Lower Columbia Salmon Recovery
And
Fish & Wildlife Subbasin Plan

Volume II – Subbasin Plan

Chapter F – Kalama

Salmon-Washougal and Lewis Rivers (WRIAS 27-28)

Watershed Management Plan

Chapter 6 Appendix – Management of Fish Habitat Conditions

Lower Columbia Fish Recovery Board

December 15, 2004

Preface

This is one in a series of volumes that together comprise a Recovery and Subbasin Plan for Washington lower Columbia River salmon and steelhead:

--	Plan Overview	*Overview of the planning process and regional and subbasin elements of the plan.*
Vol. I	Regional Plan	*Regional framework for recovery identifying species, limiting factors and threats, the scientific foundation for recovery, biological objectives, strategies, measures, and implementation.*
Vol. II	Subbasin Plans	*Subbasin vision, assessments, and management plan for each of 12 Washington lower Columbia River subbasins consistent with the Regional Plan. These volumes describe implementation of the regional plan at the subbasin level.* *II.A. Lower Columbia Mainstem and Estuary* *II.B. Estuary Tributaries* *II.C. Grays Subbasin* *II.D. Elochoman Subbasin* *II.E. Cowlitz Subbasin* *II.F. Kalama Subbasin* *II.G. Lewis Subbasin* *II.H. Lower Columbia Tributaries* *II.I. Washougal Subbasin* *II.J. Wind Subbasin* *II.K. Little White Salmon Subbasin* *II.L. Columbia Gorge Tributaries*
Appdx. A	Focal Fish Species	*Species overviews and status assessments for lower Columbia River Chinook salmon, coho salmon, chum salmon, steelhead, and bull trout.*
Appdx. B	Other Species	*Descriptions, status, and limiting factors of other fish and wildlife species of interest to recovery and subbasin planning.*
Appdx. C	Program Directory	*Descriptions of federal, state, local, tribal, and non-governmental programs and projects that affect or are affected by recovery and subbasin planning.*
Appdx. D	Economic Framework	*Potential costs and economic considerations for recovery and subbasin planning.*
Appdx. E	Assessment Methods	*Methods and detailed discussions of assessments completed as part of this planning process.*

This plan was developed by of the Lower Columbia Fish Recovery Board and its consultants under the Guidance of the Lower Columbia Recovery Plan Steering Committee, a cooperative partnership between federal, state and local governments, tribes and concerned citizens.

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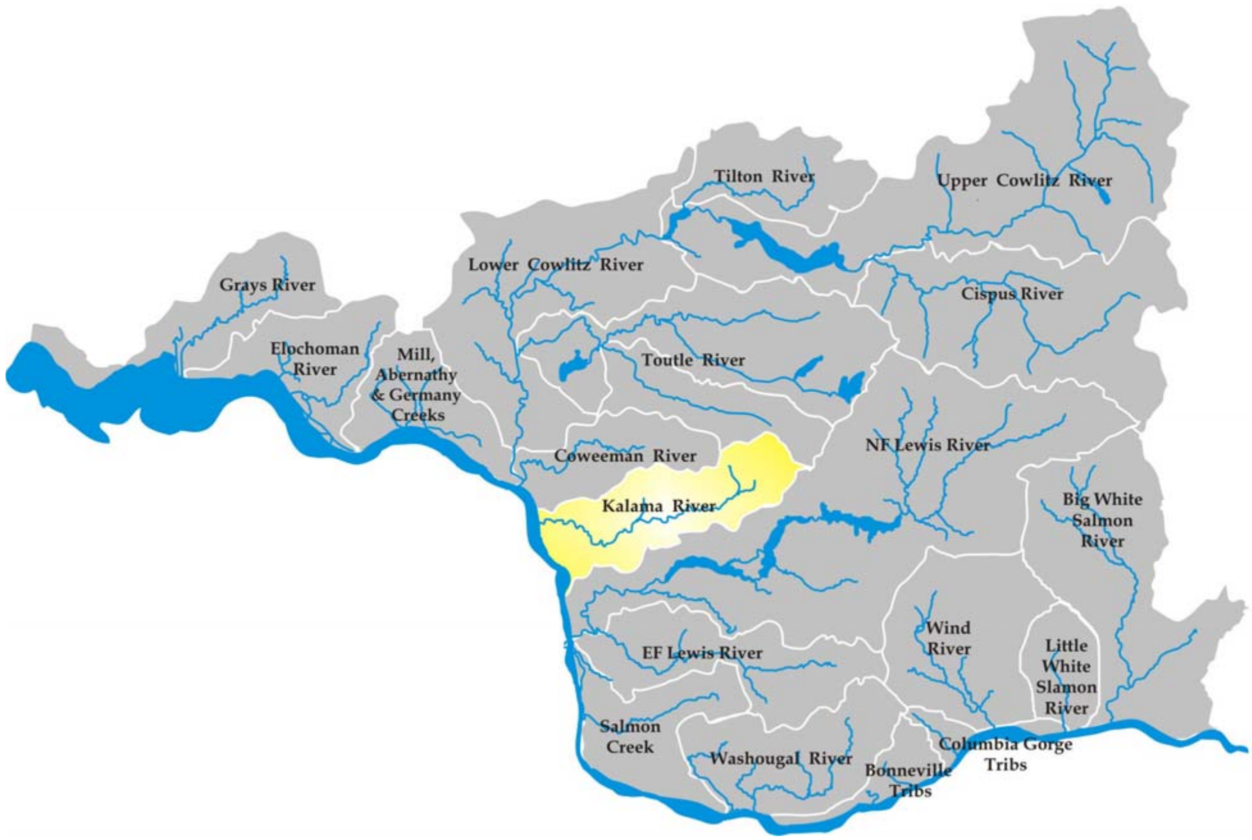
Subbasin Plan Vol. II.F.
Kalama Subbasin



Contents

1.0 Kalama River – Executive Summary

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

The Kalama River is one of eleven major subbasins in the Washington portion of the Lower Columbia Region. This subbasin historically supported thousands of fall Chinook, winter steelhead, chum, and coho. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook, chum, and steelhead have been listed as Threatened under the Endangered Species Act and coho is proposed for listing. 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 altered or eliminated by modifications to stream channels, floodplains, and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has reduced productivity. Hydropower construction and operation on the Columbia has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

Kalama River fall Chinook, spring Chinook, winter steelhead and summer steelhead will need to be restored to a high 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. Coho will need to be restored to a medium level of viability and chum to a low level of viability to contribute to recovery.

In recent years, agencies, local governments, and other entities have addressed 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 the various threats and limiting factors that impact Kalama River fish populations. Specific strategies, measures, actions and priorities have been developed to address these threats and limiting factors. The specified strategies identify the best long term and short term avenues for achieving fish restoration and mitigation goals. While it is understood that data, models, and theories have their limitations and growing knowledge will certainly spawn new strategies, the Board is confident that by implementation of the recommended actions in this plan, the population goals in the Kalama River Subbasin 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.

1.1 Key Priorities

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

1. Manage Subbasin Forests to Restore Watershed Processes

Most of the Kalama Subbasin is forested and forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing sediment, and reducing riparian zones in much of the basin. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices rules for private timber lands is expected to dramatically improve conditions by restoring passage, protecting riparian conditions, reducing sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species and particularly steelhead and coho.

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

The human population in the basin is relatively low, but it is projected to grow by at least one third in the next twenty years. Nearly the entire basin is managed for commercial timber production (96%). Population growth and resource extraction will provide a variety of risks and opportunities for preserving the rural character and local economic base while also protecting and restoring natural fish populations and habitats. The lower few reaches of the Kalama mainstem have experienced residential and industrial development. Careful growth management in and around sensitive areas (floodplains, wetlands, riparian zones) will be necessary to prevent habitat degradation.

3. Restore Passage at Culverts and Other Artificial Barriers

There are several culvert barriers at road crossings and the diversion at the hatchery on Hatchery (aka Fallert) Creek also limits passage. Correcting passage barriers could open up as many as 14 additional miles of habitat. Further assessment of passage barriers is needed throughout the subbasin.

4. 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. The Kalama River hatchery programs will produce and/or acclimate fall Chinook, spring Chinook, coho, summer steelhead, and winter steelhead for use in the Kalama subbasin. The goals of the new wild stock steelhead programs are to enhance recreational harvest opportunity and to serve as a risk management tool, maintaining wild broodstock in case of a catastrophic event that negatively effects the natural population. The other hatchery programs continue to support harvest as part of the hydrosystem mitigation.

