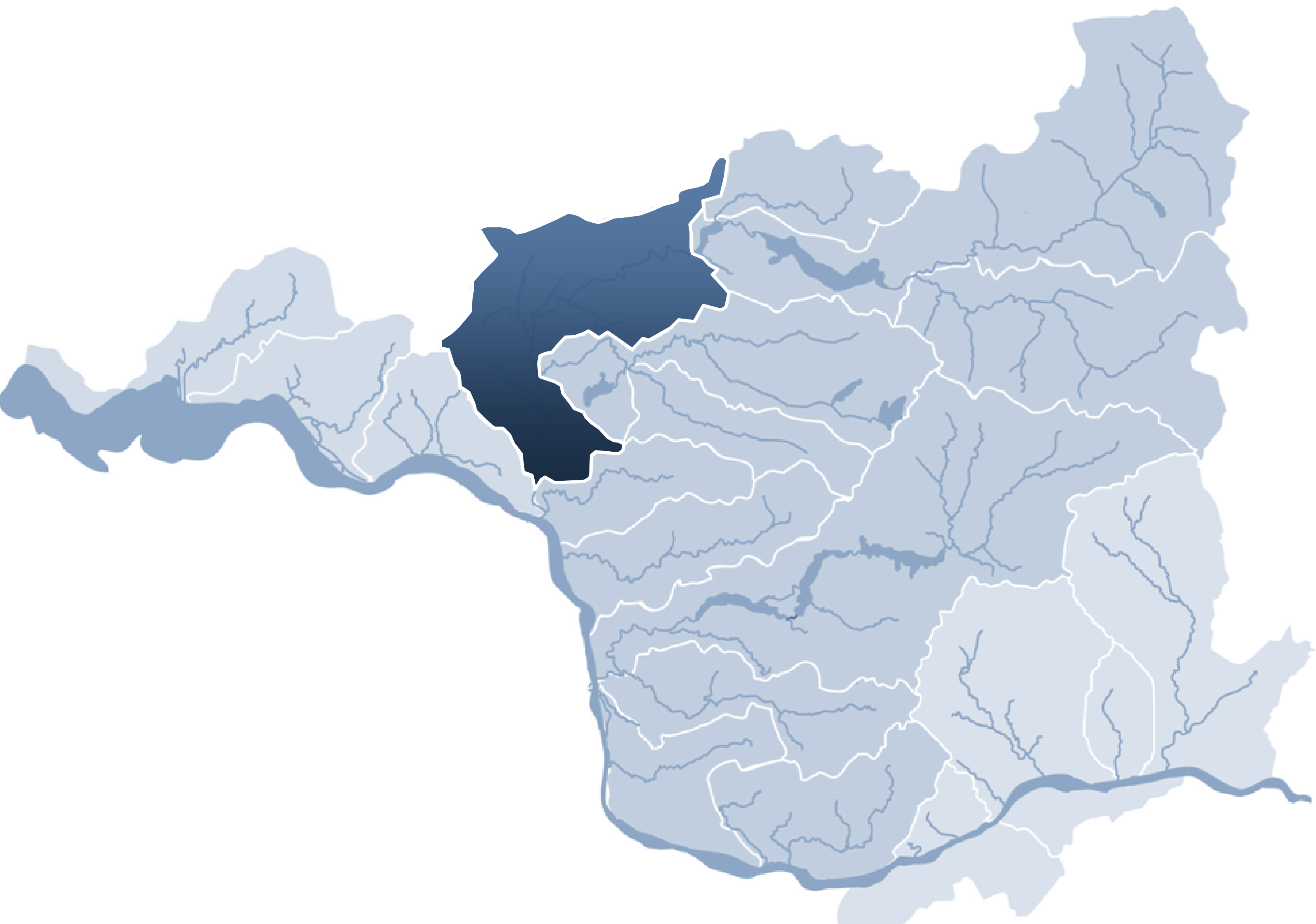
G. LOWER COWLITZ SUBBASIN



G. LOWER COWLITZ SUBBASIN

Tables

Figures

G.1. Executive Summary

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 hydropower system in Washington lower Columbia River subbasins. Recovery of listed species and hydropower mitigation is accomplished at a regional scale. This plan for the lower Cowlitz River describes implementation of the regional approach within this subbasin, 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, federal agencies, state agencies, tribal nations, local governments, and others.

Figure G-1. Map of the Lower Cowlitz River.

The Cowlitz River is one of twelve major NPCC subbasins in the Washington portion of the Lower Columbia Region. The basin historically supported thousands of fall Chinook, winter steelhead, chum, and coho. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. 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. Freshwater and estuary habitat quality has been reduced by agricultural and forestry practices. Key habitats have been isolated or eliminated by dredging and channel modifications and diking, filling, or draining floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has reduced productivity. Hydropower construction and operation has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

Lower Cowlitz River salmon and steelhead need to be restored to medium or high levels of population viability to meet regional recovery objectives. This means that the population is productive, abundant, exhibits multiple life history strategies, and utilizes significant portions of the subbasin.

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 Lower 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 Lower 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.

G.1.1. Key Priorities

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

1. Manage Regulated Stream Flows through the Hydropower System

Hydro-regulation on the Cowlitz River has altered the natural stream flow regime below Mayfield Dam. To support fish and their habitat, hydro-regulation will need to provide adequate flows for habitat formation, fish migration, water quality, floodplain connectivity, habitat capacity, and sediment transport below Mayfield Dam. Due to alterations to the channel and floodplain in the lower river, the ability to restore the natural flow regime is limited and will need to occur in concert with restoration of lower river floodplain function.

2. Restore Floodplain Function, Riparian Function and Stream Habitat Diversity

Most of the Cowlitz mainstem and many of the larger tributaries (e.g. Olequa Creek, Lacamas Creek, Salmon Creek) are in agriculture, rural residential, or urban uses. Many riparian forests have been harvested or developed. Construction of levees, bank stabilization, and riparian vegetation removal have heavily impacted fish habitat. The majority of the mainstem Cowlitz floodplain has been disconnected from the river through channel and floodplain modifications. 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 chum, fall Chinook, and coho. Partially restoring normal floodplain function will also help control downstream catastrophic flooding and will provide wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and riparian 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.

3. 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 one third in the next twenty years. The local economy is also in transition with reduced reliance on forest products and farming. Population growth will primarily occur within 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. Land-use changes will provide a variety of risks to terrestrial and aquatic habitats. Careful land-use planning will be necessary to protect and restore natural fish populations and habitats and will also present opportunities to preserve the rural character and local economic base of the basin.

4. Address Immediate Risks with Short-term Habitat Fixes

Restoration of normal watershed processes that allow a basin to restore itself over time has proven to be the most effective strategy for long term habitat improvements. However, restoration of some critical habitats may take decades to occur. In the near term, it is important to initiate short-term fixes to address current critical low numbers of some species. Examples in the Lower Cowlitz Basin include building chum salmon spawning channels and constructing coho overwintering habitat such as alcoves, side channels, and log jams. In the absence of large-scale floodplain and channel migration zone restoration, opportunistic habitat creation and enhancement may be one of the few viable options for providing critical habitat, especially in the lower mainstem. Benefits of structural enhancements are often temporary but will help bridge the period until normal habitat-forming processes are reestablished.

5. Manage Forest Lands to Protect and Restore Watershed Processes

Many of the headwater watersheds of lower Cowlitz tributaries are forested and are managed for commercial timber production. These areas have experienced intensive past forest practices activities and proper forest management is critical to fish recovery. Forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing fine sediment, and degrading 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 lands) and Forest Practices Rules (private lands) are expected to substantially improve conditions by restoring passage, protecting riparian conditions, reducing fine sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead and coho.

6. Restore Passage at Culverts and Other Artificial Barriers

There are many culvert and other barriers throughout the basin (approximately 25 barriers total). Correcting passage barriers could open up as many as 50 additional miles of habitat. The blocked habitat is believed to be marginal in most cases but cumulatively, passage restoration could have substantial benefits to habitat capacity. Further assessment and prioritization of passage barriers is needed in the basin.

7. Align Hatchery Priorities 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 some fishery mitigation benefits. The Cowlitz River hatchery programs will produce fall Chinook, spring Chinook, coho, and summer and winter steelhead for use in the lower Cowlitz. Hatchery produced salmon and steelhead 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. The Cowlitz Trout Hatchery also acclimates and releases a temporally-segregated hatchery winter steelhead run for reintroduction and harvest in the Upper Cowlitz and Tilton Basin.

8. 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 lower Cowlitz River salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some lower Cowlitz 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 lower Cowlitz. Steelhead and chum 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.

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

Lower 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 in-subbasin 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.

G.2. Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's lower 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.

G.3. Assessment

G.3.1. Subbasin Description

Topography & Geology

For the purposes of this assessment, the Lower Cowlitz basin is the Cowlitz watershed below Mayfield Dam, not including the Toutle and Coweeman basins. The basin encompasses approximately 440 square miles in portions of Lewis and Cowlitz Counties and lies within WRIA 26 of Washington State. The Cowlitz enters the Columbia at RM 68, approximately 3.5 miles southeast of Longview, WA. The Coweeman and Toutle are the two largest tributaries. These basins are covered in separate chapters. Other significant tributaries include Salmon Creek, Lacamas Creek, Olequa Creek, Delameter Creek, and Ostrander Creek.

Mayfield Dam (RM 52), constructed in 1962, blocks all natural passage of anadromous fish to the upper basin. The Cowlitz 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. Below the Barrier Dam, the river flows south through a broad valley. Much of the lower mainstem Cowlitz suffers from channelization features related to industrial, agricultural, and urban development.

The Toutle River, which enters the Cowlitz at RM 20, is a major lower tributary that drains the north and west sides of Mount St. Helens. The Toutle River was impacted severely by the 1980 eruption of Mt. St. Helens and the resulting massive debris torrents and mudflows, which also impacted the Cowlitz mainstem downstream of the Toutle confluence. Following the eruption, the lower mainstem Cowlitz was dredged and dredge spoils were placed in the floodplain.

The lower valley is comprised of Eocene basalt flows and flow breccia. Alpine glaciation and subsequent fluvial working of glacially derived sediments have heavily influenced valley morphology and soils. 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 subbasin has a typical northwest maritime climate. Summers are dry and warm and winters are cool, wet, and cloudy. Mean monthly precipitation ranges from 1.1 inches (July) to 8.8 inches (November) at Mayfield Dam. Annual precipitation averages 46 inches near Kelso, WA (WRCC 2003). Most precipitation occurs between October and March. Snow and freezing temperatures are common in the upper elevations while rain predominates in the middle and lower elevations.

Land Use, Ownership, and Cover

Forestry is the dominant land use in the subbasin. Commercial forestland makes up over 80% of the Cowlitz basin below Mayfield Dam. Much of the private land in the lower 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, with the larger towns of Castle Rock and Longview/Kelso along the lower river. Projected population change from 2000 to 2020 for unincorporated areas in WRIA 26 is 22%. The following towns in the lower Cowlitz basin are listed with their estimated population change between 2000 and 2020: Longview 21%, Kelso 42%, Castle Rock 2%, Vader 64%, Toledo 64%, and Winlock 49% (LCFRB 2001). The State of Washington owns, and the Washington State

Department of Natural Resources (DNR) 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 G-2. In most areas, 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 G-2. Figure G-3 displays the pattern of land cover / land-use.

Human Disturbance Trends

Projected population change from 2000 to 2020 for unincorporated areas in WRIA 26 is 22%. The following towns in the lower Cowlitz basin are listed with their estimated population change between 2000 and 2020: Longview 21%, Kelso 42%, Castle Rock 2%, Vader 64%, Toledo 64%, and Winlock 49% (LCFRB 2001). Population growth will result in conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions. It is important that growth management policy adequately protect sensitive habitats and the conditions that create and support them.

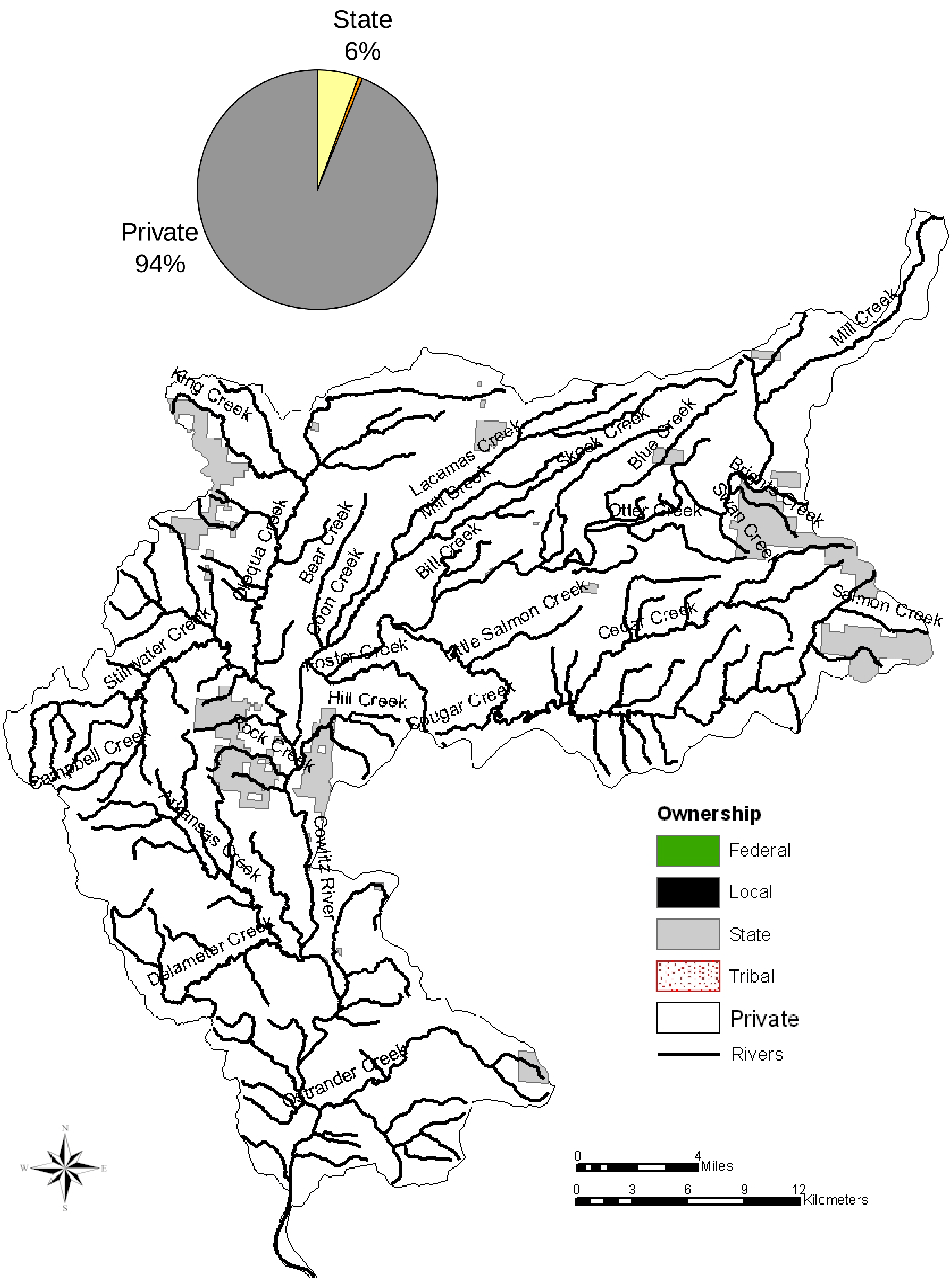


Figure G-2. Landownership within the lower Cowlitz basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

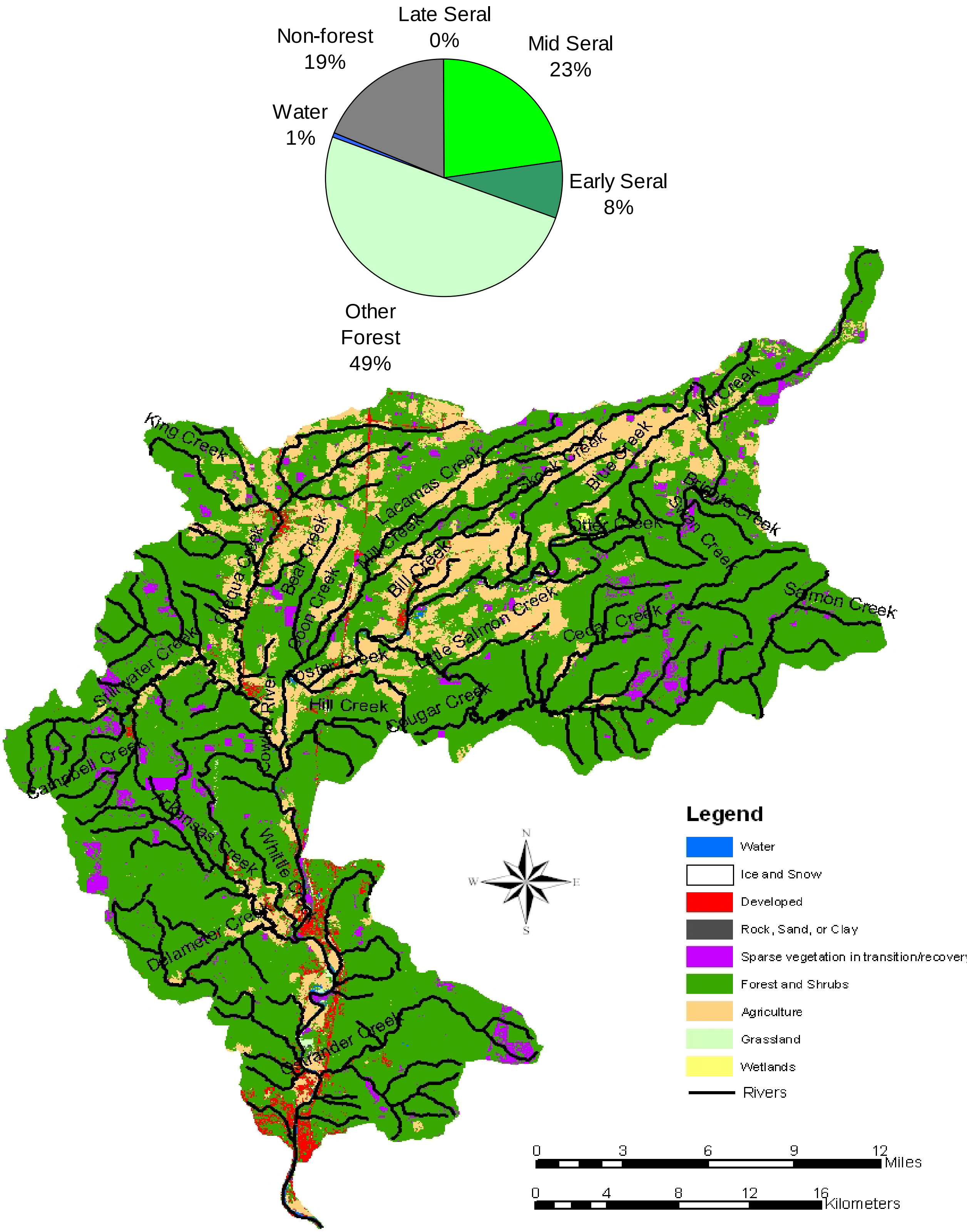


Figure G-3. Land cover within the lower Cowlitz basin. Vegetation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. 1997. Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

G.3.2. Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the lower 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 the Federal Columbia Hydropower system. Federal hydropower systems in the Cowlitz River have significantly affected anadromous species in the lower Cowlitz which are also subject to effects in the Columbia River, estuary, and nearshore ocean. The lower 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 lower Cowlitz River watersheds include fall Chinook, chum, coho, and winter steelhead. Spring Chinook are a focal species in the upper Cowlitz River. Bull trout do not occur in the subbasin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table G-1). Extinction risks are significant for all focal species – the current health or viability ranges from very low for chum and coho to low for winter steelhead and medium for fall Chinook. Returns of fall Chinook, coho, and winter steelhead include both natural and hatchery produced fish. The lower Cowlitz chum population is a subset of a larger population which also includes chum produced in the Toutle and Coweeman rivers.

Table G-1. Status and goals of focal salmonid and steelhead populations in the lower Cowlitz basin

Species	Population	Recovery Priority[1]	Viability		Improve-ment[4]	Abundance		
			Status[2]	Obj.[3]		Historic[5]	Current[6]	Target[7]
Fall Chinook (Tule)	L. Cowlitz	Contributing	VL	M+	50%	24,000	500	3,000
Chum (Fall)	L. Cowlitz	Contributing	VL	M	>500%	195,000	<300	900
Chum (Summer)	L. Cowlitz	Contributing	VL	M	>500%	n/a	n/a	900
Winter Steelhead	L. Cowlitz	Contributing	L	M	5%	1,400	350	400
Coho	L. Cowlitz	Primary	VL	H	100%	18,000	500	3,700

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.

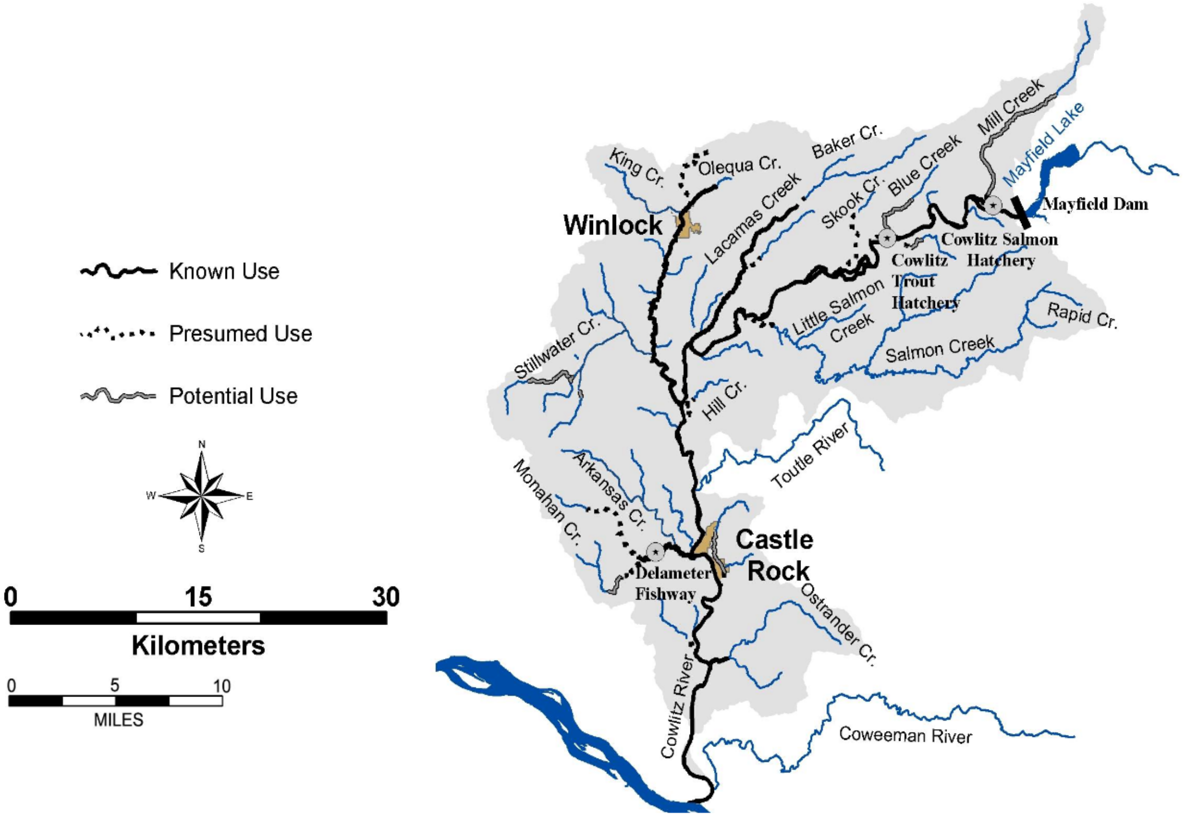
Other species of interest in the Lower Cowlitz Subbasin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

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 (Lower Cowlitz)

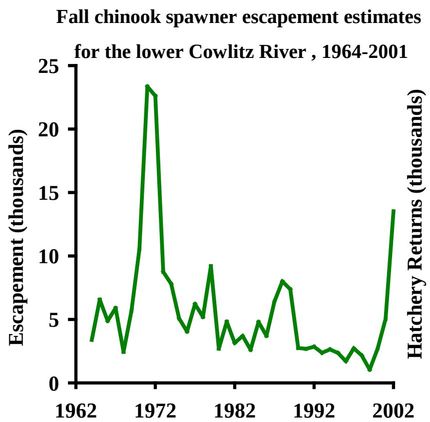
ESA: Threatened 1999 **SASSI: Depressed 2002**

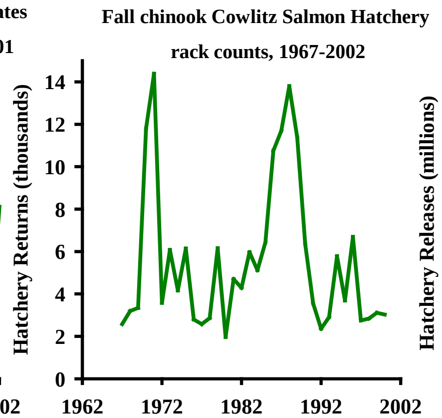
The historical lower Cowlitz adult population is estimated from 30,000-40,000 fish. Current natural spawning returns range from 1,000-13,000 with the majority hatchery origin fish. There is also a number of North Lewis wild fall Chinook which stray into the Lower Cowlitz and spawn. Spawning is primarily concentrated in 11 miles of river from the Cowlitz Salmon Hatchery downstream to the Cowlitz Trout Hatchery. Juvenile rearing occurs near and downstream of the spawning area. Juveniles emerge in early spring and migrate to the Columbia in spring and summer of their first year.

