall Cr - 1		Cispus NF-1	Mid Cowlitz -2
Upper Cowlitz-1C	Mid Cowlitz-6		Cispus 1B	Mid Cowlitz -3
Upper Cowlitz-1CC	Cispus -1E		Crystal Cr - 1	Mid Cowlitz -4
Upper Cowlitz-1CCC	Skate Cr - 1		Cunninham Creek	Mid Cowlitz -5A
Upper Cowlitz-1E	Upper Cowlitz -4		Davis Creek-1	Mid Cowlitz -5B
Cispus-2	Cispus -4		Dry Creek	Mullins Creek
Cispus-3	Cispus -1D		Garret Creek	Quartz Cr - 1
Upper Cowlitz-1D	Butter Creek-1		Greenhorn Cr - 1	Siler Creek-1
Cispus-1F	Yellowjacket-2		Hampton Creek	Silver Cr - 2
Silver Cr - 1	Schooley Creek		Iron Cr - 1	Skate Cr - 2
Upper Cowlitz-1A			Johnson Cr -2	Skate Cr - 3
Upper Cowlitz -2			Kilborn Creek	Smith Cr - 1
Mid Cowlitz-7			Kiona Cr - 1	Upper Cowlitz -3
Johnson Cr - 1			Kiona Cr - 2	Willamette Cr - 1
Yellowjacket-1			Lower Cowlitz-1	Woods

Table F-20. Reach Tiers in the Tilton River Basin

Tier 3	Tier 4
Lake Creek	Connelly-1
Tilton EF-1	Tilton NF-1
Tilton EF-2	Tilton SF-1
Tilton-1	Tilton WF-1
Tilton-3	Tilton-2
Tilton-4	
Tilton-5	
Tilton-6	

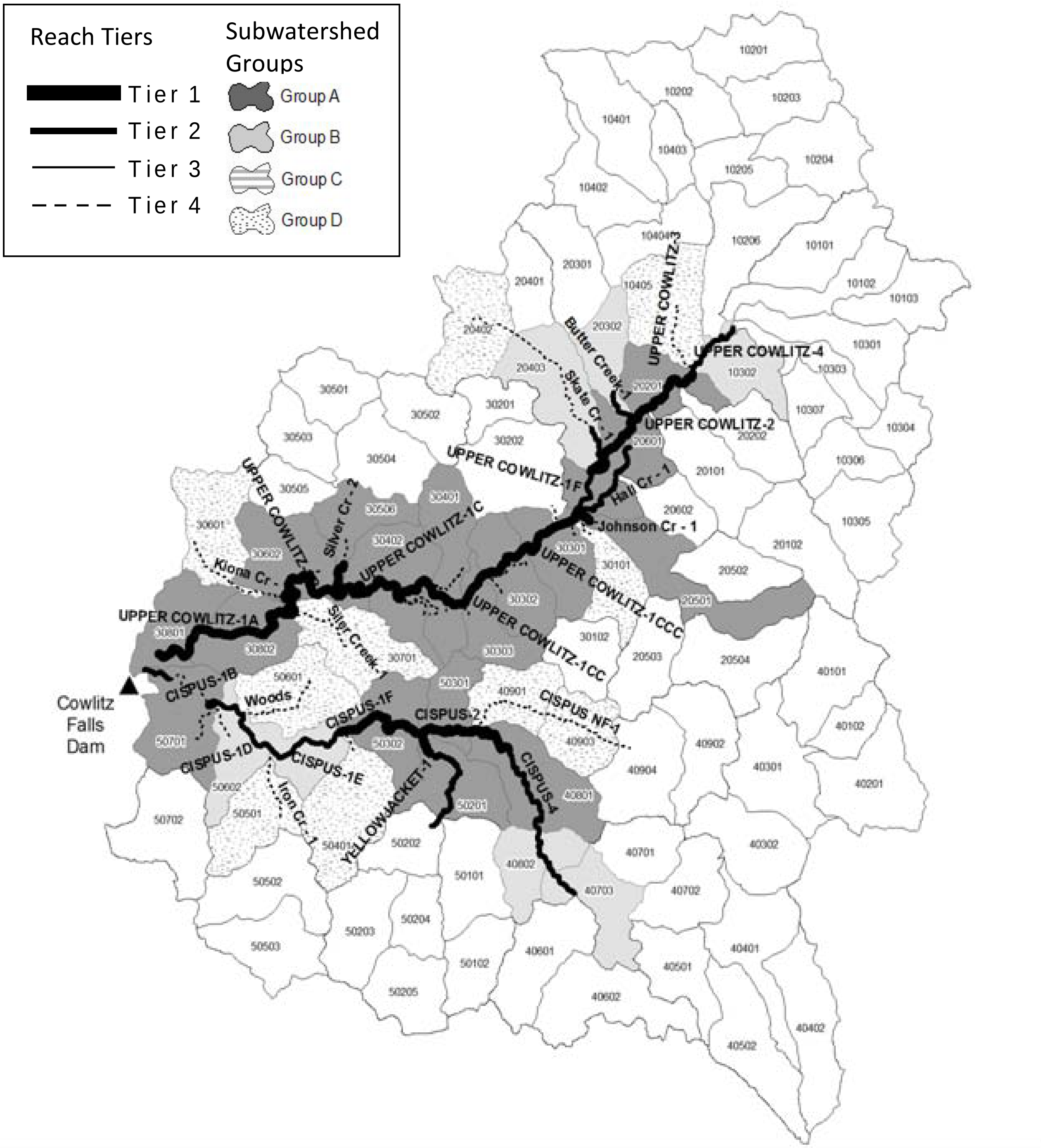


Figure F-40. **Reach tiers and subwatershed groups in the Upper mainstem Cowlitz / Cispus Basin. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities at the reach scale are useful for identifying stream corridor recovery measures. Priorities at the subwatershed scale are useful for identifying watershed process recovery measures. Watershed process recovery measures for stream reaches will need to occur within the surrounding (local) subwatershed as well as in upstream contributing subwatersheds.**