5. 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 Kalama River salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some Kalama River salmon and steelhead are incidentally taken in mainstem Columbia River and ocean mixed stock fisheries for strong wild and hatchery runs of fall Chinook and coho. These fisheries will be managed with strict limits to ensure this incidental take does not threaten the recovery of wild populations including those from the Kalama. 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.

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

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

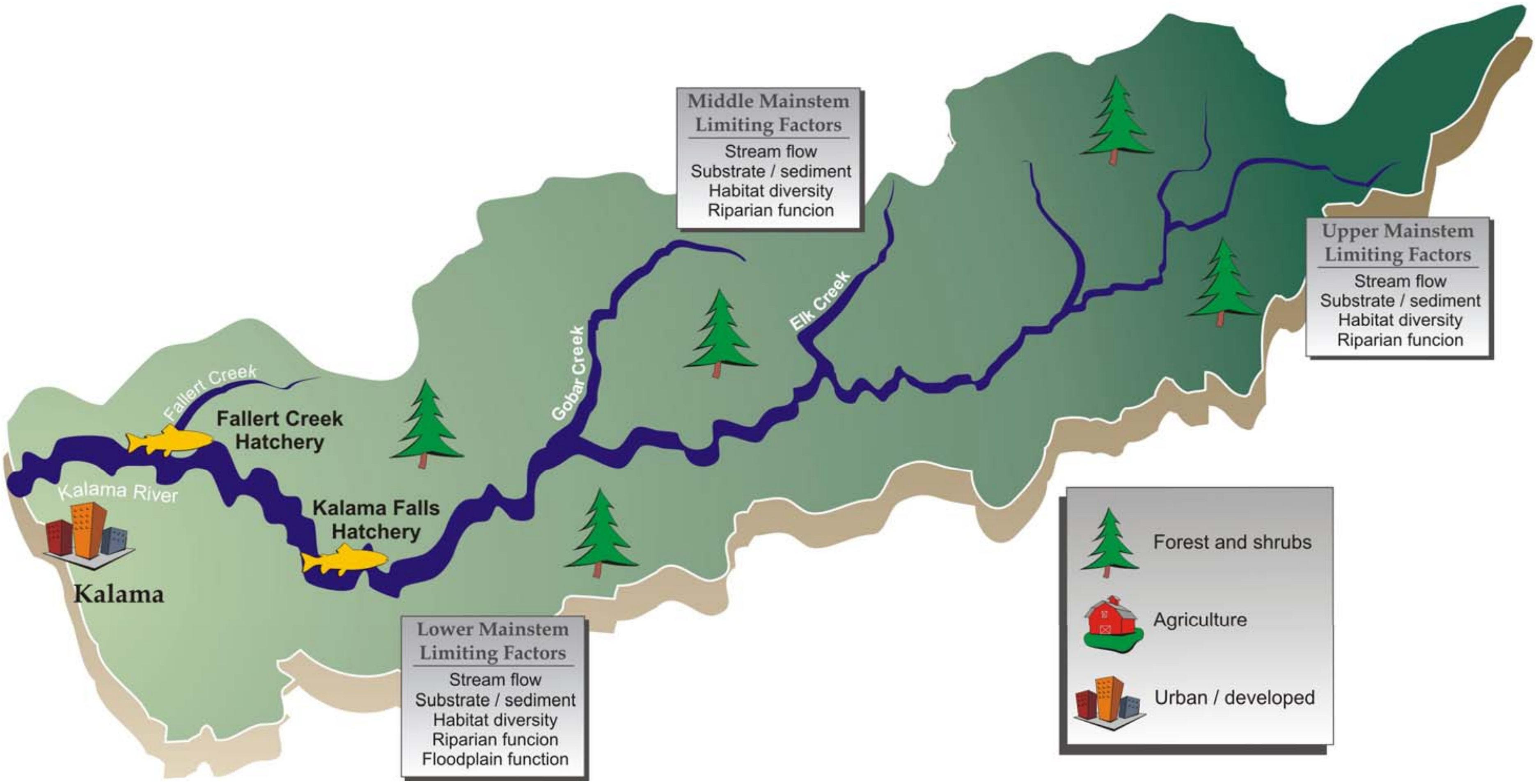


Figure 1. Key features of the Kalama River Subbsin including a summary of limiting fish habitat factors in different areas and the status and relative distribution of focal salmonid species.

2.0 Background

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

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

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

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

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

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

3.0 Assessment

3.1 Subbasin Description

3.1.1 *Topography & Geology*

The Kalama River Subbasin is a 205 square mile watershed extending from the southwest slopes of Mount St. Helens to the Columbia River, where it enters at RM 73.1. The watershed is bordered by the Toutle and Coweeman basins to the north and the NF Lewis basin to the south. The headwaters are in Skamania County although 99% of the basin lies within Cowlitz County.

The elevation ranges from sea level at the Columbia River to near 8000 feet on Mount St. Helens. Past eruptions of Mount St. Helens and associated lahars have shaped the landscape of the basin over the past 20,000 years. The lahars left unconsolidated deposits creating slope stability concerns in the steep upper watershed (USFS 1996).

The lower basin is low gradient, with tidal influence extending up to RM 2.8. Lower Kalama Falls at RM 10 blocked most anadromous fish access except for summer steelhead until it was laddered in 1936. Only summer steelhead and some spring Chinook are now passed above the falls. The river courses through a narrow V-shaped valley above RM 10. Passage to all anadromous fish is blocked by a falls at RM 35. The upper watershed tributaries have steep gradients only accessible to anadromous fish in the lowest reaches (Wade 2000).

3.1.2 *Climate*

The Kalama basin experiences a maritime climate with cool, wet winters and dry, warm summers. Mean annual precipitation is 68 inches at the Kalama Falls Hatchery and is over 120 inches in the upper subbasin (WRCC 2003). The bulk of the precipitation occurs from the first of October through March.

3.1.3 *Land Use, Ownership, and Cover*

Most of the basin is forested and nearly the entire basin is managed for commercial timber production (96%). Only 1.3% is non-commercial forest and 1.5% is cropland. Areas along the lower river have experienced industrial and residential development, resulting in channelization of the lower river. A portion of the upper basin is located within the Mount St. Helens National Volcanic Monument. National Monument land is managed primarily for natural resource protection and tourism. The State of Washington owns, and the Washington State Department of Natural Resources (DNR) manages the beds of all navigable waters within the subbasin. Any proposed use of those lands must be approved in advance by the DNR. A breakdown of land ownership and land cover/land use in the Kalama basin is presented in Figure 2 and Figure 3, respectively.

3.1.4 *Development Trends*

Population density and development in the watershed are low. The year 2000 population was approximately 5,300 persons (LCFRB 2001). The City of Kalama, located near the mouth, is the only urban area in the subbasin. Residential development has increased in recent years along the lower mainstem Kalama. Future development pressures are likely to continue to be located within the mainstem river valley and the lower portions of the larger mainstem tributaries.

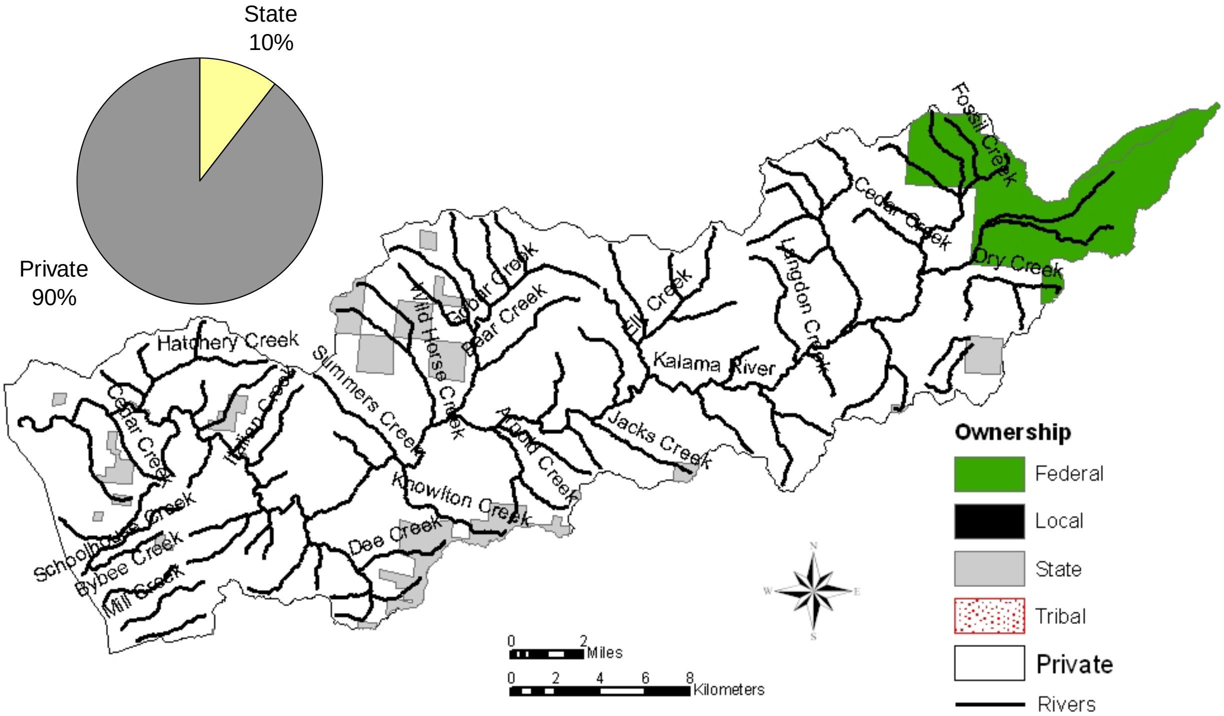


Figure 2. Landownership within the Kalama basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