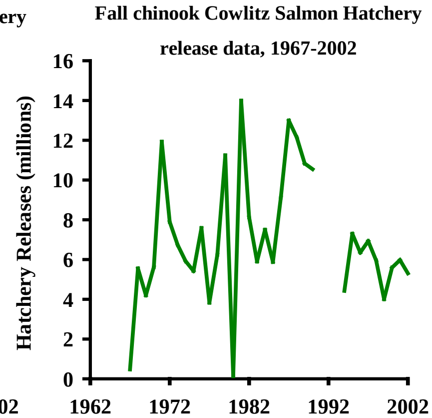


Distribution

- Spawning occurs in the mainstem Cowlitz River 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 not currently being hauled to the upper Cowlitz to avoid conflict with spring Chinook reintroduction efforts







Life History

- Fall Chinook enter the Cowlitz River from early September to late November
- Natural spawning in the Cowlitz River occurs between October and November, over a broader time period than most lower Columbia fall Chinook; the peak is usually occurs during 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 River 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 River and minor tributaries, 8,100 in the Cispus, and 500 in the Tilton
- From 1961-1966, an average of 8,535 fall Chinook were counted annually at Mayfield Dam
- Lower Cowlitz River spawning escapement from 1964-2002 ranged from 1,045 to 23,345 (average 5,522)
- Currently hatchery production accounts for most fall Chinook returning to the Cowlitz River
- WDFW interim 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 lower Cowlitz subbasin
- 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 derived from 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
- Cowlitz hatchery fall Chinook are not currently being reintroduced above Cowlitz Falls Dam

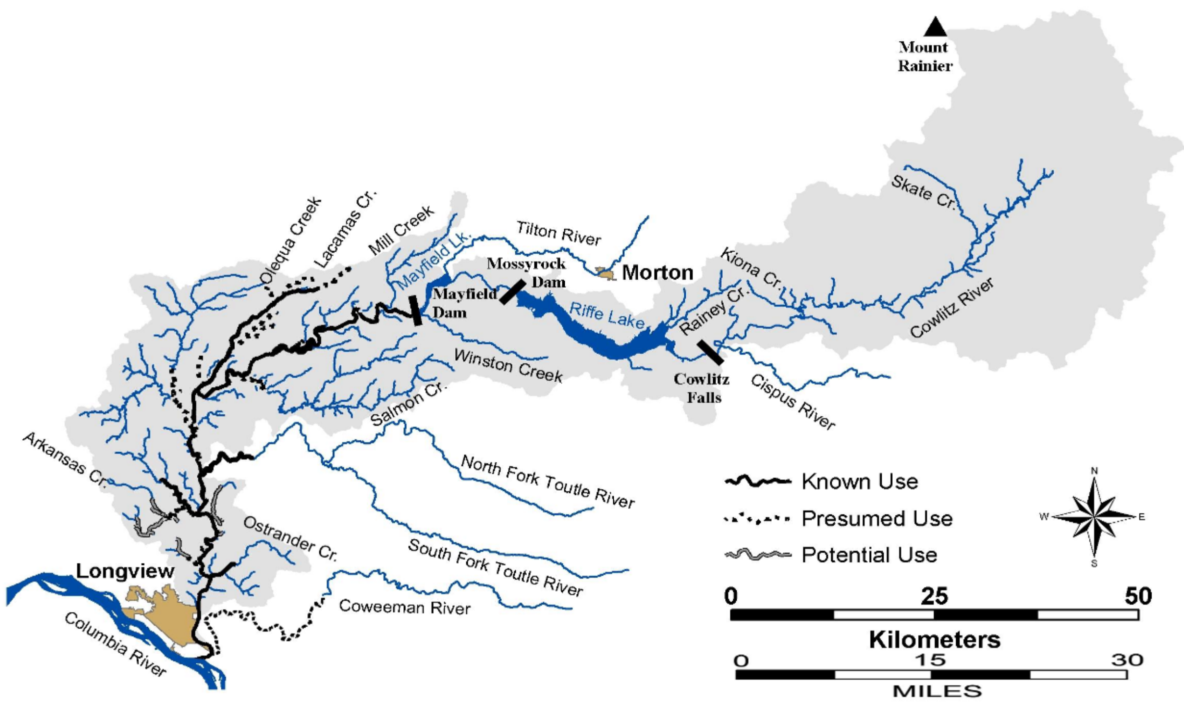
Harvest

- 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 River and Coweeman River wild fall Chinook Endangered Species Act (ESA) harvest rate limits which limits the harvest of Cowlitz fall Chinook
- Cowlitz River 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 Pacific Salmon Commission (PSC)(U.S./Canada), Pacific Fisheries Management Council (PFMC) (U.S. ocean), and Columbia River Compact Forums
- Sport harvest in the Cowlitz River averaged 2,672 fall Chinook annually from 1977-1986
- Freshwater sport fisheries in the Cowlitz River are managed to achieve adult fall Chinook hatchery escapement goals

Chum—Cowlitz Subbasin (Lower Cowlitz)

ESA: Threatened 1999 **SASSI: NA**

The historical Cowlitz adult population was the largest in the lower Columbia and estimated from 300,000-500,000 fish. This estimate includes production from the mainstem Cowlitz, Toutle, and Coweeman rivers. Current returns are very low, likely less than 150 fish. Typically, less than 20 chum are collected annually in the hatchery trap at the Barrier Dam. Natural spawning primarily occurs in the lower Cowlitz, lower mainstem Toutle, Ostrander Creek, and the lower Coweeman. Peak spawning occurs in late November although chum salmon recovered near the Cowlitz Salmon Hatchery have an earlier "summer" run timing. Juveniles emerge in the early spring and migrate to the Columbia after a short rearing period.



Distribution

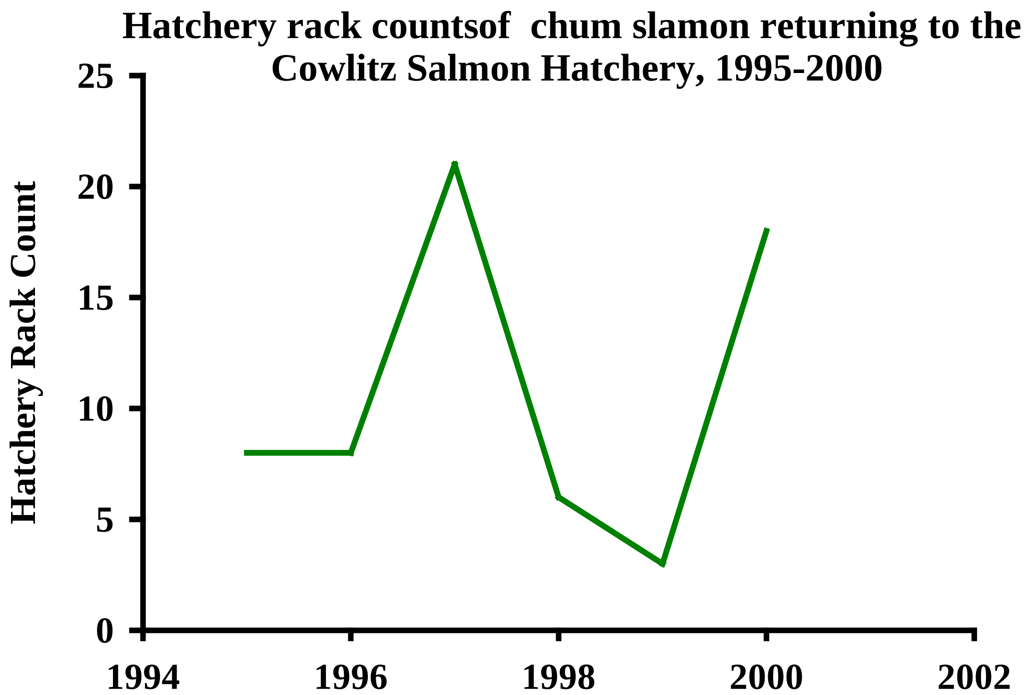
- Chum were reported to historically migrate beyond the Mayfield Dam site and spawned in the lower Cowlitz River and tributaries including: Coweeman River, Ostrander Creek, Arkansas Creek, Toutle River, Salmon Creek, Olequa Creek, and Lacamas Creek.
- Chum salmon recently recovered in the Cowlitz River and hatchery have an early "summer" run timing

Life History

- Lower Columbia River fall chum salmon run from mid-October through November; peak spawner abundance occurs in late November
- Dominant age classes of adults are 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts generally from March to May

Diversity

- No hatchery releases of chum have occurred in the Cowlitz basin
- "Summer" chum salmon are genetically distinct from fall chum salmon in the Cowlitz River



Abundance

- Estimated escapement of approximately 1,000 chum in early 1950's
- Between 1961 and 1966, the Mayfield Dam fish passage facility counted 58 chum
- Typically less than 20 adults are collected annually at the Cowlitz Salmon Hatchery

Productivity & Persistence

- Anadromous chum production primarily in lower watershed
- Harvest, habitat degradation, and to some degree construction of Mayfield and Mossyrock Dams contributed to decreased productivity
- Baseline risk assessment determined a high to very high risk of extinction for summer and fall Chum in the Cowlitz subbasin

Hatchery

- Cowlitz Salmon Hatchery does not produce/release chum salmon
- Chum salmon are captured annually in the hatchery rack

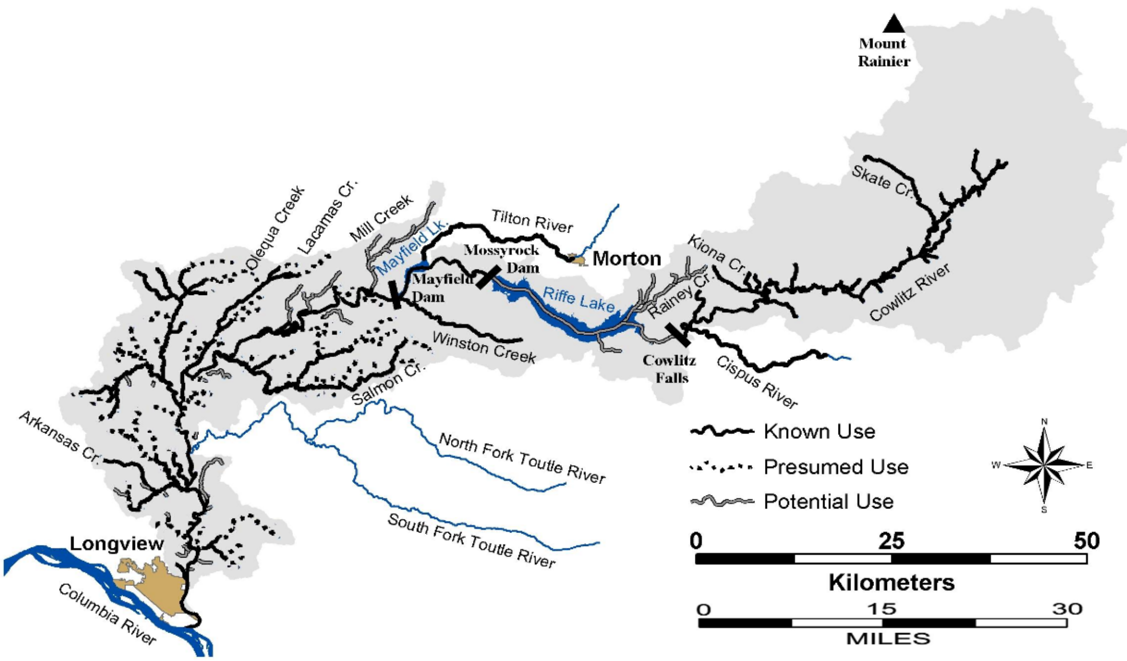
Harvest

- Currently very limited chum harvest occurs in the ocean and Columbia River and is incidental to fisheries directed at other species
- Columbia River commercial fishery historically harvested chum salmon in large numbers (80,000 to 650,000 in years prior to 1943); from 1965-1992 landings averaged less than 2,000 chum, and since 1993 less than 100 chum
- In the 1990s November commercial fisheries were curtailed and retention of chum was prohibited in Columbia River sport fisheries
- The ESA limits incidental harvest of Columbia River chum to less than 5% of the annual return.

Coho—Cowlitz Subbasin (Lower Cowlitz)

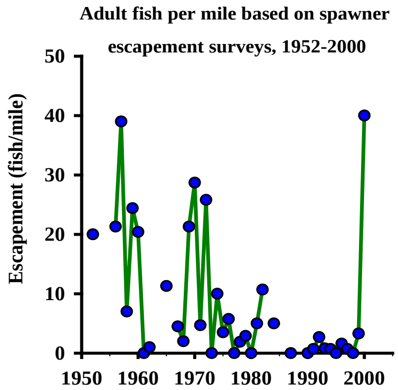
ESA: Threatened 2005 **SASSI: Cowlitz—Depressed 2002;**

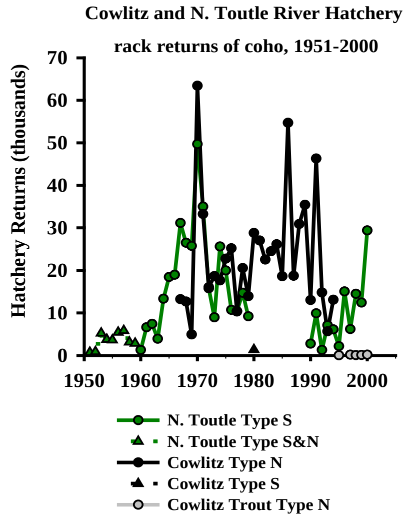
The historical lower Cowlitz adult population is estimated from 20,000-120,000 fish with the majority of returns being late stock which spawn in November. Current returns are unknown but assumed to be low. A number of hatchery produced fish spawn naturally. Natural spawning occurs primarily in Olequa, Lacamas, Ostrander, Blue, Otter, Mill, Arkansas, Foster, Stillwater, Campbell, and Hill creeks. 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.

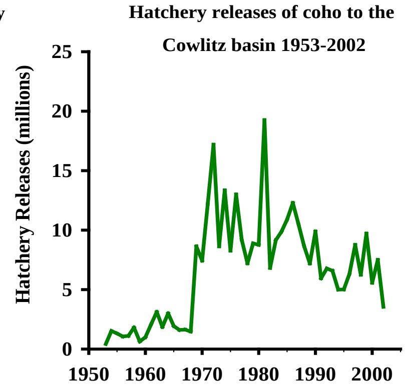


Distribution

- 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
- Baseline risk assessment determined a high to very high risk of extinction for coho in the lower Cowlitz subbasin

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

Hatchery

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

Harvest

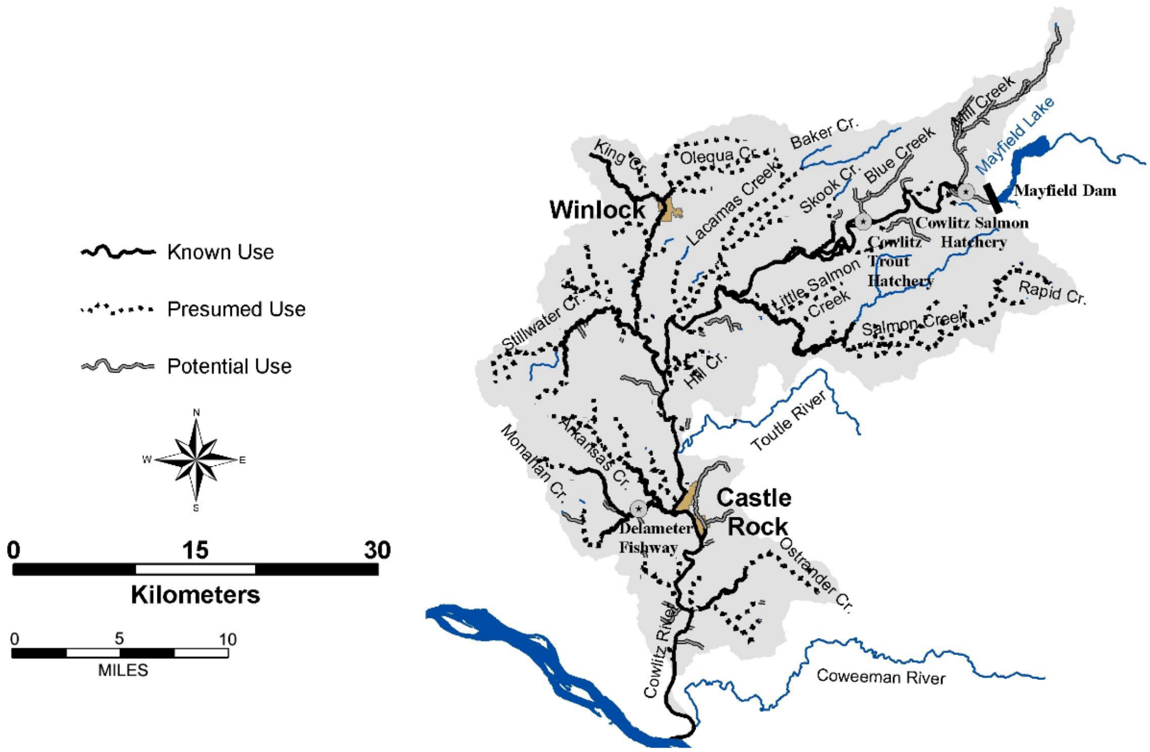
- Until recent years, natural produced coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest of Columbia produced coho ranged from 70% to over 90% from 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho stocks
- Columbia River commercial coho fisheries in November were eliminated in the 1990s to reduce harvest of late Clackamas River wild coho
- Since 1999, Columbia River hatchery fish have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon State listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho is constrained by fall Chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early hatchery coho, but late coho harvest can also be substantial
- An average of 1,494 coho (1986-1990) were harvested annually in the Cowlitz River sport fishery
- The Toutle River sport fishery was closed in 1982 after the eruption of Mt. St. Helens; the Green River sport fishery was closed from 1981 to 1988 after the eruption of Mt. St. Helens and was reopened in 1989
- CWT data analysis of the 1995-97 North Toutle Hatchery early coho indicates 34% were captured in fisheries and 66% were accounted for in escapement

- CWT data analysis of the 1994 and 1997 brood Cowlitz Hatchery late coho indicates 64% were captured in fisheries and 36% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 Toutle coho were distributed between Columbia River (47%), Washington ocean (37%), and Oregon ocean (15%) sampling areas
- Fishery CWT recoveries of 1994 and 1997 brood Cowlitz coho were distributed between Columbia River (55%), Washington ocean (30%), and Oregon ocean (15%) sampling areas

Winter Steelhead—Cowlitz Subbasin (Lower Cowlitz)

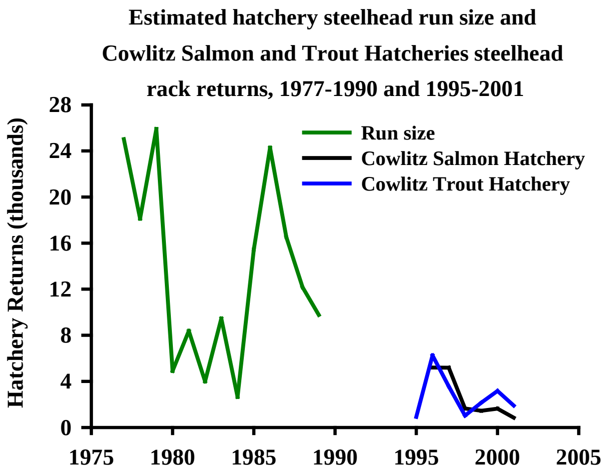
ESA: Threatened 1998	SASSI: Unknown 2002

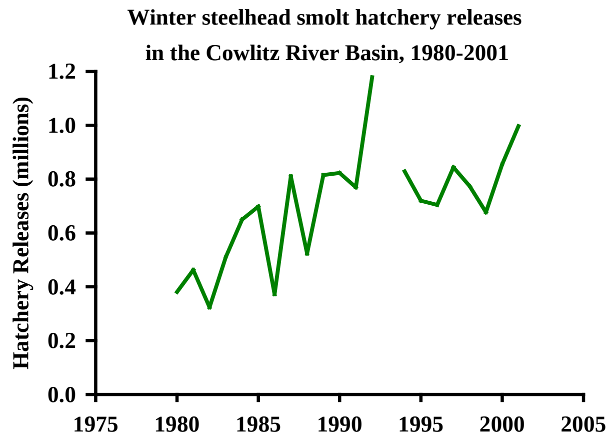
The historical lower Cowlitz adult population is estimated from 2,000-28,000 fish. Current natural spawning returns are unknown. Some interaction may occur between the natural population and Cowlitz origin winter steelhead produced from the hatchery. Interaction with Chambers Creek stock hatchery steelhead is likely low due to different spawn timing. Spawning in the lower Cowlitz primarily occurs in Olequa, Ostrander, Salmon, Arkansas, Delameter, and Stillwater creeks. Spawning time is March to early 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.



Distribution

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

Diversity

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

Abundance

- Historically, annual wild winter steelhead runs to the Cowlitz River were estimated at 20,000 fish; escapement was estimated 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 1983-1995, the annual escapement of Cowlitz River (hatchery and wild)winter steelhead ranged from 4,067 to 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%
- Baseline risk assessment determined a high risk of extinction for winter steelhead in the lower Cowlitz subbasin
- Estimated potential winter steelhead smolt production for the Cowlitz River is 63,399

Hatchery

- The Cowlitz Trout Hatchery, located on the mainstem Cowlitz at RM 42, is the only hatchery in the Cowlitz basin producing winter steelhead
- Hatchery winter steelhead have been planted in the Cowlitz River basin since 1957; broodstock from the Cowlitz River and Chambers Creek have been used; an annual average of 180,000 hatchery winter steelhead smolts were released in the Cowlitz River from 1967-1994; smolt release data are displayed from 1980-2001
- Hatchery fish account for the majority of the winter steelhead run to the Cowlitz River basin

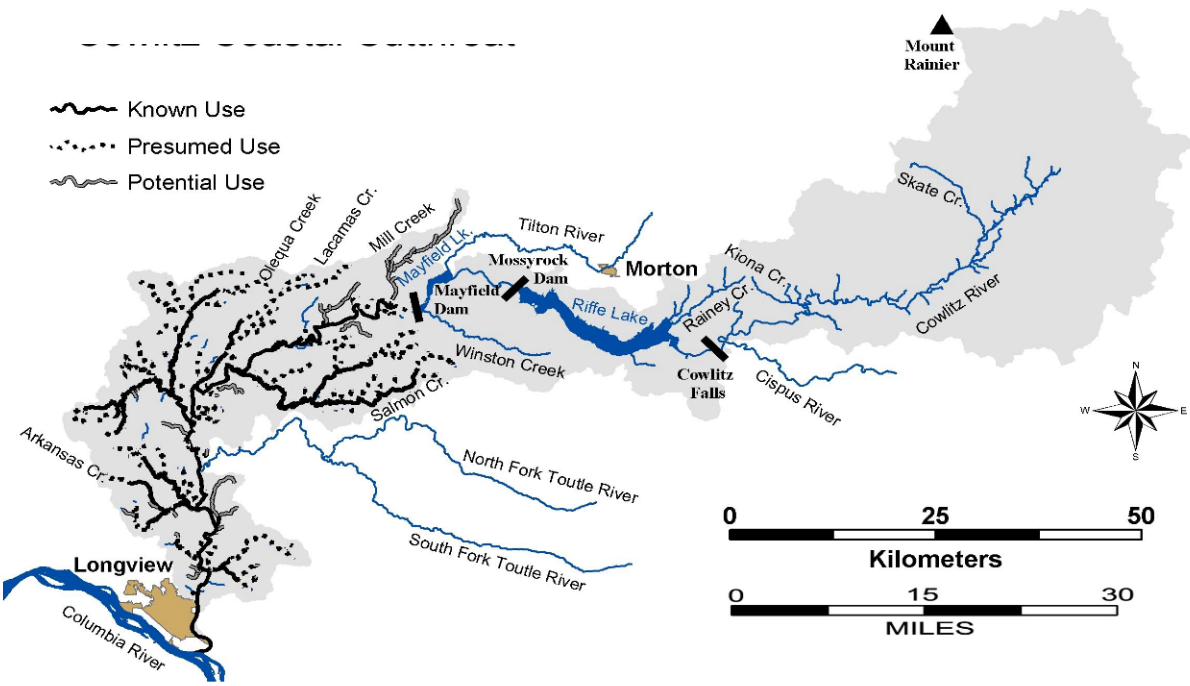
Harvest

- No directed commercial or tribal fisheries target Cowlitz winter steelhead; incidental mortality currently occurs during the lower Columbia River spring Chinook tangle net fisheries
- Steelhead sport fisheries in the Columbia must release wild winter steelhead which are not marked with an adipose fin clip
- ESA limits fishery impact of Cowlitz wild winter steelhead in the mainstem Columbia and in the Cowlitz River
- 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 (Lower Cowlitz)

ESA: Not Listed	SASSI: Depressed 2000

Coastal cutthroat abundance in the lower Cowlitz has not been quantified but the population is considered depressed. Cutthroat trout are present throughout the basin. Both anadromous (fish which have both freshwater and marine life history) and resident forms of cutthroat trout are found in the basin. A Cowlitz Trout Hatchery program produces anadromous cutthroat trout. Anadromous cutthroat enter the Cowlitz from July to October and spawn from January to April. Most juveniles rear 2-3 years before migrating from their natal stream.