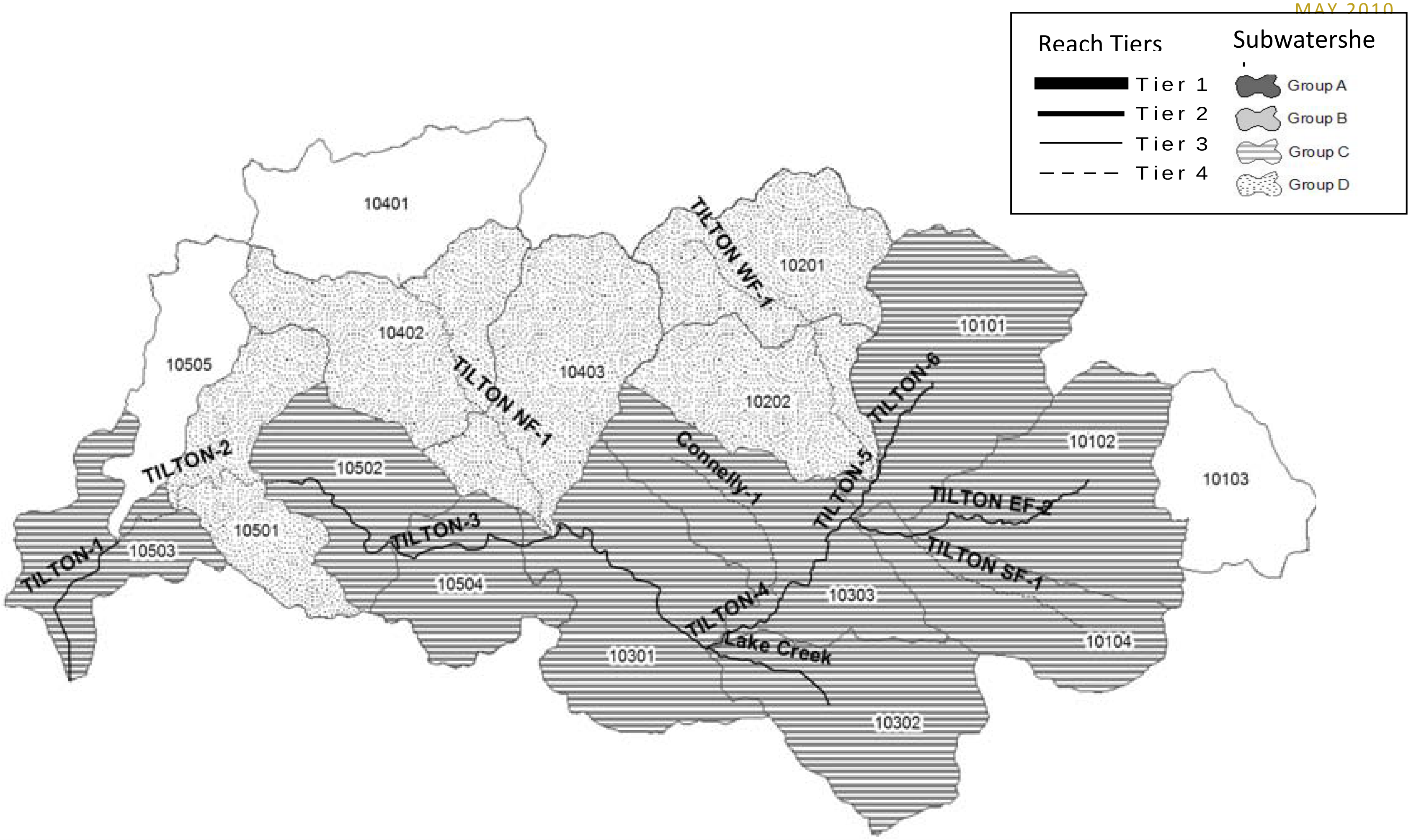


Figure F-41. Reach tiers and subwatershed groups in the Tilton Basin. The subwatershed groups are based on Reach Tiers. Priorities at the reach scale are useful for identifying stream corridor recovery measures. Priorities at the subwatershed scale are useful for identifying watershed process recovery measures. Watershed process recovery measures for stream reaches will need to occur within the surrounding (local) subwatershed as well as in upstream contributing subwatersheds.

Habitat Measures

Measures are means to achieve the regional strategies that are applicable to the Upper Cowlitz subbasin and necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin (Section 3.0) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the Upper Cowlitz Basin are presented in priority order in Table F-21. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the subbasin. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

Following the list of priority locations is a list of the programs that are the most relevant to the measure. Each program is qualitatively evaluated as to whether it is sufficient or needs expansion with respect to the measure. This exercise provides an indication of how effectively the measure is already covered by existing programs, policy, or projects; and therefore indicates where there is a gap in measure implementation. This information is summarized in a discussion of Program Sufficiency and Gaps.

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following priorities for approaches: 1) protect existing functional habitats and the processes that sustain them, 2) allow no further degradation of habitat or supporting processes. 3) re-connect isolated habitat, 4) restore watershed processes (ecosystem function), 5) restore habitat structure, and 6) create new habitat where it is not recoverable. These priorities are adjusted depending on the results of the technical assessment and on the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

Habitat Actions

The prioritized measures and associated gaps are used to develop specific Actions for the subbasin. These are presented in Table F-22. Actions are different than the measures in a number of ways: 1) actions have a greater degree of specificity than measures, 2) actions consider existing programs and are therefore not based strictly on biophysical conditions, 3) actions refer to the agency or entity that would be responsible for carrying out the action, and 4) actions are related to an expected outcome with respect to the biological objectives. Actions are not presented in priority order but instead represent the suite of activities that are all necessary for recovery of listed species. The priority for implementation of these actions must consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table F-21. Prioritized measures for the Upper Cowlitz Basin, including the Cispus and Tilton systems.

Habitat Measure #1 – Restore access above hydropower system

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access above Mayfield, Mossyrock, and Cowlitz Falls Dams if warranted to achieve recovery goals	• Blockages to channel habitats	Cowlitz hydropower system	Spring chinook, fall chinook, winter steelhead, coho	The system of dams on the mainstem Cowlitz River, beginning with Mayfield Dam at River Mile 52, block all volitional access to the upper basin, consisting of up to 300 or more miles of habitat for anadromous species. Juvenile and adult fish are currently trucked around the system of dams and reservoirs.

Priority Locations

1st- Cowlitz hydropower system (Mayfield, Mossyrock, and Cowlitz Falls Dams and reservoirs)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Tacoma Public Utilities	Cowlitz River Project (Mayfield, Mossyrock, and Barrier Dams)		✓
Lewis County PUD/BPA	Cowlitz Falls Dam		✓
Federal Energy Regulatory Commission (FERC)	Hydropower Project Licensing		✓
WDFW	Habitat Program		✓

Program Sufficiency and Gaps

Tacoma Public Utilities was issued a new license for the Cowlitz River Hydropower Project in 2002. As part of the license agreement, Tacoma Public Utilities is required to evaluate fish returns and survival through the reservoirs in order to assess the feasibility of providing volitional access. Currently, fish are transported upstream and downstream around the dams and reservoirs but it is anticipated that improved passage will eventually be provided at the facilities and Tacoma Public Utilities has been required to set funds aside in escrow for that purpose. Passage at Mayfield Dam would likely be provided through construction of a ladder, whereas passage at the much larger Mossyrock Dam would be provided by either trap and haul or a tramway. Whether or not volitional passage will be required, and the methods of providing such passage, will be determined based on on-going fish survival studies and consultations with the Fisheries Technical Committee and agencies (Settlement Agreement License Article 3). It is anticipated that this process will effectively address passage issues on Cowlitz mainstem dams.