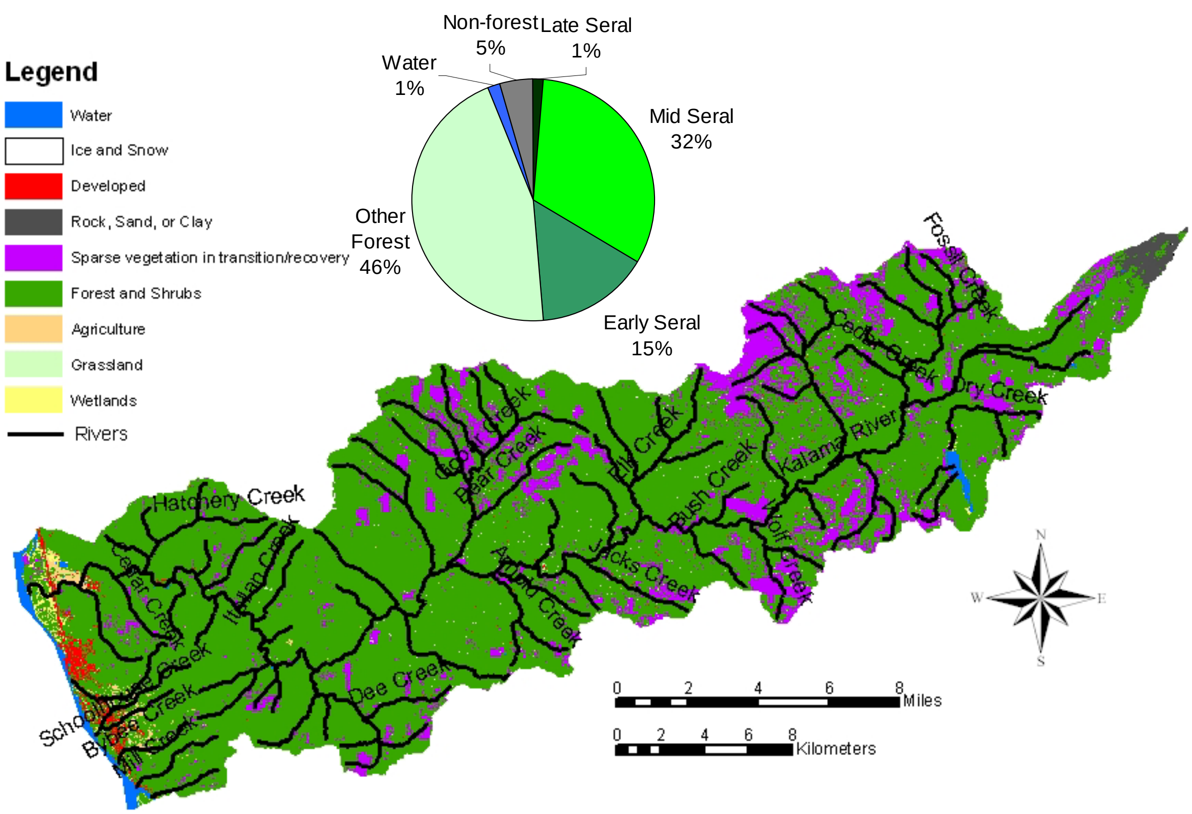


Figure 3. Land cover within the Kalama basin. Vegetation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. (1997). Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the Kalama Subbasin. Other species of interest were also identified as appropriate. Species were selected because they are listed or under consideration for listing under the U.S. Endangered Species Act or because viability or use is significantly affected by the Federal Columbia Hydropower system. Federal hydropower system effects are not significant within the Kalama River basin although anadromous species are subject to effects in the Columbia River, estuary, and nearshore ocean. The Kalama 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 Kalama River watersheds include fall Chinook, spring Chinook, chum, coho, summer steelhead, and winter steelhead. Bull trout do not occur in the subbasin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table 1). Extinction risks are significant for all focal species – the health or viability of these populations ranges from very low (chum and spring Chinook) to above medium (winter steelhead). Focal populations need to improve to a targeted level that contributes to recovery of the species (see Volume I, Chapter 6). Recovery goals call for restoring Chinook and steelhead populations to a high or very high viability level. Chum recovery goals call for medium viability levels. Recovery goals for coho call for stabilizing the population at the current low viability level.

Table 1. Status of focal salmond and steelhead populations in the Kalama River subbasin.

Focal Species	ESA Status	Hatchery Component[1]	Historical numbers[2]	Recent numbers[3]	Current viability[4]	Extinction risk[5]
Fall Chinook	Threatened	Yes	3,800-20,000	3,800-20,000	Low+	~30%
Spring Chinook	Threatened	Yes	6,000-15,000	50-600	Very Low	~60%
Chum	Threatened	No	15,000-40,000	<50	Very Low	~70%
Coho	Proposed	Yes	2,000-26,000	Unknown	Low	~70%
Summer Steelhead	Threatened	Yes	1,300-7,000	200-2,300	Low+	~30%
Winter Steelhead	Threatened	Yes	1,000-8,000	500-2,300	Med+	~10%

[1] *Significant numbers of hatchery fish are released in the subbasin.*
[2] *Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations.*
[3] *Approximate current annual range in number of naturally-produced fish returning to the subbasin.*
[4] *Propsects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.*
[5] *Probability of extinction within 100 years corresponding to estimated viability.*

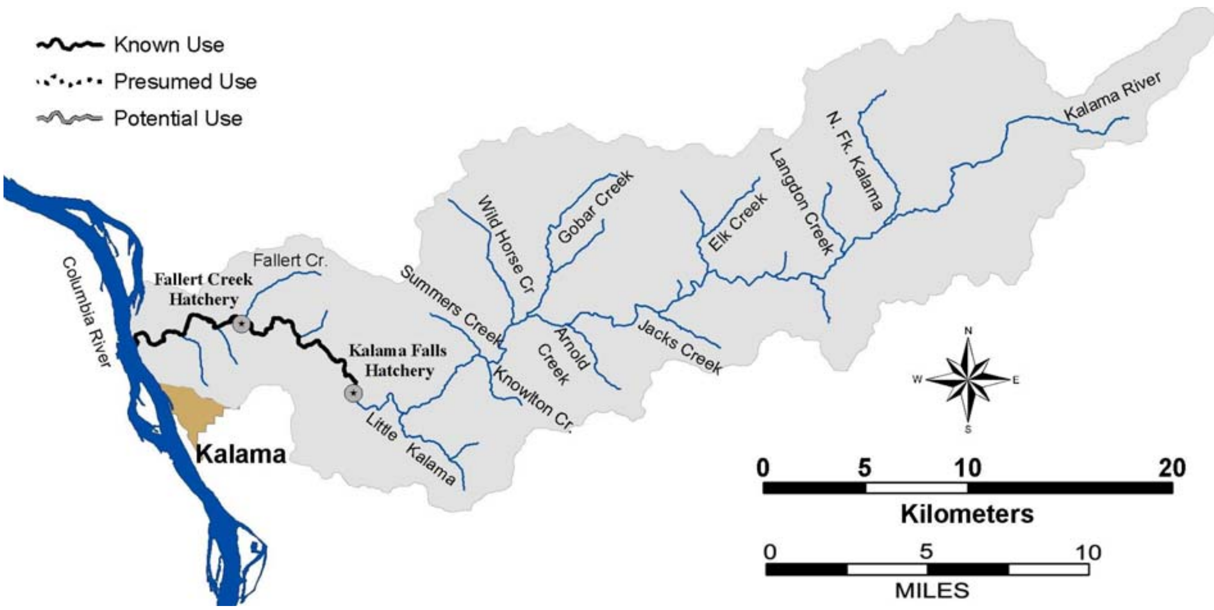
Other species of interest in the Kalama Subbasin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

Brief summaries of the population characteristics and status follow. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

3.2.1 *Fall Chinook—Kalama Subbasin*

ESA: Threatened 1999	**SASSI: Healthy 2002**

The historical Kalama adult population is estimated from 3,800-20,000 fish. The current natural spawning numbers are similar, but the majority of the returns are hatchery fall Chinook released as juveniles from the Kalama hatchery facilities. Natural spawning occurs from late September through October in eleven miles of the mainstem Kalama from Kalama Falls Hatchery downstream to just above the I-5 Bridge. Juvenile rearing occurs near and downstream of the spawning areas. Juveniles migrate from the Kalama in the spring and early summer of their first year.

