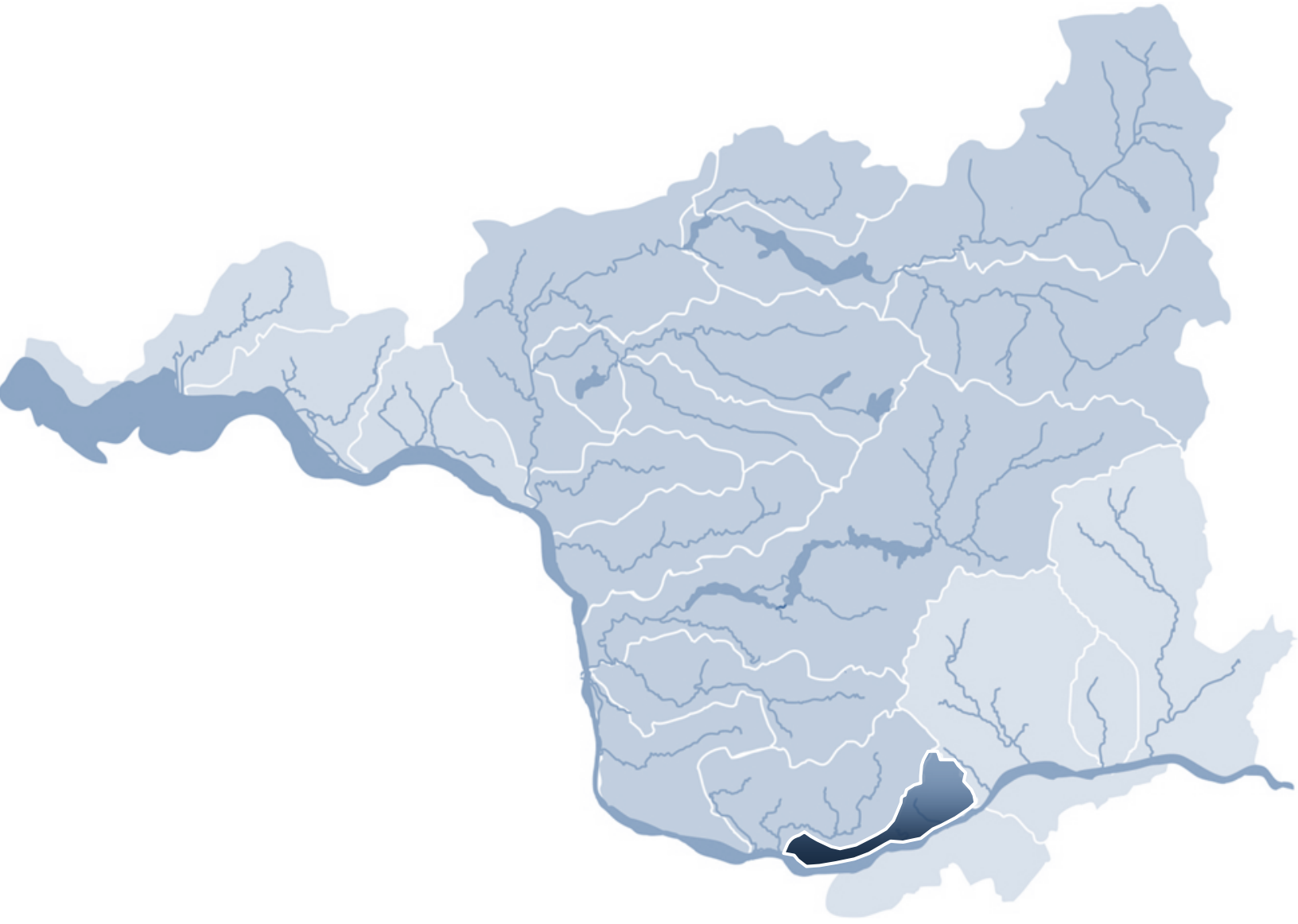
O. LOWER GORGE TRIBUTARIES



O. LOWER COLUMBIA GORGE TRIBUTARIES

Tables

Figures

O.1. Executive Summary

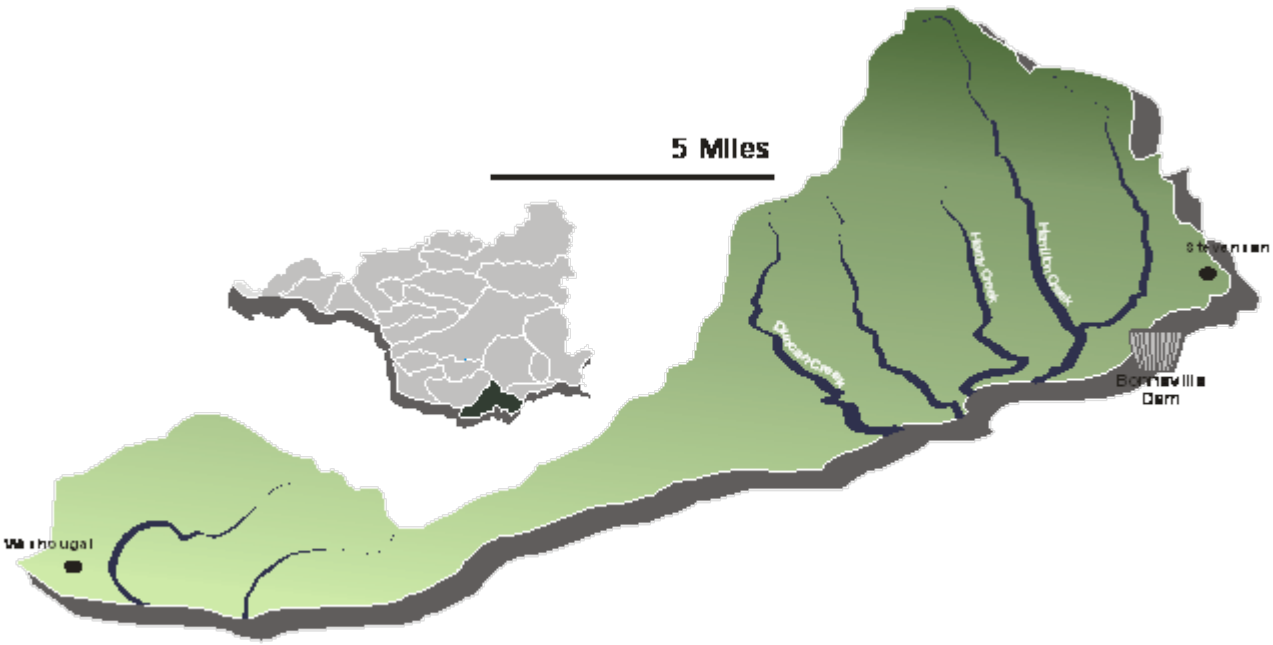


Figure O-1. Map of Lower Columbia Gorge Triburaties

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 Columbia Gorge Tributaries (Lower Gorge Tributaries) describes implementation of the regional approach within this basin, as well as assessments of local fish populations, limiting factors, and ongoing activities that underlie local recovery or mitigation actions. The plan was developed in a partnership between the Lower Columbia Fish Recovery Board (LCFRB), Northwest Power and Conservation Council (NPCC), federal agencies, state agencies, tribal nations, local governments, and others.

The Lower Gorge Tributaries are part of the Columbia Lower Subbasin as defined by the NPPC (Figure O-1). The primary streams are Gibbons Creek, Lawton Creek, Duncan Creek, Hardy Creek, and Hamilton Creek. These streams historically supported abundant winter steelhead, chum, coho, and fall chinook. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook, coho, steelhead and chum 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 channel and floodplain modifications. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has reduced productivity. Hydropower construction and operation on the Columbia has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

Lower Gorge Tributaries winter steelhead and coho will need to be restored to a high level of viability, chum to a very high level of viability, and fall Chinook to a medium level of viability to meet regional

recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize 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 Gorge Tributaries 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 Gorge Tributaries 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.

O.1.1. Key Priorities

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

1. Provide Adequate Water Flows in Bonneville Dam Tailrace for Downstream Habitats

Bonneville Dam flow regimes effect chum and fall Chinook access to spawning habitats in Hamilton and Hardy creeks. The fall and early winter flows also affect the amount of spawning habitat available for chum and fall chinook in the mainstem Columbia near Pierce and Ives islands. The winter and early spring flows at Bonneville Dam are also critical to prevent dewatering and decreased flows through redds during the egg incubation period. Regulating discharge from Bonneville Dam to provide adequate water flow in the fall and early winter for spawning access and in the winter and early spring for egg incubation is critical for Lower Gorge Tributaries area chum and fall Chinook restoration.

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

Many of the streams in this basin are characterized by lowland floodplains just before their confluence with the Columbia River. These floodplains have been isolated or eliminated as a result of development, stream channel diversion, and transportion corridors. These practices have also degraded riparian vegetation. Removing or modifying channel control and containment structures to reconnect streams to their floodplains (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. Restoration of riparian function will enhance bank stability, water quality, and channel complexity. These improvements will be particularly beneficial to chum, fall Chinook, and coho, which utilize lower elevation reaches. Partially restoring

normal floodplain functions will also provide wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and riparian areas 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

Human population and development trends vary dramatically between the western and eastern portions of the basin. The western portion of the basin is a populated area adjacent to the expanding city of Washougal, WA. The eastern portion lies within the Columbia River Gorge National Scenic Area (CRGNSA), is less populated, and is subject to land-use controls associated with the provisions of the CRGNSA. The population of the entire basin is projected to grow by at least one third in the next twenty years. Population growth will primarily occur in the western portion of the basin and along the Columbia River in the eastern portion. This growth will result in the conversion of forest, rural residential and agricultural land uses to high-density 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. Manage Forest Lands to Protect and Restore Watershed Processes

Much of the basin is managed for commercial timber production and has experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing 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), Forest Practices Rules (private lands), and the Northwest Forest Plan / CRGNSA (federal 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.

5. Restore Passage at Culverts and Other Artificial Barriers

There are several passage issues in the basin related to channel alterations (e.g. Gibbons Creek) and transportation corridors (Highway 14 and the railroad corridor). Correcting passage barriers could open up as many as 6 additional miles of habitat. There have already been some significant accomplishments with respect to passage, including enhancement of passage at lower Duncan Creek. Further assessment and prioritization of passage barriers is needed throughout the basin.

6. 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 Gorge Tributaries include building chum salmon spawning channels and constructing coho overwintering habitat such as alcoves, side channels, and log jams. Benefits of structural enhancements are often temporary but will help bridge the period until normal habitat-forming processes are reestablished.

7. Align Hatchery Priorities 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 fishing benefits. There are no hatcheries operating in the Lower Gorge Tributaries. The Washougal hatchery facility will continue to release chum into Duncan Creek as part of a chum rebuilding program and a risk reduction program for the mainstem Columbia, Hamilton and Hardy Creek chum populations.

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 Gorge Tributaries salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some Lower Gorge Tributaries 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 Gorge Tributaries. 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 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 Gorge Tributaries salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the basin. 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-basin actions can be realized. To ensure equivalent sharing of the recovery and mitigation burden, impacts in each area of effect (habitat, hydropower, etc.) should be reduced in proportion to their significance to species of interest.

O.2. Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's Lower Gorge Tributaries, which is located within the Lower Columbia Tributaries Subbasin as defined by the Northwest Power and Conservation Council (NPCC). 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 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 statute (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 tovernments, 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.
- 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.

O.3. Assessment

O.3.1. Subbasin Description

Topography & Geology

The Lower Gorge Tributaries contain the stream systems that drain into the Columbia River between the Washougal River and Bonneville Dam. The basin lies within Clark and Skamania Counties. Streams in the Lower Gorge Tributaries originate on the steep valley walls of the Columbia River Gorge and flow south through Columbia River floodplain terraces before entering the Columbia River. Most of the stream lengths are high gradient and spawning habitat is only available in the lowest reaches. The major streams (from west to east) are Gibbons, Lawton, Duncan, Woodward, Hardy, and Hamilton Creeks. Hamilton Creek has the largest channel length at over 8 miles. Anthropogenic disturbances are related to expanding development (western portion of basin) and transportation corridors that parallel the Columbia River (eastern portion).

Surface geology in the basin is primarily sedimentary, with volcanic material in headwater areas. Lower elevations are underlain by alluvium from catastrophic flooding of the Columbia River during Pleistocene Ice Ages (Bretz Floods) and from more recent floodplain deposits.

Climate

The climate is typified by cool, wet winters and warm, dry summers. Temperatures are moderated by mild, moist air flowing up the Columbia from the Pacific. Precipitation levels are high due to orographic effects. Mean annual precipitation is 85 inches at the Skamania Fish Hatchery in the Columbia Gorge. The average annual minimum and maximum temperatures at the Skamania Hatchery are 38°F (3°C) and 62°F (17°C), respectively. Winter temperatures seldom fall below freezing, with very little snowfall (WRCC 2003).

Land Use, Ownership, and Cover

The Lower Gorge Tributaries are mostly forested, with a higher degree of residential and agricultural development in the western portion, especially near the town of Washougal. The eastern portion of the basin lies within the Columbia River Gorge National Scenic Area (CRGNSA), where land use and development is limited; however, rural residential and industrial uses are located along the Columbia on the lower reaches of some streams. 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. Lower Gorge Tributaries land ownership and land cover/land use are illustrated by Figure O-2 and Figure O-3.

Development Trends

Human population and development trends vary dramatically between the western and eastern portions of the basin. The western portion of the basin is a populated area adjacent to the expanding city of Washougal, WA. The eastern portion lies within the CRGNSA, is less populated, and is subject to land-use controls associated with the provisions of the CRGNSA. The only population center in the eastern portion of the basin is the town of North Bonneville, situated on the Columbia River just west of

Bonneville Dam. The year 2000 population is estimated at approximately 7,000 persons, and is expected to increase to 10,500 by 2020. Population growth will primarily occur in the western portion of the basin and along the Columbia River in the eastern portion. This growth will result in the conversion of forest, rural residential and agricultural land uses to high-density residential uses, with potential impacts to habitat conditions. Land-use changes will provide a variety of risks to terrestrial and aquatic habitats.

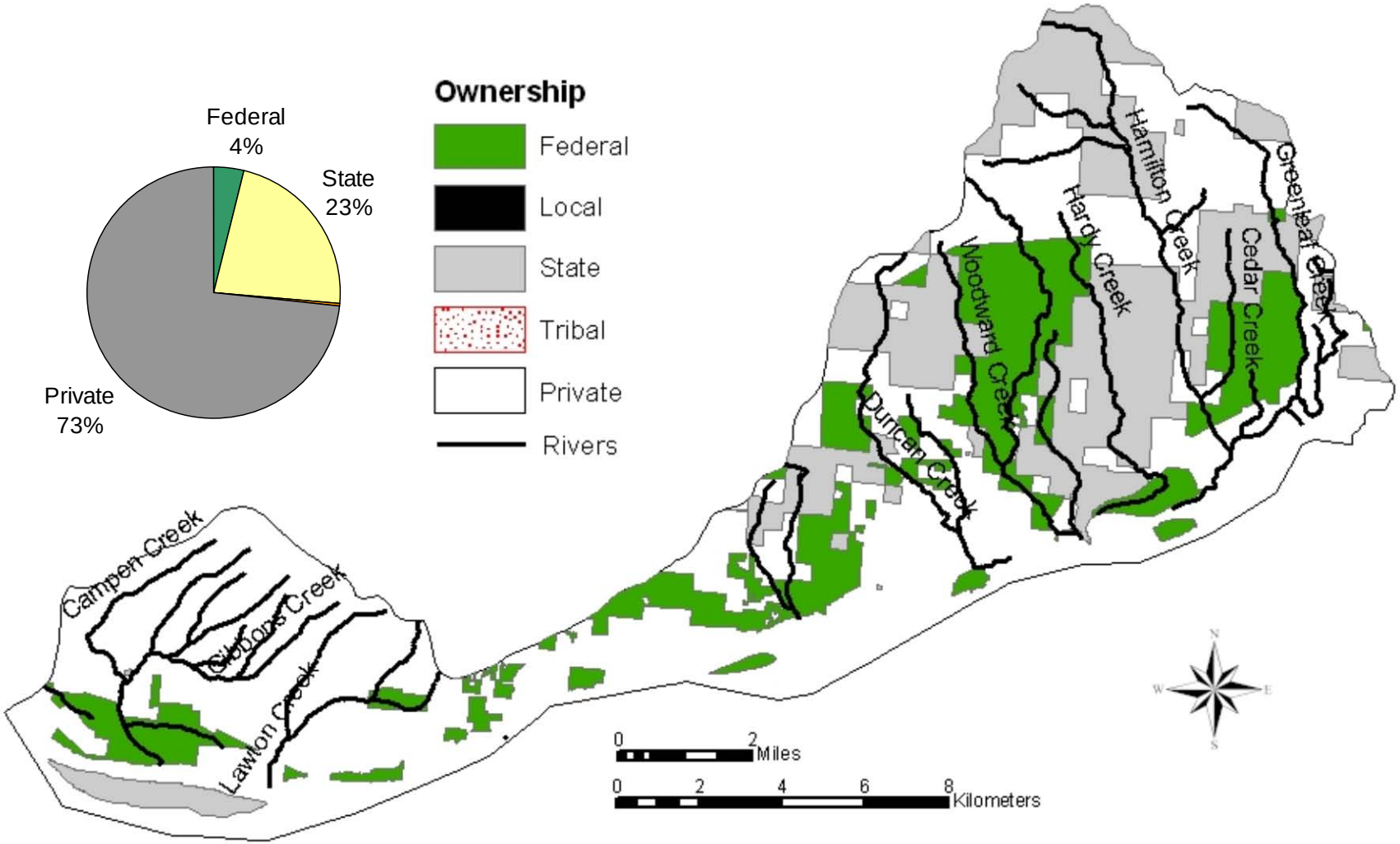


Figure O-2. Landownership within the Lower Gorge Tributaries. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