Habitat Measure #2 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	All Species	Stream corridors in the upper Cispus and upper mainstem Cowlitz, which are located primarily in National Forest land, are in good condition and are protected through existing programs. Stream corridors in the lower portion of the upper Cowlitz mainstem and much of the Tilton basin is in private mixed-use (agriculture, rural residential, industrial) and is at risk of increasing development. It is crucial that adequate protections are in place in these areas to prevent further habitat degradation. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation
Reaches: Upper Cowlitz 1A-2; Cispus 1A, 1C; Hall Cr; Johnson Cr 1; Silver Cr 1

2nd- Tier 3 reaches in mixed-use lands at risk of further degradation
Reaches: Butter Creek 1; Schooley Creek; Skate Cr 1; Tilton 3-6; Tilton EF 1; Lake Creek (Tilton Basin)

3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NMFS	ESA Section 7 and Section 10	✓	
U.S. Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
USFS	Northwest Forest Plan	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Lewis County	Comprehensive Planning		✓
City of Morton	Comprehensive Planning, Water Supply		✓
Town of Mossyrock	Comprehensive Planning, Water Supply		✓
Lewis Conservation District / Natural Resources Conservation Service (NRCS)	Agricultural Habitat Protection Practices		✓

Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, Control	✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements	✓

Program Sufficiency and Gaps

Alterations to stream corridor structure that may impact aquatic habitats are regulated through the WDFW Hydraulics Project Approval (HPA) permitting program. Other regulatory protections are provided through USACE permitting, ESA consultations, HCPs, and local government ordinances. Riparian areas within federal timber lands are protected as part of the Northwest Forest Plan. Riparian areas within private timberlands are protected through the Forest Practices Rules (FPR) administered by WDNR. The FPRs came out of an extensive review process and are believed to adequately protect riparian areas with respect to stream shading, bank stability, and LWD recruitment. The program is new, however, and careful monitoring of the effect of the regulations is necessary, particularly effects on subwatershed hydrology and sediment delivery. Land-use conversion and development are increasing throughout the basin and local government ordinances must ensure that new development occurs in a manner that protects key habitats. Conversion of land-use from forest or agriculture to residential use has the potential to increase impairment of aquatic habitat, particularly when residential development is paired with flood control measures. Local governments can limit potentially harmful land-use conversions by thoughtfully directing growth through comprehensive planning and tax incentives, by providing consistent protection of critical areas across jurisdictions, and by preventing development in floodplains, and planning support at the state level (Ecology) will be necessary to facilitate the creation of local floodplain ordinances. In cases where programs are unable to protect critical habitats due to inherent limitations of regulatory mechanism, conservation easements and land acquisition may be necessary.

Habitat Measure #3 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage agricultural practices to minimize impacts to sediment supply processes, runoff regime, and water quality C. Manage growth and development to minimize impacts to sediment supply processes, runoff regime, and water quality	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes • Development – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest, forest road building, agriculture, and development, particularly in the Tilton Basin and in tributary basins to Mayfield and Riffe Reservoirs. Lowland hillslope processes have been impacted by agriculture and development. Limiting additional degradation will be necessary to prevent further habitat impairment.

Priority Locations

1st- Functional subwatersheds contributing to Tier 1 or 2 reaches (functional for sediment *or* flow according to the IWA – local rating)
Subwatersheds: Cispus Basin (all functional subwatersheds); upper mainstem Cowlitz Basin (all functional subwatersheds)
2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: Cispus Basin (all moderately impaired subwatersheds); upper mainstem Cowlitz Basin (all moderately impaired subwatersheds)
3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: Tilton Basin (all moderately impaired subwatersheds)
4th- All remaining subwatersheds

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
USFS	Northwest Forest Plan	✓	
Lewis County	Comprehensive Planning		✓
City of Morton	Comprehensive Planning		✓
City of Mossyrock	Comprehensive Planning		✓
Lewis Conservation District / NRCS	Agricultural land habitat protection programs		✓

Program Sufficiency and Gaps

Hillslope processes on federal timber lands are protected through the Northwest Forest Plan. Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands (agriculture and developed), local governments comprehensive planning is the primary nexus for protection of hillslope processes. Local governments can control impacts through zoning that protects existing uses, through stormwater management ordinances, and through tax incentives to prevent agricultural and forest lands from becoming developed. These protections are especially important in the Upper Cowlitz basin due to expanding growth. There are few to no regulatory protections of hillslope processes that relate to agricultural practices; such deficiencies need to be addressed through local or state authorities. Protecting hillslope processes on agricultural lands would also benefit from the expansion of technical assistance and landowner incentive programs (NRCS, Conservation Districts).

Habitat Measure #4 - Restore floodplain function and channel migration processes in the mainstem and major tributaries

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Set back, breach, or remove artificial confinement structures	• Bed and bank erosion • Altered habitat unit composition • Restricted channel migration • Disrupted hyporheic processes • Reduced flood flow dampening • Altered nutrient exchange processes • Channel incision • Loss of off-channel and/or side-channel habitat • Blockages to off-channel habitats	• Floodplain filling • Channel straightening • Artificial confinement	All species	There has been significant degradation of floodplain connectivity and constriction of channel migration zones along the lower portion of the upper mainstem Cowlitz, along the middle mainstem Tilton, and along several tributaries. Selective breaching, setting back, or removing confining structures would help to restore floodplain and CMZ function as well as facilitate the creation of off-channel and side channel habitats. There are feasibility issues with implementation due to private lands, existing infrastructure already in place, potential flood risk to property, and large expense.

Priority Locations

1st- Tier 1 reaches with hydro-modifications
Reaches: Upper Cowlitz 1AA, 1B, , 1C, 1CC
2nd- Tier 2 reaches with hydro-modifications
Reaches: Upper Cowlitz 1A, 2; Hall Cr 1; Johnson Cr 1; Silver Cr
3rd- Other reaches with hydro-modifications
Reaches: Butter Cr 1; Tilton 3-6; Lake Creek (Tilton trib)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

There currently are no programs or policy in place that set forth strategies for restoring floodplain function and channel migration processes in the Upper Cowlitz Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs and government entities to conduct projects. Floodplain restoration projects are often expensive, large-scale efforts that require partnerships among many agencies, NGOs, and landowners. Building partnerships is a necessary first step toward floodplain and CMZ restoration.

Habitat Measure #5- Restore degraded hillslope processes on forest, agricultural, and developed lands

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Upgrade or remove problem forest roads B. Reforest heavily cut areas not recovering naturally C. Employ agricultural Best Management Practices with respect to contaminant use, erosion, and runoff D. Reduce watershed imperviousness E. Reduce effective stormwater runoff from developed areas	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes • Development – impacts to water quality and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest, road building, agriculture, and development. These processes must be addressed for reach-level habitat recovery to be successful.