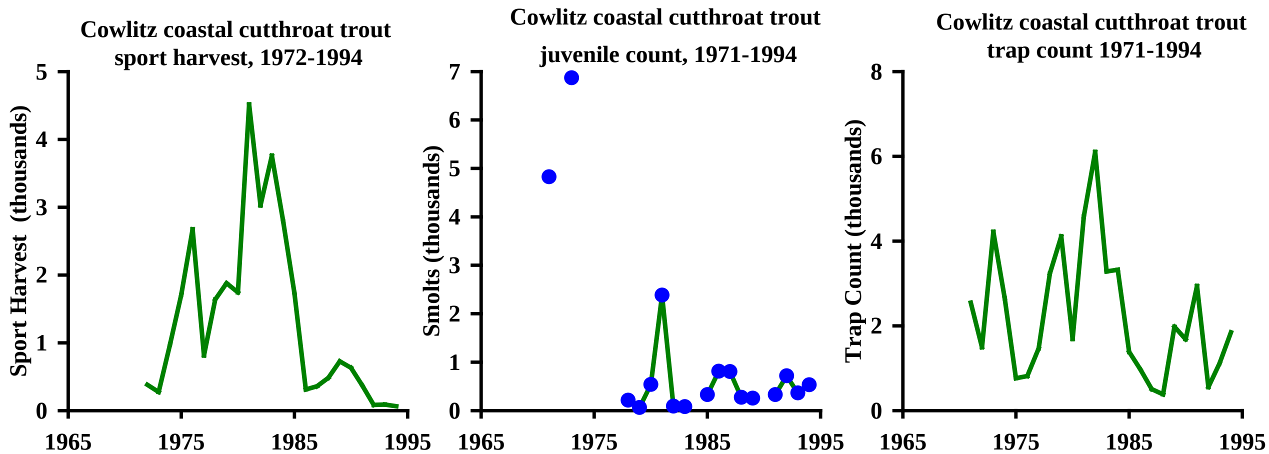


Distribution

- 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 lower 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 lower Cowlitz basin. 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.

G.3.3. 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.

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 from rain-on-snow events. Flow in the mainstem is regulated in large part by the hydropower system. Mayfield Dam (RM 52) is 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 upstream.

Flood flows in the lower mainstem have been substantially reduced due to flow regulation at the dams. Low summer flows have increased due to flow releases designed to protect the fishery resource in the lower river. In general, average summer, fall, and winter flows have increased and average spring flows have decreased since Mayfield Dam came online in 1956 (**Error! Reference source not found.**). This altered streamflow regime is believed to have improved conditions for some anadromous fish that spawn in the lower river but it is also believed to improve conditions for the intermediate host of the salmonid parasite, Ceratomyxa Shasta (Mobrand Biometrics 1999).

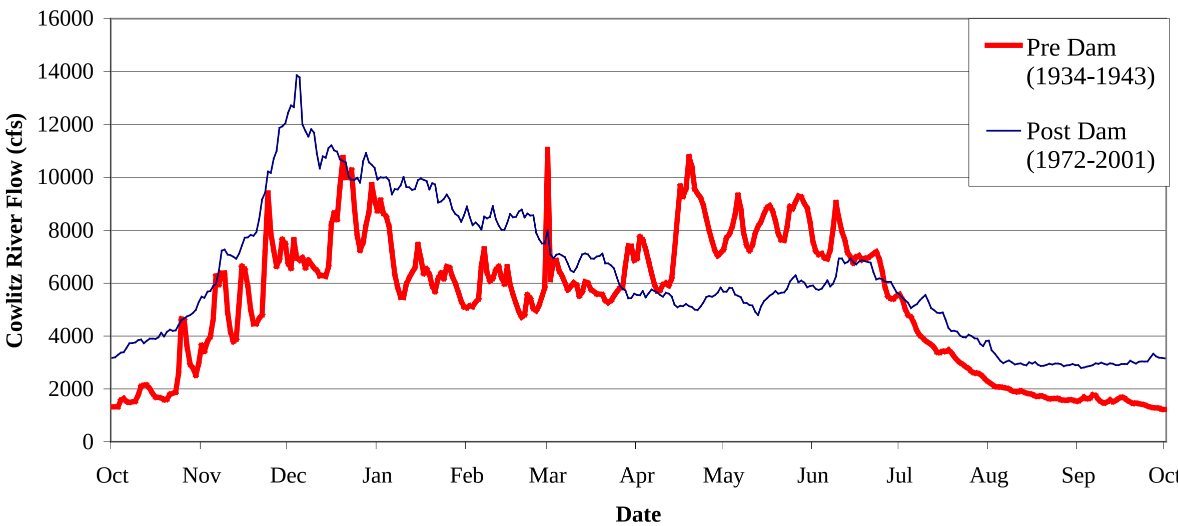


Figure G-4. Lower Cowlitz River flow pre and post Mayfield Dam (1956). Values are average daily flows. Hydropower operations have altered the annual streamflow regime. Data are from USGS Stream Gage #14238000; Cowlitz River Below Mayfield Dam, Wash.

The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that runoff conditions are 'impaired' throughout the basin, with only a couple of exceptions where conditions are 'moderately impaired'. These ratings are consistent with a peak flow assessment conducted by Lewis County GIS (2000) that identified the entire lower Cowlitz basin as 'impaired' with regards to an elevated risk of peak flow volumes. Hydrologic impairment is related to a number of factors. Much of the developed land in the lower basin has high watershed imperviousness, which contributes to degraded runoff conditions. Other areas have immature forest stands and high forest road densities, which creates a risk of increased peak flow volumes.

Analysis of low flows in Ostrander Creek and several other smaller tributaries to the Cowlitz using the Toe-Width method indicated that flows were below optimal levels in the fall for spawning and rearing (Caldwell et al. 1999). It is believed that low flows are responsible for low production in these streams (Wade 2000).

Based on the population projections and the estimated total groundwater use in the subbasin, the current and future projected groundwater withdrawal appears to be much less than the groundwater available in the basin; however, local groundwater withdrawals in lower Cowlitz tributaries may have significant impacts on streamflows (LCFRB 2001).

Passage Obstructions

The hydropower system blocks upstream passage and has flooded many miles of stream habitat. Now, 100 percent of fall Chinook and 60 percent of steelhead spawning in the Cowlitz River mainstem occurs in the lower basin (Mobrand Biometrics 1999). The Cowlitz River Barrier Dam (RM 49.5) blocks most anadromous fish and the Mayfield Dam presents a complete barrier. Some stocks are collected at the Barrier Dam and passed into upper basin streams. A notable passage barrier is a hydroelectric dam on Mill Creek (confluence near the Barrier Dam) that blocks approximately 5.2 miles of anadromous habitat. Culverts, floodgates, inadequate fish ladders, and dams present passage barriers to anadromous fish in many of the smaller tributaries to the lower mainstem Cowlitz. A full description can be found in the limiting factors analysis (Wade 2000).

Water Quality

The lower Cowlitz (RM 4.9) was placed on Washington State's 303(d) list for impaired water bodies in 1996 for exceedances of pH, water temperature, and fecal coliform standards. The 1998 list only included this reach as having an exceedance of arsenic levels (WDOE 1998). Elevated dissolved gas levels in the mainstem below the dams have been measured during high flow events (Harza 1999a as cited in Wade 2000). The lead standard was exceeded in one sample collected at Cowlitz River at Toledo (USEPA, STORET database). Several exceedances of temperature and fecal coliform have occurred on Cowlitz tributaries. Pesticide and herbicide chemicals have been detected on Olequa Creek (Wade 2000). A TMDL study was initiated on Salmon Creek in 1999 for fecal coliform, temperature, and turbidity.

Key Habitat Availability

Most of the lower mainstem Cowlitz (up to RM 17) and the lower 4 miles of the Coweeman are tidally influenced and contain pool habitat of low quality due to channelization. Diking, placement of dredge spoils, and transportation corridors have eliminated the bulk of the side-channel habitat on the lower Cowlitz and the lower reaches of tributaries (Wade 2000). Gravel mining has eliminated historical side channel habitat at various sites along the mainstem from RM 20 – 50. Exposed gravel bars along the channel have decreased since 1939. Measures of pool habitat in the mainstem below the Barrier Dam ranged from 3% (10,000 cfs) to 17% (2,140 cfs) (Harza 2000). Stream surveys conducted by the Cowlitz Conservation District in the 1990s identified low pool frequencies in 7 tributaries between RM 20 and 50 (Wade 2000).

Substrate & Sediment

The eruption of Mt. St. Helens added an enormous amount of fine sediments to the lower mainstem Cowlitz channel and floodplain. Spawning size gravel is limited in the mainstem from Mayfield Dam to the Cowlitz Trout Hatchery due to transport capacity exceeding input. The opposite occurs between the I-5 Bridge and the Trout Hatchery, resulting in large accumulations of gravels and transport to downstream reaches (Harza 1999). There are excessive quantities of substrate fines below the Barrier Dam due to land-use activities in the lower basin (Mobrand Biometrics 1999). The limiting factors TAG identified numerous problems with substrate fines in tributary streams. A detailed description can be found in the WRIA 26 Limiting Factors Analysis (Wade 2000).

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented in greater detail later in this chapter. IWA model results estimate 'moderately impaired' sediment supply conditions throughout the basin. Exceptions include the lowermost subwatersheds, which are 'impaired', and the Little Salmon Creek, Skook Creek, and portions of the upper Lacamas Creek drainage, which rate as 'functional'. Sediment supply impairments are related to road and vegetative cover conditions. Road densities in the lower Cowlitz basin are consistently greater than 4 mi/mi^2 and are greater than 7 mi/mi^2 in some areas. Approximately 31% of anadromous stream channels have stream-adjacent roads (Lewis County GIS 2000).

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

The lower 20 miles of the Cowlitz mainstem and most of the smaller tributaries have low quantities of stable LWD due to scour from past splash damming and/or active removal. Given its large size, this reach may never have been able to retain LWD (Wade 2000). However, the lower mainstem above the Toutle and Coweeman Rivers historically contained large log jams (Mobrand Biometrics 1999). An analysis of historical aerial photographs revealed many accumulations of logs along channel margins in 1939, attributed to upstream harvest practices and subsequent flood deposition. A lack of wood observed in 1960s photos was attributed to removal for fish habitat improvement and a lack of recruitment potential due to harvest. A slight increase in in-stream wood observed on 1996 photos is assumed to be the result of discontinued stream cleaning practices and increased recruitment due to the re-growth of riparian forests (Harza 2000). Stream surveys and observations in the Cowlitz tributaries between RM 20 and 52 have identified a general lack of in-stream LWD

Channel Stability

Bank stability is generally good along the lower Cowlitz mainstem though erosion of dredge spoils may be a concern in some areas. Bank stability problems have been observed from RM 20 – 25, however, overall stability may have been enhanced along the lower mainstem due to hydropower regulation (Mobrand Biometrics 1999). Bank stability problems in the small lower Cowlitz tributaries are identified in the limiting factors analysis. Many of these are related to cattle impacts (Wade 2000).

Riparian Function

Riparian forests along the lower 20 miles of the Cowlitz River and within the lower reaches of the smaller tributaries have been severely degraded through industrial and commercial development.

Agriculture and forestry activities have also impacted riparian areas. Riparian forests on the Cowlitz River from RM 20 – 52 lack mature forests and adequate buffer widths (Wade 2000). An aerial photo analysis on this reach revealed that coniferous cover types currently make up less of the riparian forest than they did historically. Gravel bars currently have more vegetative cover compared to conditions in 1939, possibly due to reduction of flood flows by upstream dams. Another change since 1939 is a decrease in the meadow/grasslands cover type, likely related to current agriculture, shrub encroachment, and residential uses (Harza 2000).

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, about half of the subwatersheds in the lower Cowlitz basin are 'impaired' and half are 'moderately impaired'. One subwatershed, located in the headwaters of Cedar Creek (Salmon Creek tributary), was rated as 'functional'. The greatest impairment occurs in the lower basin that has experienced widespread development. Impaired areas are also located along Olequa and Lacamas Creeks, which have received impacts related to agriculture, grazing, residential development, and forestry activities.

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 lower 20 miles of the Cowlitz has experienced severe loss of floodplain connectivity due to dikes, riprap, and/or deposited dredge spoils originating from the Mount St. Helens eruption. Only the Sandy River Bend area near Castle Rock retains connected floodplain habitat. Floodplain loss in the lower reaches of many of the smaller tributaries is a result of I-5, the railroad corridor, and the placement of dredge spoils (Wade 2000).

The mainstem Cowlitz between RM 20 and RM 52 (Mayfield Dam) has scattered areas with bank revetments, though floodplain connection is generally in good shape. However, there has been a decrease in total square feet of habitat per mile from 1936 to 1996 (Mobrand Biometrics 1999). Channel incision, diking, dredging, bank hardening, and various types of development have disconnected floodplains from channels in several tributaries to this reach. A detailed description is given in the limiting factors analysis (Wade 2000).

G.3.4. 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, chum, coho, and winter 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.

G.3.5. Population Analysis

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

Habitat-based assessments were completed in the Lower Cowlitz Basin for fall Chinook, chum, coho and winter steelhead. Model results indicate the largest proportional decrease in adult productivity has occurred with winter steelhead, though results are similar for both chum and coho (Table G-2). The estimated proportional changes in adult abundance vary depending on the species, with chum experiencing a dramatic 96% decline from historical numbers (Figure G-5). This can be attributed to severe degradation of the historically available chum habitat in the lower river. Winter steelhead, coho, and fall Chinook declines have also been severe, with respective declines in abundance of 77%, 75%, and 66% (Figure G-5). Diversity (as measured by the diversity index) has declined for all species (Table G-2), with winter steelhead and chum diversity declining by 44% and 56%, respectively.

Smolt productivity has also declined from historical levels for each species in the lower Cowlitz basin (Table G-2). For fall Chinook and chum, smolt productivity has decreased by 69% and 44% respectively. For both coho and winter steelhead the decrease was estimated as approximately 88% and 83%, respectively. Smolt abundance in the lower Cowlitz has declined most dramatically for chum, with an estimated 94% decrease from historical levels (Table G-2). Current fall Chinook, coho, and winter steelhead smolt abundance levels are modeled at approximately 25-40 % of historical numbers (Table G-2).

Table G-2. Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient) and historical (T or template)[1] habitat conditions.

	Adult Abundance		Adult Productivity		Diversity Index		Smolt Abundance		Smolt Productivity	
Species	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**
Fall Chinook	8,218	23,980	5.6	14.3	0.64	1.00	1,344,061	3,511,194	536	1,307
Chum	6,239	166,140	1.9	9.8	0.44	1.00	3,080,762	48,310,830	582	1,042
Coho	4,629	18,200	3.6	16.4	0.79	1.00	88,808	352,126	70	307
Winter Steelhead	450	1,358	2.8	16.9	0.50	0.90	8,746	25,046	56	316

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

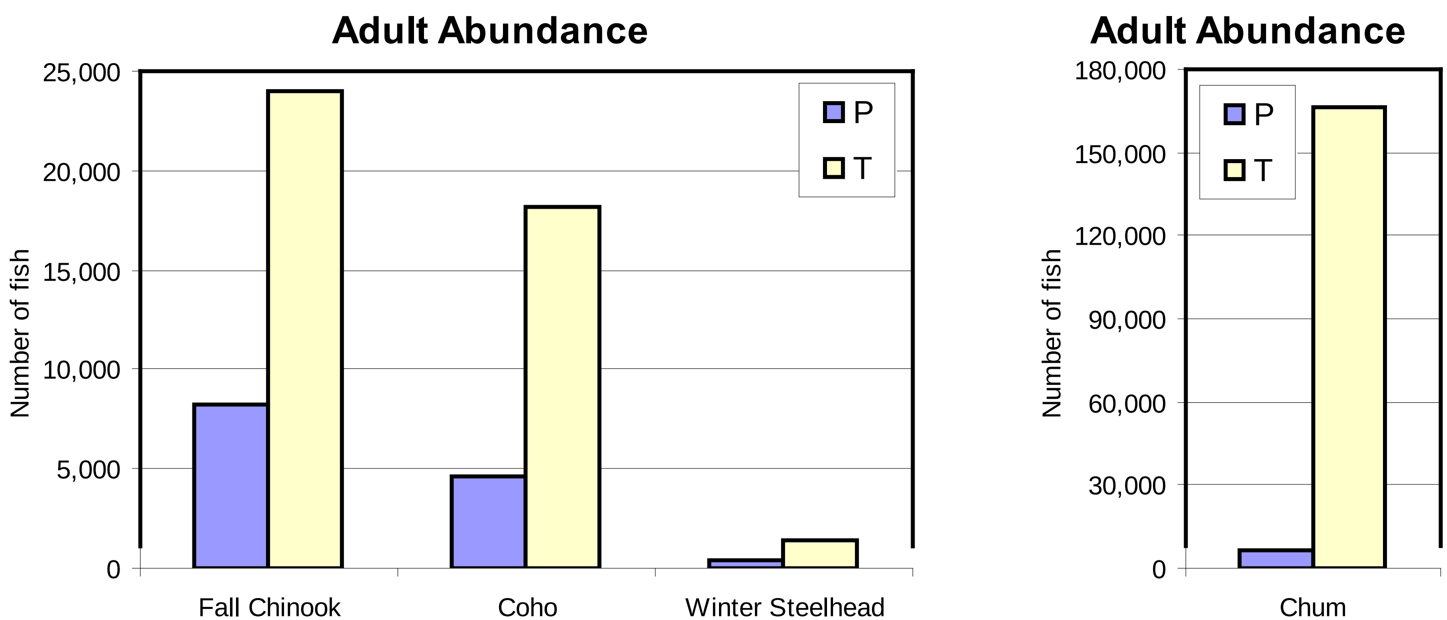


Figure G-5. Adult abundance of Lower Cowlitz River fall Chinook, coho, winter steelhead and chum based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

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 subbasin. Reach locations are displayed in Figure G-6.

High priority reaches for fall Chinook include middle Cowlitz reaches Mid Cowlitz-1C through Mid Cowlitz-1F (Figure G-7). These reaches, along with most other important fall Chinook reaches, show a strong preservation emphasis. Important reaches for chum include mainstem reaches (Lower Cowlitz 1, and Mid Cowlitz 6 and 7), as well as tributary reaches (Lacamas Cr 1, Olequa Cr 1, and Salmon Cr 1 and 2) (Figure G-8). These high priority reaches show mixed recovery emphases, with reach Lower Cowlitz 1 having the largest restoration potential of any reach modeled for chum.

For coho, high priority reaches are spread throughout the basin (Figure G-9). Many of these important reaches are located in tributaries, including Lacamas Creek, Arkansas Creek, Salmon Creek, and Olequa Creek. The vast majority of reaches modeled for coho show a restoration recovery emphasis, with reaches Lacamas Cr 1 A and Arkansas Cr 1 B having the largest restoration potential of any reaches modeled for coho.

Winter steelhead make extensive use of the available lower Cowlitz habitats, reaching well into Olequa, Lacamas, Salmon, Arkansas, Delameter, and Monahan Creeks. In contrast, fall Chinook use primarily only mainstem habitats from the mouth to the barrier dam. Chum and coho also use mostly mainstem habitats but will make some use of the lower reaches of tributary habitats.

High priority reaches for winter steelhead are located primarily in the middle mainstem (Mid Cowlitz 4 – 6) and in Salmon and Stillwater Creeks (Figure G-10). Mainstem reaches are most important for juvenile rearing. As with coho, the vast majority of reaches modeled for winter steelhead show a restoration recovery emphasis.

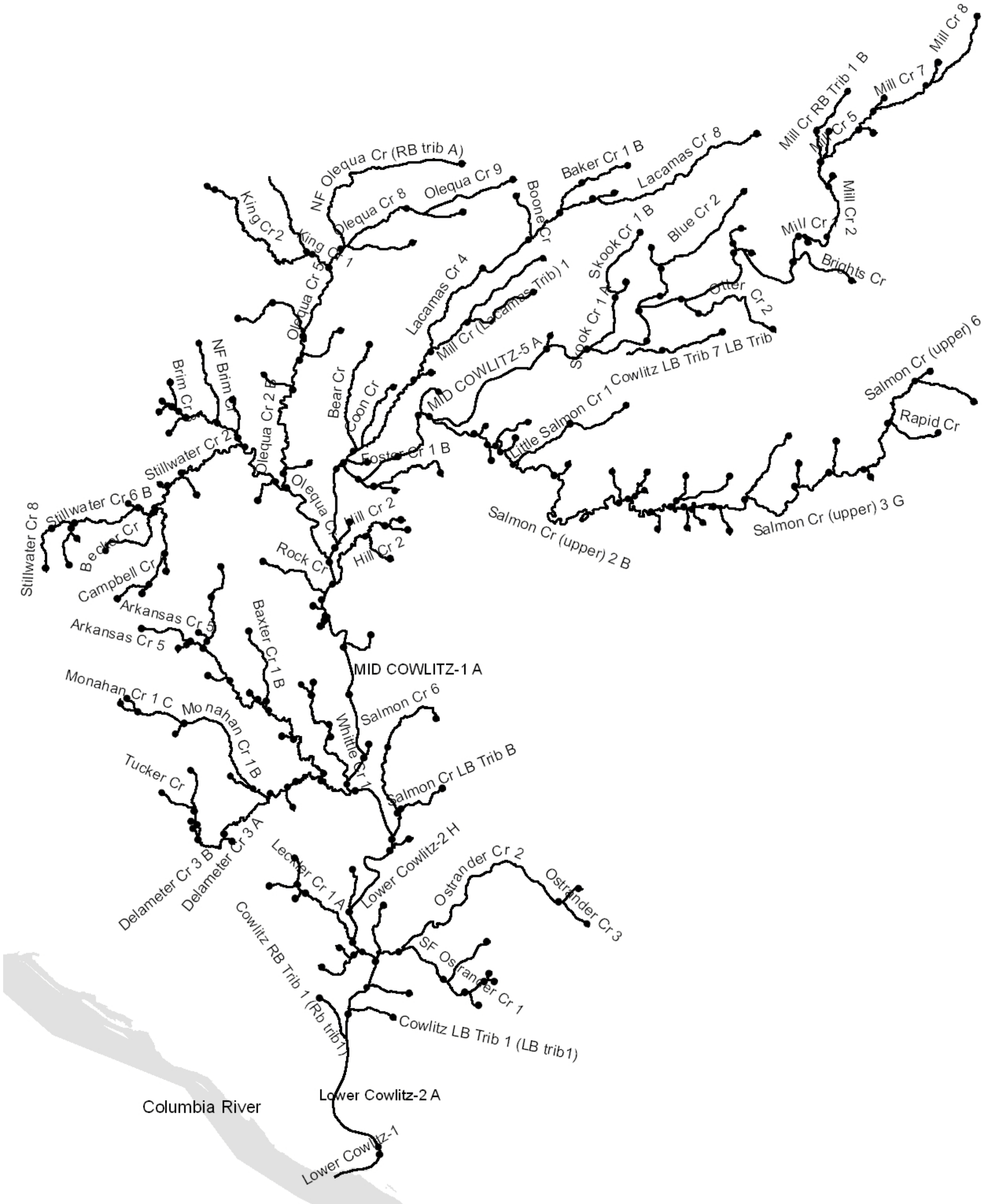


Figure G-6. Lower Cowlitz subbasin with EDT reaches identified. For readability, not all reaches are labeled.

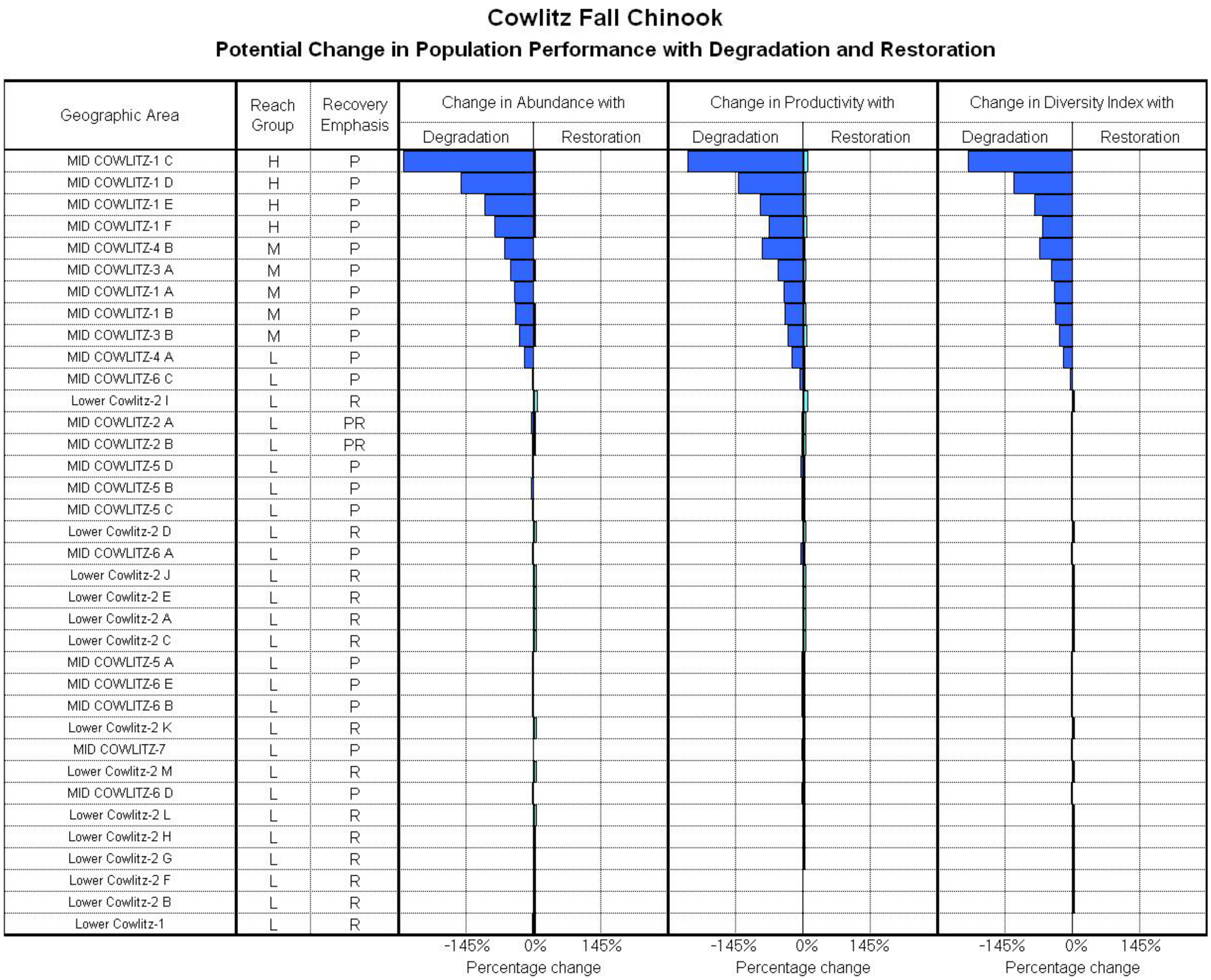


Figure G-7. Lower Cowlitz River subbasin fall Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current 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.