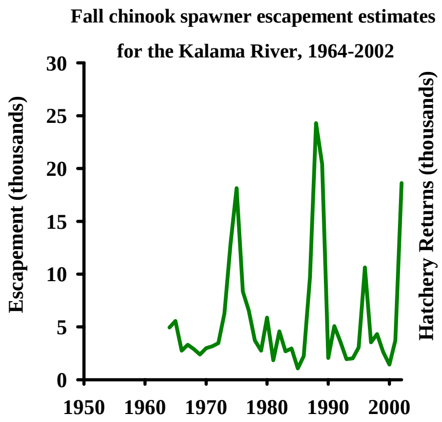


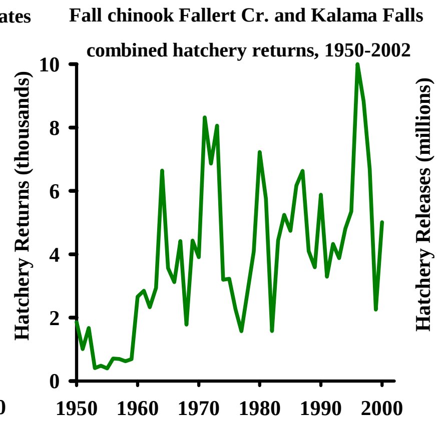
Distribution

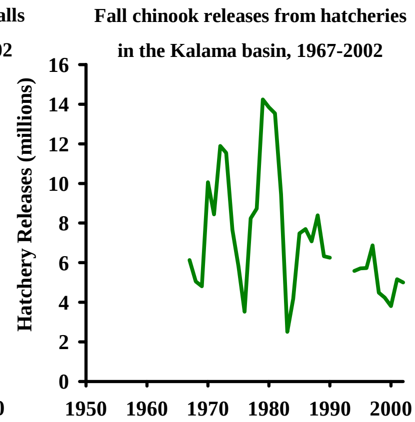
- In the Kalama River, spawning primarily occurs in the mainstem between Kalama Falls Hatchery and the I-5 Bridge (11miles); Lower Kalama Falls (10.5) is a natural barrier to upstream migration; surplus hatchery Chinook are released above the falls

Life History

- Fall Chinook upstream migration in the Columbia River occurs in mid August to mid September, partly depending on early rainfall; peak entry into the Kalama is late August to early September
- Spawning in the Kalama River occurs between late September and October; the peak is usually around mid-October
- Age ranges from 2-year old jacks to 6-year old adults, with dominant adult ages of 3 and 4
- Fry emerge around early March/April, depending on time of egg deposition and water temperature; fall Chinook fry spend the spring in fresh water, and emigrate in the late spring/summer as sub-yearlings
- Kalama fall Chinook display early migration and spawning characteristics of tule fall Chinook but ocean distribution is typically farther north than most tule stocks (similar to Cowlitz fall Chinook)







Diversity

- The Kalama fall Chinook stock designated based on distinct spawning distribution
- Genetic analysis of Kalama River Hatchery fall Chinook determined they were significantly different from most other lower Columbia River tule fall Chinook stocks, and most similar to Cowlitz Hatchery fall Chinook

Abundance

- In 1936, fall Chinook escapement to the Kalama River was 20,000: 13,000 were collected at the hatchery and 7,000 were allowed to spawn naturally
- Kalama River spawning escapements from 1964-2001 ranged from 1,055 to 24,297 (average 5,514)
- Hatchery production accounts for most fall Chinook returning to the Kalama River
- Kalama River WDFW interim escapement goal is 2,000 fish; the goal is commonly met
- A significant portion of the natural spawners are hatchery produced fish

Productivity & Persistence

- NMFS Status Assessment for the Kalama River indicated a 0.21 risk of 90% decline in 25 years and a 0.25 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.03
- Smolt density model predicted natural production potential for the Kalama River above Kalama falls of 162,000 fingerlings; below Kalama Falls the model predicts production potential of 428,670 fingerlings
- WDFW concluded that a natural spawning escapement of 24,549 in 1988 only produced an estimated 522,312 to 964,439 juvenile fall Chinook in 1989

Hatchery

- Lower Kalama (Fallert Creek) Hatchery (RM 4.8) was completed in 1895 (the oldest hatchery in the Columbia basin); Kalama Falls Hatchery (RM 10.5) was completed in 1959
- Hatchery releases of fall Chinook in the Kalama began in 1895; hatchery releases are displayed for 1967-2002
- The current hatchery program releases 5.1 million juvenile fall Chinook per year into the Kalama River, 2.5 million from Fallert Creek and 2.6 million from Kalama Falls
- Hatchery adult rack returns have ranged from 1,000 to 8,000 since 1960

- Kalama Falls hatchery released upriver bright Chinook salmon beginning in the 1970s as an egg bank for Snake River wild fall Chinook; the last release was in 1984; a natural run of upriver brights was not established in the Kalama

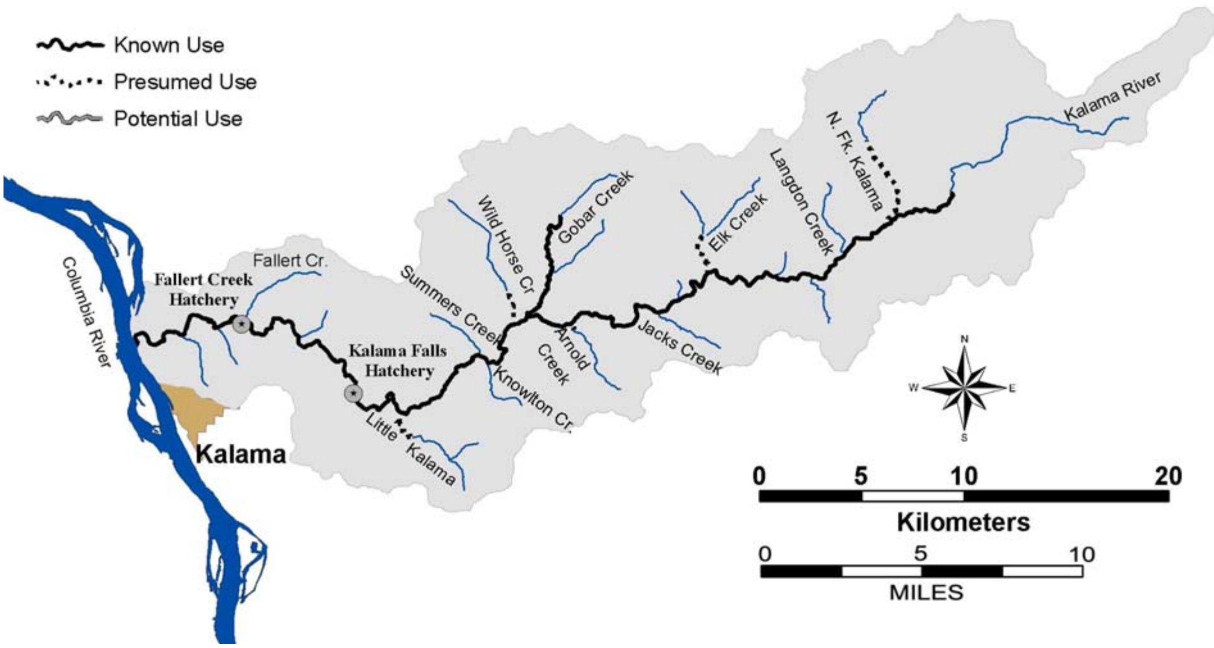
Harvest

- Fall Chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial gill net and sport fisheries
- Kalama Chinook are important contributors to the lower Columbia estuary (Buoy 10) sport fishery, the Columbia River September commercial fishery, and tributary sport fishing in the Kalama
- Columbia River mainstem and Washington/Oregon ocean fisheries harvest is constrained by ESA harvest limitations (49%) on Coweeman wild fall Chinook
- Total annual harvest is dependent on management response to annual abundance in PSC (U.S/Canada), PFMC (U.S. ocean), and Columbia River Compact forums
- CWT data analysis of the 1992-1994 brood years indicates a total Kalama fall Chinook harvest rate of 32%, with 68% accounted for in escapement
- Fishery CWT recoveries of 1992-94 brood indicate the majority of the Kalama fall Chinook stock harvest occurred in British Columbia (36%), Alaska (38%), Washington ocean (6%), and Columbia River (14%) fisheries
- Kalama River tributary sport harvest of fall Chinook averaged 895 adults during 1979-86