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: upper mainstem Cowlitz Basin (all moderately impaired or impaired subwatersheds in the basin except for 30801, 30802, 30701); Cispus (all moderately impaired or impaired subwatersheds in the basin)

2nd- Moderately impaired or impaired subwatersheds contributing to Tier 2 reaches
Subwatersheds: upper mainstem Cowlitz (30801, 30802, 30701)

3rd- Moderately impaired or impaired subwatersheds contributing to Tier 3 or 4 reaches
Subwatersheds: Tilton (entire basin)

4th- All remaining subwatersheds

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Lewis Conservation District / NRCS	Agricultural Habitat Restoration Programs		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Lewis County	Comprehensive Planning		✓
City of Mossyrock	Comprehensive Planning		✓
City of Morton	Comprehensive Planning		✓

Program Sufficiency and Gaps

Forest management programs including the Northwest Forest Plan (federal timber lands), new Forest Practices Rules (private timber lands), and the WDNR HCP (state timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements for private timber lands are expected to actively address road-related impairments within a 15 year time-frame. While these strategies are believed to be largely adequate to protect watershed processes, the degree of implementation and the effectiveness of the prescriptions will not be fully known for at least another 15 or 20 years. Of particular concern is the capacity of some forest land owners, especially small forest owners, to conduct the necessary road improvements (or removal) in the required timeframe. Additional financial and technical assistance would enable small forest landowners to conduct the necessary improvements in a timeline parallel to large industrial timber land owners. Ecological restoration of existing developed and agricultural lands occurs relatively infrequently and there are no programs that specifically require restoration in these areas. Restoring existing developed and farmed lands can involve retrofitting facilities with new materials, replacing existing systems, adopting new management practices, and creating or re-configuring landscaping. Means of increasing restoration activity include increasing landowner participation through education and incentive programs, building support for projects on public lands/facilities, requiring Best Management Practices through permitting and ordinances, and increasing available funding for entities to conduct projects.

Habitat Measure #6 - Restore riparian conditions throughout the basin

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore the natural riparian plant community B. Exclude livestock from riparian areas C. Eradicate invasive plant species from riparian areas	• Reduced stream canopy cover • Altered stream temperature regime • Reduced bank/soil stability • Reduced wood recruitment • Lack of stable instream woody debris • Exotic and/or invasive species	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to agriculture and residential development	All species	There is a high potential benefit due to the many limiting factors that are addressed. Riparian impairment is related to most land-uses and is a concern throughout the basin. The increasing abundance of exotic and invasive species is of particular concern. Riparian restoration projects are relatively inexpensive and are often supported by landowners.

Priority Locations

1st- Tier 1 reaches
2nd- Tier 2 reaches
3rd- Tier 3 reaches
4th- Tier 4 reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Lewis Conservation District / NRCS	Agricultural Habitat Restoration Programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Control, Enforcement		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring riparian conditions; however, existing programs will afford protections that will allow for the *passive* restoration of riparian forests. These protections are believed to be adequate for riparian areas on forest lands that are subject to Forest Practices Rules or the State forest lands HCP. Other lands receive variable levels of protection and passive restoration through the local government comprehensive plans. Many degraded riparian zones in urban, agricultural, rural residential, or transportation corridors will not passively restore with existing regulatory protections and will require active measures. Riparian restoration in these areas may entail livestock exclusion, tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

Habitat Measure #7 – Restore degraded water quality with emphasis on temperature impairments

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Increase riparian shading B. Decrease channel width-to-depth ratios	• Altered stream temperature regime	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to rural development and agriculture	• All species	Several reaches within the Cispus Basin are listed on the 2002-2004 draft 303(d) list for temperature impairment. Restoration of riparian vegetation and a reduction in elevated width-to-depth ratios would present the greatest potential benefit.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 draft list)
Reaches: Cispus 1F (temperature); Yellowjacket 1 (temperature)

2nd- Other reaches with 303(d) listings
Reaches: Yellowjacket 2 (temperature); Greenhorn Cr 1 (temperature); Cispus 1E, 1D (temperature); Iron Cr 1 (temperature)

3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Lewis Conservation District / NRCS	Agricultural Habitat Restoration Programs, Centennial Clean Water		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Lewis County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

Ecology's Water Quality Program manages the State 303(d) list of impaired water bodies. There are several listings in the Cispus Basin for temperature (WDOE 2004). A Water Quality Clean-up Plan (TMDL) is required by Ecology and it is anticipated that the TMDL will adequately set forth strategies to address the temperature impairments. It will be important that the strategies specified in the TMDLs are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin, especially regarding agricultural pollutants.

Habitat Measure #8 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve flows during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Upper Cowlitz Basin have been identified as part of Watershed Planning for WRIA 26 (LCFRB 2004). Strategies include water rights closures, setting of minimum flows, and drought management policies. This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hydropower regulation and hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Resources Program		✓
WRIA 25/26 Watershed Planning Unit	Watershed Planning		✓
Town of Mossyrock	Water Supply Program		✓

Program Sufficiency and Gaps

The Water Resources Program of Ecology, in cooperation with the WDFW and other entities, manages water rights and instream flow protections. A collaborative process for setting and managing instream flows was launched in 1998 with the Watershed Planning Act (HB 2514), which called for the establishment of local watershed planning groups whose objective was to recommend instream flow guidelines to Ecology through a collaborative process. The current status of this planning effort is to adopt a watershed plan by December 2004. Instream flow management in the Upper Cowlitz Basin will be conducted using the recommendations of the WRIA 25/26 Planning Unit, which is coordinated by the LCFRB. Draft products of the WRIA 25/26 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the Planning Unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies. It is important for Ecology to follow the instream flow rule-making recommendations of the Planning Unit.

Habitat Measure #9 – Restore access to habitat blocked by artificial barriers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access to isolated habitats blocked by culverts, dams, or other barriers	• Blockages to channel habitats • Blockages to off-channel habitats	Dams, culverts, in-stream structures	Spring Chinook, fall Chinook, winter steelhead, coho	There are many blockages in the Tilton, Cispus, Upper Cowlitz, and reservoir tributaries basins. Many of these are inadequately sized culverts at road crossings. The full extent of these blockages is unknown.

Priority Locations

1st- Many tributary streams with blockages

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
USFS	Northwest Forest Plan, Habitat Projects		✓
WDNR	Forest Practices Rules, Family Forest Fish Passage, State Forest Lands HCP		✓
WDFW	Habitat Program		✓
Washington Department of Transportation / WDFW	Fish Passage Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Lewis County	Roads		✓

Program Sufficiency and Gaps

The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The USFS has identified and repaired many blockages as a part of on-going programs. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Past efforts have corrected major blockages and have identified others in need of repair. Additional funding is needed to correct remaining blockages. Further monitoring and assessment is needed to ensure that all potential blockages have been identified and prioritized.

Habitat Measure #10 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Large wood installation projects could benefit habitat conditions in many areas although watershed processes contributing to wood deficiencies should be considered and addressed prior to placing wood in streams. Other structural enhancements to stream channels may be warranted in some places, especially in lowland alluvial reaches that have been simplified through channel straightening and confinement.