Lower Cowlitz Chum

Potential change in population performance with degradation and restoration

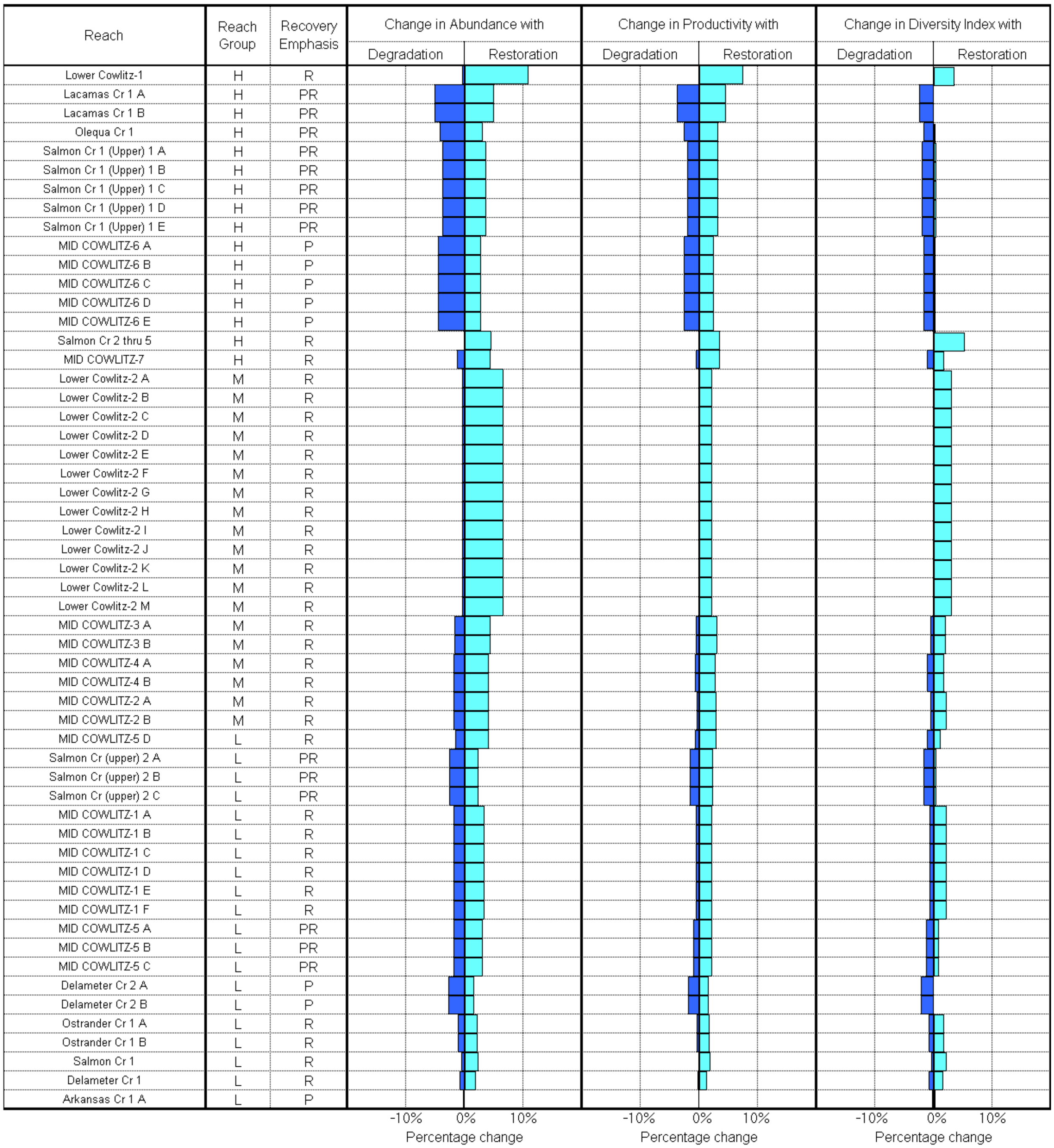


Figure G-8. **Lower Cowlitz subbasin chum ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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.**

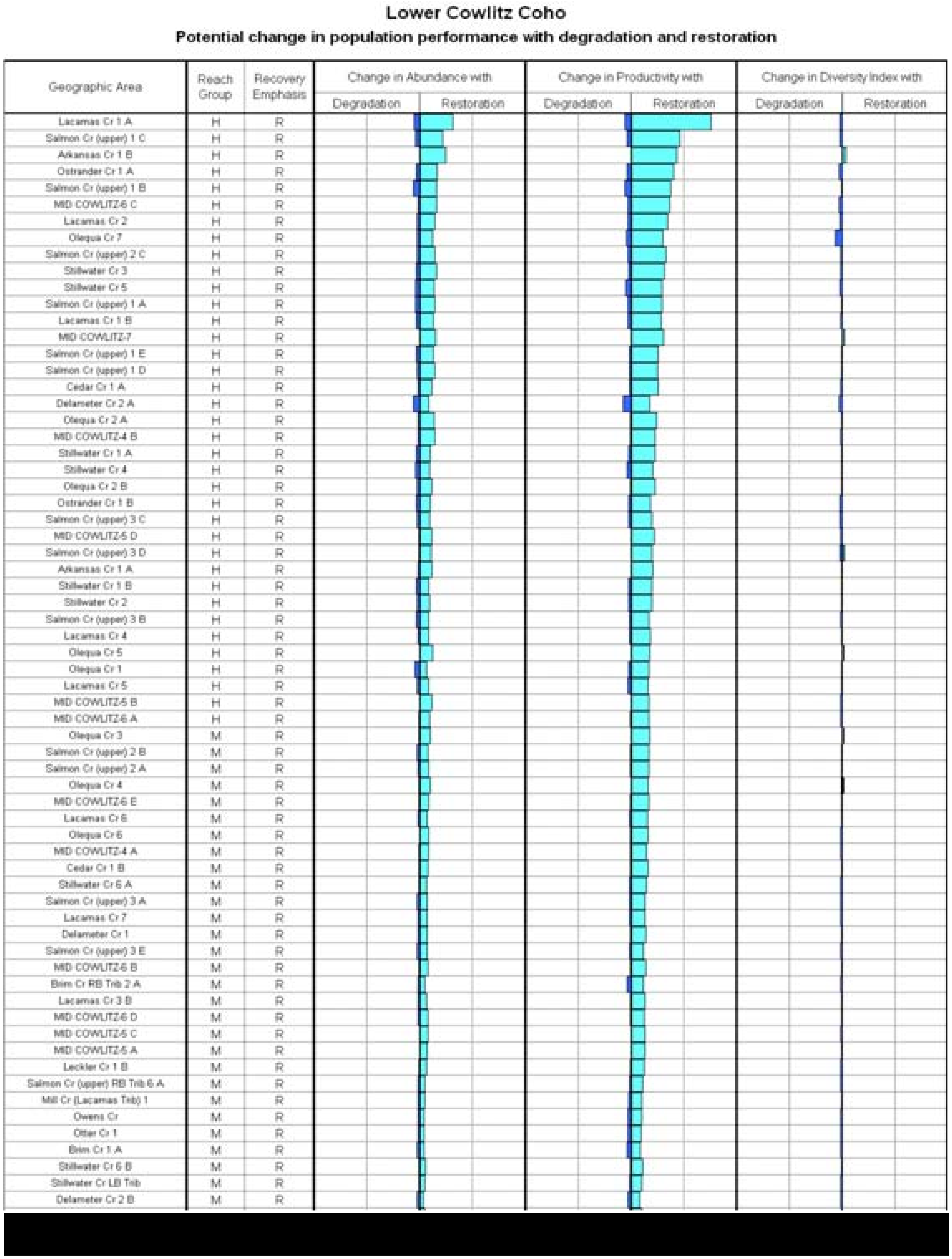


Figure G-9. Cowlitz River subbasin coho ladder diagram. Some low priority reaches are not included for display purposes. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units 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.

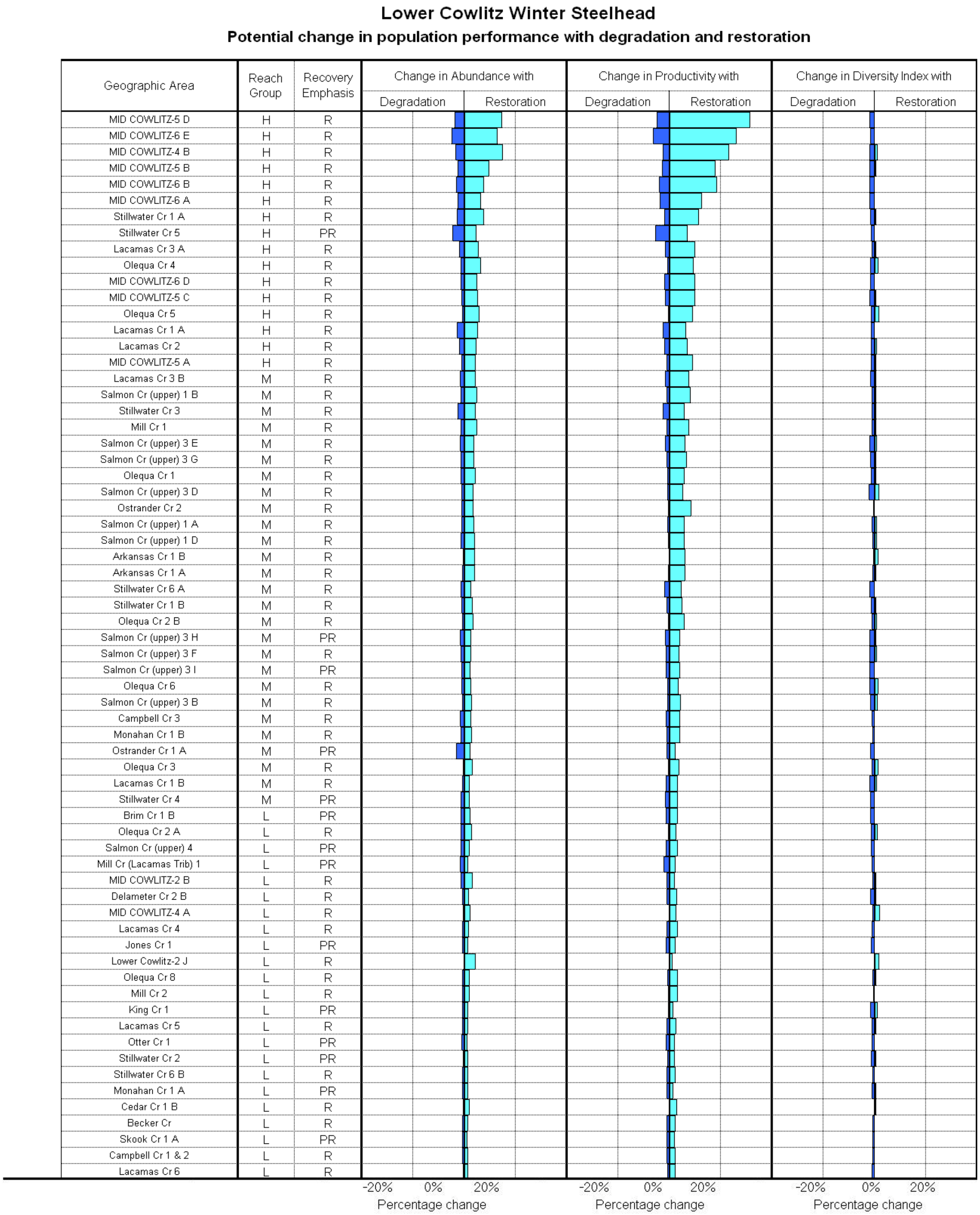


Figure G-10. Cowlitz River subbasin winter steelhead ladder diagram. Some low priority reaches are not included for display purposes. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. 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 Table G-3.

Table G-3. 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*
Lower Cowlitz Fall Chinook				
most critical	Egg incubation	channel stability, sediment	key habitat	pathogens
second	Prespawning holding	habitat diversity	flow, harassment	pathogens
third	Fry colonization	habitat diversity	channel stability, flow, food, sediment, predation, key habitat	pathogens
Lower Cowlitz Chum				
most critical	Egg incubation	channel stability, sediment	key habitat	flow, pathogens
second	Prespawning holding	habitat diversity	harassment, pathogens	key habitat, flow
third	Spawning	habitat diversity	flow, pathogens, harassment	key habitat
Lower Cowlitz Coho				
most critical	Egg incubation	channel stability, sediment	key habitat	
second	0-age winter rearing	habitat diversity, key habitat	channel stability, flow	food
third	0-age summer rearing	competition (hatchery), habitat diversity, temperature, key habitat	channel stability, flow, food, pathogens, predation	
Lower Cowlitz Winter Steelhead				
most critical	Egg incubation	sediment, temperature	channel stability, key habitat	
second	0-age summer rearing	competition (hatchery), flow, habitat diversity, pathogens, temperature	channel stability, food, predation	
third	0,1-age winter rearing	habitat diversity	channel stability, flow, sediment	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 impact of habitat attributes on reach-level performance.

For the fall Chinook population, primary habitat impairments are related to sediment and habitat diversity (Figure G-11). The channel is severely channelized by levees, which have served to simplify and limit available habitat. Riparian areas are in poor condition and LWD levels are low. Historically, large log jams may have been present in the lower mainstem. Stream cleanouts in the 1960s, reduced recruitment due to riparian harvest, and intercepted transport from upstream due to the dams, have significantly reduced LWD levels.

Coho habitat in the lower Cowlitz subbasin has been affected by a variety of factors. These impacts include loss of habitat diversity, increased sediment, loss of key habitat, reduced channel stability and an altered temperature regime (Figure G-12). Loss of habitat diversity is related to increased bed scour as a result of confinement, degraded riparian areas, and a lack of LWD. Key habitat has been reduced due to the dramatic reduction in historically available side-channels. Sediment input is a major factor and primarily stems from sediments originating from the 1980 Mount St. Helens eruption that are delivered via the Toutle River. Riparian timber harvest, agriculture, and residential development have impacted riparian zones and LWD recruitment.

The habitat factor analysis for winter steelhead identified numerous impacts to current population performance. High impact attributes in steelhead stream reaches include habitat diversity, temperature, sediment, flow, and channel stability (Figure G-13). Habitat diversity is low due to degraded riparian areas, low LWD levels, and incised channels. There is a risk of increased peak flow due to upper basin timber harvest, roads, and an increase in impervious surfaces due to residential and agricultural development. Low flows have been identified as a problem for summer rearing (Caldwell et al. 1999). Sediment contributions stem from high road densities and agriculture/grazing practices. Degraded riparian areas affect temperature, food, and channel stability.

High priority reaches for chum have been negatively impacted by habitat degradation, with the greatest impacts related to habitat diversity, key habitat, and sediment (Figure G-14). The land-use impacts are the same as those discussed above for fall Chinook and coho.

Lower Cowlitz Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration														
Geographic area	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
MID COWLITZ-1 C	•				•	•	●	•			•		●			•
MID COWLITZ-1 D	•				•	•	●	•			•		●			•
MID COWLITZ-1 E	•				•	•	●	•			•	•	●			•
MID COWLITZ-1 F	•				•	•	●	•			•		●			•
MID COWLITZ-4 B	•				•	•	●	•			•		•			•
MID COWLITZ-3 A	•				•	•	●	•			•		●			•
MID COWLITZ-1 A	•				•	•	●	•			•	•	●			•
MID COWLITZ-1 B	•				•	•	●	•			•	•	●			•
MID COWLITZ-3 B	•				•	•	●	•			•		●			•
MID COWLITZ-4 A	•				•	•	●	•			•		•			•
MID COWLITZ-6 C	•				•	•	•	•			•					
Mill Cr 4	•				•	•	●						●	•		●
Lower Cowlitz-2 A	⬤		•		●	•	⬤	●			•	•	⬤	•		•
MID COWLITZ-2 B	•				•	•	●	•			•	•	●			•
MID COWLITZ-2 A	•				•	•	●	•			•		●			
MID COWLITZ-5 D	•				•	•	●	•			•		•			•
MID COWLITZ-5 A	•				•	•	●	•			•		•			•
Lower Cowlitz-2 I	⬤		•		●	•	⬤	•			•	•	⬤	•		•
MID COWLITZ-6 A	•				•	•	•	•			•					
Lower Cowlitz-2 B	⬤		•		●	•	⬤	●			•	•	⬤	•		•
MID COWLITZ-5 C	•				•	•	●	•			•		•			•
MID COWLITZ-5 B	•				•	•	●	•			•		•			•
MID COWLITZ-6 B	•				•	•	•	•			•					
Lower Cowlitz-2 H	⬤		•		●	•	⬤	●			•	•	⬤	•		•
MID COWLITZ-6 E	•				•	•	•	•			•					
MID COWLITZ-7	•				•	•	●	•					•			•
Lower Cowlitz-2 M	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-2 F	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-2 C	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-2 G	⬤		•		●	•	⬤	•			•	•	⬤	•		•
Lower Cowlitz-2 J	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-2 E	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-2 K	⬤		•		●	•	⬤	●			•	•	⬤	•		•
MID COWLITZ-6 D	•				•	•	•	•			•					
Lower Cowlitz-2 D	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-2 L	⬤		•		●	•	⬤	●			•	•	⬤	•		•
Lower Cowlitz-1	•		•		•	•	●	•			•	•	●			•
Mill Cr 2	•				•	•	⬤									●
Mill Cr 3	•				•	•	●									●
Mill Cr 1	•				•		●							•		●

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
◯ / ⬤ High	O / ● Medium	∘ / • Low	Indirect or General

Figure G-11. **Lower Cowlitz subbasin 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 impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.**

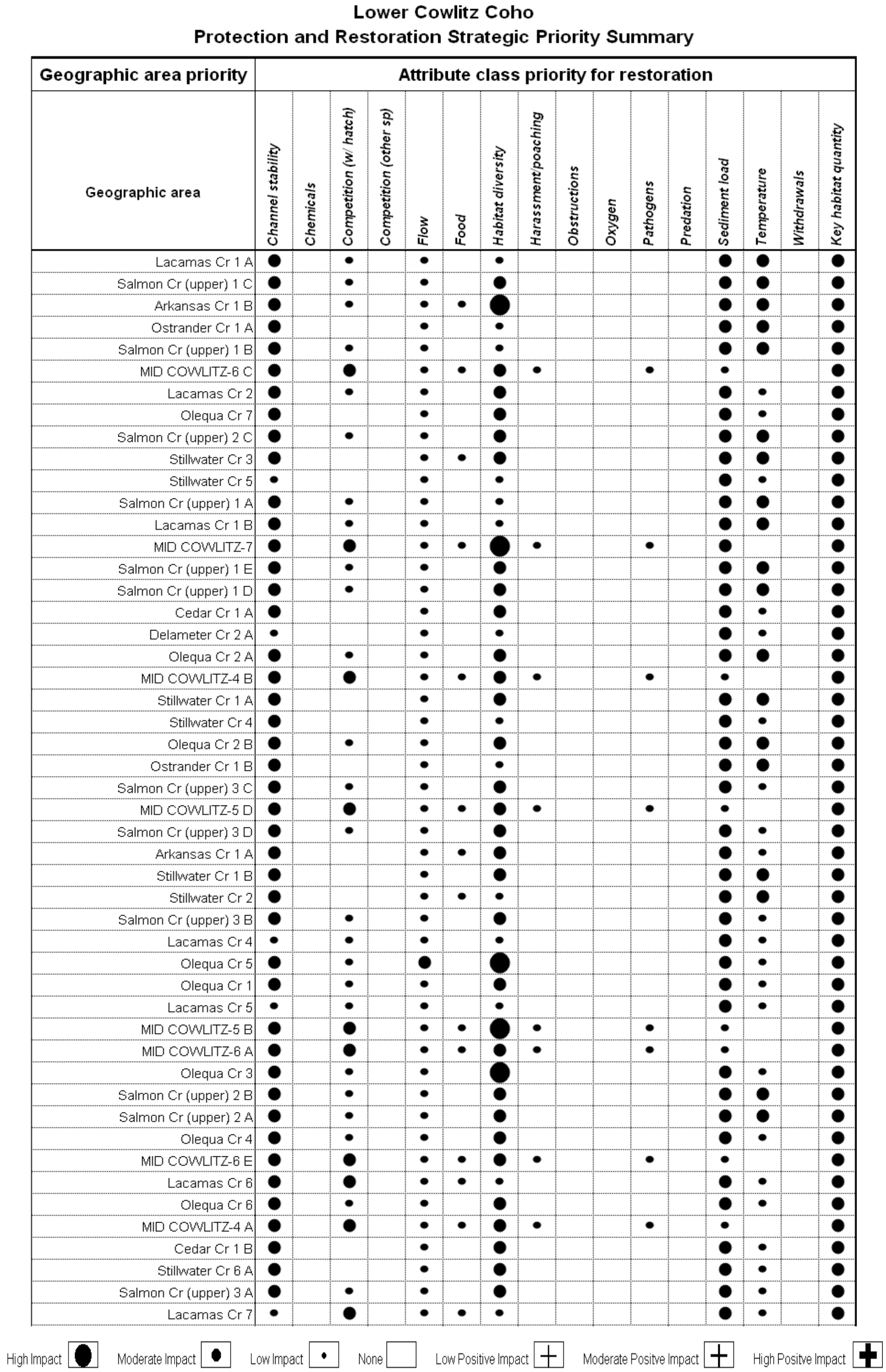


Figure G-12. Lower Cowlitz coho habitat factor analysis diagram. Some low priority reaches may not be included for display purposes. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors 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 impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

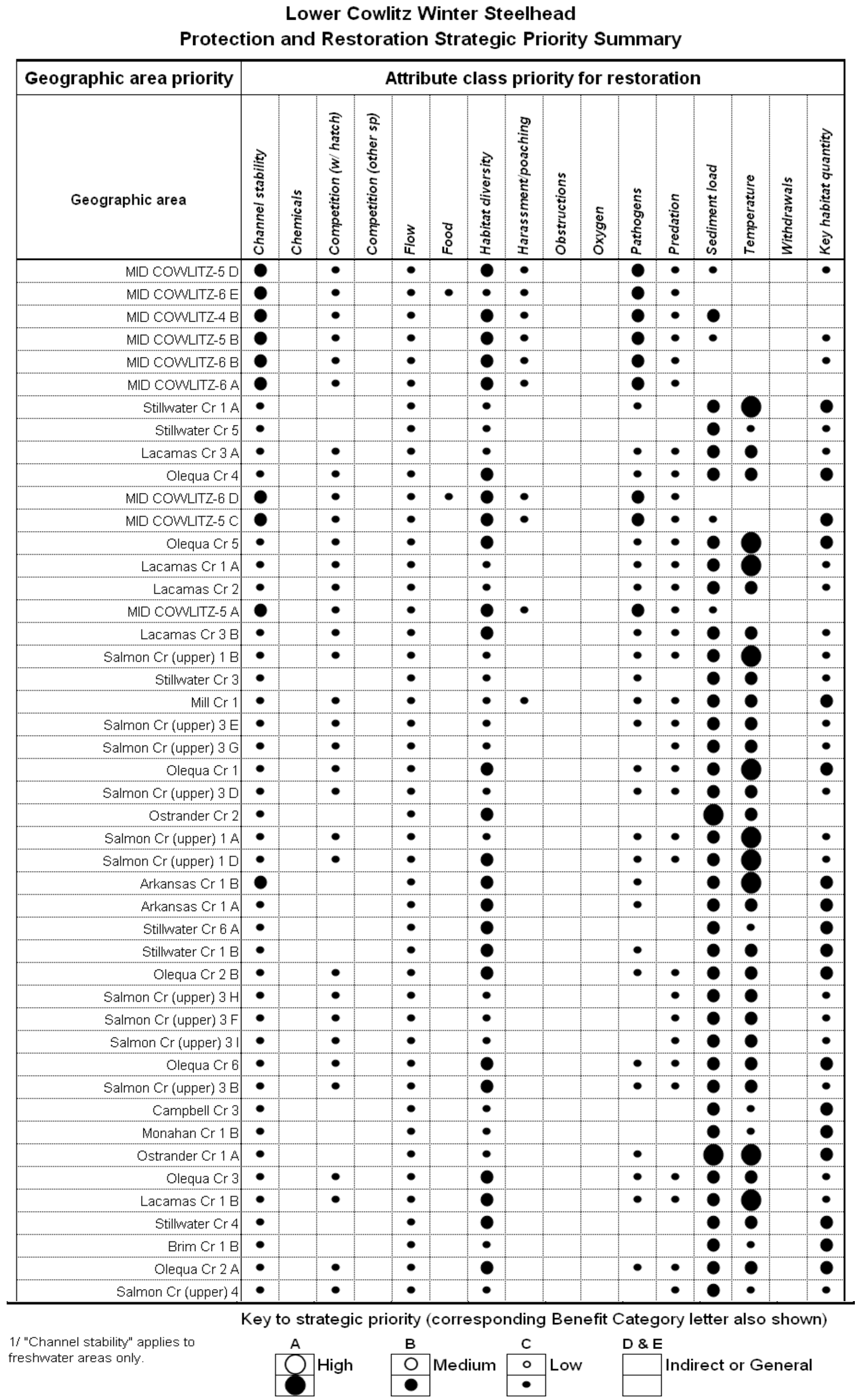


Figure G-13. Lower Cowlitz River subbasin winter steelhead habitat factor analysis diagram. Some low priority reaches may not be included for display purposes. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation 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 impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