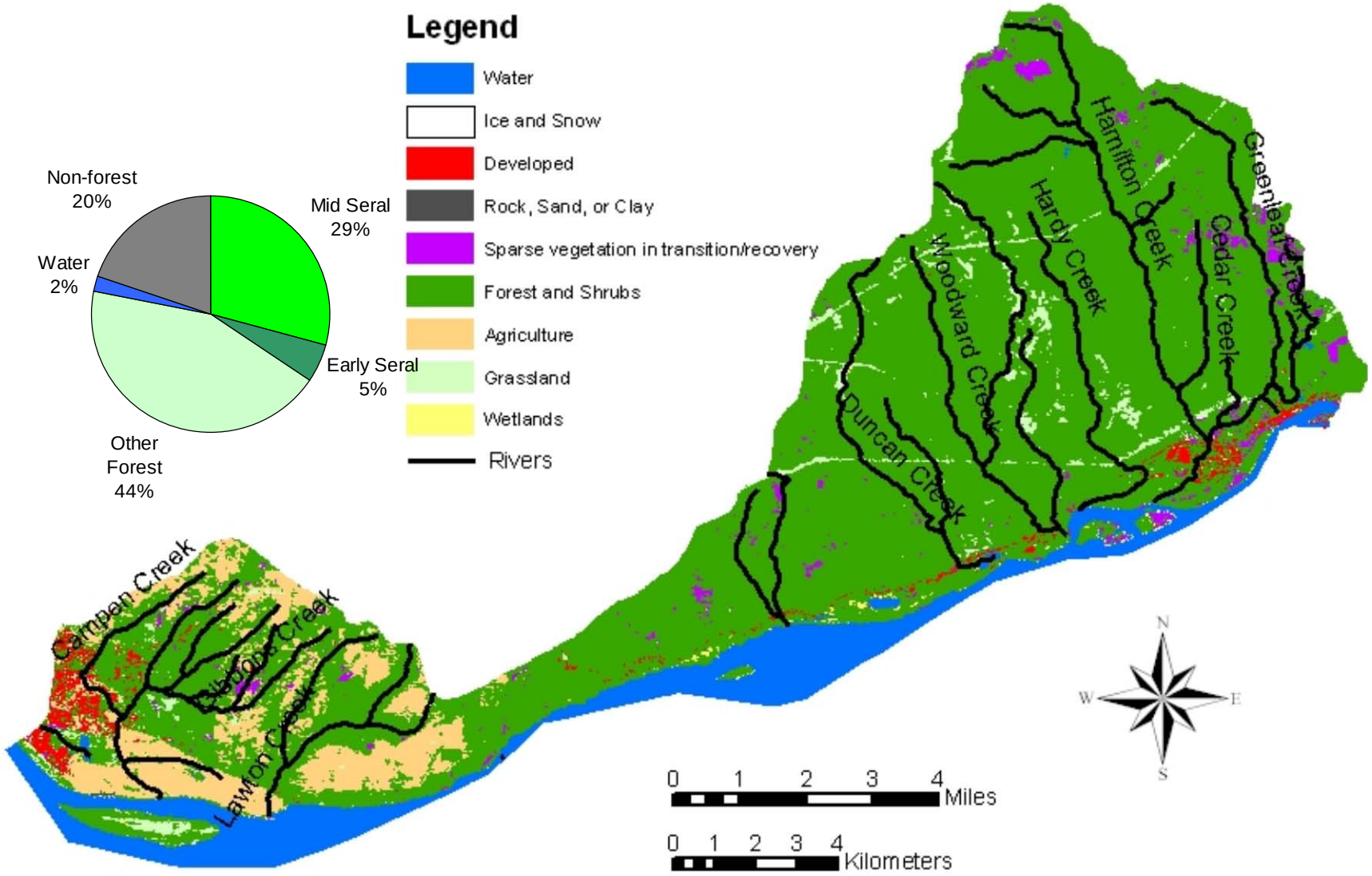


Figure O-3. Land cover within the Lower Gorge Tributaries. Vegetation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. (1997). Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

O.3.2. Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the Lower Gorge Tributaries. 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. The Federal hydropower system effects spawning and incubation of Lower Gorge Tributary salmon with flow operations at Bonneville Dam and migrating juveniles are subject to effects in the Columbia River, estuary, and nearshore ocean. The Lower Gorge Tributaries 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 Gorge Tributaries include winter steelhead, chum, coho, and fall Chinook. Bull trout do not occur in the basin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table O-1). With the exception of chum, extinction risks are significant for all focal species – the current health or viability of Lower Gorge Tributary salmonids ranges from low for winter steelhead and very low for coho and fall Chinook. Returns of Lower Gorge Tributary chum include both natural and hatchery produced fish.

Other species of interest in the Lower Gorge Tributaries 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).

Table O-1. Status of focal salmon and steelhead populations in the Lower Gorge Tributaries.

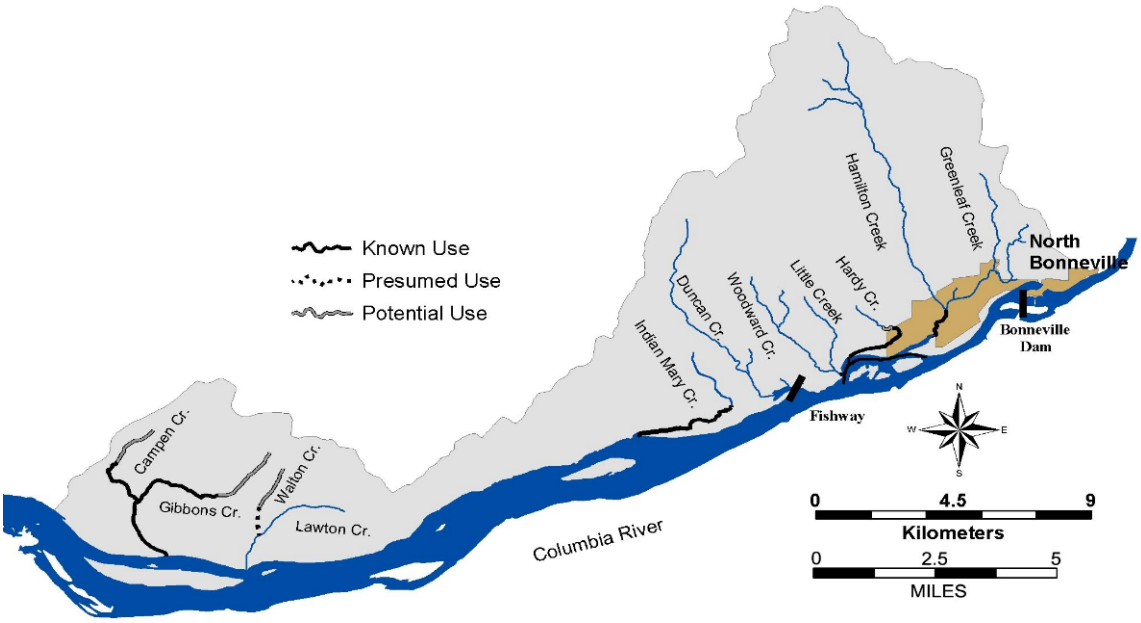
Species	Population	Recovery Priority[1]	Viability		Improve-ment[4]	Abundance		
			Status[2]	Obj[3]		Historical[5]	Current[6]	Target[7]
Fall Chinook (Tule)	L. Gorge	Contributing	VL	M	>500%	n/a[8]	<50	1,200
Chum	L. Gorge	Primary	H	VH	0%[9]	6,000	2,000	2,000
Winter Steelhead	L. Gorge	Primary	L	H	45%	n/a[8]	200	300
Coho	L. Gorge	Primary	VL	H	400%	n/a[8]	<50	1,900

[1] Primary, Contributing, and Stabilizing designations reflect the relative contribution of a population to major population group recovery goals.
[2] Baseline viability is based on Technical Recovery Team viability rating approach.
[3] Viability objective is based on the scenario contribution.
[4] Improvement is the relative increase in population production required to reach the prescribed viability goal
[5] Historical population size inferred from presumed habitat conditions using EDT Model and NMFS back-of-envelope calculations.
[6] Approximate current annual range in number of naturally-produced fish returning to the watershed.
[7] Abundance targets were estimated by population viability simulations based on viability goals.
[8] A recovery goal is not available at this time due to a lack of information regarding population dynamics.
[9] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.

Fall Chinook—Lower Columbia Gorge Tributaries Subbasin

ESA: Threatened 1999 **SASSI: Unknown 2002**

The historical Lower Gorge Tributaries adult tule fall chinook population is estimated from 300-3,000 fish. The current natural spawning number in the tributaries is about 100 tule fall chinook. However, there are significant numbers of upriver bright stock fall Chinook (not part of the lower Columbia ESU) that spawn primarily in the mainstem Columbia near the Lower Gorge Tributaries. Natural spawning of tule fall chinook occurs primarily in the lower reaches of Hamilton and Hardy creeks. Access in the early fall is dependent on mainstem Columbia and tributary flow conditions. Spawning time in the tributaries peaks in October. Juvenile rearing occurs near and downstream of the spawning areas. Juveniles migrate from the Lower Gorge Tributaries in the spring and early summer of their first year.

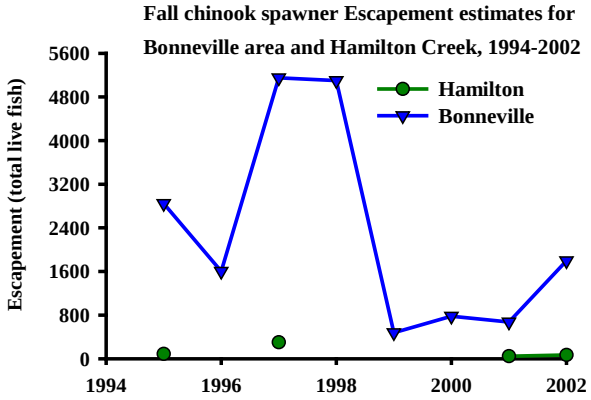


Distribution

- Fall Chinook have recently been observed in the mainstem Columbia River from the upper end of Pierce Island to the lower end of Ives Island, along the Washington shore in Hamilton Slough, between the mouths of Duncan and Hardy Creeks, and in the lower reaches of Hardy and Hamilton Creeks; available spawning habitat depends on the spill regime at Bonneville Dam

Life History

- Fall chinook upstream migration in the Columbia River begins in early August or September, depending on early rainfall
- Spawning in the mainstem Columbia River and Lower Gorge Tributaries occurs from mid-October to late November
- Age ranges from 2 year-old jacks to 6 year-old adults, with dominant adult ages of 3 and 4
- Fry emerge around early 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



Diversity

- Early spawning components are considered part of the tule population in the lower Columbia River Evolutionary Significant Unit (ESU)
- Lower Gorge Tributaries (Bonneville) upriver bright fall chinook stock spawning was discovered in 1994 in the mainstem Columbia immediately below Bonneville Dam; stock origin remains unknown; stock was designated based on distinct spawning distribution
- Allozyme analysis indicate that late bright fall chinook, spawning in the mainstem Columbia below Bonneville Dam, are genetically distinct from other Columbia River bright fall chinook stocks although they resemble Yakima bright fall chinook and upriver bright fall chinook maintained at the Little White Salmon National Fish Hatchery and Bonneville Hatchery

Abundance

- Hamilton Creek spawning escapements from 1995-2001 ranged from 47-300 (average 144)
- Lower Gorge Tributaries area spawning escapements from 1994-2001 ranged from 477-5,151 (average 2,143)

Productivity & Persistence

- Productivity data is limited for Lower Gorge area fall Chinook
- Seining operations conducted by the WDFW and ODFW have shown consistent juvenile production from late spawning adults in the mainstem Columbia River below Bonneville Dam
- Baseline risk assessment determined a high to very high risk of extinction for fall Chinook in lower Columbia Gorge Tributaries

Hatchery

- The Spring Creek National Fish Hatchery near the White Salmon River released 50,160 fall Chinook into Hamilton Creek in 1977

Harvest

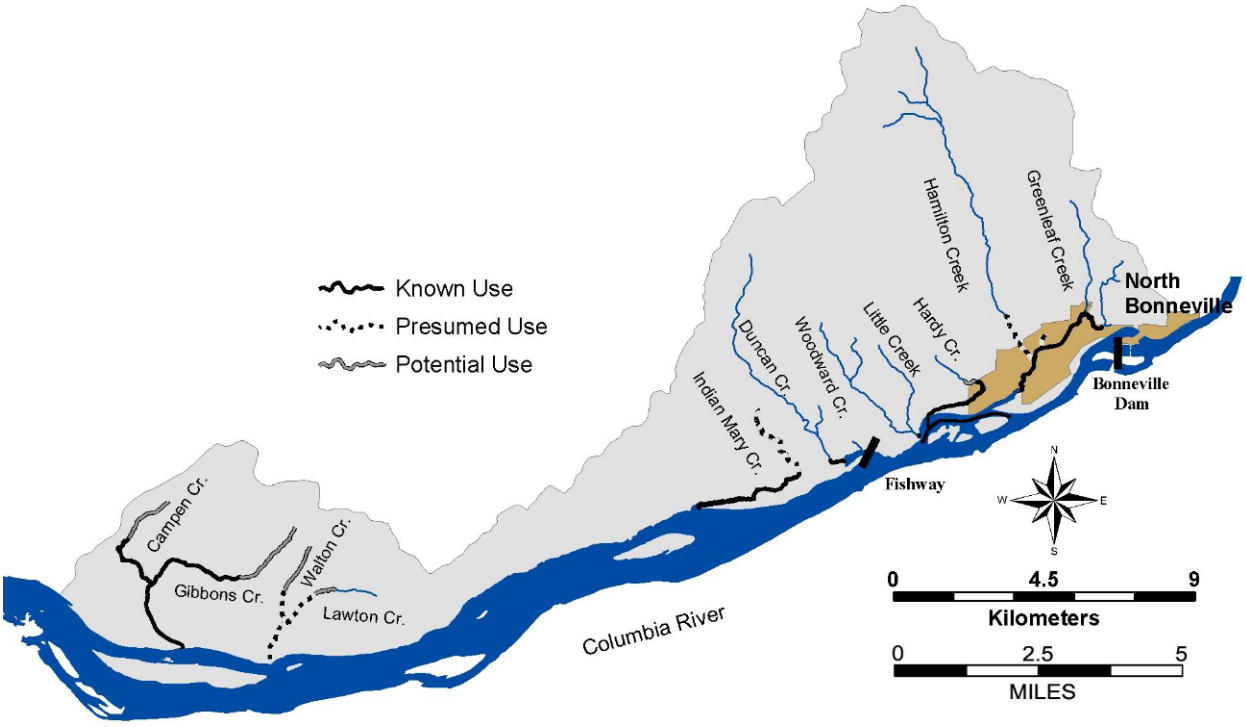
- Fall Chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska and Columbia River commercial gill net and sport fisheries
- No specific CWT data is available for these populations, however migration patterns and harvest of the bright Chinook populations is likely similar to upriver bright (URB) fall Chinook and the tule populations similar to lower Columbia hatchery tule Chinook
- Columbia River URB Chinook harvest is limited to 31.29% based on ESA limits on Snake River wild fall Chinook; however, lower river URB Chinook are harvested at a lower rate as they do not pass through the Treaty Indian fishery

- Combined ocean and Columbia River tule fall Chinook harvest is currently limited to 49% as a result of ESA limits on Coweeman tule fall Chinook
- A popular sport fishery has developed in the mainstem Columbia in late September and early October, targeting on the late spawning bright Chinook

Chum—Lower Columbia Gorge Tributaries Subbasin

ESA: Threatened 1999 **SASSI: 2002**

The historical Lower Gorge tributary adult population is estimated from 9,000-40,000. Current natural spawning returns range from 1,000-6,000, including tributary and mainstem Columbia spawning. Spawning occurs in the lower 1.0 miles of Hardy and Hamilton creeks, Hamilton Slough, Duncan Creek, and in the mainstem Columbia near Ives and Pierce islands. Spawning occurs from late November through December. Natural spawning chum in the Lower Gorge Tributaries are all naturally produced as no hatchery chum are released in the area. Juveniles rear in the lower reaches for a short period in the early spring and quickly migrate to the Columbia.



Distribution

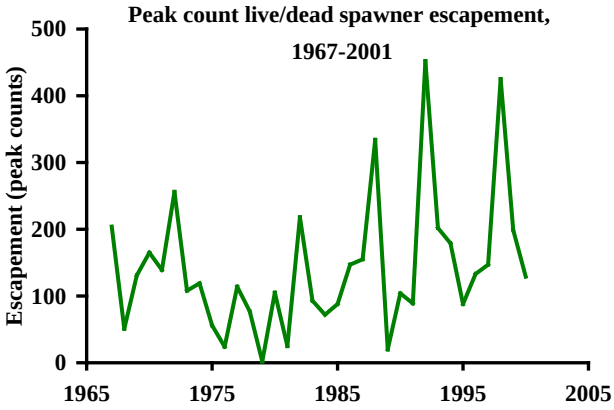
- Spawning occurs in the lower 1.0 miles of Hardy Creek and Hamilton Creeks, Hamilton Slough, Duncan Creek, and in the mainstem Columbia at Ives and Pierce Islands.