Priority Locations

1st- Tier 1 reaches
2nd- Tier 2 reaches
3rd- Tier 3 reaches
4th- Tier 4 reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
USFS	Northwest Forest Plan, Habitat Projects		
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Lewis Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring channel stability and structure. Passive restoration is expected to slowly occur as a result of protections afforded to riparian areas and hillslope processes. Past projects have largely been opportunistic and have been completed due to the efforts of local NGOs, landowners, and government agencies; such projects are likely to continue in a piecemeal fashion as opportunities arise and if financing is made available. The lack of LWD in stream channels, and the importance of wood for habitat of listed species, places an emphasis on LWD supplementation projects. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

Table F-22. Habitat actions for the Upper Cowlitz Basin

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
U-Cowl 1. Restore access above hydropower system	Expansion of existing program or activity	Tacoma Power, Lewis County PUD, FERC	1	High: the system of dams on the Cowlitz blocks volitional anadromous access to approximately 300 miles of habitat	High: Increased spawning and rearing capacity due to access to blocked habitat	High
U-Cowl 2. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	2, 3, 5, 6, 7 & 9	High: National Forest and National Monument lands in the upper basin	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
U-Cowl 3. Conduct floodplain restoration where feasible along the upper mainstem Cowlitz and the middle mainstem Tilton. Build partnerships with landowners and provide financial incentives	New program or activity	NRCS, LCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 6, 7, 9 & 10	Medium: Upper mainstem Cowlitz and middle mainstem Tilton	High: Restoration of floodplain function, habitat diversity, and habitat availability.	High
U-Cowl 4. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	2, 3, 5, 6, 7 & 9	High: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium

[1] Relative amount of basin affected by action
[2] Expected response of action implementation
[3] Relative certainty that expected results will occur as a result of full implementation of action

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
U-Cowl 5. Expand standards in local government comprehensive plans to afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Lewis County, City of Morton, Town of Mossyrock	2 & 3	Medium: Private lands under local jurisdiction (Tilton Basin, Reservoir Basins, and the mainstem Cowlitz valley from Lake Scanewa to Coal Creek)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
U-Cowl 6. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Lewis County, Ecology	2	Medium: Private lands under County jurisdiction (Tilton Basin, Reservoir Basins, and the mainstem Cowlitz valley from Lake Scanewa to Coal Creek)	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
U-Cowl 7. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of lands to developed uses through zoning regulations and tax incentives	Expansion of existing program or activity	Lewis County, City of Morton, Town of Mossyrock	2 & 3	Medium: Private lands under County jurisdiction (Tilton Basin, Reservoir Basins, and the mainstem Cowlitz valley from Lake Scanewa to Coal Creek)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
U–Cowl 8. Implement the prescriptions of the WRIA 25/26 Watershed Planning Unit regarding instream flows	Activity is currently in place	Ecology, WDFW, WRIA 25/26 Planning Unit, Lewis County, City of Morton, Town of Mossyrock	8	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
U-Cowl 9. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Lewis CD, LCFEG	4, 5, 6, 7, 9 & 10	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
U-Cowl 10. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	2, 3, 5, 6, 7 & 9	Low: Small private timberland owners	High: Reduction in road-related fine sediment delivery; restoration and preservation of fish access to habitats	Medium
U-Cowl 11. Increase funding available to purchase easements or property in sensitive areas where existing programs may not be able to fully protect watershed function	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	2 & 3	Low: Private lands in sensitive areas at risk of further degradation (e.g. small timber parcels in floodplains at risk of development)	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
U-Cowl 12. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, Lewis CD, WDNR, WDFW, Lewis County	2, 3, 4, 5, 6, 7, 8, 9 & 10	Medium: Private lands. Applies primarily to lands in agricultural or forestry uses	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
U-Cowl 13. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats (passage obstruction at mainstem dams is considered in a separate	Expansion of existing program or activity	WDFW, WDNR, Lewis County, WSDOT, LCFEG, USFS	9	Medium: There are many artificial barriers throughout the Tilton, Cispus, and Upper Mainstem Cowlitz	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is believed to be marginal in most cases	High

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
action)				Basins		
U-Cowl 14. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	2, 3, 5, 6, 7 & 9	Low: State timber lands in the U. Cowlitz Basin (approximately 2% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium
U-Cowl 15. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Lewis CD, LCFEG	2 & 6	Medium: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
U-Cowl 16. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	Expansion of existing program or activity	Lewis County, Lewis CD	7	Low: Private agricultural and rural residential lands	Medium: Protection and restoration of water quality (bacteria)	Medium
U-Cowl 17. Monitor an notify FERC of significant license violations, enforce terms and conditions of section 7 consultations on FERC relicensing agreements, and encourage implementation of section 7 conservation recommendations on FERC relicensing agreements	Activity is currently in place	NMFS, USFWS		High: Entire basin	High: Adequate flows for life stage requirements and habitat-forming processes, protection of water quality, increased habitat availability for spawning and rearing	High
U-Cowl 18. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed management	Expansion of existing program or activity	Lewis County, Mossyrock, Morton,	2, 5, 6, & 7	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High

F.6.5. Hatcheries

This subbasin plan describes potential hatchery strategies and actions designed to address recovery objectives and hatchery risks detailed in Volume I and in hatchery program assessments described earlier in this Volume II chapter. These strategies and actions are largely based on assessments in the interim planning process that was completed in 2004. Strategies and actions are generally consistent with more recent plans based on HSRG analyses and WDFW's Conservation and Sustainable Fisheries Plan. However, in several cases, the ongoing hatchery reform and planning process has identified revisions to the alternatives presented herein.

Subbasin Hatchery Strategy

The desired future state of fish production within the Upper Cowlitz Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery actions in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. This often involves substantial changes in many hatchery programs from their historical focus on production for mitigation. The recovery strategy includes a mixture of conservation programs and mitigation programs for lost fishing benefits. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the Upper Cowlitz Basin are displayed by species in Table F-23. More detailed descriptions and discussion of the regional hatchery strategy can be found in Volume I.

Table F-23. Summary of potential natural production and fishery enhancement strategies to be implemented in the Upper Cowlitz River Basin.

		Fall Chinook	Spring Chinook	Coho	Chum	Winter Steelhead
Natural Production Enhancement	Supplementation		✓	✓		✓
	Hatch/Nat Conservation [1]		✓			
	Isolation					✓[2]
	Refuge					
Fishery Enhancement	Hatchery Production					

[1] Hatchery and natural population management strategy implemented to meet biological recovery objectives. Strategy may include integration and/or isolation over time. Strategy will be unique to biological and ecological circumstances in each watershed.
[2] Includes isolation from non-indigenous hatchery steelhead stocks only

Conservation-based hatchery programs include strategies and actions which are specifically intended to enhance or protect production of a particular wild fish population within the basin. A unique conservation strategy is developed for each species and watershed depending on the status of the natural population, the biological relationship between the hatchery and natural populations, ecological attributes of the watershed, and logistical opportunities to jointly manage the populations. Four types of hatchery conservation strategies may be employed:

Natural Refuge Watersheds: In this strategy, certain sub-basins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These refugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural and will be key indicators of natural population status within the ESU. The upper Cowlitz could become a refuge area for spring Chinook, coho, or steelhead in the future if natural populations are sustainable without supplementation.

Hatchery Supplementation: This strategy utilizes hatchery production as a tool to assist in rebuilding depressed natural populations. Supplementation would occur in selected areas that are producing natural fish at levels significantly below current capacity or capacity is expected to increase as a result of immediate benefits of habitat or passage improvements. This is intended to be a temporary measure to jump start critically low populations and to bolster natural fish numbers above critical levels in selected areas until habitat is restored to levels where a population can be self sustaining. This strategy would include spring Chinook and coho in the upper Cowlitz Basin.