3.2.2 *Spring Chinook—Kalama Subbasin*

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

The historical Kalama adult population is estimated from 6,000-15,000 fish, although these estimates may be high. The majority of the habitat for spring Chinook production is upstream of the lower Kalama Falls which was an historical passage block for Chinook. Current natural spawning numbers range from less than 50 to 600, with the majority of the natural spawners originating from the Kalama hatcheries. Natural spawning occurs in the mainstem above the lower Kalama Falls, when fish are passed above Kalama Falls Hatchery, and in the mainstem in the first few miles downstream of the Kalama Falls Hatchery. Juveniles rear for a full year before migrating from the Kalama in the spring.

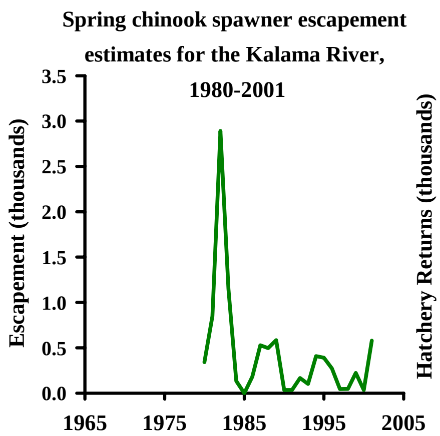


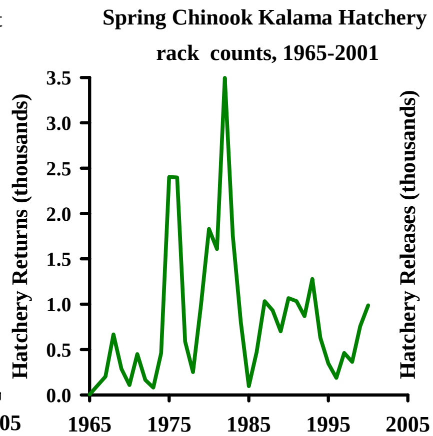
Distribution

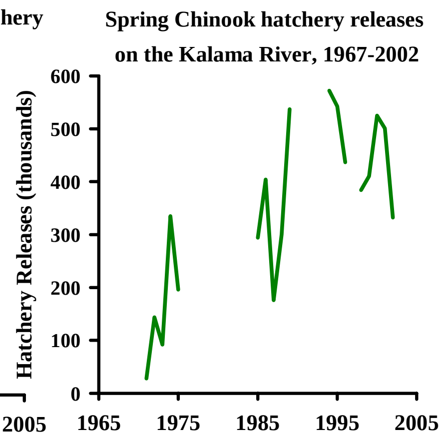
- Currently, natural spawning is concentrated in the mainstem Kalama between the Kalama Falls (RM 10.5) and Fallert Creek (Lower Kalama) hatcheries (RM 4.8)
- Some spring Chinook are passed above Lower Kalama Falls; spawners have been observed up to upper Kalama Falls (RM 36.8)

Life History

- Spring Chinook enter the Kalama River from March through July
- Spawning in the Kalama River occurs between late August and early October, with peak activity in September
- Age ranges from 2-year old jacks to 6-year old adults, with 4- and 5-year olds usually the dominant age class (averages are 48.3% and 38.1%, respectively)
- Fry emerge between November and March, depending on time of egg deposition and water temperature; spring Chinook fry spend one full year in fresh water, and emigrate in their second spring as age-2 smolts







Diversity

- One of four spring Chinook populations in the Columbia River Evolutionarily Significant Unit
- The Kalama spring Chinook stock designated based on distinct spawning distribution, spawning timing, and genetic composition
- Genetic analysis of Fallert Creek (Lower Kalama) Hatchery spring Chinook in 1990 indicated they are genetically similar to, but distinct from, Cowlitz Hatchery and Lewis spring Chinook and significantly different from other Columbia Basin spring Chinook stocks

Abundance

- Reports of considerable historical numbers of spring Chinook in the Kalama have not been verified
- By the 1950s, only remnant (<100) spring Chinook runs existed on the Kalama
- Kalama River spawning escapements from 1980-2001 ranged from 0 to 2,892 (average 444)
- Hatchery strays account for most spring Chinook spawning in the Kalama River

Productivity & Persistence

- NMFS Status Assessment for the Kalama River indicated a 0.56 risk of 90% decline in 25 years and a 0.82 risk of 90% decline in 50 years; the risk of extinction in 50 years was not calculated
- Smolt density model predicted natural production potential for the Kalama River below Kalama Falls of 111,192 smolts plus 465,160 smolts above Kalama Falls
- Juvenile production from natural spawning is presumed to be low

Hatchery

- Fallert Creek (Lower Kalama) Hatchery (RM 4.8) was completed in 1895; Kalama Falls Hatchery (RM 10.5) was completed in 1959; spring Chinook have also been reared at Gobar Pond (~4 miles up Gobar Creek); hatchery brood stock is mostly native Kalama stocks with some Cowlitz sock transfers occuring
- Adult returns above hatchery brood stock needs are released above Lower Kalama Falls
- Hatchery releases of spring Chinook in the Kalama began in the 1960s; total spring Chinook releases into the Kalama Basin from 1967-2002 averaged 378,280
- In 2002 releases into the Kalama from Kalama Falls and Fallert Creek Hatcheries totaled 332,200