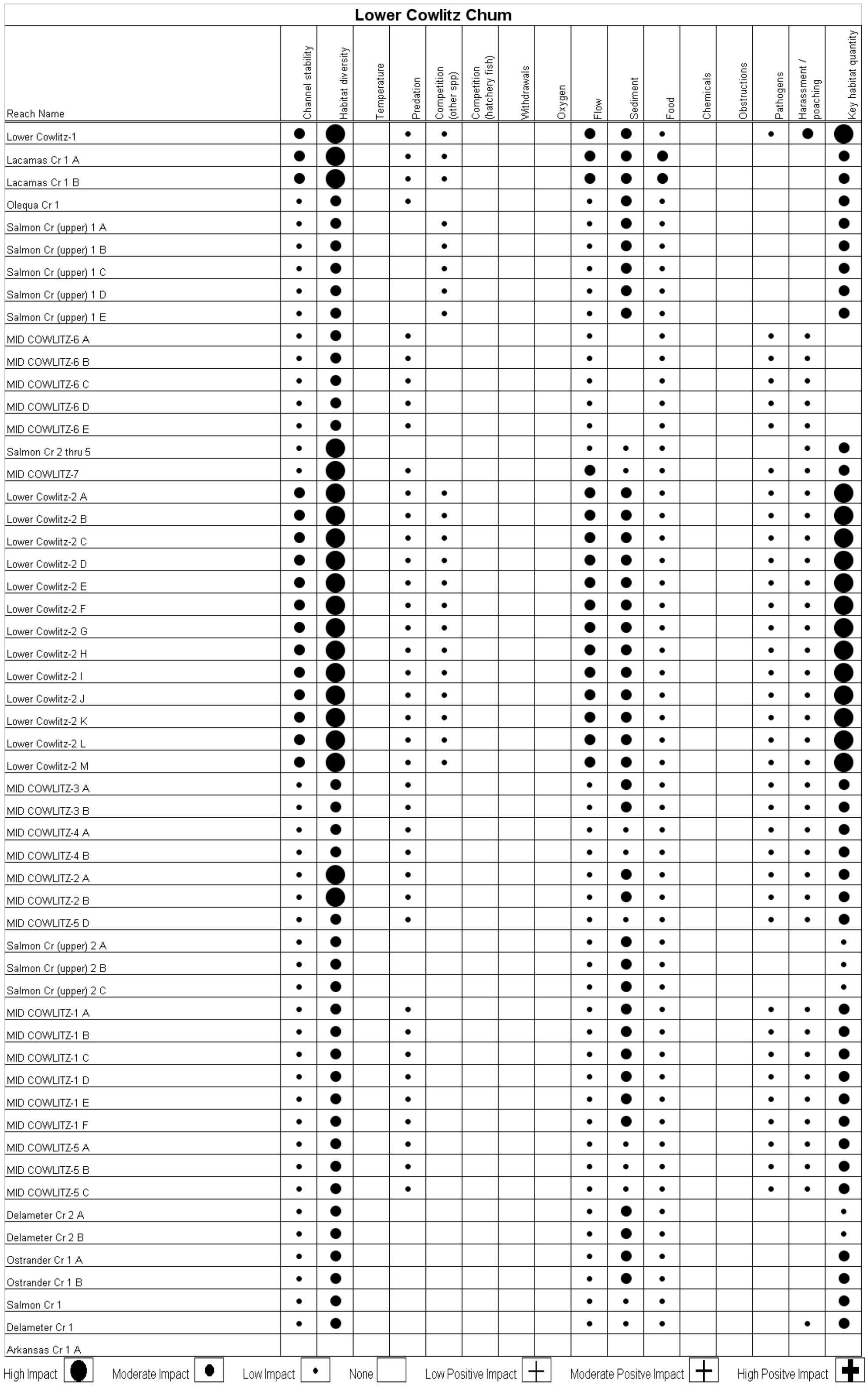


Figure G-14. **Lower Cowlitz subbasin chum habitat factor analysis diagram. This chum habitat factor analysis diagram differs from the others in that the dot size represents not only the relative within-reach impact of the habitat attributes, but also the relative contribution of each reach's impact on total population performance. The dots therefore decrease in size towards the bottom of the chart.**

G.3.6. 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 lower Cowlitz watershed, which encompasses a total of 483 square miles, is divided into 40 subwatersheds for the IWA. The upstream end of the lower Cowlitz watershed terminates at Mayfield Dam. Upstream of the dam are the Mayfield-Tilton, Riffe Lake, Cispus River, and Upper Cowlitz watersheds. These seven watersheds comprise the Cowlitz River subbasin. IWA results for the Lower Cowlitz watershed are shown in Table G-4. A reference map showing the location of each subwatershed in the basin is presented in Figure G-15. Maps of the distribution of local and watershed level IWA results are displayed in the Appendix.

Hydrology

Current Conditions— Local level hydrologic conditions in the lower Cowlitz watershed are impaired in virtually all subwatersheds, with only two moderately impaired subwatersheds located off the upper mainstem. The lower mainstem of the Cowlitz River has undergone extensive agricultural and residential development. Population centers in the subbasin consist primarily of small rural towns, with the larger towns of Castle Rock, Kelso, and Longview situated along the lower river. The hydrologic impacts of development include increased magnitude, frequency, and intensity of storm runoff, reduced ground water recharge, and lower stream flows during summer baseflow periods. These effects stem from vegetation removal, an increase in the quantity of impervious surfaces, and an increase in the channel network. Thirty-nine of 40 subwatersheds have less than 50% of total area in hydrologically mature forest cover. It should be noted, however, that much of this area is in what was once lowland prairie, and sparse tree cover is a natural condition in some areas. In the mainstem Cowlitz, impacts to streamflow may be overshadowed by the effects of hydro-regulation.

Watershed level results for hydrologic condition are generally similar, with the exception that hydrologic conditions rated as impaired at the local level in three subwatersheds become moderately impaired at the watershed level, due to the influence of upstream contributing subwatersheds. When considering these results it is important to note that the IWA does not explicitly consider the effects of the dams on streamflows within mainstem Lower Cowlitz subwatersheds. The three subwatersheds with improved hydrology ratings at the watershed level are in the Cowlitz mainstem below Mayfield Dam. Given the expected influence of dam operations on mainstem hydrology, the IWA watershed level rating does not accurately represent the effects of upstream influences. For the purpose of the IWA analysis, watershed level effects are calculated as though the watershed terminates at the dam.

Predicted Future Trends— Due to the low forest cover within the forested subwatersheds and the low percentage of forested subwatersheds, hydrologic conditions in the lower Cowlitz watershed are predicted to remain unchanged (i.e., impaired) over the next 20 years unless specific actions are taken to ameliorate the problem. Conditions in the mainstem are generally driven by hydropower operations, and are determined to a lesser extent by tributary conditions. Hydropower operations may be modified in the future to benefit salmon recovery, but for the purpose of this analysis these operations are predicted to remain constant over this period.

Sediment Supply

Current Conditions — Most subwatersheds are rated as moderately impaired for local sediment supply conditions. Four adjacent subwatersheds (60303, 60403, 60404, and 60401) are rated as locally functional for sediment. A few subwatersheds in the lower portion of the basin, including the mouth subwatershed, are rated impaired. The remainder are moderately impaired. Based on geology type and slope class, subwatersheds rated as functional for sediment were found to have natural erodability ratings in the low-to-intermediate range, ranging from 37 to 43 on a scale of 0 to 126. Road densities are generally moderate to high and streamside road densities are mostly moderate in these subwatersheds.

Locally functional and impaired sediment ratings in two subwatersheds, respectively, become moderately impaired at the watershed level. This implies that hydrologic and sediment conditions in these subwatersheds are potentially affected by upstream as well as local conditions. However, when considering these results it is important to note that the IWA does not explicitly consider the effects of the dams on streamflows within mainstem Lower Cowlitz subwatersheds. Two subwatersheds with changing sediment ratings are located along the lower Cowlitz mainstem, which is affected both by the effect of dams (which capture sediment from the upper subbasin) and the influence of undammed tributaries within the Coweeman and Toutle River watersheds.

Predicted Future Trends — Sediment conditions are generally rated as moderately impaired to impaired throughout the lower Cowlitz basin, with the exception of the Mill Creek tributary to Lacamas Creek (functional). The watershed is characterized by a broad array of land uses, ranging from agriculture and timber to urban and industrial development, and also contains the developing I-5 corridor.

Land uses in tributary watersheds are generally predicted to continue, and may in some cases shift towards residential and urban development along the I-5 corridor. Based on the trajectory of predominant land uses, sediment conditions in tributary drainages are predicted to trend towards increasing degradation. These impacts may be mitigated to some degree by improved forestry and road management practices on public and private timberlands, and improved stormwater controls. Nevertheless, the predicted overall trend is toward increasing degradation in tributary drainages.

Sediment conditions in the mainstem Cowlitz are determined by the presence of major dams, sediment delivery from tributary drainages, and significantly, from tributary watersheds such as the Toutle and Coweeman Rivers. Of particular note, the Toutle River watershed was heavily impacted with sediment from the Mt. St. Helens eruption in 1980. Sediment delivery from the Toutle River watershed is a consistent management challenge in the lower Cowlitz mainstem. The trend in sediment conditions in the mainstem is expected to remain constant in subwatersheds above the confluence with the Toutle, and to degrade over the next 20 years in mainstem reaches downstream of the Toutle.

Table G-4. IWA results for the Lower Cowlitz Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
80407						Toutle
80201	I	M	I	I	M	none, east Willapa
80203	I	I	I	I	M	east Willapa
70606, 80201, 80202, 80203	I	I	I	I	M	60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60304, 60305, 60401, 60402, 60403, 60404, 60405, 60406, 60407, 60408, 70101, 70102, 70103, 70104, 70105, 70201, 70202, 70203, 70204, 70205, 70501, 70502, 70503, 70504, 70505, 70601, 70605, 80202
80201						60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60304, 60305, 60401, 60402, 60403, 60404, 60405, 60406, 60407, 60408, 70101, 70102, 70103, 70104, 70105, 70201, 70202, 70203, 70204, 70205, 70501, 70502, 70503, 70504, 70505, 70601, 70605, 70606
80202	I	M	I	I	M	none
80203	I	I	I	I	M	none
70504	I	M	I	I	M	70501, 70502, 70503, 70505
70501	I	M	M	I	M	none
70501--70502	I	M	I	I	M	70501
70502	I	M	I	I	M	70501
70503	I	I	M	I	I	none
70504						
70505	I	M	M	I	M	70503
70601	I	M	M	I	M	none
70605	I	M	M	I	M	60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60304, 60305, 60401, 60402, 60403, 60404, 60405, 60406, 60407, 60408, 70101, 70102, 70103, 70104,70105, 70201, 70202, 70203, 70204, 70205, 70501, 70502, 70503, 70504, 70505, 70601
70606	I	I	I	I	M	60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60304, 60305, 60401, 60402, 60403, 60404, 60405, 60406, 60407, 60408, 70101, 70102, 70103, 70104, 70105, 70201, 70202, 70203, 70204, 70205, 70501, 70502, 70503, 70504, 70505, 70601, 70605
70605, 70606	I	I	I	I	M	60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60304, 60305, 60401, 60402, 60403, 60404, 60405, 60406, 60407, 60408, 70101, 70102, 70103, 70104, 70105, 70201, 70202, 70203, 70204, 70205, 70501, 70502, 70503, 70504, 70505, 70601, 70605
70104	I	M	M	I	M	70105
70104, 70105	I	M	M	I	M	70105

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
70103	I	M	M	I	M	70101, 70102, 70104, 70105, 70201, 70202, 70203, 70204, 70205
70102	I	M	I	I	M	70101
70101	I	M	M	I	M	none
70201	I	M	I	I	M	none
70202	I	M	I	I	M	none
70203	I	M	I	I	M	none
70204	I	M	I	I	M	70201, 70202, 70203
70205	I	M	I	I	M	70201, 70202, 70203, 70204
60408	I	M	I	I	M	60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60304, 60305, 60401, 60402, 60403, 60404, 60405, 60406, 60407
60401	I	F	I	I	F	none
60402	I	M	M	I	M	none
60403	I	F	M	M	M	60101, 60102, 60103, 60104, 60402
60404	M	F	I	M	F	none
60405	I	M	M	I	F	60401
60406	I	M	M	I	F	60401, 60405, 60404
60202	I	M	M	I	M	60201
60103	I	M	M	I	M	60104
60303	I	F	M	I	M	none
60302	I	M	M	I	M	60201, 60202, 60304, 60305
60301, 60304	I	M	M	I	M	60305
60304	I	M	M	I	M	60305
60305	I	M	M	I	M	none
60403, 60407	I	M	I	I	M	60101, 60102, 60103, 60104, 60201, 60202, 60301, 60302, 60303, 60402, 60403
60102	I	M	M	M	M	60103, 60104, 60402
60101, 60102	I	M	M	M	M	60103, 60104, 60402
60101	I	M	M	M	M	60103, 60104
60201	M	M	F	M	M	none
60104	I	M	M	I	M	none
80101	I	M	M	I	M	none
80102	I	M	M	I	M	80101

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800010#####.
[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.

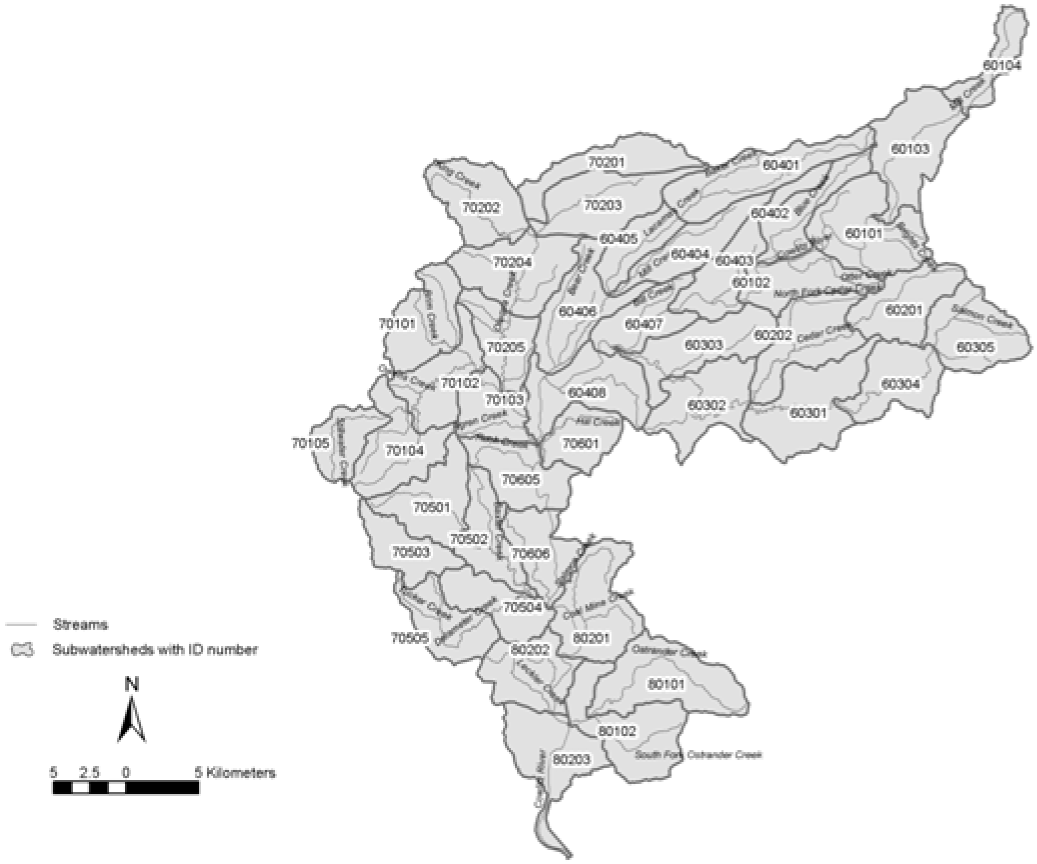


Figure G-15. Map of the Lower Cowlitz basin showing the location of the IWA subwatersheds.

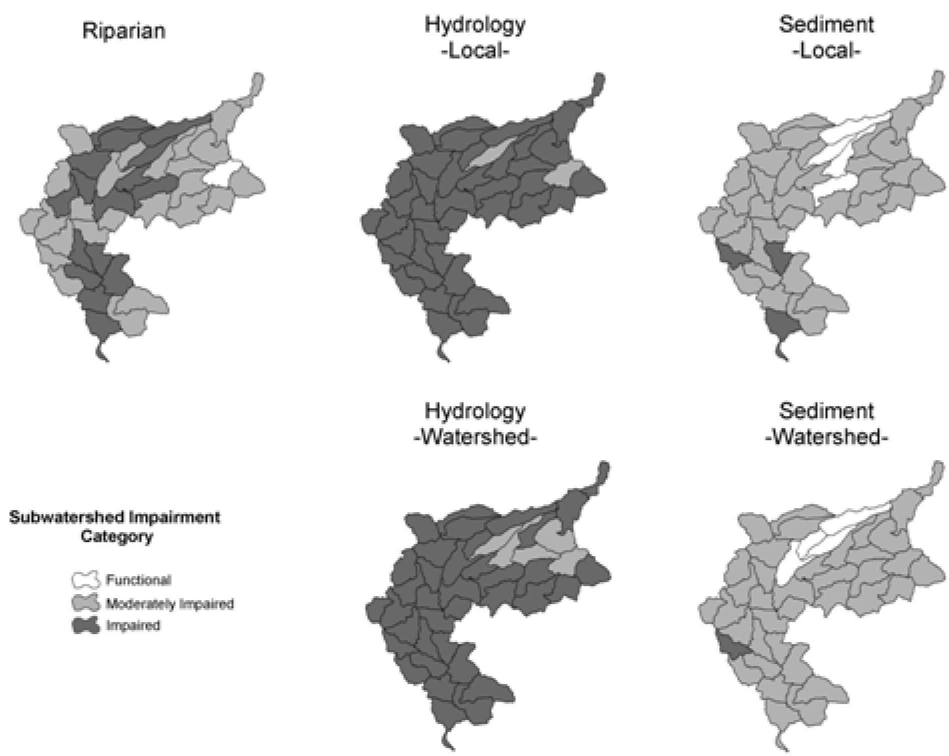


Figure G-16. IWA subwatershed impairment ratings by category for the Lower Cowlitz basin

Riparian Condition

Current Conditions— Riparian conditions are rated as moderately impaired or impaired, with only one subwatershed, Cedar Creek (60201), rated as functional. Moderately impaired conditions are present in 23 subwatersheds and the remaining 16 subwatersheds are rated as impaired. Generally, riparian conditions in the Puget Trough subwatersheds in the more northern and eastern portion of the watershed are better than the Willapa Hills subwatersheds to the west and south.

Riparian forests along the lower 20 miles of the Cowlitz and within the lower reaches of the smaller tributaries have been severely degraded through industrial and commercial development. Agriculture and forestry activities have also impacted riparian areas (Wade 2000).

Predicted Future Trends— Riparian forests along the lower 20 miles of the Cowlitz and within the lower reaches of the smaller tributaries have been severely degraded through industrial and commercial development. Riparian conditions are rated functional in Cedar Creek (60201), moderately impaired in 23 subwatersheds, and impaired in the remaining 14 subwatersheds. Conditions in middle and upper tributary subwatersheds are generally predicted to remain stable over the next 20 years, trending towards gradual improvement as regrowth in degraded watersheds proceed.

Riparian conditions along the lower mainstem and in lower tributary drainages are expected to trend downward over the next 20 years, as development pressure around the towns of Castle Rock, Longview, and Kelso increase. Channelization and bank modifications along the mainstem further limit the potential for riparian recovery in many areas.

G.3.7. 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 but 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 Lower Cowlitz Basin and discusses their potential effects.

Hatcheries have operated in the Cowlitz River Basin since the early 1900s. For example, the Tilton River Hatchery released coho salmon in the Cowlitz River from 1915–21 and a salmon hatchery operated in the upper Cowlitz near the mouth of the Clear Fork until 1949. Three hatcheries currently operate in the basin: the Cowlitz Salmon Hatchery, the Cowlitz Trout Hatchery, and the North Toutle Hatchery (formerly the Green River Hatchery). The three hatcheries coordinate annual production efforts and are collectively referred to as the Cowlitz River Hatchery Complex.

Cowlitz Salmon Hatchery

The Cowlitz Salmon Hatchery, completed in 1967, is approximately two miles downstream of Mayfield Dam. Current production goals are 5 million fall Chinook juveniles released in the Cowlitz River, approximately 1.2 million spring Chinook smolts (967,000 into the lower Cowlitz, and 100,000 to the Deep River net pens), 300,000 spring Chinook fry for release into the upper Cowlitz above Cowlitz Falls Dam, and 3.2 million late-stock coho smolts (Figure G-17).

Cowlitz Trout Hatchery

The Cowlitz Trout Hatchery is located on the mainstem Cowlitz at RM 42. Current production goals include 300,000 early run winter steelhead smolts released to the lower Cowlitz River; 352,500 late-run winter steelhead smolts to the lower Cowlitz River; 250,000 fingerlings and 37,500 late-run winter steelhead smolts to the upper Cowlitz and Cispus rivers, and 100,000 late-run winter steelhead fingerlings to the Tilton River; 500,000 summer steelhead smolts in the lower Cowlitz River; 100,000 sea run cutthroat trout fingerlings in the Tilton River; and 160,000 sea-run cutthroat trout fingerlings in the Cowlitz River and Blue Creek (Figure G-17).

The North Toutle Hatchery

The North Toutle Hatchery, on the Green River less than a mile upstream of the confluence with the NF Toutle River, began operations in 1956 and was destroyed in the 1980 Mt. St. Helens eruption. Rearing ponds near the hatchery site were developed after the eruption and operations were restored in 1985. The rebuilt hatchery resumed collecting broodstock in 1990. Current hatchery release goals are 2.5 million sub-yearling fall Chinook, 800,000 early-stock coho smolts, and 50,000 summer steelhead (from Skamania Hatchery) smolts (Figure G-18). Rearing ponds located at RM 8 on the Coweeman River are used to acclimate winter steelhead for release in the basin. Annual production goals are 14,000 smolts; an additional 6,000 smolts are released directly to the Coweeman River without acclimation at the ponds (Figure G-18).

Table G-5. Cowlitz Basin hatchery production.

Hatchery	Release Location	Fall Chinook	Spring Chinook	Late Coho	Sea-run Cutthroat	Winter Steelhead	Summer Steelhead
Cowlitz Salmon	Lower Cowlitz	5,000,000	967,000	3,200,000			
	Upper Cowlitz		300,000				
Cowlitz Trout	Lower Cowlitz				150,000	652,500	500,000
	Upper Cowlitz					287,500	
	Tilton					100,000	

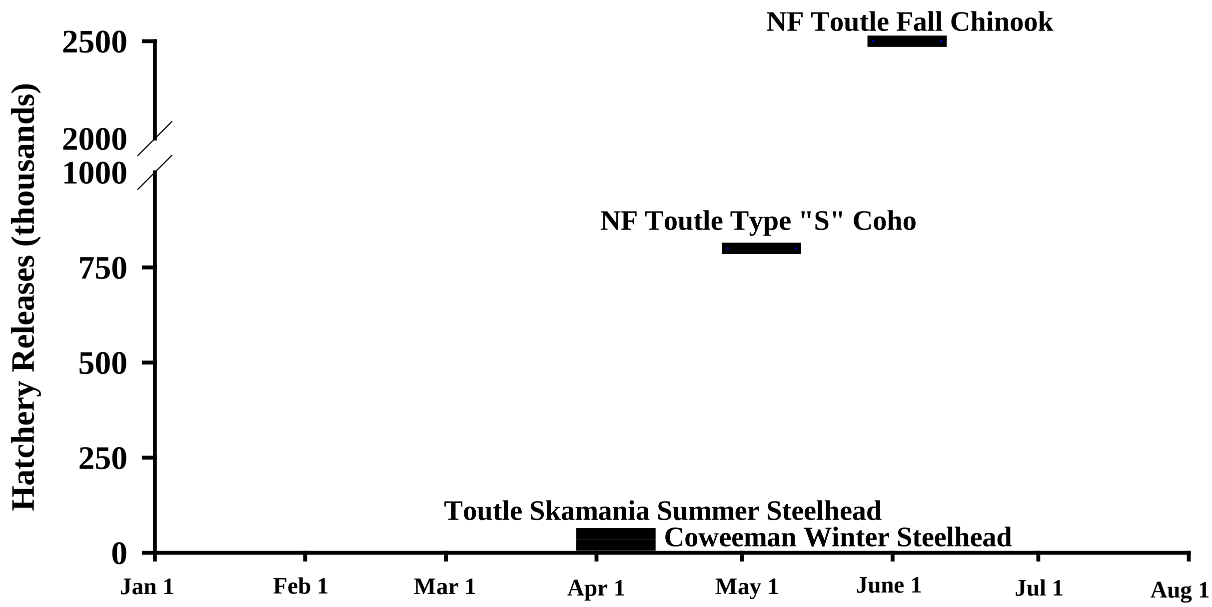


Figure G-17. Magnitude and timing of hatchery releases in the Toutle and Coweeman River basins by species, based on 2003 brood production goals.