Hatchery/Natural Isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of spring and fall Chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations. This strategy is currently included for winter steelhead in the upper Cowlitz where early-timed hatchery produced steelhead are not passed upstream of the dams..

Hatchery/Natural Merged Conservation Strategy: This strategy addresses the case where natural and hatchery fish have been homogenized over time such that they are principally all one stock that includes the native genetic material for the basin. Many spring Chinook, fall Chinook, and coho populations in the lower Columbia currently fall into this category. In many cases, the composite stock productivity is no longer sufficient to support a self-sustaining natural population especially in the face of habitat degradation. The hatchery program will be critical to maintaining any population until habitat can be improved and a strictly natural population can be re-established. This merged strategy is intended to transition these mixed populations to a self-supporting natural population that is not subsidized by hatchery production or subject to deleterious hatchery impacts. Elements include separate management of hatchery and natural subpopulations, regulation of hatchery fish in natural areas, incorporation of natural fish into hatchery broodstock, and annual abundance-driven distribution. Corresponding programs are expected to evolve over time dependent on changes in the populations and in the habitat productivity. This strategy is primarily aimed at Chinook salmon in areas where harvest production occurs, which applies to spring Chinook in the upper Cowlitz.

Not every lower Columbia River hatchery program will be turned into a conservation program. The majority of funding for lower Columbia basin hatchery operations is for producing salmon and steelhead for harvest to mitigate for lost harvest of natural production due to hydro development and habitat degradation. Programs for fishery enhancement will continue during the recovery period, but will be managed to minimize risks and ensure they do not compromise recovery objectives for natural populations. It is expected that the need to produce compensatory fish for harvest through artificial production will reduce in the future as natural populations recover and become harvestable. There are fishery enhancement programs for spring Chinook, coho, and winter steelhead in the Upper Cowlitz Basin.

The Cowlitz Complex Hatchery programs will be operated to include natural production enhancement strategies for upper Cowlitz spring Chinook. The Cowlitz Hatchery Complex will continue to support upper Cowlitz spring Chinook, coho, and winter steelhead with hatchery releases in the Upper Cowlitz Basin. Fall Chinook will not be included as a component of the hatchery program in the Upper Cowlitz. There are no new conservation programs for the Upper Cowlitz in this plan.

Hatchery Measures and Actions

Hatchery strategies and measures are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within Upper Cowlitz River facilities have been evaluated in detail through the WDFW Benefit-Risk Assessment Procedure (BRAP) relative to risks to natural populations. The BRAP results were utilized to inform the development of these program actions specific to the Upper Cowlitz River Basin (Table F-25). The Sub-Basin plan hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NMFS approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the Upper Cowlitz River Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in Volume I.

Table F-24. A summary of conservation and harvest strategies with the potential to be implemented through Upper Cowlitz Hatchery programs.

	Conservation Programs				Harvest Programs	
Hatchery	Supplementation	Hatchery/Natural Strategy[1]	Isolation	Broodstock Development	In-Basin Released (final rearing site)	Out of Basin Releases (final rearing site)
Cowlitz Complex	L. Cowlitz Coho √ U. Cowlitz Spring Chinook U. Cowlitz Coho U. Cowlitz Winter Steelhead Lower Columbia Chum √	L. Cowlitz Fall Chinook √ U. Cowlitz Spring Chinook	U. Cowlitz Winter Steelhead [2]	Cowlitz Chum √ Cowlitz Late Winter Steelhead	Cowlitz Late Coho Cowlitz Fall Chinook Cowlitz Spring Chinook Cowlitz Winter Steelhead Cowlitz Summer Steelhead Cowlitz Sea-run Cutthroat	

[1] May include integrated and/or isolated strategy over time.
[2] Includes isolation from early-timed winter steelhead stocks

√ Denotes new program

Table F-25. Potential hatchery program actions in the Upper Cowlitz River Basin.

Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Action	Expected Outcome
** Conservation management strategy implemented for spring Chinook hatchery production and upper Cowlitz natural spring Chinook. *preclude outside basin transfers of spring Chinook, steelhead and coho eggs or juveniles for release into the upper Cowlitz basin	Cowlitz Salmon Hatchery coho, and spring Chinook. Cowlitz Trout Hatchery late-winter steelhead.	upper Cowlitz spring Chinook, winter steelhead, and coho	Domestication Diversity Abundance	• Non-local genetic traits	• Reintroduction program for spring Chinook would include development of a biologically appropriate relationship and management strategy for hatchery and wild brood stock program over time. • Winter steelhead supplementation into the upper basin would only use late-winter Cowlitz Basin brood stock. Early winter stock for lower Cowlitz harvest only. • Coho supplementation into the upper Basin would only utilize Cowlitz late stock coho. • Continue long-standing WDFW policy of no outside chinook and coho transfers into the basin	• Increased genetic diversity in natural and hatchery spring Chinook populations • Spring Chinook, coho, and steelhead stocks are ecologically adapted to upper Cowlitz habitat resulting in adequate productivity and abundance to sustain populations upstream of the hydro system.
*Adipose fin-clip mark hatchery produced coho, spring chinook, steelhead, and sea-run cutthroat released in the lower Cowlitz *Blank wire-tag Mayfield Dam collected fish and do not mark or tag natural fish produced upstream of Cowlitz Falls Dam.	Cowlitz Salmon Hatchery fall chinook spring chinook and coho. Cowlitz Trout Hatchery steelhead and cutthroat.	Upper Cowlitz and Cispus spring chinook, coho, and winter steelhead, and Tilton winter steelhead and coho.	Domestication, Diversity, Abundance	• In-breeding • Harvest	• Continue 100 percent mark of hatchery produced steelhead, coho, spring chinook, and sea-run cutthroat released into the lower Cowlitz. • Tag w/o fin-clip mark Mayfield trapped coho, steelhead, and chinook to distinguish from natural production collected upstream at Cowlitz falls and hatchery production released into the lower Cowlitz. • Do not mark or tag (except small experimental groups) natural spring chinook, coho, or steelhead collected at Cowlitz Falls Dam. Unmarked or tagged adults will be	• Maintain selective fishery opportunity for spring chinook, coho, steelhead, and sea-run cutthroat, and only incidental harvest impacts to natural produced fish. • Enable visual identification of hatchery and wild returns to provide the means to account for and manage the hatchery and wild escapement consistent with biological objectives • Enable sorting of upper Cowlitz , Cispus, and Tilton natural produced adults for transport and distribution to

Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Action	Expected Outcome
					identified as natural production from the upper Cowlitz and Cispus basins.	appropriate habitats for spawning • Minimize handling impacts to the vast majority of natural produced juveniles, resulting in increased abundance to the most productive habitats in the upper Cowlitz and Cispus rivers.
**Cowlitz Basin hatchery facilities utilized for supplementation and enhancement of natural coho, spring chinook, and late winter steelhead populations	Cowlitz Hatchery late coho, late winter steelhead, and spring chinook.	Upper Cowlitz and Cispus coho, winter steelhead, and spring chinook. Tilton coho and late winter steelhead.	Abundance, Spatial distribution	• Low numbers of natural spawners • Ecologically appropriate natural brood stock	• Develop a coho brood stock using the latest (December-January) arriving late hatchery coho. Utilize production from the existing programs and new late program to supplement wild coho production in the upper Cowlitz tributaries and for harvest. • Continue to propagate late returning winter steelhead as brood stock for supplementing upper Cowlitz natural production until a self-sustaining population is established • Utilize current hatchery spring chinook brood stock to supplement upper Cowlitz and Cispus natural production until a self sustaining population is established. Maintain integrated brood stock in the hatchery indefinitely for risk management purposes.	• Development of a late-timed hatchery brood stock would increase diversity and develop similar to the historical populations in the Cowlitz Basin. Improve abundance and distribution of natural produced coho. • Late winter steelhead self-sustaining population developed that is ecologically adapted to the upper basin habitat. • Spring chinook self-sustaining population developed that is ecologically adapted to the upper basin habitat. • Coho self-sustaining population is ecologically adapted to the watershed. • Hatchery brood stock is available for continued supplementation as needed.

Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Action	Expected Outcome
*Evaluate facilities and operations for reintroduction of salmon and steelhead	Spring chinook, steelhead, coho	Spring chinook, steelhead, and coho	Abundance, spatial distribution	• Juvenile collection efficiency • Adult collection and sorting • Handling, transport, stress relief	• Juvenile collection efficiency improvements are made at Cowlitz Falls Dam to ensure replacement of spring chinook, coho, and winter steelhead natural production. • Trapping and sorting facilities at Cowlitz Salmon Hatchery are evaluated to ensure efficient and low stress handling of adults prior to distribution. • Hatchery trucks are adequate in number and capacity to handle peak periods of juvenile and adult transport without overloading. • Pond space and water quality is adequate to supply stress relief for Cowlitz Falls collected juveniles prior to release into the lower Cowlitz River	• Passage survival of adult and juvenile spring chinook, coho, and steelhead produced in the upper Cowlitz basin is high enough to enable a self-sustaining population to be developed. • Handling, sorting, and stress relief facilities provide low impact to the natural produced salmon and steelhead from the upper basin.
** Monitoring and evaluation, adaptive management	All species	All species	Hatchery production performance, Natural production performance	• All of above	• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes • Performance standards developed for each actions with measurable criteria to determine success or failure • Adaptive Management applied to adjust or change actions as necessary	• Clear standards for performance and adequate monitoring programs to evaluate actions. • Adaptive management strategy reacts to information and provides clear path for adjustment or change to meet performance standard

* Extension or improvement of existing actions-may require additional funding
** New action-will likely require additional funding

F.6.6. Harvest

Fisheries are both an impact that reduces fish numbers and an objective of recovery. The long-term vision is to restore healthy, harvestable natural salmonid populations in many areas of the lower Columbia basin. The near-term strategy involves reducing fishery impacts on natural populations to ameliorate extinction risks until a combination of actions can restore natural population productivity to levels where fishing that targets current ESA-listed stocks may resume. The regional strategy for interim reductions in fishery impacts involves: 1) elimination of directed fisheries on natural populations, 2) regulation of mixed stock fisheries for healthy hatchery and natural populations to limit and minimize indirect impacts on natural populations, 3) scaling of allowable indirect impacts for consistency with recovery, 4) annual abundance-based management to provide added protection in years of low abundance while allowing greater fishing opportunity consistent with recovery in years with higher abundance, and 5) mass marking of hatchery fish for identification and selective fisheries.

Actions to address harvest impacts are generally focused at a regional level to cover fishery impacts accrued to lower Columbia salmon as they migrate along the Pacific Coast and through the mainstem Columbia River. Fisheries are no longer directed at weak natural populations but incidentally catch these fish while targeting healthy wild and hatchery stocks. Subbasin fisheries affecting natural populations have been largely eliminated. Fishery management has shifted from a focus on maximum sustainable harvest of the strong stocks to ensuring protection of the weak stocks. Weak stock protections often preclude access to large numbers of otherwise harvestable fish in strong stocks.

Fishery impact limits to protect ESA-listed weak populations are generally based on risk assessments that identify points where fisheries do not pose jeopardy to the continued persistence of a listed group of fish. In many cases, these assessments identify the point where additional fishery reductions provide little reduction in extinction risks. A population may continue to be at significant risk of extinction but those risks are no longer substantially affected by the specified fishing levels. Often, no level of fishery reduction will be adequate to meet naturally-spawning population escapement goals related to population viability. The elimination of harvest will not in itself lead to the recovery of a population. However, prudent and careful management of harvest can help close the gap in a coordinated effort to achieve recovery.

Fishery actions specific to the subbasins are addressed through the Washington State Fish and Wildlife sport fishing regulatory process. This public process includes an annual review focused on emergency type regulatory changes and a comprehensive review of sport fishing regulations which occurs every two years. This regulatory process includes development of fishing rules through the Washington Administrative Code (WAC) which are focused on protecting weak stock populations while providing appropriate access to harvestable populations. The actions consider the specific circumstances in each area of each subbasin and respond with rules that fit the relative risk to the weak populations in a given time and area of the subbasin. Regulatory and protective fishery actions pertaining to salmon and steelhead in the upper Cowlitz are presented in Table 26. Additional sport fishing rule detail can be found in the WDFW sport fishing regulation pamphlet.

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. Harvest actions with significant application to the Upper Cowlitz Subbasin populations are summarized in Table F-27.

Table F-26. Summary of sport fishing regulatory and protective actions in the Upper Cowlitz.

Species	General Fishing Actions	Explanation	Other Protective Fishery Actions	Explanation
Spring Chinook	Retain only adipose fin-clipped Chinook	Selective fishery for hatchery Chinook, unmarked/ reintroduced wild spring Chinook must be released	Minimum size restrictions	Minimum size protects juveniles
Coho	Retain only adipose fin-clip marked coho	Selective fishery for hatchery coho, unmarked/reintroduced wild coho must be released	Minimum size restrictions. Small tributaries and Upper reaches of Cispus and Cowlitz closed	Closures protect wild spawners in tributary creeks and upper watersheds. Minimum size protects juveniles
Winter steelhead	Retain only fin-clipped steelhead in the Cispus River	Selective fishery for hatchery steelhead in Cispus to protect wild fish produced from the reintroduction program	Steelhead and trout fishing closed in the spring and minimum size restrictions in affect	Spring closure Protects adult wild steelhead during spawning and minimum size protects juvenile steelhead

Table F-27. Regional harvest actions from Volume I with significant application to the Upper Cowlitz River Subbasin populations.

Action	Description	Responsible Parties	Programs	Comments
	Monitor and evaluate commercial and sport impacts to naturally-spawning steelhead in salmon and hatchery steelhead target fisheries.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Includes monitoring of naturally-spawning steelhead encounter rates in fisheries and refinement of long-term catch and release handling mortality estimates. Would include assessment of the current monitoring programs and determine their adequacy in formulating naturally-spawning steelhead incidental mortality estimates.
	Continue to improve gear and regulations to minimize incidental impacts to naturally-spawning steelhead.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Regulatory agencies should continue to refine gear, handle and release methods, and seasonal options to minimize mortality of naturally-spawning steelhead in commercial and sport fisheries.
	Maintain selective sport fisheries in ocean, Columbia River, and tributaries and monitor naturally-spawning stock impacts.	WDFW, NMFS, ODFW, USFWS	PFMC, Columbia Compact, BPA Fish and Wildlife Program, WDFW Creel	Mass marking of lower Columbia River coho and steelhead has enabled successful ocean and freshwater selective fisheries to be implemented since 1998. Marking programs should be continued and fisheries monitored to provide improved estimates of naturally-spawning salmon and steelhead release mortality.