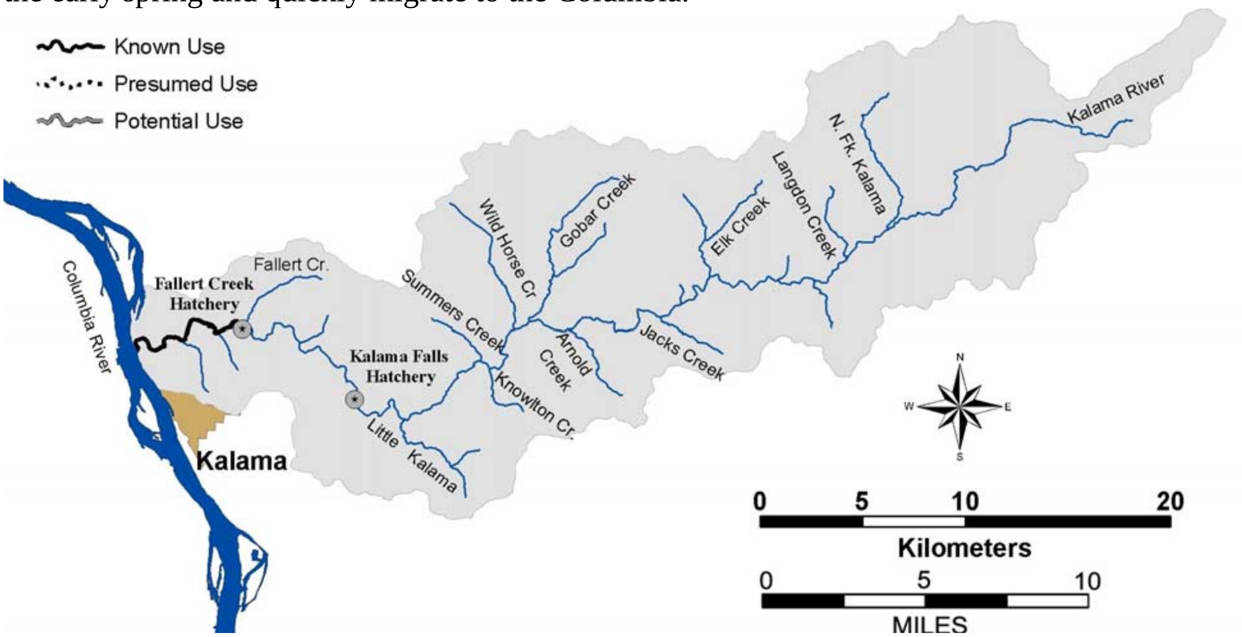
Harvest

- Kalama spring Chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial and sport fisheries
- CWT data analysis of the 1989-1994 brood Fallert Creek indicates that 32% of the Kalama spring Chinook were harvested and 68% escaped to spawn
- Fishery recoveries of the 1989-1994 brood Cowlitz River Hatchery spring chinook: Kalama sport (52%), British Columbia (17%), Alaska (10%), Washington Coast (9%), Columbia River (6%), and Oregon coast (6%)
- Mainstem Columbia River Harvest of Kalama spring Chinook was very low after 1977 when April and May spring Chinook seasons were eliminated to protect upper Columbia and Snake wild spring Chinook.
- Mainstem Columbia harvest of Kalama River Hatchery spring Chinook increased in 2001-2002 when selective fisheries on adipose marked hatchery fish enabled mainstem spring fishing in April (and in May, 2002) again
- Sport harvest in the Kalama River averaged 1,900 spring Chinook annually from 1980-1994, reduced to less than 100 from 1995-1999, and has increased to 400 from 2000-2002
- Tributary harvest of hatchery spring Chinook is managed to attain the Kalama hatchery adult broodstock escapement goal
- Since 2002, tributary fisheries have been selective to retain only adipose fin-clipped hatchery spring Chinook and release unmarked wild spring Chinook

3.2.3 *Chum—Kalama Subbasin*

ESA: Threatened 1999 **SASSI: NA**

The historical Kalama adult population is estimated from 15,000-40,000. Current natural spawning estimate is less than 50 fish in the Kalama. Spawning occurs in the lower reaches of the mainstem Kalama between Modrow Bridge and lower Kalama Falls. Spawn timing is mid November-December. Natural spawning chum in the Kalama 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

- Chum spawning habitat is limited to the mainstem Kalama, between Modrow Bridge (RM 2.4) and Lower Kalama Falls (RM 10)

Life History

- Lower Columbia River chum salmon run from mid-October through November; peak spawner abundance occurs in late November
- Dominant age classes of adults are age 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts with little freshwater rearing time

Diversity

- No hatchery releases of chum have occurred in the Kalama basin

Abundance

- In 1951 estimated chum escapement to the Kalama River was 600

Productivity & Persistence

- Current juvenile production is assumed to be low

Hatchery

- The Fallert Creek (Lower Kalama) Hatchery and the Kalama Falls Hatchery do not produce/release chum salmon; chum salmon releases into the Kalama basin from other hatcheries have not been documented

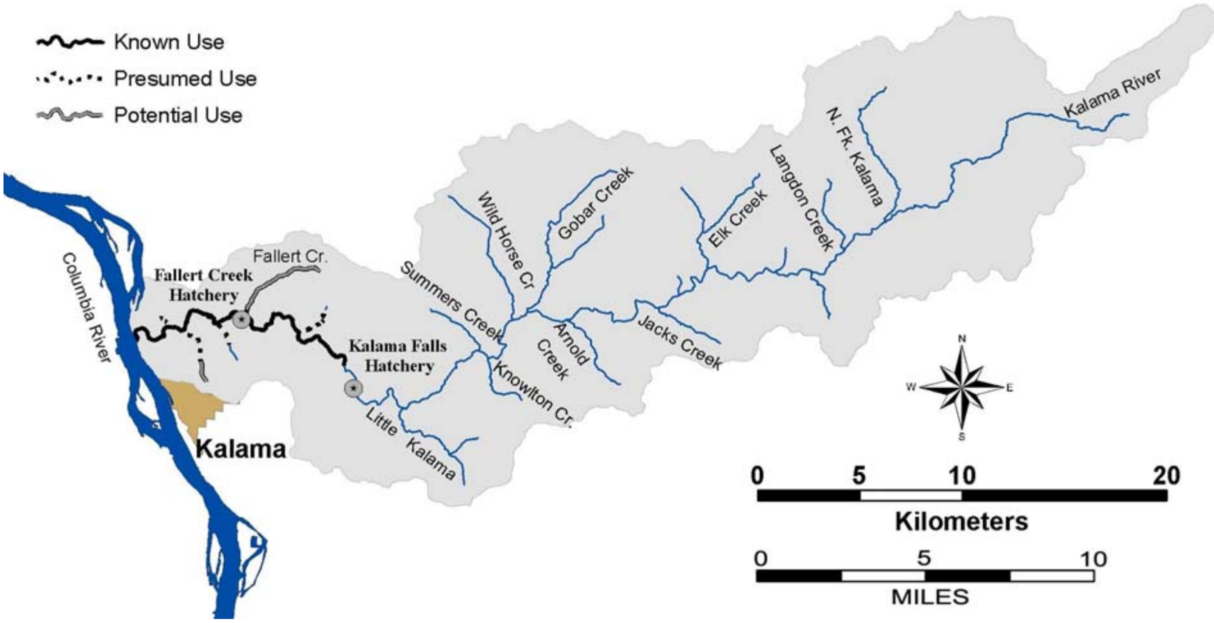
Harvest

- 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

3.2.4 *Coho—Kalama Subbasin*

ESA: Candidate 1995	**SASSI: Unknown 2002**

The historical Kalama adult population is estimated from 2,000-26,000, with both early and late stock present. Early coho spawn primarily in November while late stock spawning is spread from late November to March. Current returns are unknown but assumed to be very low. A number of hatchery produced fish spawn naturally. Natural spawning occurs in the mainstem and tributaries downstream of lower Kalama Falls. Juveniles rear for a full year in the Kalama Basin before migrating as yearlings in the spring.

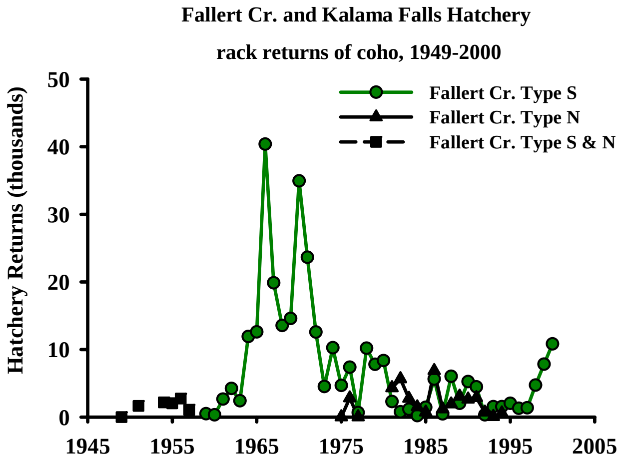


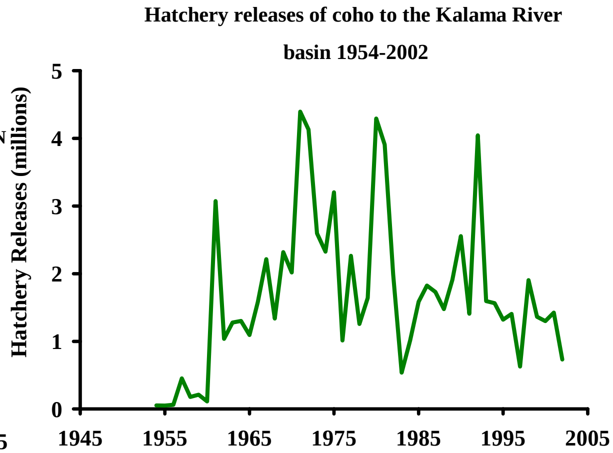
Distribution

- Managers refer to early coho as Type S due to their ocean distribution generally south of the Columbia River
- Managers refer to late coho as Type N due to their ocean distribution generally north of the Columbia River
- Natural spawning area is generally limited to accessible tributaries below Kalama Falls (RM 10)
- A fish ladder was installed at Kalama Falls in 1936, providing access above the falls; however, a 1951 WDF survey indicated most fish were distributed below the falls

Life History

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





Diversity

- Late stock coho (or Type N) were historically produced in the Kalama basin with spawning occurring from late November into March
- Early stock coho (or Type S) were historically produced in the Kalama basin with spawning occurring from October to mid November
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar

Abundance

- Kalama River wild coho run is a fraction of its historical size
- An escapement survey in the late 1930s observed 1,422 coho in the Kalama
- In 1951, WDF estimated coho escapement to the basin was 3,000; both early and late coho were present
- Hatchery production accounts for most coho returning to the Kalama River

Productivity & Persistence

- Natural coho production is presumed to be very low
- Electrofishing for juveniles in the Little Kalama River (a major tributary downstream of Kalama Falls) in 1994 and 1995 showed no coho but good numbers of steelhead

Hatchery

- Fallert Creek Hatchery (completed in 1895) is located about RM 4.3 and the Kalama Falls Hatchery (completed in 1959) is located at RM 10.0
- Coho have been planted in the Kalama basin since 1942; releases were increased substantially in 1967
- The coho program at the two Kalama hatchery complexes was greatly reduced in recent years because of federal funding cuts; the remaining coho program is about 700,000 smolts released annually, split evenly between early stock (reared at Fallert Creek) and late stock (reared at Kalama Falls)

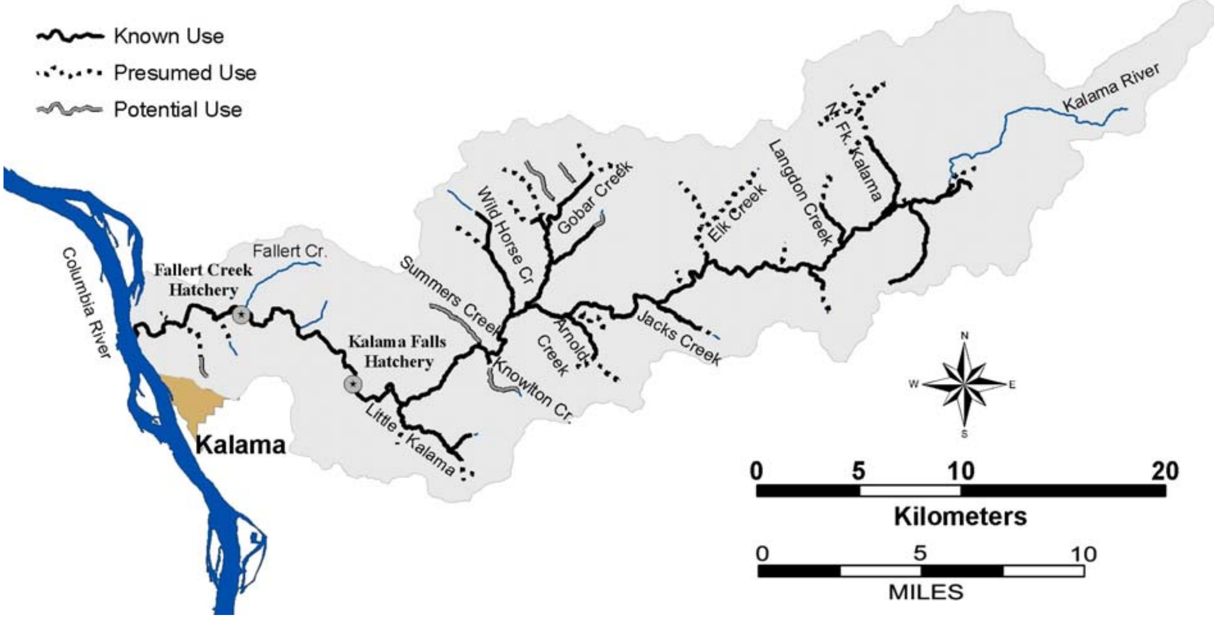
Harvest

- 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% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas River wild coho
- Since 1999, returning Columbia River hatchery coho have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho in September is constrained by fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon State listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early coho, but late coho harvest can also be substantial
- An average of 1,272 coho (1979-1986) were harvested annually in the Kalama River sport fishery
- CWT data analysis of the 1995-97 Fallert Creek Hatchery early coho indicates 30% were captured in a fishery and 70% were accounted for in escapement
- CWT data analysis of 1995-97 brood Kalama Falls Hatchery late coho indicates 76% were captured in a fishery and 24% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 brood Kalama early coho are distributed between Columbia River (49%), Washington Ocean (42%), and Oregon ocean (9%) sampling areas
- Fishery CWT recoveries of Kalama late coho are distributed between Columbia River (58%), Washington ocean (32%), and Oregon ocean (10%) sampling areas

3.2.5 *Summer Steelhead—Kalama Subbasin*

ESA: Threatened 1998	SASSI: Depressed 2002

The historical Kalama adult population is estimated from 1,300- 7,000 fish. Current natural spawning returns range from 200-2,300 fish. In-breeding with Skamania Hatchery produced steelhead is thought to be low because of differences in spawn timing. Spawning occurs primarily in the mainstem and tributaries upstream of Kalama Falls Hatchery. Spawn timing is generally from February to April. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Kalama.

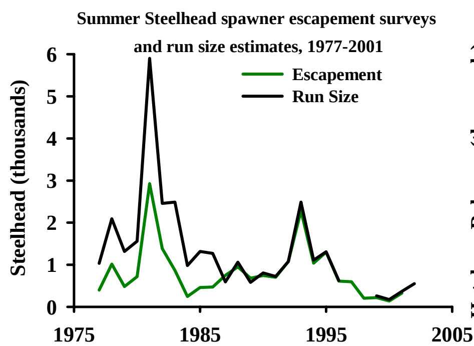


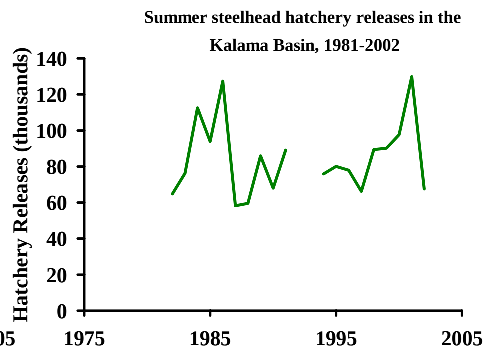
Distribution

- Spawning occurs above Lower Kalama Falls in the mainstem and NF Kalama River and throughout many tributaries, including Gobar, Elk, Fossil, and Wild Horse Creeks
- A 35ft falls at RM 36.8 blocks all upstream migration

Life History

- Adult migration timing for Kalama summer steelhead is from early June through October
- Spawning timing on the Kalama is generally from mid-January through April, with peak spawning in February
- Thirteen age classes have been observed; dominant age class is 2.2 (average 64.1%)
- Wild steelhead fry emerge from March through May; juveniles generally rear in fresh water for two years; emigration occurs from March to June, with peak migration from mid-April to mid-May





Diversity

- Stock designated based on distinct spawning distribution and early run timing
- Estimated 40% of returning naturally produced adults had at least one hatchery parent; however, wild stock has retained genetic traits of considerable adaptive value relative to the transplanted hatchery stock (Hulett and Leider 1989)
- Conversely, electrophoretic examination of a specific genetic marker suggests that the genetic integrity of wild populations may be at risk because of inbreeding with hatchery stocks (Milner et al. 1980)
- After the1980 Mt. St. Helens eruption, straying Cowlitz River steelhead spawned with native Kalama stocks
- Kalama summer and winter steelhead have been observed spawning, therefore runs are not always reproductively separate

Abundance

- In 1936-37 steelhead were documented in the Kalama River during escapement surveys
- Wild summer steelhead run size in the 1950s was estimated to be less than 1,500 fish
- Escapement counts from 1977-2001 ranged from 140 to 2,926; run size estimates from 1977-1999 ranged from 582 to 5,903 summer steelhead
- Escapement goal for the Kalama is 1,000 wild adult steelhead; goal has not been met since 1995

Productivity & Persistence

- NMFS Status Assessment indicated a 0.22 risk of 90% decline in 25 years and a 0.42 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.01
- WDW estimated potential summer and winter steelhead smolt production was 34,850; naturally-produced steelhead smolts migrating annually from 1978-1984 ranged from 11,175 to 46,659

Hatchery

- Two hatcheries in the Kalama basin: Fallert Creek (Lower Kalama) Hatchery (RM 4.3) and Kalama Falls Salmon Hatchery (RM 10)
- Gobar Pond, located about 4 miles up Gobar Creek (RM 19.5), is used as a steelhead acclimation pond for 1-2 months prior to release
- Summer steelhead from Beaver Creek and Skamania Hatcheries have been transferred to Gobar Pond as yearlings; steelhead acclimated at Gobar Pond have been released directly to

Gobar Creek or trucked and released directly into the Kalama River; release data are displayed from 1981-2002.