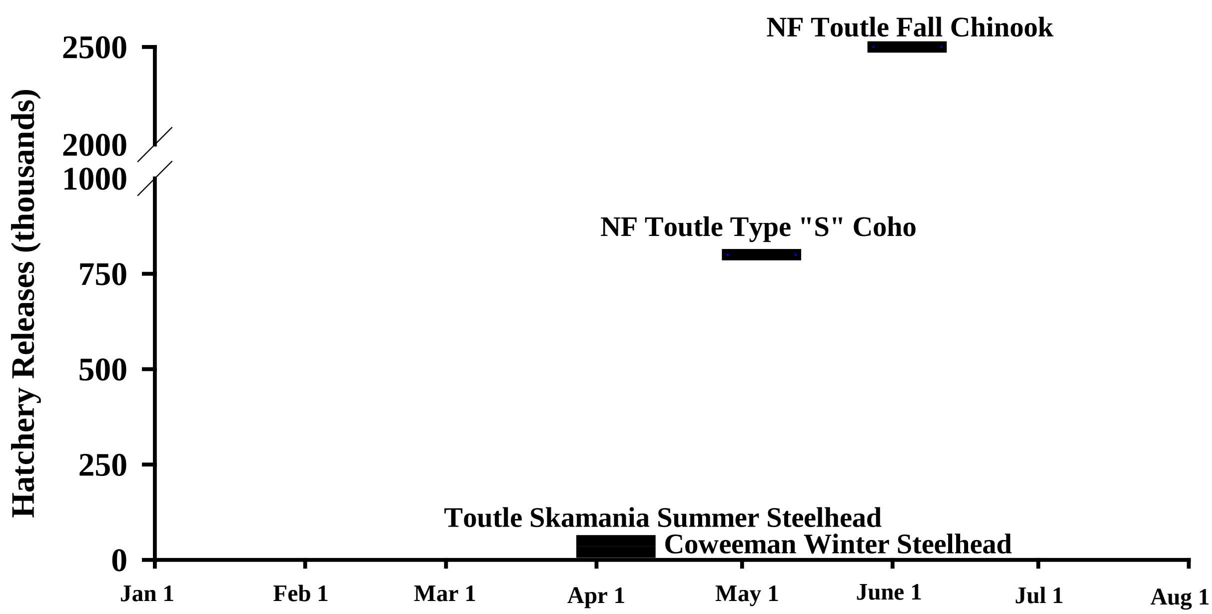


Figure G-18. Magnitude and timing of hatchery releases in the Toutle and Coweeman River basins by species, based on 2003 brood production goals

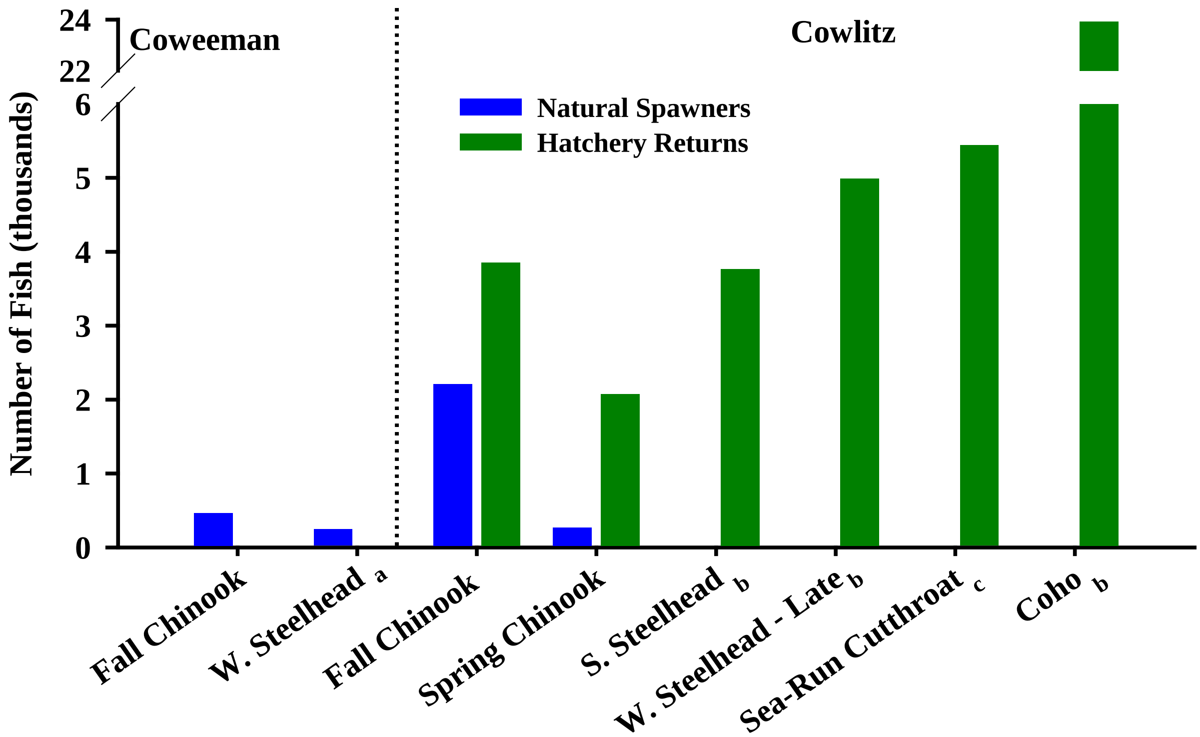


Figure G-19. **Recent average hatchery returns and estimates of natural spawning escapement in the Cowlitz River basin by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present. Calculation of each average utilized a minimum of 5 years of data.**

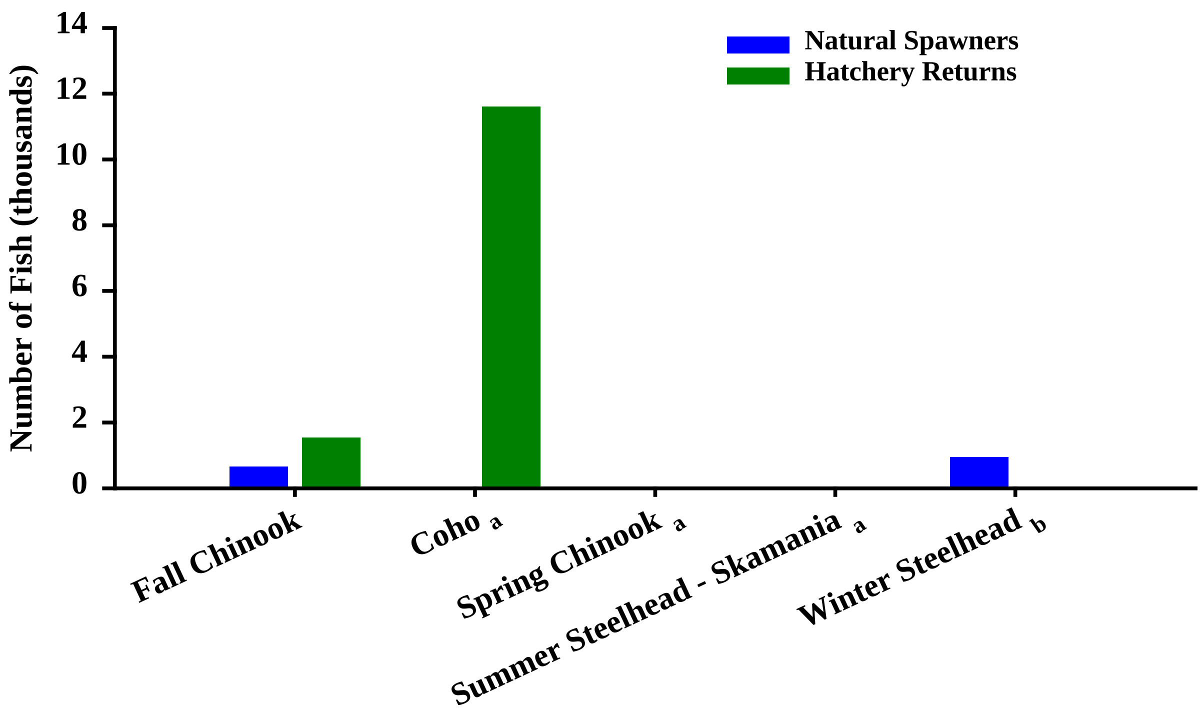


Figure G-20. **Recent average hatchery returns and estimates of natural spawning escapement in the Toutle River basin by species.**

Hatchery Effects

Genetics

Broodstock for fall Chinook at the Cowlitz Salmon Hatchery have come almost entirely from native Cowlitz fall Chinook, with hatchery fall Chinook transfers into the Cowlitz in a few years. There have been no transfers of fall Chinook into the Cowlitz since 1990, and past transfers have all come from hatcheries within the Lower Columbia ESU. Genetic analysis from the 1980s indicated that Cowlitz Salmon Hatchery fall Chinook were similar to, but distinct from, Kalama Hatchery fall Chinook and distinct from other Washington fall Chinook stocks in the lower Columbia River.

Fall Chinook broodstock at the North Toutle Hatchery have been primarily collected from the Toutle River although there have been been significant transfers made from lower Columbia ESU hatchery stocks, most significantly Spring Creek Hatchery and Kalama Hatchery fall Chinook. Specific genetic data is not available for Toutle Fall Chinook.

Fall Chinook in the Coweeman River basin are considered wild fish with little hatchery influence. Hatchery fall Chinook from the Spring Creek, Washougal, and Toutle Hatcheries were released periodically in the Coweeman during 1951–1979, but releases were discontinued in 1980. Since the early 1980s, hatchery-tagged fall Chinook have not been recovered in the Coweeman basin during spawning surveys, indicating the population is not influenced by stray hatchery fish.

Spring Chinook broodstock for the Cowlitz Salmon Hatchery has been almost exclusively collected from Cowlitz River native spring Chinook (In the late 1960s there were fewer than a million Willamette spring Chinook released into the Cowlitz). Genetic analysis in the 1980s indicated that Cowlitz Salmon Hatchery spring Chinook were genetically similar to, but distinct from, Kalama Hatchery and Lewis River wild spring Chinook and significantly different from other lower Columbia River spring Chinook stocks.

Broodstock for the coho salmon hatchery programs has come from native Cowlitz River (Cowlitz Salmon Hatchery) and Toutle River (North Toutle Hatchery) stocks. These stocks also have been used as broodstock for other lower Columbia River coho hatchery programs. Late stock coho salmon (Type N) and early coho salmon (Type S) are informally considered synonymous with Cowlitz River and Toutle River coho stocks, respectively. Columbia River early and late stock coho salmon produced from Washington hatcheries have not been found to be genetically different.

Both early and late winter steelhead hatchery programs exist at the Cowlitz Trout Hatchery. Broodstock for the early winter steelhead has come from a combination of Chambers Creek, Elochoman River, and Cowlitz River winter steelhead. Broodstock for the late-run winter steelhead program has come only from the Cowlitz River late winter steelhead stock. Genetic analysis in the mid-1990s was unable to determine the distinctiveness of Cowlitz basin winter steelhead from other lower Columbia winter steelhead stocks. Broodstock for the summer steelhead hatchery program at the Cowlitz Trout Hatchery and the North Toutle Hatchery originated from Skamania stock. The North Toutle Hatchery continues to receive broodstock from the Skamania Hatchery, while summer steelhead broodstock for the Cowlitz program is collected at the Cowlitz Trout and Salmon hatcheries. Winter steelhead broodstock for smolts acclimated and released from the Coweeman rearing ponds comes from hatchery returns to the Elochoman River Hatchery.

Broodstock for the cutthroat trout program at the Cowlitz Trout Hatchery originated from native Cowlitz River sea-run cutthroat trout with some limited influence from Beaver Creek stocks. Current broodstock collection comes from adults returning to the hatchery.

Interactions—Hatchery fall Chinook account for most adults returning to the Cowlitz, Toutle, and Green rivers. Hatchery returns are approximately double the natural escapement in the Cowlitz basin (Figure G-19 and Figure G-20). Many natural spawners are expected to be first generation hatchery fish; wild fish abundance is likely low. The Toutle and Green River fall Chinook populations are being re-established after the 1980 Mt. St. Helens eruption. Depending on the rebuilding success of these populations, the potential for wild/hatchery fish interactions may increase. The lower Cowlitz River downstream of the Cowlitz Salmon Hatchery barrier dam is an important rearing area for naturally produced fall Chinook. Hatchery-origin fall Chinook released in the lower Cowlitz may compete with natural-origin fall Chinook for food and space; research to study this potential interaction is in progress. Hatchery-origin fall Chinook fingerlings released in the lower Cowlitz also may be preyed upon by wild steelhead and cutthroat trout smolts.

Hatchery spring Chinook account for most adults returning to the Cowlitz River (Figure G-19) Hatchery spring Chinook are released downstream of the Hatchery Barrier Dam as smolts for the harvest mitigation program and into the upper Cowlitz (upstream of Cowlitz Falls Dam) as subyearlings to supplement the natural reintroduction program. Some predation by hatchery-origin smolts may occur on naturally produced fall Chinook, coho, or chum fry. However, the potential for these interactions is minimized by timing the release of hatchery smolts (March) to when the fish are smolted and prepared to quickly emigrate from the river to the Columbia estuary.

Hatchery coho salmon, account for most adults returning to the Cowlitz and Toutle rivers (Figure G-19 and Figure G-20). Significant coho production can occur in the upper Cowlitz basin from adults transplanted from the lower river; these fish are usually first generation hatchery fish. The smolt-to-adult survival of naturally produced coho juveniles in the upper Cowlitz has been low in the initial years of the program, so few naturally produced coho adults have been available for transplanting to the upper Cowlitz. Hatchery smolts released in the lower Cowlitz River potentially compete with wild fall Chinook, steelhead, and chum salmon for food and space, but competition is limited to smolt migration time through the basin. Migration time is minimized by releasing smolts (in May) when they are prepared to move towards the Columbia estuary.

Hatchery fish account for most winter steelhead adults returning to the Cowlitz and Coweeman rivers (Figure G-19). In the Toutle River system, the winter steelhead annual return is thought to be primarily comprised of naturally produced fish (Figure G-20). Potential for interaction between wild and hatchery adults is expected to be low because of relative numbers of natural and hatchery fish and temporal and spatial segregation. Summer steelhead are not expected to reproduce naturally in the Cowlitz River (Figure G-19) because they are introduced to the basin and there is no intention for a naturally reproducing population. Hatchery summer and winter steelhead smolts are released from the Cowlitz Trout Hatchery and Coweeman rearing ponds in May at a size and stage of smoltification intended to minimize travel time during emigration. In addition, hatchery summer steelhead are released from net pens in the Lower Cowlitz river and from a small acclimation pond in the lower S. Fk. Toutle River. Preliminary data suggests that steelhead smolts move downstream rapidly at approximately 20 miles per day so competition with native and non-native species in the lower Cowlitz is considered low. However, steelhead smolts that residualize may actively prey upon spring and fall Chinook, coho, and chum fry that are present in the lower Cowlitz River basin. Large releases of hatchery smolts may attract additional predators causing increased predation on wild fish, but conversely, wild fish may benefit from the presence of large numbers of hatchery fish because wild fish usually have better predator avoidance capabilities.

Hatchery sea-run cutthroat trout account for most adults returning to the Cowlitz River (Figure G-19). A natural population (anadromous and resident below the dams and resident above the dams) exists but is assumed to be relatively small. Hatchery sea run cutthroat trout smolts are released from the Cowlitz Trout Hatchery in April at a target size of 8.3 in (210 mm) FL; trout at this size generally exhibit smolt characteristics and rapidly emigrate. Hatchery cutthroat smolts have the potential to compete for food and space or to prey on juvenile fish in the system, however, competition with native and non-native species in the lower Cowlitz is considered low. Competition with, and predation on, other salmonids is likely greater when cutthroat trout smolts residualize.

Water Quality/Disease — Water for the Cowlitz Salmon Hatchery comes from three sources. The majority of water is supplied from the Cowlitz River, with an average 75,000 gpm available to the rearing ponds and 15,000 gpm available for the fish separator and ladder. Two separate well systems provide 1,000 and 700 gpm, respectively, between August and April and generally are used for egg incubation and early fry rearing. During incubation, salmon *Saprolegniasis* (fungus) is the primary concern and requires daily formalin treatments at 1:600 for 15 minutes. Excessive gas in the incubation effluent is variable and may be associated with periodic increases in yolk coagulation in eggs and fry. Water flow to fry is kept below 6 gpm to reduce or eliminate Bacterial Cold Water Disease (BCWD). A fish pathologist routinely checks for Infectious Hematopoeitic Necrosis Virus (IHNV) and Bacterial Kidney Disease (BKD). All equipment in the rearing ponds is sanitized with an iodine solution after each use.

Water for the Cowlitz Trout Hatchery also comes from three sources. Nine shallow wells on either side of the river provide up to 5 cfs. The well water is generally used for initial rearing and for water temperature regulation throughout the facility. The north well has had some bacteria and gas problems, is not used, and may be abandoned. An ozone plant operates from May to December to disinfect up to 20 cfs of Cowlitz River water; the ozone plant removes pathogens (primarily *Ceratomyxa shasta*) present in the river water. Untreated river water up to 50 cfs is available when the ozone plant is not in operation. All water entering the facility is stored in basins, where it flows to the fish rearing ponds via gravity. Because of a limited water supply, all water is reused in the lower rearing ponds and some may be used three times without treating. Hatchery staff follows protocols in the Fish Health Manual to reduce the occurrence of disease. During incubation, diseases that occur include BCWD and *Trichodina*. Rearing fish are routinely examined by hatchery staff and a fish health specialist; treatments are prescribed accordingly.

Water for the North Toutle Hatchery comes from the Green River; the hatchery has a water right totaling 26,031 gpm. A rearing site associated on the South Fork Toutle River utilizes 3-4 cfs directly from the river. Rearing ponds at the facility are sanitized with chlorine at 20 parts per million before being stocked with fry. Equipment used at the rearing ponds is routinely disinfected with an iodine solution. Fish are monitored throughout the rearing phase by WDFW pathologists.

Water for the Coweeman rearing ponds comes directly from tributary creeks of the Coweeman River. Operations of the acclimation ponds are not subject to NPDES requirements, thus discharge water quality parameters are not monitored. Fish health is monitored daily and the area fish health specialist conducts monthly visits and advises disease treatment. Sanitizing rearing pond equipment is done according to the Fish Health Manual.

Mixed Harvest—The purpose of the fall Chinook hatchery program at the Cowlitz Salmon Hatchery is to mitigate for losses resulting from hydroelectric development in the basin. Historically, exploitation rates of hatchery and wild fall Chinook likely were similar. Fall Chinook are an important target species in ocean and Columbia River commercial and recreational fisheries, as well as in Cowlitz River recreational fisheries. CWT data analysis of the fall Chinook 1989–1994 brood years from the Cowlitz Salmon and North Toutle hatcheries indicate a 33% and 41% exploitation rate, respectively, leaving 67% and 59% of the respective adult return for escapement. Exploitation of wild fish during the same period likely was similar. Hatchery and wild fall Chinook harvest rates remain similar and are now constrained by ESA harvest limitations.

At the Cowlitz Salmon Hatchery, the spring Chinook program mitigates for salmon lost as a result of hydroelectric development in the basin. The program provides fish for harvest while minimizing adverse effects on ESA-listed fish. Historically, exploitation rates of hatchery and wild spring Chinook were likely similar. Spring Chinook are an important target species in Columbia River commercial and recreational fisheries, as well as tributary recreational fisheries. CWT data analysis of the 1989–1994 brood years from the Cowlitz Salmon Hatchery indicate a 40% exploitation rate on spring Chinook; 60% of the adult return was accounted for in escapement. Most of the harvest occurred in the Cowlitz River sport fishery. Exploitation of wild fish during the same period likely was similar. Selective fisheries targeting hatchery spring Chinook have been implemented in recent years in the mainstem Columbia sport and commercial fisheries and in the Cowlitz River sport fishery. Regulations allowing retention of hatchery fish and requiring release of wild fish increase opportunity to catch hatchery fish and significantly decrease impacts to wild fish. The selective fishery program enables the spring Chinook reintroduced into the upper Cowlitz to pass through the fisheries.

Mitigating for late run coho salmon lost as a result of hydroelectric development is a goal of the Cowlitz Salmon Hatchery coho salmon program. The program provides fish for harvest while minimizing adverse effects on ESA-listed fish. All hatchery smolts are adipose fin-clipped to allow for selective harvest. Ocean and Columbia River sport and commercial fisheries and Cowlitz River sport fisheries benefit from this program. Historically, naturally produced coho from the Columbia River were managed like hatchery fish and subjected to similar exploitation rates. Ocean and Columbia River combined harvest of Columbia River-produced coho ranged from 70% to over 90% during 1970–1983. To protect several wild coho stocks, ocean fisheries were limited beginning in the mid-1980s and Columbia River commercial fisheries were temporally adjusted in the early 1990s. With the advent of selective fisheries for marked hatchery fish, exploitation of wild coho has been reduced, while hatchery fish can be harvested at higher rates. Currently, Cowlitz wild coho benefit from ESA harvest restrictions placed on Oregon Coastal natural coho (federal listing) in ocean fisheries and Oregon Lower Columbia natural coho (state listing) in Columbia River fisheries.

At the Cowlitz Trout Hatchery, the early and late winter steelhead hatchery programs mitigate for winter steelhead lost as a result of hydroelectric development in the basin; the program provides fish for harvest while minimizing adverse effects on ESA-listed fish. Fisheries that benefit include lower Columbia and Cowlitz River sport fisheries; approximately 6.2% of the returning Cowlitz Trout Hatchery steelhead are harvested in the lower Columbia River sport fishery and about 70% are harvested in the Cowlitz River sport fishery. Prior to selective fishery regulations, exploitation rates of wild and hatchery winter steelhead likely were similar. Mainstem Columbia River sport fisheries became selective for hatchery steelhead in 1984 and Washington tributaries became selective during 1986–1992 (except the Toutle in 1994). Current selective harvest regulations in the lower Columbia and tributary sport fisheries have targeted hatchery steelhead and limited harvest of wild winter steelhead to less than 10% (estimated at 6% for the Cowlitz tributary sport fishery). In the Cowlitz River, winter steelhead originating from the upper Cowlitz are marked with a right ventral fin clip and are protected from harvest in the lower Cowlitz fishery. Ventral fin-clipped fish that return to either of the Cowlitz River hatcheries are transported to the upper Cowlitz River to provide harvest opportunity for anglers and spawners for the reintroduction program.

The Coweeman rearing ponds provide winter steelhead for tributary sport harvest opportunity. Sport fisheries in the Coweeman, lower Cowlitz, and lower Columbia rivers benefit from this program. Selective fishery regulations allow for protection of wild winter steelhead while maximizing harvest rates on Coweeman hatchery winter steelhead. The Coweeman tributary fishery harvest rate for hatchery winter steelhead is estimated to be 30% with a 4% mortality impact estimated for wild winter steelhead.

At the Cowlitz Trout Hatchery and the North Toutle Hatchery, the summer steelhead hatchery programs mitigate for steelhead lost as a result of hydroelectric development in the basin and provide harvest opportunity. Summer steelhead are introduced to the basin; there is no intention of trying to develop a self-sustaining population of summer steelhead. Fisheries that benefit include tributary and lower

Columbia River recreational fisheries. Selective fishing regulations and the differences in the timing of runs focus harvest on hatchery summer steelhead and minimize effects to wild steelhead.

The Cowlitz Trout Hatchery's sea-run cutthroat trout program mitigates for losses resulting from hydroelectric development in the basin and provides harvest opportunity. These fish contribute to the tributary sport fishery; harvest effects on wild fish should be minimal because of the differences in the timing of runs of cutthroat trout and regulations about minimum size, bag limit, and wild cutthroat trout release.

Passage—At the Cowlitz Salmon Hatchery, the adult collection facility is a barrier dam across the entire width of the river that prevents upstream migration of all returning salmonids. Returning adults enter through a fish ladder into a sorting, transfer, and holding facility. Fish to be retained for broodstock are directed to the holding facilities, while fish to be transported and released in the upper watershed are directed toward transfer facilities. If fish are able to bypass collection, Mayfield Dam—with no fish passage facilities—is approximately two miles upstream.

At the Cowlitz Trout Hatchery, the adult collection facility consists of a weir and fish ladder in Blue Creek and upstream migration in the mainstem Cowlitz River is unimpeded. Fish are hand-sorted and retained in adult holding ponds if they are needed for broodstock. Fish exceeding broodstock needs are transferred back to the river, or to the Cowlitz Salmon Hatchery, via specialized fish tanker trucks.

At the North Toutle Hatchery, the adult collection facility is a temporary weir for collecting coho salmon and fall Chinook. The weir is installed and removed annually and only effects fish passage during the time of adult coho and fall Chinook collection.

There are no adult collection facilities at the Coweeman rearing ponds. Hatchery programs at this facility obtain broodstock from other hatchery facilities.

Supplementation—The Cowlitz Salmon Hatchery spring Chinook program is partly intended to restore natural spawning populations of spring Chinook in the upper Cowlitz River basin. Current production goals are 300,000 fingerling spring Chinook for annual release. As well, hatchery-origin adult returns in excess of annual broodstock needs are transported above Cowlitz Falls Dam as part of the reintroduction program. Reintroduction efforts have been challenged by low success in collecting emigrating juveniles to pass through the hydro system.

This hatchery's late stock coho salmon (Type-N) program also provides for restocking of the upper Cowlitz basin. Annual production goals depend on the availability of adults for natural spawning in the upper basin. If insufficient adults are available, the release goal is 1 million fry annually in the upper Cowlitz. Reintroduction efforts indicate good production capabilities in tributaries above the dams. Although coho smolt collection at the hydroelectric facility has been more successful then Chinook, reintroduction efforts are also challenged in passing juveniles through the system.

The Cowlitz Trout Hatchery has an annual goal of restoring natural spawning late-run winter steelhead populations in the upper Cowlitz and Tilton River basins. Current annual release goals are 350,000 fingerlings and 37,500 smolts in the upper watershed. Juvenile downstream migrant passage is better at the hydro-facility than for Chinook, and similar to coho.