* Extension or improvement of existing action
** New action

F.6.7. Hydropower

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 hatchery Barrier Dam (RM 49) and Mayfield Dam (RM 52) prevent all volitional passage of anadromous fish above RM 52. A facility at the Barrier Dam collects coho, fall Chinook, spring Chinook, winter steelhead, and coastal cutthroat trout. Spring Chinook, coho, and steelhead which originated above the hydro system, are separated from hatchery broodstock and hauled to appropriate locations in the upper Cowlitz basin. Upper Cowlitz Spring Chinook are all released above Cowlitz Falls Dam, while coho, winter steelhead and cutthroat trout are identified (by tag or no tag) for release into either the Tilton or above 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). There is a juvenile collection facility at Mayfield Dam, where the fish are collected and tagged with a blank-wire to enable identification of the site they were collected as juveniles when they return as adults. Unmarked and untagged adults are released upstream of the Cowlitz Falls Dam, while unmarked and blank wire-tagged adults are released above Mayfield Dam to spawn in the Tilton River

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.

F.6.8. Mainstem and Estuary Habitat

Upper Cowlitz River anadromous fish populations will also benefit from regional recovery strategies and measures identified to address habitat conditions and threats in the Columbia River mainstem and estuary. Regional recovery plan strategies involve: 1) avoiding large scale habitat changes where risks are known or uncertain, 2) mitigating small-scale local habitat impacts to ensure no net loss, 3) protecting functioning habitats while restoring impaired habitats to functional conditions, 4) striving to understand, protect, and restore habitat-forming processes, 5) moving habitat conditions in the direction of the historical template which is presumed to be more consistent with restoring viable populations, and 6) improving understanding of salmonid habitat use in the Columbia River mainstem and estuary and their response to habitat changes. A series of specific measures are detailed in the regional plan for each of these strategies.

F.6.9. Ecological Interactions

For the purposes of this plan, ecological interactions refer to the relationships of salmon and steelhead with other elements of the ecosystem. Regional strategies and measures pertaining to exotic or non-native species, effects of salmon on system productivity, and native predators of salmon are detailed and discussed at length in Volume I and are not reprised at length in each subbasin plan. Strategies include 1) avoiding, eliminating introductions of new exotic species and managing effects of existing exotic species, 2) recognizing the significance of salmon to the productivity of other species and the salmon themselves, and 3) managing predation by selected species while also maintaining a viable balance of predator populations. A series of specific measures are detailed in the regional plan for each of these strategies. Implementation will occur at the regional and subbasin scale.

F.6.10. Monitoring, Research, & Evaluation

Biological status monitoring quantifies progress toward ESU recovery objectives and also establishes a baseline for evaluating causal relationships between limiting factors and a population response. Status monitoring involves routine and intensive efforts. Routine monitoring of biological data consists of adult spawning escapement estimates, whereas routine monitoring for habitat data consists of a suite of water quality and quantity measurements.

Intensive monitoring supplements routine monitoring for populations and basins requiring additional information. Intensive monitoring for biological data consists of life-cycle population assessments, juvenile and adult abundance estimates and adult run-reconstruction. Intensive monitoring for habitat data includes stream/riparian surveys, and continuous stream flow assessment. The need for additional water quality sampling may be identified. Rather than prescribing one monitoring strategy, three scenarios are proposed ranging in level of effort and cost from high to low (Level 1-3 respectively). Given the fact that routine monitoring is ongoing, only intensive monitoring varies between each level.

An in-depth discussion of the research, monitoring, and evaluation (MR&E) approach for the Lower Columbia Region is presented in the Regional Recovery and Management Plan. It includes site selection rationale, cost considerations and potential funding sources. The following tables summarize the biological and habitat monitoring efforts specific to the Upper Cowlitz subbasin.

Table F-28. Summary of the biological monitoring plan for the upper Cowlitz and Cispus River populations.

Upper Cowlitz/Cispus: Lower Columbia Biological Monitoring Plan			
Monitoring Type	**Spring Chinook**	**Coho**	**Winter Steelhead**
Routine	AA	AA	AA
Intensive			
Level 1	×	×	×
Level 2	×	×	×
Level 3	×	×	×

AA -Annual adult abundance estimates
✓Adult and juvenile intensive biological monitoring occurs periodically on a rotation schedule (every 9 years for 3-year duration)
× Adult and juvenile intensive biological monitoring occurs annually

Table F-29. Summary of the biological monitoring plan for the Tilton River populations.

Tilton: Lower Columbia Biological Monitoring Plan		
Monitoring Type	**Coho**	**Winter Steelhead**
Routine	AA	AA
Intensive		
Level 1	×	×
Level 2	×	×
Level 3	×	×

AA- Annual adult abundance estimates
✓Adult and juvenile intensive biological monitoring occurs periodically on a rotation schedule (every 9 years for 3-year duration)
× Adult and juvenile intensive biological monitoring occurs annually

Table F-30. Summary of the habitat monitoring plan for the upper Cowlitz and Cispus River populations.

Upper Cowlitz/Cispus : Lower Columbia Habitat Monitoring Plan				
Monitoring Type	**Watershed**	**Existing stream / riparian habitat**	**Water quantity[3] (level of coverage)**	**Water quality [2] (level of coverage)**
Routine [1] (level of coverage)	Baseline complete	Good	Stream Gage-Good IFA-Poor	Ecology-Poor USGS-Moderate Temperature-Good
Intensive				
Level 1		✓		
Level 2				
Level 3				

IFA Comprehensive Instream Flow Assessment (i.e. Instream Flow Incremental Methodology)
[1] Routine surveys for habitat data do not imply ongoing monitoring
[2] Intensive monitoring for water quality to be determined
[3] Water quantity monitoring may include stream gauge installation, IFA or low flow surveys

Table F-31. Summary of the habitat monitoring plan for the Tilton River populations.

Tilton : Lower Columbia Habitat Monitoring Plan				
Monitoring Type	**Watershed**	**Existing stream / riparian habitat**	**Water quantity (level of coverage)**	**Water quality [2] (level of coverage)**
Routine [1] (level of coverage)	Baseline complete	Poor	Stream Gage-Good IFA-Poor	Ecology-Poor USGS-Poor Temperature-Poor
Intensive				
Level 1				
Level 2				
Level 3				

IFA Comprehensive Instream Flow Assessment (i.e. Instream Flow Incremental Methodology)
[1] Routine surveys for habitat data do not imply ongoing monitoring
[2] Intensive monitoring for water quality to be determined
[3] Water quantity monitoring may include stream gauge installation, IFA or low flow surveys

F.7. References

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