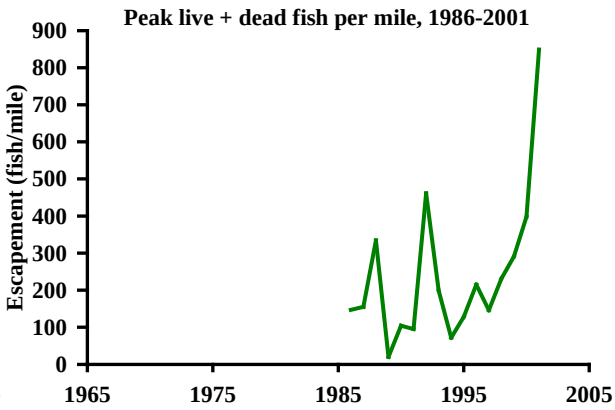
Life History

- Adults enter the Lower Gorge Tributaries from mid-October through November
- Peak spawning occurs in mid-December, but continues into January
- Dominant adult ages are 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts with little freshwater rearing time

Diversity

- One of two genetically distinct populations in the Columbia River ESU
- Stock designated based on spawning distribution and genetic composition; allozyme and DNA analyses indicate that chum from Hardy Creek, Hamilton Creek, and the mainstem Columbia below Bonneville Dam are one stock (Bonneville chum) and distinct from other Washington Chum stocks





Abundance

- Adult fish/mile ranges from 20-849 for Bonneville chum from 1986-2001 as estimated from peak live/dead escapement ground spawner surveys.
- In 2002, WDFW estimated 2,256 adult chum spawned in Hamilton, Hardy, and Duncan creeks and another 3,209 chum in the mainstem Columbia River near Ives and Pierce islands

Productivity & Persistence

- Baseline risk assessment determined a low risk of extinction for chum in lower Columbia Gorge Tributaries
- Hardy and Hamilton Creeks population forms one of the most productive populations remaining in the Columbia basin
- A chum habitat restoration and enhancement program is currently underway in Duncan Creek

Hatchery

- Hatchery releases have not occurred on Hardy or Hamilton Creeks; USFWS maintains and artificial spawning channel in Hardy Creek to increase chum spawning habitat
- Washougal Hatchery is currently rearing Hardy Creek stock chum to enhance returns to Duncan Creek

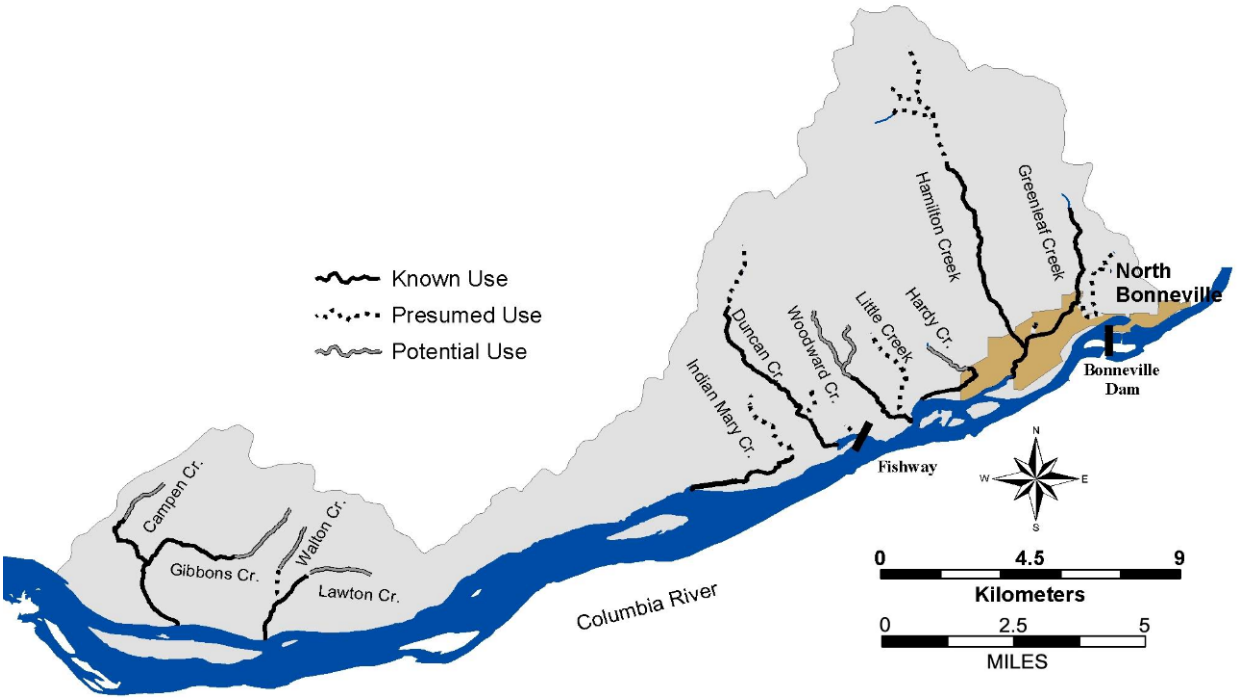
Harvest

- 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 then 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 then 5% of the annual return

Coho—Lower Columbia Subbasin

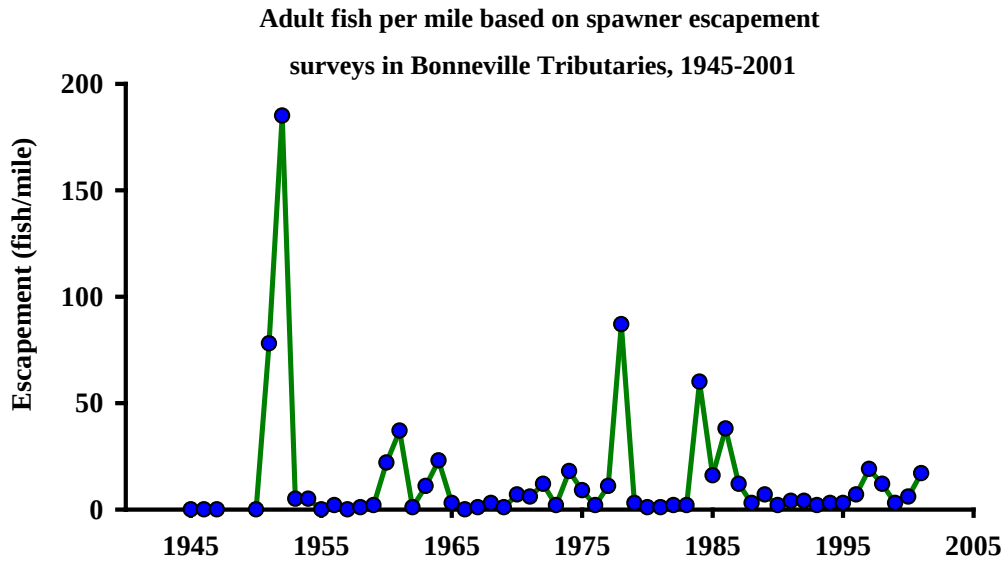
ESA: Threatened 2005	SASSI: Lower Gorge (Bonneville) Depressed 2002; Salmon Creek—Unknown 2002

The historical Lower Gorge Tributary adult population is estimated from 300-13,000, with both early and late stock coho produced. Current natural spawning returns are presumed to be 100 fish or less. There is no hatchery production in the Lower Gorge Tributaries. Natural spawning can occur in Hamilton, Greenleaf, Hardy, Woodard, Duncan, Gibbons and Lawton creeks. Early coho spawning occurs from mid October to mid-November and late coho from mid-Novenber to March. Juvenile rearing occurs upstream and downstream of spawning areas. Juveniles rear for a full year in the Lower Gorge Tributaries before migrating as yearlings in the spring.



Distribution

- Managers refer to late stock coho as Type N due to their ocean distribution generally north of the Columbia River
- Managers refer to early stock coho as Type S due to their ocean distribution generally south of the Columbia River
- Hamilton, Hardy, Woodward, and Duncan Creeks are small Columbia River tributaries located just downstream of Bonneville Dam; Greenleaf Creek is a tributary of Hamilton Creek
- Gibbons, Lawton, and St. Cloud Creeks are located upstream of the Washougal River



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Life History

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

Diversity

- Native population in the Lower Gorge Tributaries (Duncan, Hardy, and Hamilton Creeks) were late stock coho (or type N)
- Other tributaries with historical coho production include: Gibbons Creek, Lawton Creek, St. Cloud Creek, Woodward Creek, and Greenleaf Creek (a tributary of Hamilton Creek)
- Columbia River early and late stock coho produced at Washington hatcheries are genetically similar

Abundance

- Wild coho runs in these small tributaries are believed to be a fraction of historical size
- WDFW (1951) estimated a coho escapement of 2,050 for Salmon Creek and the small tributaries between the Washougal River and Bonneville Dam combined
- Escapement surveys from 1945-2001 on Duncan, Hardy, Hamilton, and Greenleaf Creeks documented a range of 0-185 fish/mile

Productivity & Persistence

- Natural coho spawning is presumed to be very low
- Chum recovery efforts in Duncan, Hardy, and Hamilton creeks should improve coho production potential
- Baseline risk assessment determined a high to very high risk of extinction for coho in lower Columbia Gorge Tributaries

Hatchery

- There are no hatcheries on any of these tributaries
- Washougal Hatchery late coho were planted in Duncan and Greenleaf Creeks in 1983

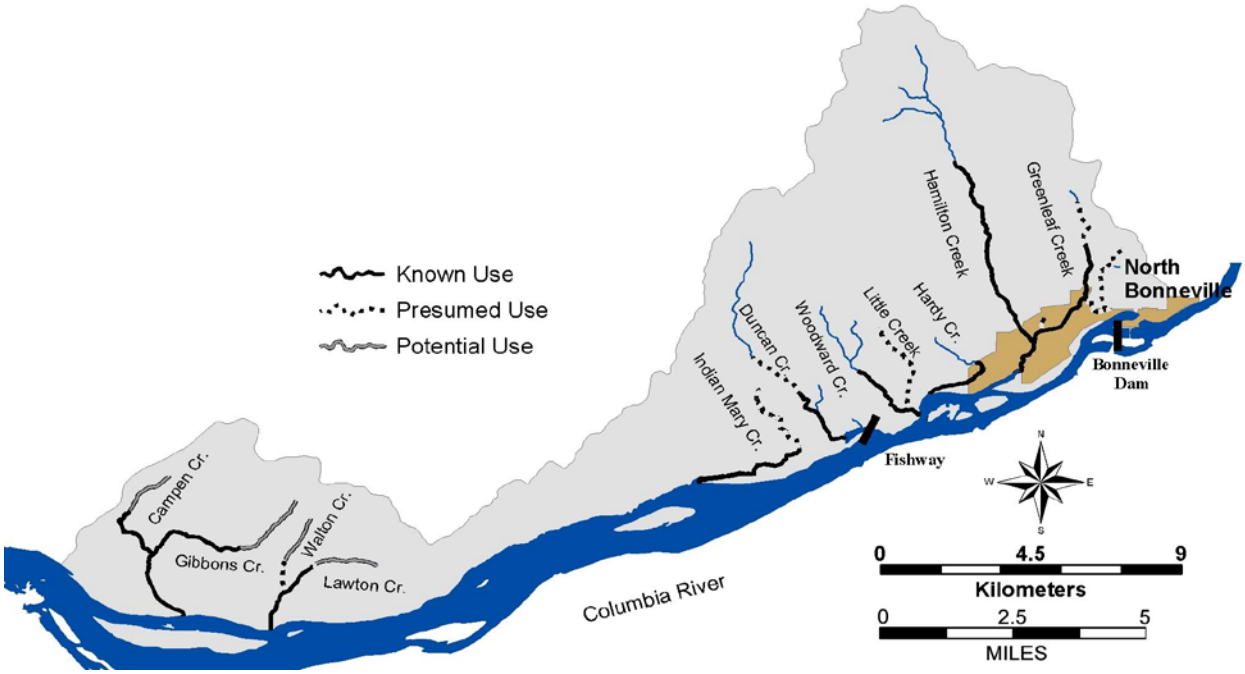
Harvest

- Until recent years, natural produced coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates 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 populations
- Columbia River commercial coho fisheries in November were eliminated in the 1990s to reduce harvest of late Clackamas River coho
- Since 1999, Columbia River hatchery coho returns have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Naturally-produced lower Columbia coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon coastal coho and Oregon listed Clackamas and Sandy coho
- During 1999-2002, harvest rates on ESA listed coho were 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 in September by fall Chinook and Sandy River coho management; commercial harvest of late coho is focused in October during peak abundance of late hatchery 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 hatchery coho harvest can also be substantial
- There is no sport harvest in these tributaries
- Harvest of coho produced in these Lower Gorge Tributaries is assumed to be similar to Oregon's Clackamas and Sandy coho, which were harvested at less then 15% during 1999-2002
- There are no adipose fin-clipped hatchery fish released in these tributaries

Winter Steelhead—Lower Columbia Gorge Tributaries Subbasin

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

The historical Lower Gorge Tributaries adult population is estimated from 600-4,000 fish. Current natural spawning returns are 200-300 fish. Spawning occurs primarily in the lower 2 miles of Hamilton Creek. Spawning time is early 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 Lower Gorge Tributaries.



Distribution

- Winter steelhead are distributed throughout the lower reaches of Hamilton Creek (~2 mi)

Life History

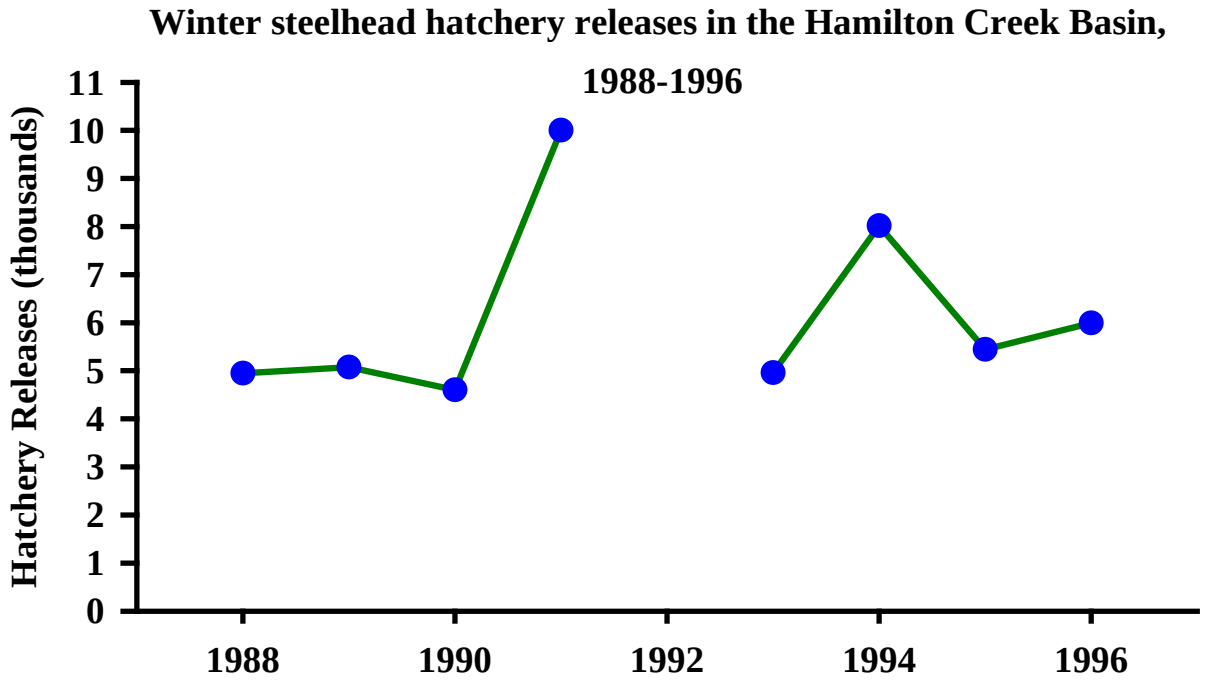
- Adult migration timing for Hamilton Creek winter steelhead is from December through April
- Spawning timing on Hamilton Creek is generally from early March to early June
- Age composition data for Hamilton Creek winter steelhead are not available
- Wild steelhead fry emerge from March through May; juveniles generally rear in fresh water for two years; juvenile emigration occurs from April to May, with peak migration in early May

Diversity

- Hamilton Creek winter steelhead stock is designated based on distinct spawning distribution
- Wild stock interbreeding with Skamania and Beaver Creek Hatchery brood stock is a potential concern

Abundance

- In 1936, steelhead were reported in Hamilton Creek during escapement surveys
- Wild winter steelhead escapement estimates for Hamilton Creek are not available



Productivity & Persistence

- Winter steelhead natural production is expected to be low
- Baseline risk assessment determined a high risk of extinction for winter steelhead in lower Columbia Gorge Tributaries

Hatchery

- There are no hatcheries on Hamilton Creek; hatchery winter steelhead from the Skamania (Washougal) and Beaver Creek (Elochoman) Hatcheries have been planted in the basin since 1958; release data are displayed from 1988-1991
- Hatchery fish contribute little to natural winter steelhead production in the Hamilton Creek basin

Harvest

- No directed commercial or tribal fisheries target Hamilton Creek winter steelhead; incidental mortality currently occurs during the lower Columbia River spring Chinook tangle net fisheries
- Treaty Indian harvest does not occur in the Hamilton Creek basin
- Winter steelhead sport harvest (hatchery and wild) in Hamilton Creek from 1977-1986 averaged 21 fish; since 1992, regulations limit harvest to hatchery fish only
- ESA practice limits fishery impact on Hamilton Creek wild winter steelhead in the mainstem Columbia River and in Hamilton Creek

Other Species

Pacific lamprey – Information on lamprey abundance is limited and does not exist for Columbia lower tributary populations. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have declined in the Columbia Lower Tributaries as well. Adult lamprey return from the ocean to spawn in the spring and summer. Juveniles rear in freshwater up to seven years before migrating to the ocean.

O.3.3. Subbasin Habitat Conditions

This section describes the current condition of aquatic and terrestrial habitats within the basin. 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

The Lower Gorge Tributaries have not had substantial impacts to hydrologic regimes, as much of the area is steep and is now protected by the provisions of the Columbia River Gorge National Scenic Area legislation. There are no permanent stream gages in the basin and little information exists on flow conditions. The streams follow the same general pattern as precipitation due to a lack of storage in the form of impoundments or permanent snowpacks.

The operation of Bonneville Dam has altered flow regimes to some degree in lower Greenleaf and Hamilton Creeks due to reduced connections to overflow channels (Wade 2001). Manipulation of stream flow occurs in a couple of streams. In lower Gibbons Creek, flow exceeding 70 cfs is diverted out of the elevated, artificial channel and into a remnant channel. In Duncan Creek, flow is impounded at the dam near the mouth during the summer months to provide a recreational pond for area residents. Flows are released through the dam at other times of the year to provide adequate passage flows for fish.