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 G-6 identifies hazards levels associated with risks involved with hatchery programs in the Grays River / Columbia Estuary Tributaries Basins. Table G-7 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 G-6. Preliminary BRAP for hatchery programs affecting populations in the Lower Cowlitz River Basin

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.
(grey shading)	Hazard not relevant to population

Lower 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				?	?	○				○	●	○
Chum	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				?	?	○				○	○	○

Table G-7. Preliminary strategies proposed to address risks identified in the BRAP for Lower Cowlitz River Basin populations

Lower Cowlitz Population	Hatchery Program: Name	Release (millions)	Address Genetic Risks: Mating Procedure	Address Genetic Risks: Integrated Program	Address Genetic Risks: Segregated Program	Address Genetic Risks: Research/ Monitoring	Address Genetic Risks: Broodstock Source	Address Ecological Risks: Number Released	Address Ecological Risks: Release Procedure	Address Ecological Risks: Disease Containment	Address Ecological Risks: Research/ Monitoring	Address Demographic Risks: Culture Procedure	Address Demographic Risks: Research/ Monitoring	Address Facility Risks: Reliability	Address Facility Risks: Improve Passage	Address Facility Risks: Improve Screening	Address Facility Risks: Pollution Abateme
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						●	●		●						

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 can result 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 G-8). 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 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 G-8. 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
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
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 Chinook to protect naturally spawning populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Rates are very low for chum salmon, which are not encountered by ocean fisheries and return to freshwater in late fall when significant Columbia River commercial fisheries no longer occur. Chum are no longer targeted in Columbia commercial seasons and retention of chum is prohibited in Columbia River and lower Cowlitz River sport fisheries. Chum are impacted incidental to fisheries directed at coho and winter steelhead.

Harvest of lower 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, like chum, 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 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 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 lower Cowlitz populations to those of most other subbasin salmonid populations. Effects are likely to be greater for chum and 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 three hydro-electric dams on the Cowlitz River are considered to be located in the upper Cowlitz basin. However, lower Cowlitz species, in particular fall Chinook have been reduced by loss of habitat in the reservoirs and are affected by flow regimes from Cowlitz River hydro operations which effect spawning and rearing habitat in the lower Cowlitz. In addition, mainstem Columbia hydro operations and flow regimes affect habitat utilized by lower Cowlitz species in migration corridors and in the estuary. 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 and chum 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 pattern is 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.

G.3.8. 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 G-21) describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Lower Cowlitz 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.

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. Loss of tributary habitat quality and quantity accounts for the largest relative impact on all species except for fall Chinook where fishing impacts dominate. Loss of estuary habitat quality and quantity are substantial for chum, and moderate for all other species. Harvest has a sizeable effect on fall Chinook and coho but is relatively minor for chum and winter steelhead. Hatchery impacts are significant for coho but relatively less so for fall Chinook and winter steelhead. Predation impacts are significant for winter steelhead, and moderate for fall Chinook and coho. Hydrosystem impacts appear to be relatively minor for all species.

Impacts were defined as the proportional reduction in average numbers or productivity associated with each effect. Subbasin 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.

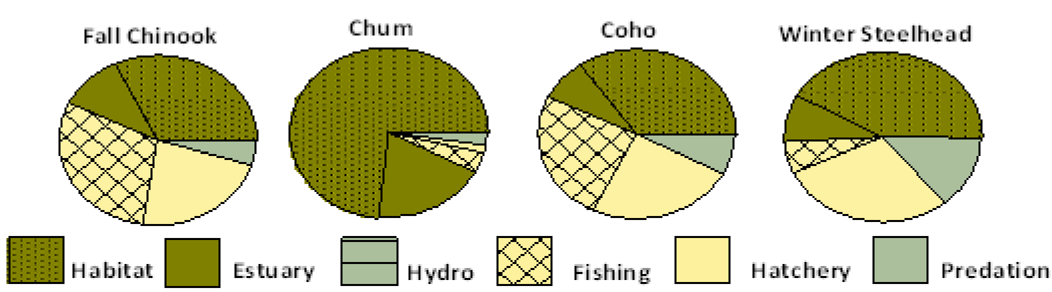


Figure G-21. Relative contribution of potentially manageable impacts on lower Cowlitz salmonid populations.

G.4. 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 subbasin. 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).

G.4.1. 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.

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.

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.

G.4.2. 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.

G.4.3. 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.

Cowlitz County

Cowlitz County updated its Comprehensive Plan to the minimum requirements of the Growth Management Act (GMA) by adding a Critical Areas Ordinance (CAO) in 1996, but it is not fully planning under the GMA. Cowlitz County manages natural resources primarily through its CAO.

City of Longview

The City's Comprehensive Plan was adopted in 1993 and is currently in the process of being updated. Natural resource impacts are managed primarily through critical areas protections, shorelines management, and stormwater management.

City of Kelso

The City of Kelso's Comprehensive Plan was adopted in 1980. Natural resource impacts are managed primarily through critical areas protections, shorelines management, and floodplain management.

Cowlitz / Wahkiakum Conservation District

The Cowlitz/Wahkiakum CD provides technical assistance, cost-share assistance, project and water quality monitoring, community involvement and education, and support of local stakeholder groups within the two county service area. The CD is involved in a variety of projects, including fish passage, landowner assistance an environmental incentive program an education program, and water quality monitoring.

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.

G.4.4. 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.

G.4.5. 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.

G.4.6. NPCC Fish & Wildlife Program Projects

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

G.4.7. Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Restoration	Skook Creek Blockage	Lower Cowlitz
Restoration	Baxter Creek Culvert Replacement	Lower Cowlitz
Restoration	Lambert Creek Barrier Removal	Lower Cowlitz
Restoration	Curtis Creek Culvert Upgrade	Lower Cowlitz
Restoration	Monahan Creek Restoration	Lower Cowlitz
Restoration	L. Cowlitz 37.5 Off Channel Habitat Rehabilitation	Lower Cowlitz
Restoration	Brim Bar: Lower Cowlitz RM 42.7 Side Channel Restoration	Lower Cowlitz

G.5. Management Plan

G.5.1. 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 Lower Cowlitz Subbasin will play a key role in the regional recovery of salmon and steelhead. Natural populations of fall Chinook, winter steelhead, chum, and coho will be restored by 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.

Columbia basin hydropower effects on Lower Cowlitz Subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Lower Cowlitz River 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.

G.5.2. Biological Objectives

Biological objectives for Lower 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, 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 Lower 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 coho to a high viability level, which provides for a 95% or better probability of population survival in 100 years, and calls for restoring fall Chinook, winter steelhead, and chum to as medium viability level. This level will provide for a 74-95% probability of population survival over 100 years (Table 1). 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 lower Cowlitz subbasin although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the subbasin.

G.5.3. 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 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. Given the ultimate uncertainty in the effects of recovery actions and the need to implement an adaptive recovery program, this approximation should be adequate for developing order-of-magnitude estimates to which recovery actions can be scaled consistent with the current best available science and data. Objectives and targets will need to be confirmed or refined during plan implementation based on new information and refinements in methodology.

The following table identifies population and factor-specific improvements consistent with the biological objectives for this subbasin. Per factor increments are less than the population net because factor affects are compounded at different life stages and density dependence is largely limited to freshwater tributary habitat. For example, productivity of lower Cowlitz fall Chinook must increase by 15% to reach population viability goals which requires impact reductions equivalent to a 3% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts on fall Chinook must decrease from a 70% to a 68% impact in order to achieve the required 3% increase in tributary habitat potential from the current 30% historical potential to 32% of the historical potential.

Table G-9. Productivity improvements consistent with biological objectives for the lower Cowlitz subbasin.

Species	Net increase	Per factor	Baseline impacts Hab	Estuary	Dams	Pred.	Fishery	Hatch.
Fall Chinook	50%	8%	0.70	0.23	0.00	0.10	0.65	0.50
Chum (Fall)	>500%	50%	0.96	0.25	0.00	0.03	0.05	0.00
Chum (Summer)	>500%	50%	0.96	0.25	0.00	0.03	0.05	0.00
Winter Steelhead	5%	2%	0.70	0.15	0.00	0.24	0.10	0.09
Coho	100%	17%	0.07	0.16	0.00	0.15	0.50	0.30

G.5.4. 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 G-22 and each component is presented in detail in the sections that follow.

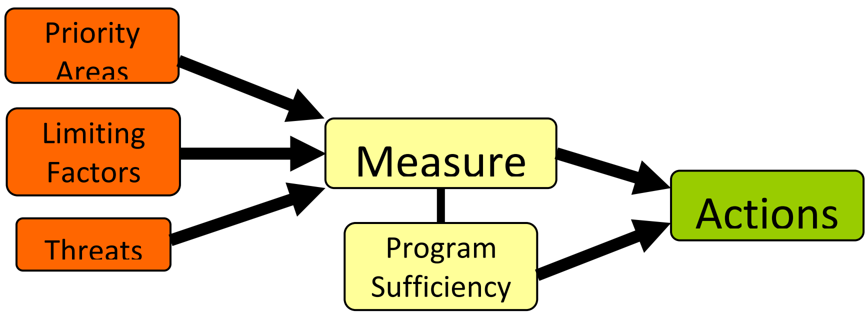


Figure G-22. Flow chart illustrating the development of subbasin measures and actions.

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 Lower Cowlitz 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 Lower 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 G-10**.

- **Lower mainstem & tributaries** – *(e.g. Lower Cowlitz mainstem, Arkansas Creek, Delameter Creek, Ostrander Creek, Leckler Creek)*. The lower mainstem Cowlitz and lower tributaries historically provided productive habitat for chum, coho, and fall Chinook. These habitats, especially the mainstem, have been heavily impacted by mixed use development. In addition to the influence of hydro-regulation from upstream dams, the primary impacts include channel manipulations, increased watershed imperviousness, and riparian degradation. Effective recovery measures will include riparian and floodplain restoration and land-use planning that protects and restores habitat and habitat-forming processes.

- **Middle mainstem** *(reaches Mid Cowlitz 1, 4, 5, 6, & 7)* – Reaches with the greatest historical productivity in the middle mainstem are located between Skook Creek and Mayfield Dam. These reaches supported chum, fall Chinook, coho, and winter steelhead. These reaches have high preservation as well as restoration value. One of the most effective recovery measures will be to preserve the canyon reaches downstream of the dam. In other areas, emphasis should be placed on restoration and preservation of riparian areas and floodplains. This mixed use area will also benefit from land-use planning that protects and restores habitat and habitat-forming processes.
- **Olequa Creek & tributaries** *(Olequa Creek, Stillwater Creek, Brim Creek)* – The Olequa Creek basin contains potentially productive habitat for coho and winter steelhead. Key reaches include the mainstem Olequa and Stillwater Creek. These reaches are impacted primarily by urban and rural development and agriculture. Recovery emphasis is for restoration of riparian areas, floodplains, and commercial forest lands. As with other rapidly developing portions of the lower Cowlitz basin, this area will benefit from land-use planning that protects and restores habitat and habitat-forming processes.
- **Lacamas Creek** – Lacamas Creek contains potentially productive habitats for coho, although winter steelhead also utilize these reaches. Lacamas Creek is impacted primarily by agriculture and rural development. The most effective recovery measures are consistent with those identified above for Olequa Creek.
- **Salmon Creek** – Salmon Creek contains productive habitat for coho and winter steelhead. Salmon Creek is impacted by agriculture along the first few reaches and by forest practices throughout the remainder of the basin. Riparian and floodplain restoration should be the emphasis along the first few reaches while restoration and preservation of watershed processes should be the emphasis on forest lands.

Table G-10. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the lower mainstem and tributaries (LM), middle mainstem and Mill Creek (MM), Olequa Creek and tributaries (OC), Lacamas Creek (LC), and Salmon Creek (upper) and tributaries (SC). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors	LM	MM	OC	LC	SC
Habitat connectivity					
Blockages to off-channel habitats	✓	✓	✓		
Blockages to channel habitats	✓	✓			✓
Habitat diversity					
Lack of stable instream woody debris	✓	✓	✓	✓	✓
Altered habitat unit composition	✓	✓	✓	✓	✓
Loss of off-channels/side-channels	✓	✓	✓		
Channel stability					
Bed and bank erosion	✓			✓	
Channel down-cutting (incision)	✓				
Riparian function					
Reduced stream canopy cover	✓		✓		✓
Reduced bank/soil stability	✓	✓	✓	✓	✓
Exotic and/or noxious species	✓	✓	✓	✓	✓
Reduced wood recruitment	✓	✓	✓	✓	✓
Floodplain function					
Altered nutrient exchange processes	✓	✓	✓	✓	✓
Reduced flood flow dampening	✓	✓	✓	✓	✓
Restricted channel migration	✓	✓	✓	✓	✓
Disrupted hyporheic processes	✓	✓	✓	✓	✓
Stream flow					
Altered magnitude, duration, rate of chg	✓	✓	✓	✓	✓
Alterations to temporal pattern of flow	✓	✓			
Water quality					
Altered stream temperature regime	✓		✓		✓
Bacteria	✓				
Chemical contaminants			✓		
Substrate and sediment					
Lack of adequate spawning substrate	✓				
Excessive fine sediment	✓	✓	✓		✓
Embedded substrates	✓	✓	✓		✓
Disrupted sediment transport (hydro)	✓	✓			

Threats	LM	MM	OC	LC	SC
Hydropower operations					
Flow manipulations	✓	✓			
Alterations to stream temperature regime	✓	✓			
Changes to sediment transport dynamics	✓	✓			
Agriculture grazing					
Clearing of vegetation	✓	✓		✓	✓
Riparian grazing	✓	✓		✓	✓
Floodplain filling	✓	✓		✓	✓
Application of chemicals			✓		
Urban/rural/suburban development					
Clearing of vegetation	✓	✓	✓		
Floodplain filling	✓	✓	✓		
Increased impervious surfaces	✓	✓	✓		
Increased drainage network	✓	✓	✓		
Roads – riparian/floodplain impacts	✓	✓	✓		
Leaking septic systems	✓				
Forest practices					
Timber harvest –sediment supply impacts			✓		✓
Timber harvests – impacts to runoff			✓	✓	✓
Riparian harvests (historical)					✓
Forest roads – sediment supply impacts			✓		✓
Forest roads – impacts to runoff			✓	✓	✓
Channel manipulations					
Bank hardening	✓	✓	✓	✓	✓
Channel straightening	✓	✓	✓	✓	✓
Artificial confinement	✓	✓	✓	✓	✓
Clearing and snagging	✓	✓			
Dredge and fill activities	✓				

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 G-11. Reach tier designations for this basin are included in Table G-12. Reach tiers and subwatershed groups are displayed on a map in Figure G-23.

Table G-11. 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 G-12. Reach Tiers in the lower Cowlitz Basin.

Tier 1	Arkansas Cr 1 A	MID COWLITZ-5 B	Ostrander Cr 1 A	Salmon Cr (upper) 3 D
	Arkansas Cr 1 B	MID COWLITZ-5 D	Ostrander Cr 1 B	Stillwater Cr 1 A
	Cedar Cr 1 A	MID COWLITZ-6 A	Salmon Cr (upper) 1 A	Stillwater Cr 1 B
	Delameter Cr 2 A	MID COWLITZ-6 C	Salmon Cr (upper) 1 B	Stillwater Cr 2
	Lacamas Cr 1 A	MID COWLITZ-7	Salmon Cr (upper) 1 C	Stillwater Cr 3
	Lacamas Cr 1 B	Olequa Cr 1	Salmon Cr (upper) 1 D	Stillwater Cr 4
	Lacamas Cr 2	Olequa Cr 2 A	Salmon Cr (upper) 1 E	Stillwater Cr 5
	Lacamas Cr 4	Olequa Cr 2 B	Salmon Cr (upper) 2 C	
	Lacamas Cr 5	Olequa Cr 5	Salmon Cr (upper) 3 B	
	MID COWLITZ-4 B	Olequa Cr 7	Salmon Cr (upper) 3 C	
Tier 2	Arkansas Cr 2 A	Lacamas Cr 3 B	MID COWLITZ-5 A	Salmon Cr (upper) 2 B
	Arkansas Cr 2 B	Lacamas Cr 6	MID COWLITZ-5 C	Salmon Cr (upper) 3 A
	Brim Cr 1 A	Lacamas Cr 7	MID COWLITZ-6 B	Salmon Cr (upper) 3 E
	Brim Cr 2	Lacamas Cr 8	MID COWLITZ-6 D	Salmon Cr (upper) 3 F
	Brim Cr RB Trib 2 A	Leckler Cr 1 A	MID COWLITZ-6 E	Salmon Cr (upper) 5
	Cedar Cr 1 B	Leckler Cr 1 B	Mill Cr (Lacamas Trib) 1	Salmon Cr (upper) RB Trib 6 A
	Delameter Cr 1	Lower Cowlitz-1	Olequa Cr 3	Salmon Cr 1
	Delameter Cr 2 B	MID COWLITZ-1 C	Olequa Cr 4	Salmon Cr 2 thru 5
	Delameter Cr 3 B	MID COWLITZ-1 D	Olequa Cr 6	Stillwater Cr 6 A
	Foster Cr 1 A	MID COWLITZ-1 E	Otter Cr 1	Stillwater Cr 6 B
	Hill Cr 1	MID COWLITZ-1 F	Owens Cr	Stillwater Cr LB Trib
	Lacamas Cr 3 A	MID COWLITZ-4 A	Salmon Cr (upper) 2 A	
Tier 3	Lower Cowlitz-2 A	Lower Cowlitz-2 H	MID COWLITZ-1 B	Ostrander Cr 2
	Lower Cowlitz-2 B	Lower Cowlitz-2 I	MID COWLITZ-2 A	Salmon Cr (upper) 3 G
	Lower Cowlitz-2 C	Lower Cowlitz-2 J	MID COWLITZ-2 B	Salmon Cr (upper) 3 H
	Lower Cowlitz-2 D	Lower Cowlitz-2 K	MID COWLITZ-3 A	Salmon Cr (upper) 3 I
	Lower Cowlitz-2 E	Lower Cowlitz-2 L	MID COWLITZ-3 B	
	Lower Cowlitz-2 F	Lower Cowlitz-2 M	Mill Cr 1	
	Lower Cowlitz-2 G	MID COWLITZ-1 A	Monahan Cr 1 B	
Tier 4	Arkansas Cr 3 A	Cowlitz LB Trib 3 (LB trib3)	Lacamas Cr RB Trib	Salmon Cr (upper) LB Trib 5
	Arkansas Cr 3 B	Cowlitz LB Trib 4 (LB trib4)	Leckler Cr 2	Salmon Cr (upper) LB Trib 6
	Arkansas Cr 3 C	Cowlitz LB Trib 5	Leckler Cr RB Trib 1	Salmon Cr (upper) RB Trib 1
	Arkansas Cr 4	Cowlitz LB Trib 6	Leckler Cr RB Trib 2	Salmon Cr (upper) RB Trib 2
	Arkansas Cr 5	Cowlitz LB Trib 7	Lenoue Cr	Salmon Cr (upper) RB Trib 3
	Arkansas Cr LB Trib 1	Cowlitz LB Trib 7 LB Trib	Little Salmon Cr 1	Salmon Cr (upper) RB Trib 4
	Arkansas Cr LB Trib 2 A (LB tribB)	Cowlitz RB Trib 1 (Rb trib1)	Little Salmon Cr 2	Salmon Cr (upper) RB Trib 5
	Arkansas Cr LB Trib 2 B (LB tribB)	Cowlitz RB Trib 2 A	Masonry Dam	Salmon Cr (upper) RB Trib 6 B
	Arkansas Cr LB Trib 2 C (LB tribB)	Cowlitz RB Trib 2 B	McCorkle Cr 1 (RB trib2)	Salmon Cr (upper) RB Trib 6 LB Trib
	Arkansas Cr LB Trib 2 RB Trib	Cowlitz RB Trib 2 RB Trib	McCorkle Cr 2 (RB trib2)	Salmon Cr (upper) RB Trib 7
	Arkansas Cr RB Trib 1	Cowlitz RB Trib 3	McMurphy Cr	Salmon Cr (upper) RB Trib 8
	Arkansas Cr RB Trib 2	Cowlitz RB Trib 4	Mill Cr (Lacamas Trib) 2	Salmon Cr (upper) RB Trib 9
	Arkansas Cr RB Trib 3 A	Cowlitz RB Trib 5	Mill Cr (Lacamas Trib) LB Trib	Salmon Cr LB Trib A (LB tribA)
	Arkansas Cr RB Trib 3 B	Curtis Cr	Mill Cr 2	Salmon Cr LB Trib B
	Baker Cr 1 A	Curtis Cr RB Trib	Mill Cr 3	Sandy Bend Cr
	Baker Cr 1 B	Delameter Cr 3 A	Mill Cr 4	SF Olequa Cr (LB tribC)
	Baxter Cr 1 A	Delameter Cr 3 C	Monahan Cr 1 A	SF Ostrander Cr 1
	Baxter Cr 1 B	Delameter Cr 3 D	Monahan Cr 1 C	SF Ostrander Cr 2
	Bear Cr	Delameter Cr 4	Monahan Cr 4	SF Ostrander Cr 3
	Becker Cr	Delameter Cr RB Trib 1	Monahan Cr RB Trib 1	SF Ostrander Cr 4
	Blue Cr 1 A	Delameter Cr RB Trib 2	Monahan Cr RB Trib 2	SF Ostrander Cr LB Trib 1
	Blue Cr 1 B	Delameter Cr RB Trib 3	Monahan Cr RB Trib 3	SF Ostrander Cr LB Trib 2
	Boone Cr	Delameter Cr RB Trib 4	NF Brim Cr	SF Ostrander Cr RB Trib 1
	Brights Cr	Ferrier Cr	NF Olequa Cr (RB trib A)	Skook Cr 1 A

Brim Cr 1 B	Foster Cr 1 B	Olequa Cr 8	Snow Cr
Brim Cr 1 C	Foster Cr LB Trib	Olequa Cr 9	Stillwater Cr 7
Brim Cr 3	Hill Cr 2	Olequa Cr LB Trib	Stillwater Cr 8
Brim Cr LB Trib	Hill Cr 3	Ostrander Cr 3	Stillwater Cr RB Trib 1
Brim Cr RB Trib 1	Hill Cr LB Trib 1	Ostrander RB Trib 1	Stillwater Cr RB Trib 2 (RB tribB)
Brim Cr RB Trib 2 B	Hill Cr LB Trib 2	Ostrander RB Trib 2 (RB trib Ostra)	Stillwater Cr RB Trib 3 A
Brim Cr RB Trib 2 LB Trib	Hopkey Cr	Otter Cr 2	Stillwater Cr RB Trib 3 B
Campbell Cr 1 & 2	Jones Cr 1	Rapid Cr	Whittle Cr 1
Campbell Cr 4	Jones Cr 2	Rock Cr	Whittle Cr 2
Campbell Cr RB Trib 1	King Cr 1	Salmon Cr (upper) 4	Whittle Cr 3
Campbell Cr RB Trib 2	King Cr 2	Salmon Cr (upper) 6	Whittle Cr Lake
Cedar Cr LB Trib	King Cr 3	Salmon Cr (upper) LB Trib 1	Whittle Cr LB Trib
Coon Cr	King Cr LB Trib (LB tribD)	Salmon Cr (upper) LB Trib 2	
Cowlitz LB Trib 1 (LB trib1)	Lacamas Cr LB Trib 1	Salmon Cr (upper) LB Trib 3	
Cowlitz LB Trib 2 (LB trib2)	Lacamas Cr LB Trib 2	Salmon Cr (upper) LB Trib 4	

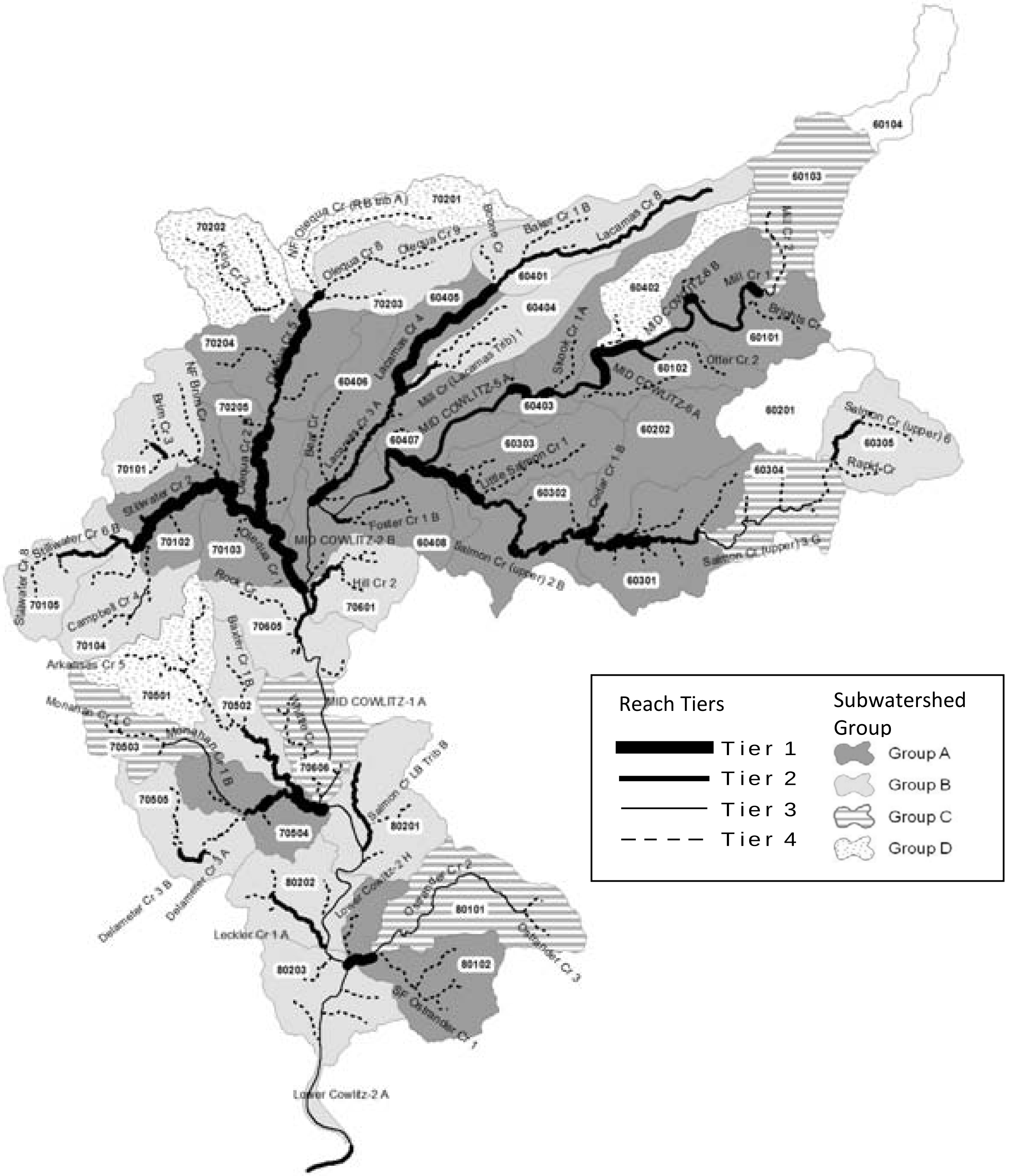


Figure G-23. **Reach tiers and subwatershed groups in the Lower Cowlitz Basin. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities 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.**

Habitat Measures

Measures are means to achieve the regional strategies that are applicable to the Lower Cowlitz Basin and are 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 Lower Cowlitz Basin are presented in priority order in Table G-13. 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 prioritized 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 have been adjusted for the specific circumstances occurring in the Lower Cowlitz Basin. These priorities are adjusted depending upon 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 G-13. 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 will consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table G-13. Prioritized measures for the Lower Cowlitz Basin.