Hydrologic (runoff) conditions were investigated as part of the Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter. The IWA results indicate that watershed conditions in 3 of the 7 subwatersheds are “impaired” with respect to conditions that influence runoff; 3 are “moderately impaired”; and only 1 is rated as “functional” (upper Hamilton Creek). The greatest impairments are located in the Lawton Creek, Hardy/Woodward Creek, Duncan Creek, and Indian Mary Creek basins. Runoff impairment in the basin is related primarily to low quantities of mature forest and high road densities. Nearly 60% of the land cover in the Gibbons and Lawton Creek basins is in either non-forest (i.e. urban, agriculture) or other (i.e. cleared, scrub) cover. Over 46% of the land cover in the Duncan, Woodward, Hardy, Hamilton, and Greenleaf Creek basins is in these categories. Land cover conditions, combined with moderate-to-high road densities (>2 mi/mi^2), increase the risk of elevated peak flows and reduced base flows.

An instream flow study utilizing the toe-width method was conducted in 1998 on Gibbons, Lawton, Duncan, Woodward, Hardy, Greenleaf, and Hamilton Creeks. Spot flow measurements were taken at three different times in the fall to compare to optimal flows for salmon and steelhead. Results suggested that for all streams, the flows were well below optimum for both salmon and steelhead spawning and rearing from the first part of September to November (Caldwell et al. 1999). Summer low flow problems have also been observed at the mouths of several streams and may possibly restrict fish passage and strand juvenile fish (Wade 2001).

Current and projected future consumptive water use in the basin is believed to represent a threat to instream flows where development may occur. Surface water rights appropriation has not been closed for these streams (LCFRB 2001).

Passage Obstructions

An historical wetland complex on Gibbons Creek was modified in 1966, creating fish passage problems. Fish passage restoration efforts completed in 1992 resulted in an elevated artificial channel with a fish ladder structure at the mouth. Observations in the summer of 2000 suggest that there may be some passage problems associated with the fish ladder and low flows at the mouth area. Passage problems are also associated with the structure that diverts water into the elevated channel at the head of the historical wetland complex. Bedload buildup during stormflows restricts overflow through a screened intake that feeds the wetlands, overwhelming the diversion channel and spilling fish into adjacent fields, where they become stranded (Wade 2001). Several culverts and other artificial barriers also block passage within the Gibbons Creek basin. Details are given in Wade (2001).

Culverts under State Route 14 and the railroad corridor provide various levels of passage concerns on Mary Creek, Woodward Creek, and Hardy Creek. Passage has been blocked on Greenia Creek (Hardy Creek tributary) to prevent fish access to a wetland managed as a western pond turtle refuge. On many of the streams, there are concerns with low flow problems associated with sediment buildup where the streams enter the Columbia. Flow becomes subsurface at times during the summer.

In the past, an earthen dam near the mouth of Duncan Creek restricted anadromous passage to this important chum spawning stream. Restoration of passage has been accomplished with the installation of a dam and fishway that allow for passage at critical migration periods, but retain recreational lake levels during the summer months.

Water Quality

Gibbons Creek is listed on the state 303(d) list for violation of fecal coliform standards. Fecal coliform levels are believed to originate from failing septic systems and small livestock operations. The greatest proportion of the fecal coliform load comes from the Gibbons Creek tributary Campen Creek (Post 2000). Temperature monitoring in the Gibbons Creek basin in the late 1990s showed regular exceedances of the state standard (64°F [18°C]) in lower Gibbons Creek and lower Campen Creek. This likely is a result of the low riparian canopy cover levels in these reaches. Water temperatures exceeded 68°F (20°C) in lower Hardy Creek on a few summer days in 1998 and 1999. Water temperature information is generally lacking for other streams.

The USFWS conducted a benthic macroinvertebrate survey at 4 sites on Gibbons and Campen Creek using the Benthic Index of Biotic Integrity (B-IBI). This survey methodology uses the presence of particular benthic macroinvertebrate communities as an indicator of overall stream health (Kerans and Karr 1994). Results revealed poor riffle and pool habitat in Campen Creek along the golf course and fair to excellent riffle and pool habitat conditions at the other locations (Wade 2001).

Nutrient deficiencies are an assumed problem due to low anadromous salmonid escapement levels compared to historical conditions. Low returns can reduce the input of carcass derived nutrients into stream systems.

Key Habitat Availability

State Highway 14 and the Burlington Northern Santa Fe Railroad impact channel morphologies in the lower reaches of most streams. Pool habitat was found to be lacking in 13 out of 19 surveyed reaches in Woodward, Duncan, Good Bear, Hardy, Hamilton, and Greenleaf Creeks. Eight of 11 surveyed reaches in the Gibbons Creek basin had less than 15% of the stream surface area in pools, though a few pools in the basin have considerable area and depth that may provide adequate habitat (Wade 2001).

The presence of side channel habitats is limited to only the lower portions of most of the streams. State Route 14, the railroad, and other development have isolated some of the historical side channels. There is some good side channel and off-channel habitat in lower Hamilton Creek, including the Hamilton Springs chum spawning channel. Minimal side or off-channel habitat exists in Woodward, Good Bear, Hardy, Duncan, or Greenleaf Creeks. Historically abundant side channel habitat was eliminated in Gibbons Creek as a result of modifications to wetlands in the lower reaches. The stream currently courses though an elevated artificial channel in its lower mile (Wade 2001).

Substrate & Sediment

USFWS surveys indicate that fine sediment is a problem throughout the Gibbons Creek basin, with all of the 11 surveyed reaches having greater than 18% fines. Only a few reaches in the upper Gibbons Creek basin had substrates suitable for salmonids. USFS surveys revealed that only the 2 upper reaches of Woodward Creek suffered from embedded substrates and that most surveyed streams consisted primarily of gravels. Local experts have expressed a concern over fine sediments in spawning areas in Hardy Creek. While Hamilton Creek does not suffer from fine sediment problems, there are concerns with the effect of bedload instability on chum production (Wade 2001). Many streams deposit large amounts of coarse sediment as they emerge from steep canyons in the Gorge. Some of this material does not reach important spawning areas due to artificial obstructions and it also creates problematic changes to channel morphology as it is routed through culverts and diversions.

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The IWA rated all the subwatersheds in the basin as "moderately impaired" with respect to landscape conditions that influence sediment supply. Sediment supply impairments are related to steep slopes and moderately high road densities. Average road densities in the basin fall between 2-3 mi/mi^2, considered moderate by most standards. There are a total of approximately 26 miles of stream-adjacent roads and an average of over four stream crossings per mile. These conditions may serve to increase sediment production and delivery to stream systems.

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

USFS surveys noted low LWD levels in Woodward, Duncan, Good Bear, Hamilton, and Greenleaf Creeks, with a general increase in LWD levels in the upstream direction. All surveyed reaches had less than 0.2 pieces of LWD/meter of stream. Lower Hamilton and Greenleaf Creeks had the lowest amounts. Medium and large LWD is also lacking in the Gibbons Creek basin, with all surveyed reaches receiving a poor rating. LWD levels are also considered low in Hardy and Indian Mary Creeks (Wade 2001).

Channel Stability

Information on bank stability is largely lacking. USFS surveys between 1994 and 1996 revealed generally good bank stability conditions on Hamilton and Greenleaf Creeks, except for a couple of portions of lower Hamilton Creek. Lower Woodward Creek is considered very unstable below the railroad. USFS surveys found moderately high width/depth ratios on many of the lower reaches of streams, indicating the potential for lateral bank erosion (Wade 2001).

Riparian Function

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, riparian conditions are "moderately impaired" in all but 1 of the 7 subwatersheds in the basin. Only the upper Hamilton Creek subwatershed received a rating of "functional". These results are consistent with an analysis of georeferenced Landsat satellite imagery data, which revealed that less than 10% of the riparian forests in the basin were in mid- to late-seral stages, and most of these were located in upper tributaries above the extent of anadromous habitats (Lewis County GIS 2000). Surveys by the USFS in the mid-1990s also revealed generally poor riparian conditions; only 5 of 18 surveyed reaches contained any large trees and most of the riparian areas were dominated by shrub/seedling, pole/sapling, or small tree associations. Riparian areas lack coniferous cover along lower Lawton Creek where Himalayan blackberry dominates. The Woodward Creek basin has experienced extensive logging and the riparian areas are dominated by deciduous species. Despite generally poor riparian conditions throughout the basin, surveys of canopy density in the Gibbons Creek basin showed good (>75%) cover in all but 2 reaches. These are lower Gibbons Creek (65%), where the stream flows in the artificial diversion channel, and lower Campen Creek (64%), where the stream flows through a golf course (Wade 2001).

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

Most of the Lower Gorge Tributaries emerge from steep canyons in the Columbia Gorge and historically contained only short sections with floodplains just upstream of their confluence with the Columbia. State Route 14, the railroad corridor, and other developments have largely eliminated floodplain connection and function (Wade 2001).

An historical wetland complex on lower Gibbons Creek was diked, drained, and diverted in the 1960s and fish passage problems were created. In an effort to restore the wetlands and fish passage, an artificial, elevated channel was constructed that provides access to spawning grounds further upstream. As a result, the stream has been disconnected from its floodplain in the lower mile, and fish access has been blocked to off-channel habitats that once existed in the Gibbons Creek and Columbia River floodplains (Wade 2001). On the Gibbons Creek tributary Campen Creek, a golf course has reduced the availability of complex floodplain habitats.

Floodplain connection has been disrupted on various other streams due to dikes, filling, gravel mining operations, channelization, and diversion. See Wade (2001) for a complete description.

O.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 Gorge Tributaries steelhead, chum, fall Chinook and coho. 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, which is most useful for practitioners who will be developing and implementing specific recovery actions.

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 for winter steelhead, fall Chinook, chum and coho in the lower Columbia Gorge basins of Hardy, Hamilton, and Duncan Creeks (HHD). Salmon and steelhead use has also been documented in several other small Lower Gorge Tributaries (i.e. Gibbons and Lawton Creeks), but abundance in these streams is believed to be low. Although the EDT model was run independently for HHD Creeks, the model outputs of these streams have been combined.

Model results indicate that adult productivity has declined for all species (Table O-2). Both chum and winter steelhead have seen the sharpest decline in productivity, with current estimates at approximately 30% of historical levels. Adult abundance has also declined for all species in the Lower Gorge basins (Figure O-4). Fall Chinook, winter steelhead, and coho abundance has declined by 45%, 56%, and 40% from historical levels, respectively. Chum abundance has declined more significantly, to only 14% of historical levels. Species diversity (as measured by the diversity index) has remained relatively constant for chum but has decreased by 47% for winter steelhead, by 50% for fall Chinook, and by 58% for coho (Table O-2).

Smolt productivity numbers are also lower for each species, except chum (Table O-2). This higher smolt productivity is an artifact of the way the EDT model calculates productivity. That is, the higher productivity of chum smolts is because Lower Gorge Tributaries chum now have many less trajectories (life history pathways) that are viable (those that result in return spawners); but the few trajectories that remain have higher productivities than historical trajectories (many of which were only marginally viable). Smolt abundance numbers have also declined for all species (Table O-2). Current smolt abundance estimates range from 42% of historical levels for coho to 69% of historical levels for winter steelhead.

Table O-2. Lower Gorge Tributaries— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient) and historical (T or template) 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	124	225	4.4	7	0.44	0.88	36,961	64,512	817	1,130
Chum	797	5,842	3.5	11.4	0.97	1	80,161	166,842	164	137
Coho	251	416	4.3	9.9	0.41	0.98	7,638	12,776	142	312
Winter Steelhead	244	556	15.7	45.8	0.4	0.76	2,400	3,496	188	344

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

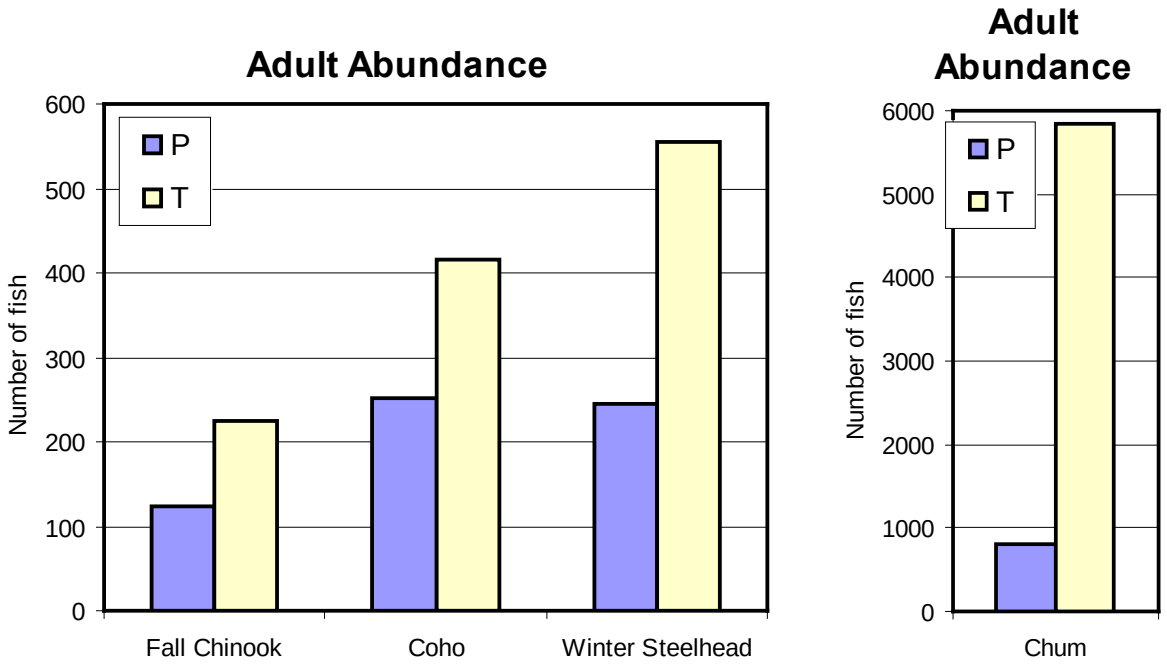


Figure O-4. Adult abundance of Lower Gorge Tributaries fall Chinook, coho, winter steelhead, and chum based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

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 basin.

The Lower Gorge Tributaries of Hardy, Hamilton, and Duncan Creeks (HHD) were divided into numerous individual reaches. These reaches represent the low gradient, lower portions of these systems that are accessible to anadromous fish. Upstream of these reaches, gradients increase dramatically where the stream valleys carve through the steep valley walls of the Columbia Gorge. Hamilton Creek has the greatest length and capacity for fish, and also has the longest tributary, Greenleaf Creek. See Figure O-5 for a map of stream reaches within the Lower Gorge basins.

Important areas for chum include the Duncan Lake outlet (reach Lake Outlet), lower Hamilton (Hamilton 1A, Hamilton 2 and Hamilton Springs) and Hardy Creeks (Hardy 2) (Figure O-6). These reaches include some of the most productive chum spawning and rearing areas in the basin. These reaches (especially Lake Outlet) show a strong habitat preservation emphasis. There is only one high priority reach for fall Chinook, located in lower Hamilton Creek (Hamilton 1A) (Figure O-7). This high priority reach has a combined habitat preservation and restoration emphasis. High priority reaches for coho are located in Hamilton, Duncan, and Greenleaf Creeks (Hamilton 2-3, Greenleaf Creek 1, & Duncan 1) (Figure O-8). Although these areas are considered important spawning reaches, the available habitat has been degraded. As a result, high priority reaches show potential restoration value. There is only one high priority reach for winter steelhead; located in upper Hamilton Creek (Hamilton 4) (Figure O-9). This reach is important for steelhead spawning, and is the least degraded. This reach has strong habitat preservation value.

Figure O-5. Lower Gorge Tributaries EDT reaches. Some reaches are not labeled for clarity.

HHD Chum

Potential change in population performance with degradation and restoration

Reach	Reach Group	Recovery Emphasis	Change in Abundance with		Change in Productivity with		Change in Diversity Index with	
			Degradation	Restoration	Degradation	Restoration	Degradation	Restoration
Lake outlet	H	P						
Hamilton 1_A	H	P						
Hamilton 2	H	P						
Hardy 2	M	P						
Hamilton Springs	M	P						
Hardy 3	L	P						
Duncan Springs	L	P						
Duncan Lake	L	R						
Hamilton 1_B	L	P						
Hardy 1 Slough	L	P						
Duncan Dam	L	PR						
			-110% 0% 110%		-110% 0% 110%		-110% 0% 110%	
			Percentage change		Percentage change		Percentage change	

Figure O-6. Lower Gorge Tributaries (HHD) 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. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Percentage change values are expressed as the change per 1000 meters of stream length within the reach.

HHD Fall Chinook

Potential change in population performance with degradation and restoration

Reach	Reach Group	Recovery Emphasis	Change in Abundance with		Change in Productivity with		Change in Diversity Index with	
			Degradation	Restoration	Degradation	Restoration	Degradation	Restoration
Hamilton 1_A	H	PR						
Hamilton 1_B	M	P						
Hamilton 2	L	P						

-40% 0% 40% Percentage change | -40% 0% 40% Percentage change | -40% 0% 40% Percentage change

Figure O-7. Lower Gorge Tributaries (HHD) 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. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Percentage change values are expressed as the change per 1000 meters of stream length within the reach.

Hamilton-Hardy-Duncan Coho

Potential Change in Population Performance with Degradation and Restoration

Geographic Area	Reach Group	Recovery Emphasis	Change in Abundance with		Change in Productivity with		Change in Diversity Index with	
			Degradation	Restoration	Degradation	Restoration	Degradation	Restoration
Hamilton 2	H	R						
Hamilton 3	H	R						
Greenleaf Creek 1	H	PR						
Duncan 1	H	PR						
Hamilton Springs	M	R						
Hardy 3	M	PR						
Duncan Springs	M	P						
Lake outlet	M	PR						
Greenleaf Creek 3	M	PR						
Hamilton 1_A	M	R						
Duncan Lake	M	R						
Hardy 2	M	PR						
Greenleaf Creek 2	M	PR						
Duncan 2	M	PR						
Hamilton Channel	L	PR						
Wood_Dunc Chan	L	P						
Hamilton 1_B	L	P						
Hamilton 4	L	R						
Greenleaf Slough	L	P						
Hardy 1 Slough	L	P						
Greenleaf outlet	L	P						
Duncan Dam	L	PR						

-40% 0% 40% Percentage change | -40% 0% 40% Percentage change | -40% 0% 40% Percentage change

Figure O-8. Lower Gorge Tributaries (HHD) coho ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Percentage change values are expressed as the change per 1000 meters of stream length within the reach.