#1 – 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	The mainstem Cowlitz below Mayfield Dam has been heavily altered due to adjacent land uses including agriculture, rural residential development, transportation corridors, urbanization, and industry. The river is heavily channelized in many areas. The lower river (below the Toutle confluence) was heavily impacted by sediment and subsequent channel dredging and confinement related to the 1980 Mount St. Helens eruption. The flow regime of the lower river has been altered through hydro-regulation. Many lower river tributary streams have been altered by agriculture, rural residential development, and past riparian timber harvest. 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; 2nd 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)	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program, Aquatic Lands Authorization	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Lewis County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
City of Longview	Comprehensive Planning		✓
City of Castle Rock	Comprehensive Planning, Water Supply		✓
City of Winlock	Comprehensive Planning, Water Supply		✓
Vader	Comprehensive Planning		✓
Cowlitz/Wahkiakum Conservation District	Agricultural land habitat protection, Education		✓
Lewis County Conservation District & NRCS	Agricultural land habitat protection, Education		✓
Lewis County Noxious Weed Control Board	Noxious Weed Education, Enforcement, Control		✓
Cowlitz County Noxious Weed Control Board	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, DNR Aquatics Lands Authorization, and local government ordinances. 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 for effects on watershed 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. In cases where programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary.

#2 – 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, sediment delivery, and water quality processes have been severely degraded due to past intensive timber harvest, forest roads, 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)
2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
Lewis County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
City of Longview	Comprehensive Planning		✓
City of Kelso	Comprehensive Planning		✓
City of Winlock	Comprehensive Planning		✓
Vader	Comprehensive Planning		✓
Lewis Conservation District / NRCS	Agricultural land habitat protection, Education		✓
Cowlitz/Wahkiakum Conservation District	Agricultural land habitat protection, Education		✓

Program Sufficiency and Gaps

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 government 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 lower 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).

#3 – Manage regulated stream flows to provide for critical components of the natural flow regime

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Provide adequate flows for specific life stage requirements (i.e. fry to smolt rearing for fall Chinook) B. Address geomorphic effects of hydro-regulation (i.e. channel-forming flows, spawning gravel recruitment)	• Alterations to the temporal pattern of stream flow • Altered stream temperature regime • Disrupted sediment transport processes • Lack of channel-forming flows	• Hydropower operations – changes to flow regime, sediment transport, and stream temperature	All species	Hydro-regulation on the Cowlitz River has altered the natural stream flow regime below Mayfield Dam. In general, summer, fall, and winter flows have increased, spring flows have decreased, and flood (pulse) flows have decreased in frequency and magnitude. To support fish and their habitat, hydro-regulation will need to provide adequate flows for habitat formation, fish migration, water quality, floodplain connectivity, habitat capacity, and sediment transport below Mayfield Dam.

Priority Locations

Lower mainstem Cowlitz (below Mayfield Dam)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Federal Energy Regulatory Commission (FERC)	Hydropower facility re-licensing	✓	
Tacoma Public Utilities	Operations at Barrier, Mayfield and Mossyrock Dams		✓
Lewis County PUD	Operations at Cowlitz Falls Dam		✓
WA Department of Ecology (Ecology)	Water Quality Program (Water Quality Certification-section 401)	✓	
WDFW	Hydroelectric Facility Re-licensing Program	✓	

Program Sufficiency and Gaps

In 2002, Tacoma Power received a new 35-year license from FERC to operate the Cowlitz River hydropower system, including Mayfield Dam, Mossyrock Dam, and the Barrier Dam (Cowlitz Falls Dam is covered under a separate license held by Lewis County PUD). The license contains a number of articles that address habitat, water quality, and flow issues in the lower river. These articles are the product of a 3-year negotiation process with agency, tribal, recreational, and NGO representatives. Instream flow requirements were based on an IFIM/PHABSIM analysis conducted on the lower river in 1997-1998, but includes flexibility for Tacoma Power to ensure reservoir refill before the summer low precipitation season begins. An alternative flow regime was proposed by the NGOs based on an independent assessment of instream flows using the Indicators of Hydrologic Alteration/Range of Variability Approach (Richter et al. 1997). As part of a license-associated requirement by the Washington State Pollution Control Hearing Board, Tacoma Power assessed how the IHA/RVA methodology (and other similar methodologies) may supplement existing flow setting methodologies and determined that existing flow regulations adequately address the multiple objectives of river management and that IHA/RVA could be utilized in the future as part of the adaptive management process (Meridian Environmental 2004). Other issues beyond instream flow setting are also covered in the license articles. These include provisions by Tacoma Power to augment spawning gravel and LWD in the lower river, among others. All of the license prescriptions are new and it will be critical that the adaptive management approach ensures that adequate flows are provided for all salmonid life-stages at all seasons, that geomorphic processes (sediment transport and habitat creation) are restored or mitigated for, that water quality is maintained, and that floodplain function is maintained to the extent possible given lower river channel confinement. There has been relatively little focus on the effects of flow regime alteration on other aquatic species, an issue that warrants further investigation.

#4 – Create/restore off-channel and side-channel habitat

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore historical off-channel and side-channel habitats where they have been eliminated B. Create new channel or off-channel habitats (i.e. spawning channels)	• Loss of off-channel and/or side-channel habitat	• Floodplain filling • Channel straightening • Artificial confinement	chum coho	There has been significant loss of off-channel and side-channel habitats, especially along the lower mainstem that has been extensively channelized. This has severely limited chum spawning habitat and coho overwintering habitat. Targeted restoration or creation of habitats would increase available habitat where full floodplain and CMZ restoration is not possible.

Priority Locations

1st- Mainstem Cowlitz and lower portions of large mainstem tributaries

2nd- Other priority reaches that may have potential for off-channel and side-channel habitat restoration or creation

Key Programs

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

Program Sufficiency and Gaps

There are no regulatory mechanisms for creating or restoring off-channel and side-channel habitat. 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.

#5 - 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	chum, fall Chinook, coho	There has been significant degradation of floodplain connectivity and constriction of channel migration zones throughout the basin, especially along the mainstem below Mayfield Dam and along lower mainstem 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
2nd- Tier 2 reaches with hydro-modifications
3rd- Other reaches with hydro-modifications

Key Programs

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

Program Sufficiency and Gaps

There currently are no programs that set forth strategies for restoring floodplain function and channel migration processes in the Lower Cowlitz Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. The level of floodplain and CMZ impairment in the Lower Cowlitz and the importance of these processes to listed fish species put an increased emphasis on restoration. 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, landowners, 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.

#6 – 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	All species	As many as 50 miles of potentially accessible habitat are blocked by culverts or other barriers (approximately 25 barriers total). The blocked habitat is believed to be marginal in most cases. Passage restoration projects should focus on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Mill Creek, Leckler Creek; Salmon Creek (lower); Foster Creek; Skook Creek; Blue Creek

2nd- Other small tributaries with blockages

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
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 Program		✓
Cowlitz County	Roads Maintenance		✓
Lewis County	Roads Maintenance		✓

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 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.

#7 – Provide for adequate instream flows during critical periods in tributaries

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 in tributaries during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Lower 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	✓	
City of Longview	Water Supply Program	✓	
City of Kelso	Water Supply Program	✓	
City of Castle Rock	Water Supply Program	✓	
City of Winlock	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 Lower 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 Unit's recommended strategies. Water supply for Winlock is limited and expansion may affect instream flows in Olequa Creek. Ecology should implement the recommendations of the WRIA 25/26 Planning Unit relative to instream flow rule development

#8- 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)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
Lewis Conservation District / NRCS	Agricultural land habitat restoration		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
City of Longview	Stormwater Management		✓
City of Kelso	Stormwater Management		✓
City of Castlerock	Stormwater Management		✓
Cowlitz County	Stormwater Management		✓

Program Sufficiency and Gaps

Forest management programs including the 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 restoration projects.

#9 - 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 • Bacteria	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to agriculture and residential development	All species	Riparian systems are degraded throughout the basin due to past timber harvest, agriculture, roadways, flood control structures, and development. Riparian restoration has a high potential benefit due to the many limiting factors that are addressed. 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		✓
Lewis Conservation District	Agricultural land habitat restoration		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, agencies, landowners	Habitat Projects		✓
Lewis County Noxious Weed Control Board	Noxious Weed Education, Control, and Enforcement		✓
Cowlitz County Noxious Weed Control Board	Noxious Weed Education, Control, and 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 Lewis and Cowlitz Counties Comprehensive Plans. Many degraded riparian zones in urban lands, agricultural lands, rural residential lands, 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.

#10 – Restore degraded water quality with emphasis on temperature impairments

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Exclude livestock from riparian areas B. Increase riparian shading in tributaries C. Decrease channel width-to-depth ratios D. Reduce delivery of chemical contaminants to streams E. Address leaking septic systems	• Bacteria • Altered stream temperature regime • Chemical contaminants	• Timber harvest – riparian harvests • Riparian grazing • Leaking septic systems • Clearing of vegetation due to rural development and agriculture • Chemical contaminants from agricultural and developed lands	• All species	The lower Cowlitz mainstem and several tributaries are listed on the 2002-2004 draft 303(d) list for temperature impairment. There are also a few tributaries listed for fecal coliform bacteria impairment, although bacteria is more of a human health concern than a fish health concern. Restoration of riparian canopy cover and livestock exclusion can be used to address temperature and bacteria impairments. Leaking septic systems may be contributing to bacteria levels in areas with concentrated residential development. The degree of impact of agricultural pollutants is unknown and needs further assessment.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings
2nd- Other reaches with 303(d) listings
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		✓
Lower Columbia Fish Enhancement Group	Habitat Program		✓
Lewis Conservation District / NRCS	Agricultural land habitat restoration, Septic System Programs		✓
Cowlitz/Wahkiakum Conservation District/ NRCS	Agricultural land habitat restoration, Septic System Programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Lewis County Health Department	Septic System Program		✓
Cowlitz County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

The Ecology Water Quality Program manages the State 303(d) list of impaired water bodies. There are a few listings in the lower Cowlitz Basin (WDOE 2004). Water Quality Clean-up Plans (TMDLs) are required by Ecology and it is anticipated that the TMDLs will adequately set forth strategies to address the temperature and bacteria 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.

#11 - 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.

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		✓
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓

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 G-14. Habitat actions for the Lower Cowlitz Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L Cow 1. Manage regulated stream flows to provide for critical components of the natural flow regime	Expansion of existing program or activity	Tacoma Power, Lewis County PUD, FERC, WDFW	3	High: Lower mainstem Cowlitz River	High: Adequate flows for life stage requirements and habitat-forming processes	High
L Cow 2. 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, Cowlitz County, Longview, Kelso, Castle Rock, Winlock, Ecology	1 & 2	High: Private lands. Applies primarily to residential, agricultural, and forest lands at risk of development	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
L Cow 3. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of agriculture and timber lands to developed uses through zoning regulations and tax incentives	Expansion of existing program or activity	Lewis County, Cowlitz County, Longview, Kelso, Castle Rock, Winlock	1 & 2	High: Private lands. Applies primarily to residential, agricultural, and forest lands at risk of development	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
L Cow 4. Monitor and notify FERC of significant license violations, enforce terms and conditions of section 7 consultations on FERC relicensing agreements, and encourage implement-tation of section 7 conservation recommendations of section 7	Expansion of existing program or activity	NMFS, USFWS	3	High: Lower mainstem Cowliz River	High: Adequate flows for life stage requirements and habitat-forming processes, protection of water quality, increased habitat availability for spawning and rearing	High
L Cow 5. 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	Cowlitz County, Lewis County, Kelso, Longview, Winlock, Vader,	1, 8, 9, & 10	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

[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]
L Cow 6. Conduct floodplain restoration where feasible along the mainstem and in major tributaries that have experienced channel confinement. Survey landowners, build partnerships, and provide financial incentives	New program or activity	NRCS, W/Cowlitz CD, LCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 6, 9, 10 & 11	High: Mainstem Cowlitz and several of the major tributaries	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
L Cow 7. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Lewis County, Cowlitz County, Ecology, Longview, Kelso, Winlock	1	Medium: Private lands currently in agriculture or timber production in lowland areas.	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
L Cow 8. Create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, W/CCD, LCD, LCFEG	4	High: Lower mainstem Cowlitz and lower portion of lower mainstem tributaries	High: Increased habitat availability for spawning and rearing	Medium
L Cow 9. Increase funding available to purchase easements or property in sensitive areas where existing programs may not be able to adequately protect watershed function	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
L Cow 10. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, W/CCD, LCD, WDNR, WDFW, Cowlitz County, Lewis County, Kelso	All measures	High: Private lands. Applies primarily to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
L Cow 11. 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	1, 2, 6, 8, 9 & 10	Medium: 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

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L Cow 12. 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, Castle Rock, Winlock, Longview, Kelso	7	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
L Cow 13. 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, W/CCD, LCD, LCFEG	4, 5, 6, 8, 9, 10 & 11	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality (temperature and bacteria), LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
L Cow 14. 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	1, 2, 6, 8, 9 & 10	Low: Small private timberland owners	High: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
L Cow 15. Expand local government Comprehensive Planning to ensure consistent protections are in place to initiate review of development and real estate transactions that may affect natural resources	Expansion of existing program or activity	Lewis County, Cowlitz County, Kelso, Longview, Castle Rock, Winlock	1 & 2	High: Private lands. Applies primarily to residential, agricultural, and forest lands at risk of development	Medium: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	Medium
L Cow 16. 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, W/CCD, LCD, LCFEG	1 & 9	High: 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
L Cow 17. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Lewis County, Cowlitz County WSDOT, LCFEG	6	Medium: As many as 50 miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L Cow 18. 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	1, 2, 6, 8, 9 & 10	Low: State timber lands in the Lower Cowlitz Watershed (approximately 10% 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
L Cow 19. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	Expansion of existing program or activity	Lewis County, Cowlitz County, Cowlitz CD, Lewis CD	10	Medium: Private agricultural and rural residential lands	Medium: Protection and restoration of water quality (bacteria)	Low

G.5.5. 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 Lower Cowlitz River 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 may involve substantial changes in some hatchery programs from their historical focus on production for mitigation for lost fishing benefits. The recovery strategy includes a mixture of conservation programs and mitigation programs. 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 Lower Cowlitz Basin are displayed by species in Table G-15. More detailed descriptions and discussion of the regional hatchery strategy can be found in Volume I.

Table G-15. Summary of potential natural production and fishery enhancement strategies for the Lower Cowlitz River.

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

[1] Hatchery and natural population management strategy coordinated to meet biological recovery objectives. Strategy may include integration and/or isolation strategy over time. Strategy will be unique to biological and ecological circumstances in each watershed.

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 population on fitness and our ability to measure natural population productivity and will be key indicators of natural population status within the ESU. This strategy would not be included in near-term measures for the lower Cowlitz Basin.

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 coho in the Lower 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 strategy would not be included in near-term measures for the Lower Cowlitz Basin but could be considered in the future for coho. 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.

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 and is included as a near term strategy for fall Chinook in the Lower Cowlitz Basin.

Not every lower Columbia River hatchery program will be turned into a conservation program. The majority of funding for lower Columbia basin hatchery operations (including the Carson National Fish Hatchery) 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 summer and winter steelhead in the Lower Cowlitz Basin.

The Cowlitz Hatchery Complex will be operated to include natural production enhancement and fishery enhancement strategies for Cowlitz populations as identified in Table G-16.

Table G-16. A summary of conservation and harvest strategies with the potential for implementation in the Lower Cowlitz basin through the Cowlitz Hatchery Complex programs.

		Stock
Natural Production Enhancement	Supplementation	L. Cowlitz Coho √
		U. Cowlitz Spring Chinook
		U. Cowlitz Coho
		U. Cowlitz Winter Steelhead
		Lower Columbia Chum √
	Hatch/Nat Conservation [1]	L. Cowlitz Fall Chinook √
		U. Cowlitz Spring Chinook
	Isolation	U. Cowlitz Winter Steelhead
	Broodstock development	Cowlitz Chum √
		Cowlitz Late Winter Steelhead
Fishery Enhancement	In-basin releases (final rearing at Cowlitz)	Cowlitz Late Coho
		Cowlitz Fall Chinook
		Cowlitz Spring Chinook
		Cowlitz Winter Steelhead
		Cowlitz Summer Steelhead
		Cowlitz Sea-run Cutthroat
	Out of Basin Releases (final rearing at Cowlitz)	

[1] May include integrated and/or isolated strategy over time.
√ Denotes new program

Hatchery Measures and Actions

Hatchery strategies and actions are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within the 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 Lower Cowlitz River Basin (Table G-17). 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 Cowlitz River Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in Volume I.

Table G-17. Potential hatchery program actions to be implemented in the Lower Cowlitz River Basin.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed
• Unique conservation strategy is developed for Cowlitz fall Chinook based on status of natural population and biological relationship between natural and hatchery populations. Options may include integration and/or segregation strategies over time as developed to meet recovery objectives. Actions may include: • Deliberate and consistent infusion of natural produced fall Chinook adults into the hatchery program. • Monitor and evaluate first generation hatchery origin fall Chinook spawning naturally (adaptive management plan developed) • Continue long-standing WDFW policy of no outside Chinook or coho transfers into the Cowlitz Basin.	**Conservation management strategy implemented for fall Chinook natural and hatchery production. *preclude outside basin transfers of fall Chinook, spring Chinook, or coho eggs or juveniles for release into the lower Cowlitz basin	Cowlitz Salmon Hatchery fall Chinook, coho, and spring Chinook	Lower Cowlitz fall Chinook and coho	Domestication Diversity Abundance	• In-breeding • Non-local genetic traits
• Establish a mass marking program for fall Chinook to enable selective fishing options and to distinguish hatchery and natural produced adults in the escapement. • Evaluate the feasibility of marking 100 percent of hatchery fall Chinook production (5 million). Evaluate alternatives. • Continue 100 percent mark of hatchery produced steelhead, coho, spring Chinook, and sea-run cutthroat released into the lower Cowlitz.	**Adipose fin-clip mark hatchery released fall Chinook *Adipose fin-clip mark hatchery produced coho, spring Chinook, steelhead, and sea-run cutthroat	Cowlitz Salmon Hatchery fall Chinook spring Chinook and coho. Cowlitz Trout Hatchery sttelhead and cutthroat	Lower Cowlitz fall Chinook, coho, and steelhead.	Domestication, Diversity, Abundance	• In-breeding • Harvest

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed
• 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 lower Cowlitz tributaries and for harvest. • Develop a chum brood stock utilizing natural returns to the Cowlitz Salmon Hatchery and/or adjacent stream populations based on assessment of genetic similarity. Utilize broodstock for supplementation and risk management of Lower Columbia chum.	**Cowlitz Basin hatchery facilities utilized for supplementation and enhancement of natural coho and chum populations	Cowlitz Hatchery late coho, and space for chum (if needed for lower Columbia chum enhancement).	Lower Cowlitz coho, Lower Columbia chum	Abundance, Spatial distribution	• Low numbers of natural spawners • Ecologically appropriate natural brood stock
• Hatchery produced steelhead, coho, and fall Chinook will be scheduled for release during the time when the maximum numbers of fish are smolted and prepared to emigrate rapidly. • Juvenile rearing strategies will be implemented to provide a fish growth schedule which coincides with an optimum release time for hatchery production success and to minimize time spent in the Cowlitz River.	*Juvenile release strategies to minimize impacts to natural populations	Cowlitz Salmon Hatchery spring Chinook, coho, and fall Chinook. Cowlitz Trout Hatchery steelhead and sea-run cutthroat	Lower Cowlitz fall Chinook, chum, and coho	Predation, Competition	• Hatchery smolt residence time in the lower Cowlitz River.
• Evaluate in-take screens at the facilities to assure they do not pose risks to wild fall Chinook juveniles • Hatchery effluent discharge complies with NPDES permit monitoring requirements. Fish health monitored and treated as per co-managers fish health policy.	*Evaluate facility operations	All species	All species	Habitat quality, survival	• water quality, • In-take screens
• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes	** Monitoring and evaluation, adaptive	All species	All species	Hatchery production performance,	• All of above

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed
• Performance standards developed for each actions with measurable criteria to determine success or failure • Adaptive Management applied to adjust or change actions as necessary	management			Natural production performance	

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

G.5.6. 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 increased fishing 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 much 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. Following is a general summary of the fishery actions specific to the lower Cowlitz (Table G-18). More complete details can be found in the WDFW Sport Fishing Rules Pamphlet.

Table G-18. Summary of regulatory and protective fishery actions in the lower Cowlitz basin

Species	General Fishing Actions	Explanation	Other Protective Fishing Actions	Explanation
Fall Chinook	Open for fall Chinook	Hatchery fish are produced for harvest. Hatchery fish are not mass marked	Night closures, gear restrictions, and closure near Barrier Dam	Protects fall Chinook in areas of high concentration
Spring Chinook	Retain only adipose fin-clipped Chinook	Selective fishery for hatchery Chinook, unmarked wild spring Chinook must be released	Minimum size restrictions and closure near Barrier Dam	Closure protects spring Chinook in areas of high concentration and minimum size protects juveniles
chum	Closed to retention	Protects natural chum. Hatchery chum are not produced for harvest		
coho	Retain only adipose fin-clip marked coho	Selective fishery for hatchery coho, unmarked wild coho must be released	Small Lower Cowlitz tributaries closed to salmon fishing	Protects wild spawners in tributary creeks. Hatchery coho are released in the lower mainstem Cowlitz
Winter steelhead	Retain only adipose fin-clip marked steelhead	Selective fishery for hatchery steelhead, unmarked wild steelhead must be released	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

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and actions 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 Lower Cowlitz populations are summarized in Table G-19.

Table G-19. Regional harvest actions from Volume I with significant application to the Lower Cowlitz Subbasin populations.

Action	Description	Responsible Parties	Programs	Comments
	Monitor chum handle rate in winter steelhead and late coho tributary sport fisheries.	WDFW	Columbia Compact	State agencies would include chum incidental handle assessments as part of their annual tributary sport fishery sampling plan.
	Consider developing a mass marking plan for hatchery tule Chinook for tributary harvest management and for naturally-spawning escapement monitoring.	WDFW, NMFS, USFWS, Col. Tribes	U.S. Congress, Washington Fish and Wildlife Commission	Provides the opportunity to implement selective tributary sport fishing regulations in the Cowlitz watershed. This program is not federally funded and therefore is not subject to the Congressional mandate to mass mark federally funded hatchery production.
	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.

G.5.7. Hydropower

The three hydro-electric dams on the Cowlitz River are considered to be located in the upper Cowlitz basin. However, lower Cowlitz River species, in particular fall Chinook, are affected by flow regimes from Cowlitz River hydro operations which effect spawning and rearing habitat in the lower Cowlitz. The quantity and quality of fall Chinook habitat in the lower Cowlitz River can be addressed by; maintaining a flow regime, including minimum flow requirements that enhance the spawning and rearing habitats for natural salmonid populations downstream of the Cowlitz hydrosystem. In addition, mainstem Columbia hydro operations and flow regimes affect habitat utilized by lower Lewis species in migration corridors and in the estuary. Key regional strategies applying to the lower Cowlitz populations are displayed in the following table.

Table G-20. Regional hydropower measure from Volume I, Chapter 10 with significant application to lower Cowlitz Subbasin populations

Measure	Description	Comments
D.M4	Operate the tributary hydrosystems to provide appropriate flows for salmon spawning and rearing habitat in the areas downstream of the hydrosystem.	The quantity and quality of spawning and rearing habitat for salmon, in particular fall Chinook in the lower Cowlitz is affected by the water flow discharged at Mayfield Dam. The operational plans for the Cowlitz hydrosystem, in conjunction with fish management plans, should include flow regimes, including minimum flow and ramping rate requirements, which enhance the lower river habitat for fall Chinook.

G.5.8. Mainstem and Estuary Habitat

Lower 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.

G.5.9. Ecological Interactions

For the purposes of this plan, ecological interactions refer to the relationships of salmon anadromous 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.

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