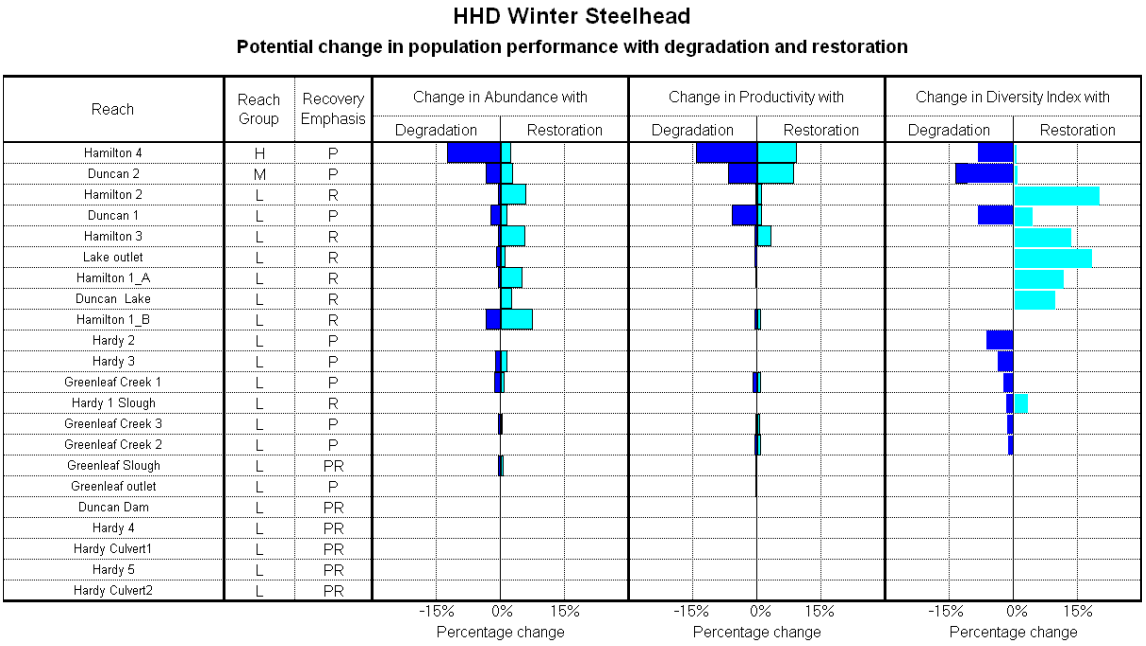


Figure O-9. Lower Gorge Tributaries (HHD) winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Percentage change values are expressed as the change per 1000 meters of stream length within the reach.

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 O-3.

Table O-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 Gorge Tributaries Chum				
most critical	Egg incubation	sediment	channel stability, harassment, key habitat	
second	Prespawning holding	habitat diversity, harassment, key habitat	temperature	
third	Spawning	habitat diversity, harassment	temperature	
Lower Gorge Tributaries Winter Steelhead				
most critical	Egg incubation	sediment	temperature	
second	0-age summer rearing	flow, temperature		
third	Fry colonization	flow		
Lower Gorge Tributaries Fall Chinook				
most critical	Spawning	temperature	key habitat	
second	Prespawning migrant	key habitat		
third	Prespawning holding	flow, habitat diversity, harassment, temperature, key habitat		
Lower Gorge Tributaries Coho				
most critical	0-age summer rearing	temperature, habitat diversity	competition (hatchery), flow, food, pathogens, predation	
second	Egg incubation	sediment, key habitat	channel stability	
third	0-age winter rearing	habitat diversity	key habitat	channel stability, flow, food, predation

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.

All reaches modeled for fall Chinook are in Hamilton Creek. These areas have been negatively impacted by a loss of key habitat, increased sediment, predation, flow and channel stability among others (Figure O-10). Habitat diversity and key habitat are low due to low quantities of instream LWD and channel incision/floodplain disconnection. Sediment impacts originate from upstream hillslope and channel sources. Temperature alteration is due to a lack of riparian shading and increased channel widths. For chum, the important reaches have suffered negative impacts from a loss of habitat diversity, loss of key habitat, increased sedimentation, and harassment (Figure O-11). A lack of riparian function and low LWD levels contribute to habitat diversity problems. Sediment and key habitat impacts are similar to those discussed above for fall Chinook.

In the priority areas for winter steelhead, key habitat, sediment, and temperature have the largest impacts (Figure O-12). Key habitat has been reduced by loss of side channels and by subsurface flow conditions that reduce available summer rearing and holding habitat. Sediment, which originates primarily from upper basin sources, settles out in these low gradient reaches, impacting egg incubation and fry emergence. Flow alterations are also due to upper basin conditions, whereas temperature concerns are related to a lack of shade from riparian forests.

Important reaches for coho are located in Hamilton, Duncan, and Greenleaf Creeks. A suite of factors has negatively impacted these areas, including impairments related primarily to fine sediment, key habitat, competition with hatchery fish, and temperature (Figure O-13). The causes of these impacts are similar to those discussed above for the other populations.

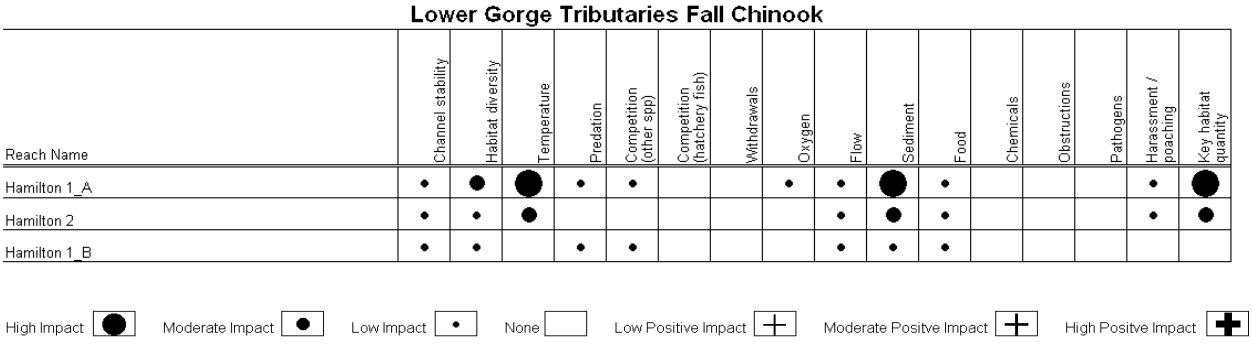


Figure O-10. Lower Gorge Tributaries (HHD) fall Chinook habitat factor analysis. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams.

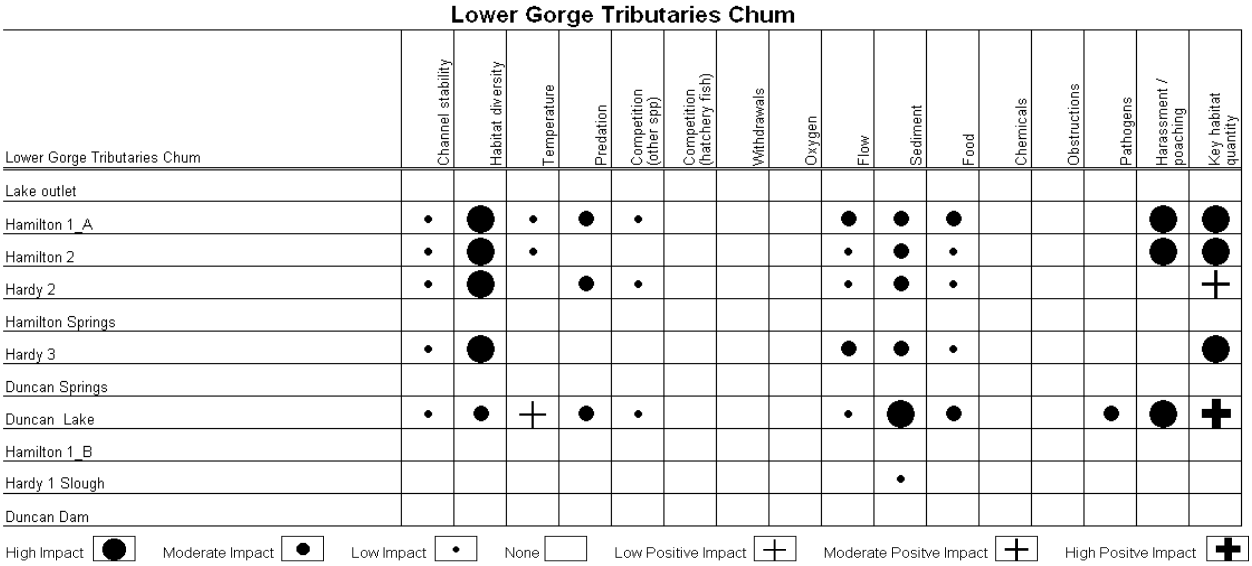


Figure O-11. Lower Gorge Tributaries (HHD) chum habitat factor analysis. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams.

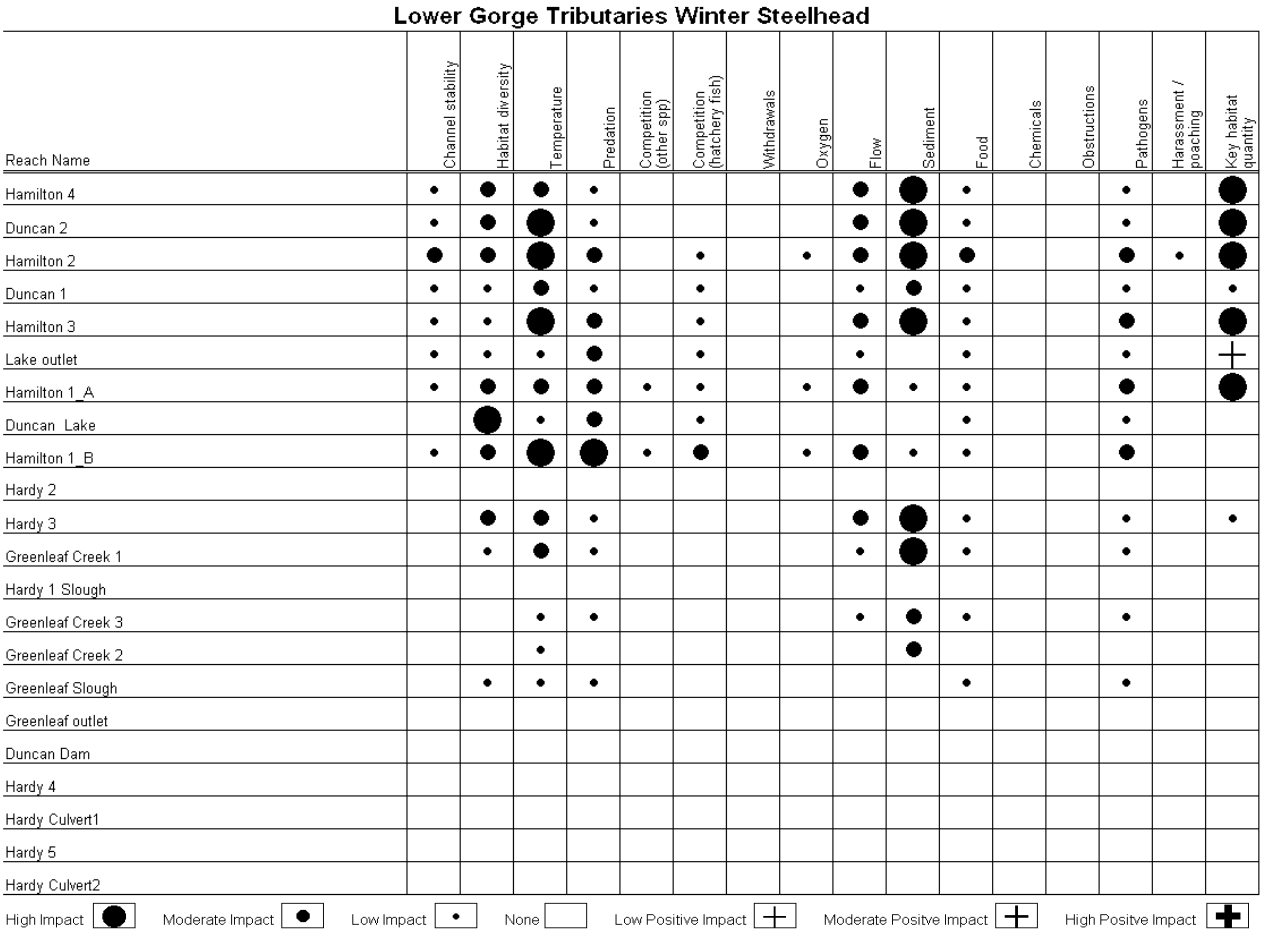


Figure O-12. Lower Gorge Tributaries (HHD) winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams.

Hamilton-Hardy-Duncan Coho
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*
Hamilton 2	●		●		●	●	●	●					●	●		●
Hamilton 3			●		●	●	●						●	●		●
Greenleaf Creek 1						●							●	•		●
Duncan 1			●		●	●	●						●	•		●
Hamilton Springs																●
Hardy 3					●		●						●	•		●
Duncan Springs			●													●
Lake outlet	●		●	●	●	●	●				●	●		•		
Greenleaf Creek 3					●	●	●						●	•		●
Hamilton 1_A			●		●	●						●		●		●
Duncan Lake	●		●	●		●	●	●			●	●	●	•		●
Hardy 2	●				●		●					●	●	•		●
Greenleaf Creek 2	●				●	●	●						●	•		●
Duncan 2	●				●		●						●	•		●
Hamilton Channel			●				●				●	●		•		
Wood_Dunc Chan							●					●				
Hamilton 1_B			●	●	●	●	●					●		●		
Hamilton 4	●						●						●	•		●
Greenleaf Slough						●	●							•		
Hardy 1 Slough				●	●		●					●	●	•		●
Greenleaf outlet						●										
Duncan Dam																

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

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

A ● High B ● Medium C • Low D & E ▭ Indirect or General

Figure O-13. Lower Gorge Tributaries (HHD) coho habitat factor analysis diagram. This diagram differs slightly from the diagrams for other HHD populations in that the size of the dot only reflects the within-reach importance of habitat factors and does not reflect the importance of factors between reaches. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams.

O.3.5. 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 Gorge Tributaries watershed is comprised of several independent tributaries to the Columbia River, including Hamilton Creek, Hardy Creek, and Duncan Creek. IWA results for the Lower Gorge Tributaries watershed are shown in Table O-4. A reference map showing the location of each subwatershed in the basin is presented in Figure O-14. Maps of the distribution of local and watershed level IWA results are displayed in Figure O-15.

Hydrology

Current Conditions— The upper Hamilton Creek subwatershed (70102) is rated as functional for hydrology, with the remaining six subwatersheds split equally between moderately impaired and impaired ratings. Except for lower Hamilton Creek (70101), all subwatersheds in the area are terminal (i.e., having no upstream subwatersheds); thus, the watershed level results are the same as the local level results.

Functional hydrology conditions in upper Hamilton Creek are driven by relatively extensive mature forest coverage (64%) and moderate road densities (2.0 mi/sq mi). Impervious surface areas are low in this lightly developed area. Over half (53%) of upper Hamilton Creek is in public lands, administered by WDNR and Beacon Rock State Park.

Hydrologic conditions are rated moderately impaired in the lower Hamilton/Greenleaf Creek subwatershed (70101). Lower Hamilton Creek is rated as moderately impaired, based on moderate mature forest coverage levels (43%) and moderately high road densities (4.2 mi/sq mi). Roads in the lower Hamilton Creek/Greenleaf Creek subwatershed are concentrated around the Bonneville Dam facilities, which are located in the low lying areas of the watershed. Road densities in the upland areas of this subwatershed are considerably lower. Thus, the moderately impaired hydrology rating for subwatershed 70101 most likely overstates actual conditions, which may be closer to functional. In the lower Hamilton/Greenleaf Creek subwatershed, 19% is publicly owned (WDNR, state parks, and USACE). Development and land use regulations are relatively strict in the Columbia Gorge National Scenic Area.

Hydrologic conditions in Hardy and Duncan Creeks (70201, 70202) are rated impaired. Duncan Creek subwatershed (70201) has low mature forest coverage (17%) and moderately high road densities (3.4 mi/sq mi). As with lower Greenleaf Creek, a significant portion of road length in these subwatersheds is concentrated in the low-lying areas adjacent to the Columbia River. Therefore, the hydrologic conditions rating may overstate actual conditions, which may lean more towards moderately impaired. Several powerline right of ways traverse these drainages, affecting forest cover.

Hydrologic conditions in Lawton Creek subwatershed (70402) are impaired and are moderately impaired in Gibbons Creek (70401) and in 70302. Impairments here are related to young forests and high road densities (>3 miles/mi2).

Predicted Future Trends— Given the relatively high percentage of public lands in upper Hamilton Creek and upper Greenleaf Creek, combined with the land management regulations of the CRGNSA, the extent of hydrologically mature forest coverage in subwatersheds 70101 and 70102 is expected to expand over time with only limited increases in road density and development. Hydrologic conditions are therefore predicted to trend towards gradual improvement as forest cover matures.

Given the land management regulations of the CRGNSA, the extent of hydrologically mature forest cover in Hardy and Duncan Creek subwatersheds (70201, 70202) is expected to expand over time with only limited increases in road density and development. Hydrologic conditions are therefore predicted to trend towards gradual improvement as forest cover matures.

Table O-4. IWA results for the Lower Gorge Tributaries Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
70101	M	M	M	M	M	70102
70102	F	M	F	F	M	none
70201	I	M	M	I	M	none
70202	I	M	M	I	M	none
70301	M	M	M	M	M	none
70401	M	M	M	M	M	none
70402	I	M	M	I	M	none

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800030#####.

[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.

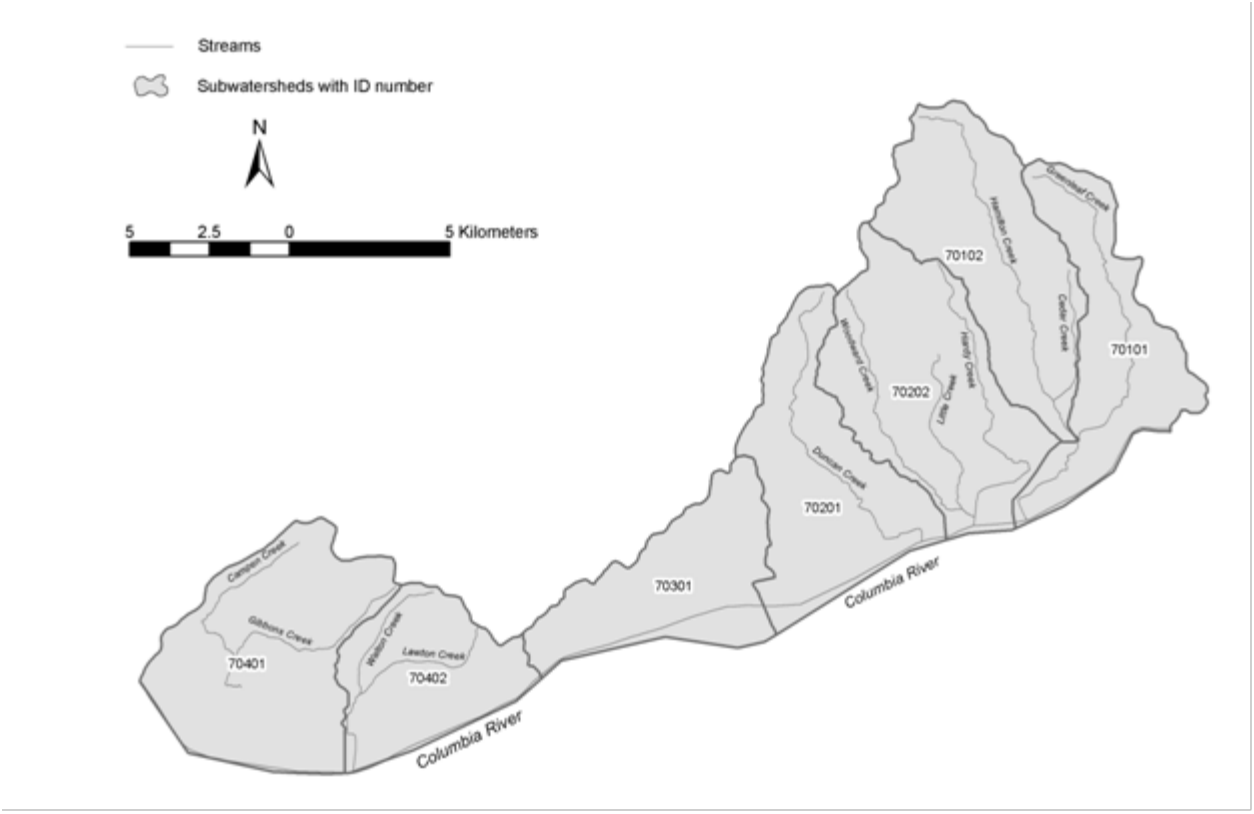


Figure O-14. Map of the Lower Gorge Tributaries Basin showing the location of the IWA subwatersheds.

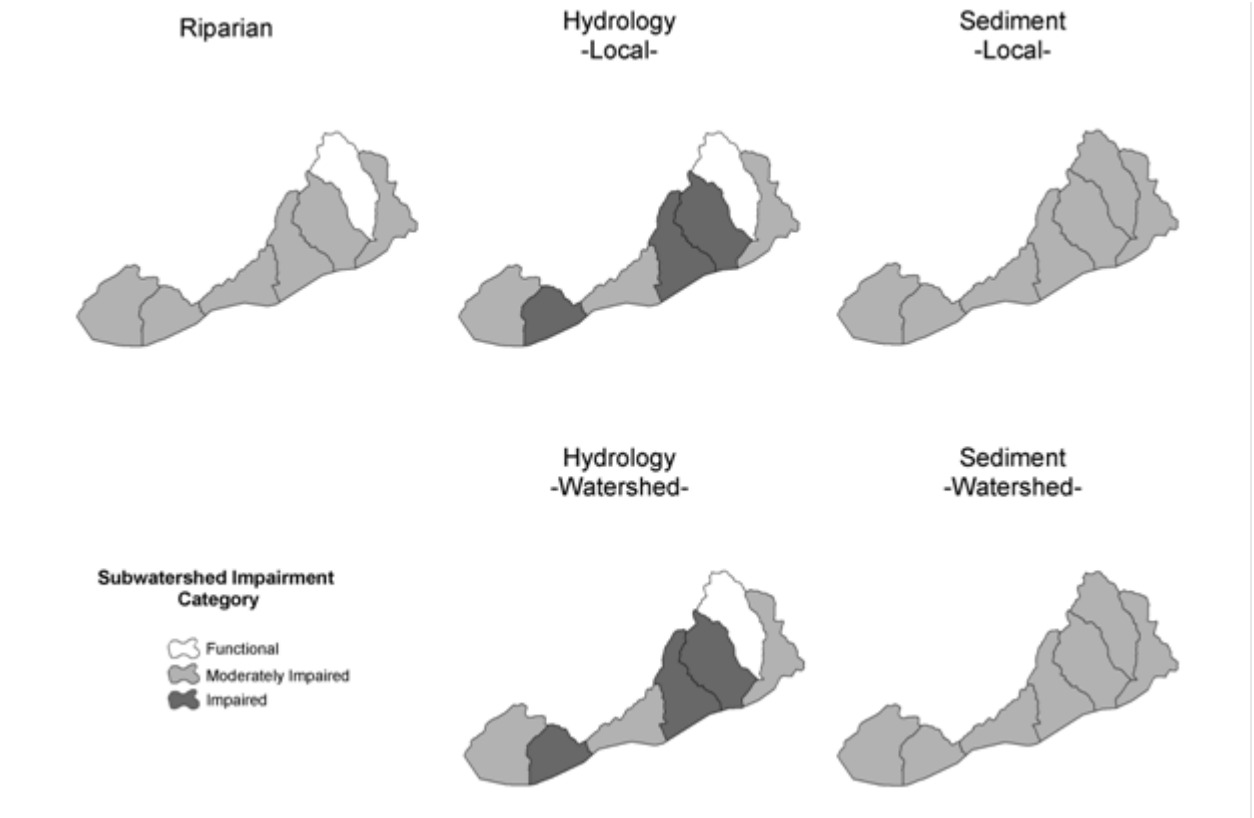


Figure O-15. IWA subwatershed impairment ratings by category for the Lower Gorge Tributaries.

Sediment Supply

Current Conditions— Sediment conditions in the Lower Gorge Tributaries watershed are rated as moderately impaired. As with hydrology, local and watershed level impairments are the same.

Erodability ratings for upper Hamilton Creek (70102) are low, whereas lower Hamilton/Greenleaf Creek (70101) is rated moderately low (7 and 26, respectively, on a scale of 0-126). The sediment supply rating for upper Hamilton Creek is borderline functional, only slightly above the threshold for a moderately impaired rating. Ratings for lower Hamilton/Greenleaf Creek are driven by high road densities on erodable geology in the low lying areas. Sediment conditions in the uplands are expected to be similar to upper Hamilton Creek, leaning towards functional. Streamside roads, which represent a significant potential source of erosion, are relatively infrequent (averaging less than 0.2 mile/mile of stream). This average is skewed by the high concentration of roads adjacent to the Columbia River and associated with Bonneville Dam facilities. Averages in the upstream areas are probably closer to 0.1 mile/stream mile.

Sediment conditions in Hardy and Duncan Creeks (70201, 70202) are rated as moderately impaired. Natural erodability ratings in this drainage are moderately low. The moderately impaired ratings are primarily driven by high road densities on erodable geology in the lowlands. Upland areas of the drainage have higher road densities relative to Hamilton Creek, exceeding 3 mi/sq mi. Streamside road densities in Duncan Creek are moderately high, approaching 0.5 mile/stream mile. Again, this average is skewed somewhat by the high density of roads adjacent to the Columbia River.

Sediment supply conditions are moderately impaired in Lawton Creek (70402), Gibbons Creek (70401), and subwatershed 70301. Road densities exceed 3 mi/mi2 in 70402 and 70401.

Predicted Future Trends.— Given the extent of state park lands within both Hamilton Creek subwatersheds (70101 and 70102) and the low likelihood of expanding development or increasing forest road densities, sediment conditions are expected to trend stable in these subwatersheds.

Based on the high road densities and higher proportion of unsurfaced roads in the upper areas of the Duncan and Hardy Creek subwatersheds (70201, 70702), sediment conditions are predicted to trend stable over the next 20 years.

Riparian Condition

Current Conditions— Riparian conditions range from functional to moderately impaired. Upper Hamilton Creek (70102) is the only subwatershed rated as functional. Riparian conditions in lower Hamilton and Greenleaf Creek (70101) and Duncan Creek (70201) are rated as moderately impaired. These conditions track well with the hydrologically mature forest cover in these subwatersheds. Moderately impaired riparian conditions in Gibbons and Lawton Creek subwatersheds (70401, 70402) are related to residential and agricultural development.

Predicted Future Trends— Given the restrictive development regulations in the CRGNSA and the emphasis on restoration of riparian zones, riparian conditions in upper and lower Hamilton Creek, Duncan Creek, and Hardy Creek subwatersheds (70101, 70102, 70201, 70202) are predicted to trend towards improvement over the next 20 years. Conditions are expected to trend stable in Gibbons and Lawton Creek subwatersheds (70401, 70402).

O.3.6. 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 Gorge Tributaries and discusses their potential effects.

There are no hatcheries in the Lower Gorge Tributaries. Sporadic hatchery releases of fall Chinook, coho salmon, and winter steelhead have occurred over time. Hatchery winter steelhead from Skamania (Washougal) and Beaver Creek (Elochoman) stocks have been planted in Hamilton Creek beginning in 1958 and continued into the 1990s. In 1977, the Spring Creek NFH released approximately 50,000 tule fall Chinook in Hamilton Creek. In 1983, the Washougal Hatchery released late-run coho in Duncan and Greenleaf creeks. More specific information regarding the hatchery programs that have released fish into the Lower Gorge Tributaries is available in the appropriate sections presenting information on each hatchery.

A spawning population of upriver bright fall Chinook was discovered in 1994 in the mainstem Columbia River immediately downstream of Bonneville Dam. The population is considered to have originated from hatchery strays from the Bonneville Hatchery in Oregon and the Little White Salmon NFH in Washington. Allozyme analysis indicated that this population was genetically distinct from other Columbia River bright fall Chinook stocks, although the population resembles Yakima bright fall Chinook and upriver bright fall Chinook produced at the Little White Salmon NFH and the Bonneville Hatchery. This population is not considered part of the LCR Chinook salmon ESU.

A chum salmon hatchery program was recently started at the Washougal Hatchery with releases beginning in 2003. The program uses Hardy Creek chum for broodstock; the program goal is to enhance chum returns to Duncan Creek. The hatchery program occurs in conjunction with habitat restoration efforts in Duncan Creek. This program also acts as a safety-net in the event that mainstem Columbia flow operations severely limit the natural spawning of chum salmon in Hamilton and Hardy creeks and the Ives Island area below Bonneville.

Table O-5. Lower Gorge Tributaries hatchery production

Hatchery	Release Location	Chum
Washougal	Duncan Creek	100,000

Hatchery Program 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 O-6 identifies hazard levels associated with risks involved with hatchery programs in the Lower Gorge Tributaries. Table O-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 O-6. Preliminary BRAP for hatchery programs affecting populations in the Lower Gorge Tributaries.

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.
	Hazard not relevant to population

Bonneville Tributary Population	Hatchery Program: Name	Release (millions)	Risk Assessment of Hazards: 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	Washougal Chum (Duncan Cr.)	0.080				○	○	○				○	○	○
Spring Chinook	Washougal Chum (Duncan Cr.)	0.080				○	○	○				○	○	○
Chum	Washougal Chum (Duncan Cr.)	0.080	○	○	○	○	○	○	○	?	○	○	○	○
Winter Steelhead	Washougal Chum (Duncan Cr.)	0.080				○	○	○				○	○	○

Table O-7. Preliminary strategies proposed to address risks identified in the BRAP for Lower Gorge Tributaries populations.

Bonneville Tributary Population	Hatchery Program: Name	Release (millions)	Risk Assessment of Hazards: 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 Abatement
Fall Chinook	Washougal Chum (Duncan Cr.)	0.080															
Spring Chinook	Washougal Chum (Duncan Cr.)	0.080															

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 Lower Columbia Gorge Tributaries, the following recommendations were made:

Duncan Creek – Chum

The HSRG recommends continuation of the hatchery program using local natural-origin broodstock as available and broodstock from natural origin returns from the Lewis River as necessary. Fry should be adipose fin-clipped to distinguish HOR from NOR adults. Monitoring of hatchery strays in spawning escapement and natural production should also occur. This program should include a "sunset" clause that would suspend the program after three generations, unless evidence suggests otherwise.

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 (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 (like the Lower Gorge Tributaries) are closed to the retention of Chinook. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Table O-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 spring Chinook, coho, and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

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 (like the Lower Gorge Tributaries) are closed to the retention of Chinook. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Table O-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
Spring Chinook	13	5	1	1	2	**22**	53	65
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	n/a	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60
Coho	<1	9	6	2	1	**18**	51	85
Steelhead	0	<1	3	0.5	5	**8.5**	70	75

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 Colulmbia lower tributary sport fisheries. Chum are impacted incidental to fisheries directed at coho and winter steelhead.

Harvest of Columbia lower tributary coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish. The Lower Gorge Tributaries are closed to fishing for coho

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 Gorge Tributaries 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

There are no hydro-electric dams in the Lower Gorge Tributaries. However, spawning habitat for salmon is affected by fall and winter flows from Bonneville Dam and migrating fish are affected by changes in the Columbia River mainstem and estuary related to Columbia basin hydropower development and operation. The mainstem Columbia River and estuary provide important habitats for anadromous species during juvenile and adult migrations between spawning and rearing streams and the ocean where they grow and mature. These habitats are particularly important for fall Chinook 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 the Regional Recovery and Subbasin Plan 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, increased 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.

O.3.7. 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 O-16 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Lower Gorge Tributaries 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.

In the Lower Gorge Tributaries loss of tributary habitat quality and quantity accounts for the largest relative impact on all species except for fall Chinook which has equally sizeable impacts from harvest. Harvest has a sizeable effect on coho and fall Chinook, but is relatively minor for chum; harvest impact on winter steelhead is intermediate. Loss of estuary habitat quantity and quality is also relatively important for all species, but more so for chum. Coho are the only species heavily impacted by hatcheries in the basin. Predation impacts are substantial for winter steelhead. Hydrosystem access and passage impacts are important for fall Chinook and chum yet relatively minor for all other 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-occuring ocean mortality) are excluded. Not every factor of interest is included in this index – only readily-quantifiable impacts are included.

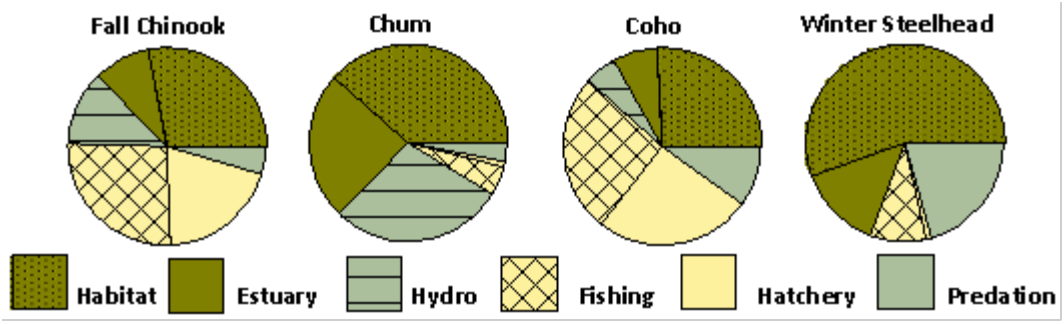


Figure O-16. Relative significance of potentially manageable impacts on Lower Columbia Gorge fish populations.

O.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 basin. These descriptions provide a context for descriptions of specific actions and responsibilities in the management plan portion of this subbasin plan. More detailed descriptions of these programs and projects can be found in the Comprehensive Program Directory (Appendix C).

O.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 Magnusen-Stevens Act, and enforcement authorities. NMFS administers the ESA under Section 4 (listing requirements), Section 7 (federal actions), and Section 10 (non-federal actions).

U.S. Army Corps of Engineers

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

Environmental Protection Agency

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

United States Forest Service

The Unites States Forest Service (USFS) manages federal forest lands within the Gifford Pinchot National Forest (GPNF) and the Columbia River Gorge National Scenic Area (CRGNSA). The GPNF operates under the Gifford Pinchot Forest Plan (GPFP). Management prescriptions within the GPFP have been guided by the 1994 Northwest Forest Plan, which calls for management of forests according to a suite of management designations including Reserves (e.g. late successional forests, riparian forests), Adaptively-Managed Areas, and Matrix Lands. Most timber harvest occurs in Matrix Lands. The GPNF implements a wide range of ecosystem restoration activities. The CRGNSA was established in 1986 to protect and provide for the enhancement of the scenic, cultural, recreational and natural resources of

the Gorge; and to protect and support the economy of the Columbia River Gorge area. CRGNSA lands designated as General Management Area are subject to review of new development and land use.

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.

O.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 & 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.

O.4.3. Local Government Programs

Clark County

Clark County is conducting Comprehensive Planning under the State's Growth Management Act. Clark County manages natural resources under various programs including Critical Areas Ordinance, ESA Program, Road Operations, Parks Operations, Stormwater Management, and the Conservation Futures Program.

Skamania County

Skamania County is not planning under the State's Growth Management Act in its Comprehensive Planning process. Skamania County manages natural resources primarily through a Critical Areas Ordinance. Skamania County has adopted special land use and environmental regulations implementing the Columbia River Gorge National Scenic Area Act for some areas within their jurisdiction.

Clark Conservation District

Clark Conservation District provides technical assistance, cost-share assistance, and project monitoring in Clark County. Clark CD assists agricultural landowners in the development of farm plans and in the

participation in the Conservation Reserve Enhancement Program. Farm plans optimize use, protect sensitive areas, and conserve resources.

Underwood Conservation District

The Underwood CD provides technical assistance, cost-share assistance, project and water quality monitoring, community involvement and education, and support of local stakeholder groups within the district. UCD implements a wide variety of programs, including conservation and restoration projects, water quality monitoring, a spring tree sales program, education and outreach activities, and support for local watershed committees.

O.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.

O.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.

O.4.6. NPCC Fish & Wildlife Program Projects

Re-introduction of Lower Columbia River Chum Salmon into Duncan Creek (Project 200105300)

Abstract: 2003 - Monitor and evaluate the success of the recently restored spawning channels for chum salmon at Duncan Creek. If necessary, jump start the population by collecting brood stock from adjacent populations. 2001 - Enhance spawning areas historically used by chum salmon in Duncan Creek. Jump-start the population by incubating eggs from adjacent stocks at this site. Conduct annual

spawning ground counts and estimate fry production. Funding Status: funded 2001, 2002, recommended 2003

Evaluate factors limiting Columbia River gorge chum salmon populations (Project 200001200)

Abstract: 2003 - Evaluate factors limiting chum salmon production in Hardy Creek, Hamilton Springs, and Columbia River side-channel. 2001 - Evaluate factors limiting chum salmon production, spawning group relationships, population dynamics, and biological and ecological characteristics of chum in tributaries and mainstem below Bonneville Dam; evaluate chum movements above Bonneville Dam. Funding Status: funded 2000, 2001, 2002, recommended for funding 2003

O.4.7. Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Restoration	Wood's Landing Chum Spawning Site	Lower Gorge Tributaries
Restoration	Hardy Creek Spawning and Rearing Channel	Lower Gorge Tributaries
Restoration	Duncan Creek Dam Fish Passage	Lower Gorge Tributaries
	Duncan Creek Dam Fish Restoration	Lower Gorge Tributaries
Restoration	Duncan Creek Restoration	Lower Gorge Tributaries
Restoration	Lower Hamilton Ck Restoration Phase I (Reach 2)	Lower Gorge Tributaries

O.5. Management Plan

O.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 Gorge Tributaries will play a key role in the regional recovery of salmon and steelhead. Natural populations of fall Chinook will be restored to a medium viability level and winter steelhead, chum, and coho will be restored to high levels of viability 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 Gorge Tributaries salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Lower Columbia 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.

O.5.2. Biological Objectives

Biological objectives for Lower Gorge Tributaries 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 the Regional Recovery and Subbasin Plan Volume I.

Focal populations in the Lower Gorge Tributaries 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.

The Lower Gorge Tributaries were identified as one of the most significant areas for salmon recovery among Washington Gorge subbasins based on fish population significance and realistic prospects for restoration. Recovery goals call for restoring Lower Gorge tributary coho, and winter steelhead to a high viability level. This level will provide for a 95% or better probability of population survival over 100 years. Recovery goals call for restoring Lower Gorge Tributaries fall Chinook to a medium viability level, providing for a 75-94% chance of persistence over 100 years. Recovery goals for restoring Lower Gorge Tributaries chum to a very high viability level, providing for a 99% chance of persistence over 100 years.

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 Columbia Lower Tributaries although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the basin.

Table O-9. Current viability status of Lower Gorge Tributaries populations and the biological objective status that is necessary to meet the recovery criteria for the Gorge strata and the lower Columbia ESU.

Species	Population	Recovery Priority[1]	Viability		Improve-ment[4]	Abundance		
			Status[2]	Obj[3]		Historical[5]	Current[6]	Target[7]
Fall Chinook (Tule)	L. Gorge	Contributing	VL	M	>500%	n/a[8]	<50	1,200
Chum	L. Gorge	Primary	H	VH	0%[9]	6,000	2,000	2,000
Winter Steelhead	L. Gorge	Primary	L	H	45%	n/a[8]	200	300
Coho	L. Gorge	Primary	VL	H	400%	n/a[8]	<50	1,900

[1] Primary, Contributing, and Stabilizing designations reflect the relative contribution of a population to major population group recovery goals.
[2] Baseline viability is based on Technical Recovery Team viability rating approach.
[3] Viability objective is based on the scenario contribution.
[4] Improvement is the relative increase in population production required to reach the prescribed viability goal
[5] Historical population size inferred from presumed habitat conditions using EDT Model and NMFS back-of-envelope calculations.
[6] Approximate current annual range in number of naturally-produced fish returning to the watershed.

[7] Abundance targets were estimated by population viability simulations based on viability goals.
[8] A recovery goal is not available at this time due to a lack of information regarding population dynamics.
[9] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.

O.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 the Regional Recovery and Subbasin Plan Volume I.

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

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

Improvement targets were developed for each impact factor based on desired population productivity improvements and estimates of potentially manageable impacts (see Vol I. Ch. 3). 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. It is anticipated that objectives and targets will be refined during plan implementation based on new information and refinements in methodology.

Population and factor-specific improvements consistent with the biological objectives for this subbasin are provided in Table O-10. 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. Thus, productivity of Lower Gorge Tributaries fall Chinook must increase by 500% to reach population viability goals which requires impact reductions equivalent to a 50% improvement in

productivity or survival for each of six factor categories. For instance, tributary habitat potential must increase from 30% of the historical potential to 65% of the historical potential.

Table O-10. Productivity improvements consistent with biological objectives for the Lower Gorge Tributaries subbasin.

Species	Net increase	Per factor	Baseline impacts					
			Trib.	Estuary	Dams	Pred.	Harvest	Hatch.
Fall Chinook	500%	50%	0.23	0.30	0.30	0.11	0.65	0.25
Winter steelhead	40%	20%	0.60	0.15	0.00	0.22	0.10	0.00
Chum	0%	0%	0.40	0.25	0.30	0.03	0.05	0.00
Coho	400%	52%	0.50	0.14	0.10	0.19	0.50	0.56

O.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 O-17 and each component is presented in detail in the sections that follow.

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.

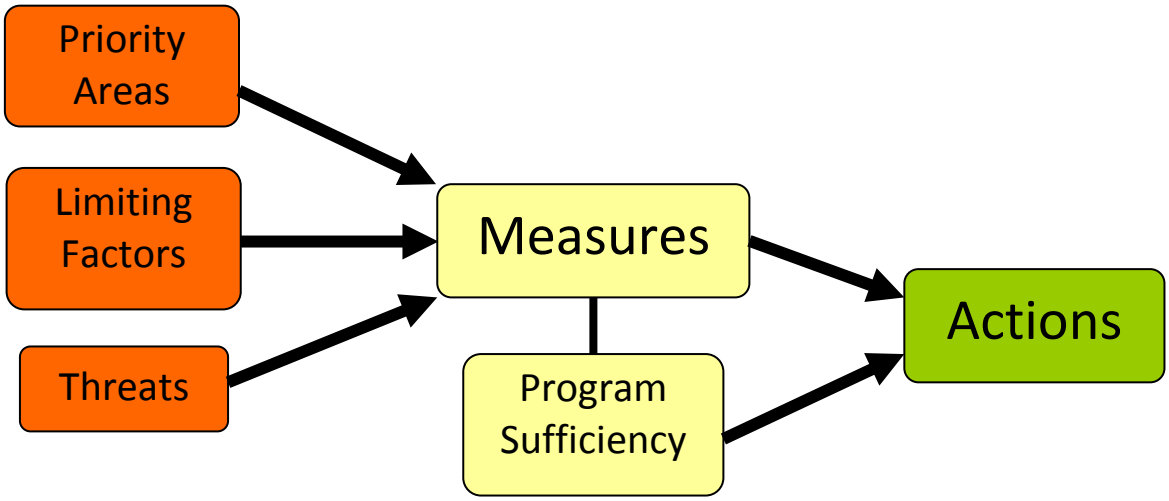


Figure O-17. Flow chart illustrating the development of subbasin measures and actions.

Summary: Decades of human activity in the Lower Gorge Tributaries have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, stream habitat conditions within the Lower Gorge Tributaries 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 O-11.

- **Lower Hamilton Creek** *(reaches Hamilton 1A, 2; Hamilton Springs)* – Lower Hamilton Creek contains potentially good spawning habitat but conditions have been impacted by development around the town of North Bonneville and by the Hwy 14 crossing. The artificially created Hamilton Springs spawning channel provides important chum spawning habitat. Effective recovery measures here will include riparian and floodplain restoration, in particular addressing channel confinement adjacent to N. Bonneville and associated with the Hwy 14 crossing. Addressing upstream fine sediment inputs will also help these reaches to recover.
- **Upper Hamilton and Greenleaf Creeks** *(reaches Hamilton 4; Greenleaf 1-3)* – Upper Hamilton and upper Greenleaf creeks contain good quality habitat for winter steelhead and coho. Above reach Hamilton 4, the gradient increases dramatically with several large falls that cannot be ascended. Reach Hamilton 4 currently supports a significant portion of the production for these populations. Preservation is the primary recovery emphasis for these areas, although restoration of sediment supply conditions will also provide important benefits.
- **Hardy and Duncan Creeks** *(reaches Duncan 1-2; Duncan Springs; Lake Outlet; Hardy 2-3)* – Most of the good spawning habitat in Duncan Creek is located just above Duncan Lake. This area is

most important for chum and coho although it is also used by fall Chinook and winter steelhead. Access to spawning areas in Duncan Creek has recently been improved by the construction of a dam that lowers lake levels during salmonid migration periods. Hardy reach 2 and 3 contain the greatest potential in Hardy Creek. Recovery measures in these areas will primarily involve floodplain and riparian restoration.

- **Gibbons & Lawton Creeks** *(no reach priorities specified)* – Gibbons and Lawton creeks were not evaluated using the EDT model and therefore specific reach and limiting factor priorities have not been developed for these streams. Although these streams do not support significant abundance of anadromous salmonids, they nevertheless contain some potentially productive habitat that is in need of restoration and preservation. These streams are threatened primarily by expanding development from the town of Washougal. Effective recovery measures will entail floodplain reconnection, riparian reforestation, and land-use planning that is adequate to protect habitat-forming processes in sensitive areas (i.e., wetlands, riparian areas, floodplains).

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 O-12. Reach tier designations for this basin are included in Table O-13. Reach tiers and subwatershed groups are displayed on a map in Figure O-18.

Table O-11. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the lower Hamilton Creek (LH), upper Hamilton & Greenleaf Creek (UH), Duncan & Hardy Creeks (DU), and Gibbons & Lawton Creek (GI). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors	LH	UH	DU	GI
Habitat connectivity				
Blockages to off-channel habitats	✓		✓	✓
Habitat diversity				
Lack of stable instream woody debris	✓	✓	✓	✓
Altered habitat unit composition	✓	✓	✓	✓
Loss of off-channel and/or 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, or rate of chng	✓		✓	✓
Water quality				
Altered stream temperature regime	✓	✓	✓	✓
Bacteria				✓
Substrate and sediment				
Excessive fine sediment	✓	✓	✓	✓
Embedded substrates	✓	✓	✓	✓

Threats	LH	UH	DU	GI
Agriculture/grazing				
Clearing of vegetation				✓
Riparian grazing				✓
Floodplain filling				✓
Urban & rural development				
Clearing of vegetation	✓		✓	✓
Floodplain filling	✓	✓	✓	✓
Increased impervious surfaces				✓
Increased drainage network				✓
Roads – riparian/floodplain impacts	✓		✓	✓
Leaking septic systems				✓
Forest practices				
Timber harvests –sediment supply impacts	✓	✓	✓	
Timber harvests – impacts to runoff	✓		✓	
Riparian harvests		✓		
Forest roads – impacts to sediment supply	✓	✓	✓	
Forest roads – impacts to runoff	✓		✓	
Channel manipulations				
Bank hardening	✓			✓
Channel straightening	✓	✓	✓	✓
Artificial confinement	✓	✓	✓	✓
Dredge and fill activities	✓	✓		

Table O-12. 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 O-13. Reach Tiers in the Lower Gorge Tributaries.

Tier 1	Tier 2	Tier 4
Duncan 1	Duncan Lake	Duncan Dam
Greenleaf Creek 1	Duncan 2	Greenleaf outlet
Hamilton 1_A	Duncan Springs	Greenleaf Slough
Hamilton 2	Greenleaf Creek 2	Hamilton 1_B
Hamilton 3	Greenleaf Creek 3	Hardy 1 Slough
Hamilton 4	Hamilton Springs	Hardy 4
Lake outlet	Hardy 2	Hardy 5
	Hardy 3	Hardy Culvert1
		Hardy Culvert2

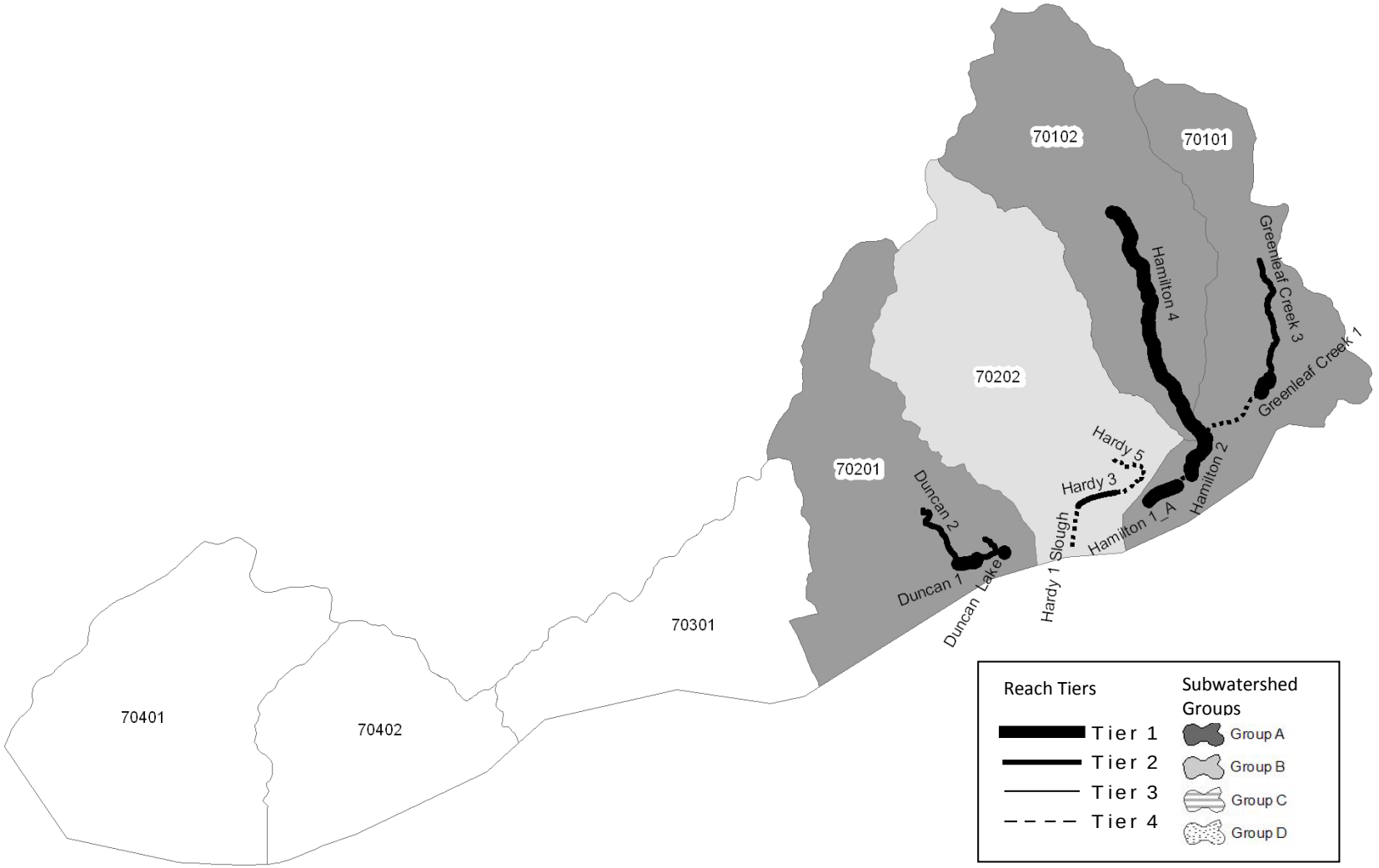


Figure O-18. Reach tiers and subwatershed groups in the Lower Gorge Tributaries. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities 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 Gorge Tributaries and are necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin (Vol I. Ch.3) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the Lower Gorge Tributaries are presented in priority order in Table O-14. 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 Gorge Tributaries. These priorities are adjusted depending on the results of the technical assessment and on the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

Habitat Actions

The prioritized measures and associated gaps are used to develop specific Actions for the subbasin. These are presented in Table O-14. 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 O-14. Prioritized measures for the Lower Gorge Tributaries.

#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	Stream corridors in the upper reaches of Hardy, Hamilton, and Duncan Creek Basins are in relatively good condition. Lower reaches are impacted by State Highway 14, the railroad, and development. Stream corridors in the Gibbons and Lawton Creek Basins are impacted by the expanding development from the west. 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 with functional riparian zones according to the IWA Reaches: Hamilton 3-4
2nd- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation Reaches: Duncan 1, 2; Duncan Springs; Lake Outlet; Hamilton 1_A; Hamilton Springs; Hardy 2-3
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NMFS	ESA Section 7 and Section 10	✓	
U.S. Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
USFS	Northwest Forest Plan, Columbia River Gorge National Scenic Area	✓	
Washington State Parks	Beacon Rock State Park	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Clark County	Comprehensive Planning		✓
Skamania County	Comprehensive Planning		✓
Clark Conservation District / Natural Resources Conservation Service (NRCS)	Landowner technical assistance, conservation planning		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation planning		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, Control		✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements		✓

Program Sufficiency and Gaps

Alterations to stream corridor structure that may impact aquatic habitats are regulated through the WDFW Hydraulics Project Approval (HPA) permitting program. Other regulatory protections are provided through USACE permitting, ESA consultations, HCPs, USFS programs, 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 with respect to the effects on watershed hydrology and sediment supply. Land-use conversion and development are increasing in the western portion of 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 existing programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary. Public land acquisition should be used as a last resort due to the strong opposition by Skamania County to reducing their tax base in an area that is already overwhelming publicly owned.

#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 (western portion of basin only) 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 (western portion of basin only) • Development – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest and road building. Agriculture and development have further impacted river systems in the western portion of the basin (Lawton and Gibbons Creek Basins). 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	✓	
Washington State Parks	Beacon Rock State Park	✓	
USFS	Northwest Forest Plan, Columbia River Gorge National Scenic Area	✓	
Clark County	Comprehensive Planning		✓
Skamania County	Comprehensive Planning		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation planning		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation planning		✓

Program Sufficiency and Gaps

Hillslope processes on state lands are protected through the State Forest Lands HCP. Federal forest lands are protected through the Northwest Forest Plan. Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands (agriculture and developed), County Comprehensive Planning is the primary nexus for protection of hillslope processes. Counties 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 western portion of the 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 - Restore floodplain function and channel migration processes in the lower reaches of the primary streams

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 along the lower portion of many streams. In the case of Hardy, Hamilton, and Duncan Creeks, this impairment is largely due to State Highway 14 and the railroad corridor as well as development around North Bonneville, which has impacted lower Hamilton Creek. Lower Gibbons Creek has been disconnected from its floodplain as a result of wetland draining and construction of an elevated channel. Re-configuring stream crossings and 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 challenges 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 (obtained from EDT ratings)
Reaches: Duncan 1; Hamilton 1_A, 2, 3

2nd- Tier 2 reaches with hydro-modifications
Reaches: Duncan 2; Hardy 2

3rd- Other reaches with hydro-modifications
Reaches: Hardy 1 Slough; Gibbons Creek; Campen Creek (Gibbons Creek trib – golf course impacts)

Key Programs

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

Program Sufficiency and Gaps

There currently are no programs that set forth strategies for restoring floodplain function and channel migration processes in the Lower Gorge Tributaries. 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 reaches of several of the streams 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 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.

#4- Restore degraded hillslope processes

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 (western portion of basin only) D. Reduce watershed imperviousness (western portion of basin only) 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 (western portion of basin only) • 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)
2nd- Moderately impaired or impaired subwatersheds contributing to other reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules, Habitat Projects	✓	
WDFW	Habitat Program		✓
Washington State Parks	Habitat Projects	✓	
USFS	Northwest Forest Plan, Columbia River Gorge National Scenic Area, Habitat Projects	✓	
Clark Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

Forest management programs including the Northwest Forest Plan (federal forest lands), 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, which are common in the western portion of the basin. 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 activities through permitting and ordinances, and increasing available funding for entities to conduct restoration projects.

#5 – 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 6 miles of potentially accessible habitat are blocked by culverts or other barriers. There are also passage concerns with culverts under SR 14. Passage restoration projects should focus only on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Lower Gibbons Creek (off-channel habitat), upper Gibbons Creek tributaries (culverts and other barriers), Hardy and Woodward Creeks (culverts under SR 14)
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 Projects		✓
Skamania County	Roads		✓
Clark County	Roads		✓

Program Sufficiency and Gaps

The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The 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 (including passage issues at Duncan Lake) 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.

#6 - Restore riparian conditions throughout the basin

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore the natural riparian plant community B. Eradicate invasive plant species from riparian areas	• Reduced stream canopy cover • Altered stream temperature regime • Reduced bank/soil stability • Reduced wood recruitment • Lack of stable instream woody debris • Exotic and/or invasive species	• Timber harvest – riparian harvests • Clearing of vegetation due to agriculture and residential development	All species	Riparian conditions have been degraded due to past timber harvests, development, and agriculture. The increasing abundance of exotic and invasive species is of particular concern. Riparian restoration has a high potential benefit due to the many limiting factors that are addressed. 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, Habitat Projects	✓	
WDFW	Habitat Program		✓
Washington State Parks	Habitat Projects		✓
USFS	Northwest Forest Plan, Columbia River Gorge National Scenic Area, Habitat Projects	✓	
Clark Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Enforcement, Education, Control		✓

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 the Northwest Forest Plan (federal lands), Forest Practices Rules (private forest lands) or the State forest lands HCP. Other lands receive variable levels of protection and passive restoration through the Clark and Skamania Counties Comprehensive Plans. Many degraded riparian zones in urban, agricultural, rural residential, or transportation corridor uses will not passively restore with existing regulatory protections and will require active measures. Riparian restoration in these areas may entail 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.

#7 – 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 portion of streams near their confluence with the Columbia where transportation corridors and other confinement structures have eliminated or blocked access to habitats. 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- Lower mainstems of most streams (e.g. Gibbons, Hardy, Woodward, Hamilton)
2nd- Other 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		✓
Washington State Parks	Habitat Projects		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
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. Construction of chum spawning channels has been conducted on Hamilton and Duncan Creeks and there may be opportunities to expand these efforts. 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.

#8 – Restore degraded water quality with an emphasis on stream temperature impairments

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Exclude livestock from riparian areas B. Increase riparian shading 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	Although there are no 303(d) listings for stream temperature, there have been regular exceedances of temperature standards in lower Hamilton, lower Hardy, and lower Duncan Creeks. Temperature impairment is likely related to riparian degradation. Other water quality impairments present human health as well as potential fish health concerns. Gibbons Creek Remnant Channel is listed on the 2002-2004 draft 303(d) list for chromium impairment and is listed as a concern for arsenic. Gibbons Creek was also listed on the 1996 and 1998 lists for fecal coliform impairment. Bacteria impairment in Gibbons Creek is believed to be related to livestock grazing and/or failing septic systems. Chromium and arsenic impairments in the Gibbon Creek Remnant Channel are related to facilities at the Camas/Washougal Industrial Park (Johnson 1998).

Priority Locations

1st- Gibbons Creek (fecal coliform, temperature, chromium, arsenic); Campen Creek (fecal coliform, temperature); Hardy Creek (temperature), Hamilton Creek (temperature), Duncan Creek (temperature)

2nd- Other stream 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		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects, Centennial Clean Water		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects, Centennial Clean Water		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Clark County Health Department	Septic System Program		✓
Skamania County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

Ecology's Water Quality Program manages the State 303(d) list of impaired water bodies. There was one listing on the draft 2002/2004 303(d) list in Gibbons Creek for chromium and it was also listed as a concern for arsenic. A Water Quality Clean-up Plan (TMDL) will be required by Ecology for chromium; it is expected that this assessment will effectively address the chromium impairment. Gibbons Creek was listed for fecal coliform bacteria impairment on the 1996 and 1998 303(d) lists. A TMDL in response to the fecal coliform bacteria listing was developed by Ecology (WDOE 1996). The plan was inconclusive in identifying the source of the impairment and recommended additional monitoring. There is little information available as to the current condition of the bacteria impairment on Gibbons Creek. Although there are no 303(d) listings in other stream systems, temperature monitoring has indicated exceedances in several instances. These exceedances need to be evaluated further.

#9 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve Summer low-flows	• Water withdrawals	All species	Instream flow management strategies for the Lower Gorge Tributaries have been identified as part of Watershed Planning for WRIA 28 (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. 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		✓

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 who's objective was to recommend instream flow guidelines to Ecology through a collaborative process. The current status of the planning effort is to adopt a watershed plan by December 2004. Instream flow management in the Lower Gorge Tributaries will be conducted using the recommendations of the WRIA 27/28 Planning Unit, which is coordinated by the LCFRB. Draft products of the WRIA 27/28 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the planning unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies. Ecology should implement the recommendations of the WRIA 27/28 Planning Unit relative to instream flow rule development.

#10 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Channel structure and stability has been impaired by a number of activities including past riparian timber harvest, development, stream crossings, and confinement. Channel stabilization projects and structural enhancements to stream channels may be warranted in some places, especially in lower alluvial reaches that have been simplified through channel son 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.

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, agencies, landowners	Habitat Projects		✓
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation planning, habitat projects		✓

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 O-15. Habitat actions for the Lower Gorge Tributaries.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
LG-Tribs 1. Conduct floodplain restoration where feasible along the lower reaches of streams before their confluence with the Columbia where they have experienced channel confinement due to development and transportation corridors. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, UCD, NGOs, WDFW, LCFRB, USACE	3, 5, 6, 8 & 10	Medium: Lower reaches of several tributaries	High: Restoration of floodplain function, habitat diversity, and habitat availability.	High
LG-Tribs 2. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Skamania County, Ecology	1	Medium: Applies to privately owned floodprone lands under county jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
LG-Tribs 3. 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, UCD, LCFEG	10	Medium: Lower reaches of several streams	High: Increased habitat availability for spawning and rearing	High
LG-Tribs 4. Expand standards in County 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	Skamania County, Ecology	1 & 2	Medium: Applies to all private lands under county jurisdiction	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
LG-Tribs 5. 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	Skamania County	1 & 2	Medium: Applies to all private lands under county jurisdiction	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
LG-Tribs 6. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Low: 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

[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]
LG-Tribs 7. 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	Skamania County	1, 4, 6, & 8	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
LG-Tribs 8. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, UCD, WDNR, WDFW, LCFEG, Skamania County	All measures	Medium: Private lands. Applies to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
LG-Tribs 9. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	1, 2, 4, 5, 6 & 8	Low: National Forest 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	High
LG-Tribs 10. 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, 4, 5, 6 & 8	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
LG-Tribs 11. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	Ecology, WDFW, WRIA 27/28 Planning Unit, Skamania County	9	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
LG-Tribs 12. 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, 3, 4, 5 & 7	Medium: State timber lands in the Washougal Basin (approximately 30% of the basin area)	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. Response is medium because of location and quantity of state lands	Medium

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
LG-Tribs 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, UCD, LCFEG	3, 4, 5, 6, 7, 8 & 10	Medium: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
LG-Tribs 14. 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, Skamania County, WSDOT, LCFEG	5	Medium: As many as 6 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
LG-Tribs 15. 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, 4, 5, 6 & 8	Low: Small private timberland owners	Medium: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
LG-Tribs 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, UCD, LCFEG	1 & 4	Medium: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
LG-Tribs 17. Assess water quality issues through the development and implementation of water quality clean up plans (TMDLs)	Expansion of existing program or activity	Ecology	5	Medium: temperature concerns throughout basin and 303(d) listings	Medium: Protection and restoration of water quality	Low

O.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 Gorge Tributaries 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 measures 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. The recovery strategy includes a mixture of conservation programs and mitigation programs for lost fishing benefits. Mitigation programs involve areas or practices selected for consistentency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies in the Lower Gorge Tributaries are displayed by species in Table O-16. There are no fishery enhancement strategies included in the Lower Gorge Tributaries. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table O-16. Summary of natural production and fishery enhancement strategies to be implemented in the Lower Gorge Tributaries.

		Species			
		Fall Chinook	**Coho**	**Chum**	**Winter Steelhead**
Natural Production Enhancement	Refuge				
	Supplementation			✓	
	Hatch/Nat Conservation [1]				
	Isolation				
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 measures 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.

***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 Washougal Hatchery chum in the Lower Gorge Tributaries.

***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 Gorge Tributaries 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. There is not a Chinook harvest program in the Lower Gorge Tributaries .

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

natural populations recover and become harvestable. There are no fishery enhancement programs for in the Lower Gorge Tributaries.

The Washougal Hatchery will be operated to include supplementation strategies for Lower Gorge Tributaries chum. Fall Chinook will not be included as a harvest program in the Lower Gorge Tributaries. This plan adds no new conservation programs at the Washougal Hatchery facility (Table O-17).

Table O-17. A summary of potential conservation and harvest strategies to be implemented through Washougal Hatchery programs.

		Stock
Natural Production Enhancement	Supplementation	Washougal River Chum
	Hatch/Nat Conservation[1]	
	Isolation	
	Broodstock development	
Fishery Enhancement	In-basin releases	
	Out of Basin Releases	

[1] May include integrated and/or isolated strategy over time.

Hatchery Measures and Actions

Hatchery strategies and measures are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within the Lower Gorge Tributaries 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 measures specific to the Lower Gorge Tributaries (Table O-18). The Sub-Basin plan hatchery recovery measures 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 measures 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 measures will be complimentary and provide a coordinated strategy for the Lower Gorge Tributaries. Further explanation of specific strategies and measures for hatcheries can be found in Volume I.

Table O-18. Potential hatchery program actions to be implemented in the Lower Gorge Tributaries.

Measure	Description	Comments
	Hatchery program utilized for supplementation and enhancement of wild chum and coho populations.	The Washougal Hatchery is currently used for supplementation and risk management of lower Gorge chum populations. This program could be potentially expanded to include more areas and populations. Supplementation programs for Washougal natural coho could be developed with appropriate brood stock in the Washougal Hatchery.
	Adaptively manage hatchery programs to further protect and enhance natural populations and improve operational efficiencies.	Appropriate research, monitoring, and evaluation programs along with guidance from regional hatchery evaluations will be utilized to improve the survival and contribution of hatchery fish, reduce impacts to natural fish, and increase benefits to natural fish.

O.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 measures can restore natural population productivity to levels where 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, and 5) mass marking of hatchery fish for identification and selective fisheries.

Measures 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 generally preclude access to large numbers of potentially harvestable fish in strong stocks.

Fishery impact limits to protect 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. Table O-19 summarizes fishery regulatory and protective actions in Lower Gorge Tributaries.

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

Table O-19. Summary of regulatory and protective fishery actions in Lower Gorge Tributaries.

Species	General Fishing Actions	Explanation	Other Protective Fishery Actions	Explanations
Fall Chinook	Closed to retention	Protects wild fall Chinook. No hatchery produced fall Chinook in the Lower Gorge Tributaries	No fisheries for other salmon	Further protection of wild fall Chinook spawners
Chum	Closed to retention	Protects wild chum. Hatchery chum are not released in the Lower Gorge Tributaries for harvest	No fisheries for other salmon and trout season in Hamilton Creek closes in late fall	Further protection of wild chum spawners
Coho	Closed to retention	Protects wild coho. Hatchery coho are not released in the Lower Gorge Tributaries for harvest.	No fisheries for other salmon and trout season in Hamilton Creek closes in late fall	Further protection of wild coho spawners
Winter steelhead	Winter season closed	Trout season closes in the fall prior to entry of winter steelhead and reopens in the summer after steelhead have spawned	Minimum size restrictions during trout season in Hamilton	Minimum size protects juveniles

Table O-20. Regional harvest measures from Volume I, Chapter 10 with significant application to the Lower Gorge Tributaries populations.

Measure	Description	Responsible Parties	Programs	Comments
	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.
	Columbia River Compact agencies will evaluate effectiveness of the current time and area management strategy for the commercial fishery.	WDFW, ODFW	U.S. vs Oregon (Technical Advisory Committee)	Late fall commercial fisheries target late stock hatchery coho and sturgeon. Chum impacts are limited by gear mesh size restrictions in sturgeon fisheries and by curtailing coho fisheries by November before significant numbers of chum are present. The Compact agencies would evaluate the effectiveness of this management strategy based on information acquired in recent years.
	Develop more specific chum management details for pre-season and in-season management of the late fall commercial fishery.	WDFW, ODFW	Columbia Compact	The Compact agencies would develop specific criteria for in-season fishery adjustments (e.g. early closures, gear adjustments, area closures) based on chum encounter rates in the fishery. These criteria would be established as part of the chum management plan.

O.5.7. Hydropower

There are no dams or hydropower facilities in the Lower Gorge Tributaries, hence, no in-basin hydropower actions are identified. However, Columbia River flow levels from Lower Gorge Dam discharge effect the migration conditions for Lower Gorge Tributary adult Chum and fall Chinook and effects access to spawning habitats in Hamilton and Hardy creeks. The fall flows from Lower Gorge Dam also affect the amount of spawning habitat available for chum and fall Chinook in the mainstem Columbia near Pierce and Ives islands. The winter and early spring flows at Lower Gorge Dam are also critical to prevent dewatering and decreased flows through redds during the egg incubation period.

Lower Gorge tributary anadromous fish populations will benefit from regional hydropower measures recovery measures and actions identified in regional plans to address habitat effects in the mainstem and estuary. The following table summarizes key regional hydropower actions with specific application to the Lower Gorge Tributary salmon and steelhead populations.

Table O-21. Regional hydropower measures from Volume I, Chapter 10 with significant application to the Lower Gorge Tributaries populations.

Measure	Description	Comments
D.M3	Maintain adequate water flows in Bonneville Dam tailrace and downstream habitats throughout salmon migration, incubation and rearing periods	Prevents dewatering and decreased flows in redds during and incubation, as well as increasing the potential spawning sites available for adults. Prevents migration barriers, high temperatures in late summer, lack of resting habitats, and predation losses.
D.M4	Operate the tributary hydro systems 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 and chum in the North Fork Lewis and Cowlitz, is affected by the water flow discharged at Merwin and Mayfield dams respectively. The operational plans for the Lewis and Cowlitz dams, 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 and chum.

O.5.8. Mainstem and Estuary Habitat

Bonneviile tributary 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. Strategies involve: 1) avoiding large scale habitat changes where risks are 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 salmonids habitats use and their response to habitat changes. A series of specific measures are detailed in the regional plan for each of these strategies.

O.5.9. Ecological Interactions

For the purposes of this plan, ecological interactions refer to the relationships of salmon and steelhead with other elements of the ecosystem. Regional strategies and measures pertaining to non-native species, effects of salmon on system productivity, and native predators of salmon are detailed and discussed at length in the Regional Recovery and Subbasin Plan Volume I and are not reprised at length

in each subbasin plan. Strategies include 1) avoiding and 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.

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