- Kalama research estimates success of hatchery fish producing adult offspring was only 12% that of wild fish
- Hatchery summer steelhead usually comprise 70-80% of the spawning escapement
- A wild broodstock summer steelhead hatchery program has initiated in recent years. Broodstock are collected, and juveniles reared and released into the Kalama River.

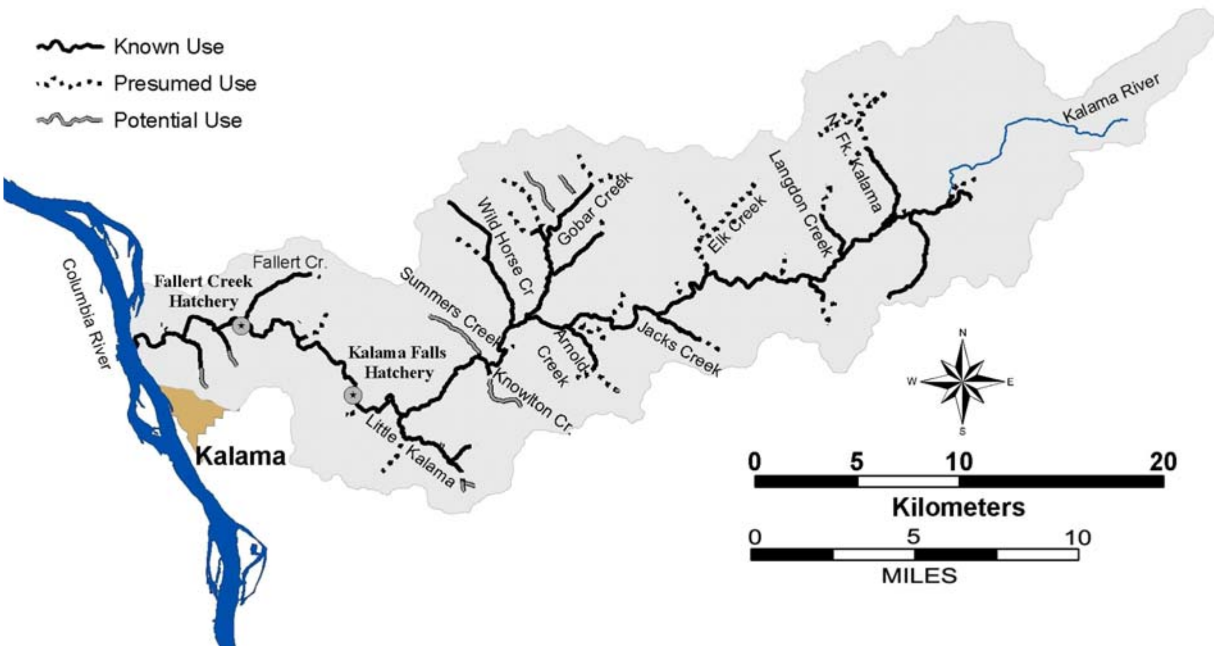
Harvest

- No directed commercial fisheries target Kalama summer steelhead; incidental mortality currently occurs during the Columbia River fall commercial fisheries and summer sport fisheries
- Wild summer steelhead sport harvest in the Kalama River from 1977-1999 ranged from 5 to 2,978; since 1986, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild Kalama steelhead in the mainstem Columbia River and in the Kalama River as per the Fisheries Management and Evaluation Plan approved by NOAA Fisheries in 2003.

3.2.6 *Winter Steelhead—Kalama Subbasin*

ESA: Threatened 1998 **SASSI: Healthy 2002**

The historical Kalama adult population is estimated from 1,000-8,000 fish. Current natural spawning returns range from 500-2,300. In-breeding with Skamania Hatchery produced steelhead is thought to be low because of differences in spawn timing. Spawning occurs primarily in the mainstem and tributaries upstream of Kalama Falls Hatchery. Spawning generally occurs from 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 Kalama.

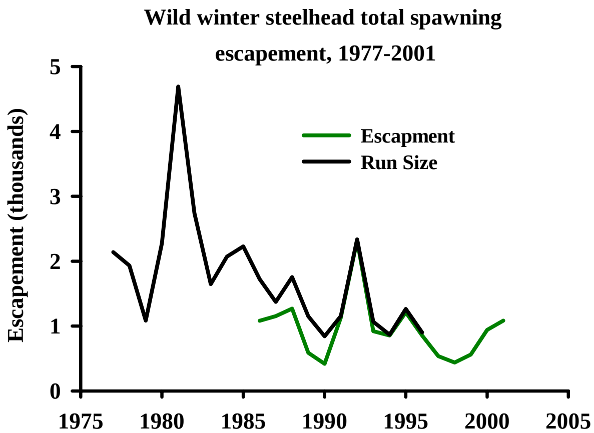


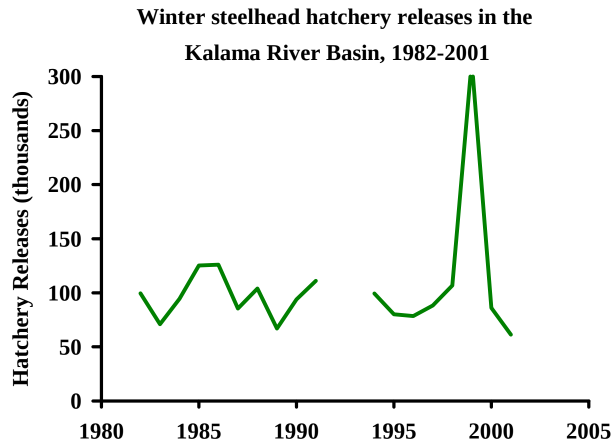
Distribution

- Spawning occurs in the mainstem Kalama River and Gobar, Elk, and Fossil Creeks
- A 35 ft falls at RM 36.8 blocks all upstream migration

Life History

- Adult migration timing for Kalama winter steelhead is from November through April
- Spawning timing on the Kalama is generally from early January to early June
- Age composition data for Kalama River winter steelhead indicate that the dominant age classes are age 2.2 and 2.3 (50.1 and 30.5%, respectively)
- Wild steelhead fry on the Kalama emerge from April through early July; juveniles generally rear in fresh water for two years; juvenile emigration occurs from March through June, with peak migration from mid-April to mid-May





Diversity

- Kalama winter steelhead stock designated based on distinct spawning distribution and late run timing
- Level of wild stock interbreeding with hatchery brood stock from the Beaver Creek Hatchery, Chambers Creek, and the Cowlitz and Elochoman Rivers is unknown
- After 1980 Mt. St. Helens eruption, straying Cowlitz River steelhead have spawned with native Kalama stocks
- Kalama summer and winter steelhead have been observed spawning, therefore runs are not reproductively separate
- Genetic sampling of juvenile Kalama steelhead in 1994 was inconclusive because the sample was likely mixed winter and summer steelhead

Abundance

- In 1936, 37 steelhead were documented in the Kalama River during escapement surveys
- Total escapement counts from 1977-2001 ranged from 371 to 2,322; run size estimates for 1977-1999 have ranged from 842 to 4,691
- Escapement goal for the Kalama River is 1,000 wild adult steelhead
- In 1997, the Kalama River had the only winter steelhead stock designated as healthy in the lower Columbia ESU

Productivity & Persistence

- NMFS Status Assessment indicated a 0.0 risk of 90% decline in 25 years and a 0.07 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.0
- Washington Department of Wildlife estimated potential summer and winter steelhead smolt production was 34,850; the number of naturally-produced steelhead smolts migrating annually from 1978-1984 ranged from 11,175 to 46,659

Hatchery

- Two hatcheries in the Kalama basin: Fallert Creek (Lower Kalama) Hatchery (RM 4.3) and Kalama Falls Salmon Hatchery (RM 10);
- Gobar Pond, located about 4 miles up Gobar Creek (RM 19.5), is used as a steelhead acclimation pond for 1-2 months prior to release
- Hatchery winter steelhead have been planted in the Kalama basin as early as 1938; consistent releases began in 1955; hatchery winter steelhead are transferred to Gobar Pond as yearlings;

steelhead acclimated at Gobar Pond are released directly to Gobar Creek or trucked and released directly into the Kalama River; the Cowlitz and Beaver Creek Hatcheries have released steelhead smolts directly to the Kalama without acclimation; release data are displayed from 1982-2001

- There is some contribution to natural production from hatchery winter steelhead spawning in the Kalama River basin
- A wild broodstock hatchery program has been initiated in recent years. Wild broodstock are collected at Kalama Falls Hatchery, and juveniles are reared and released into the Kalama River.

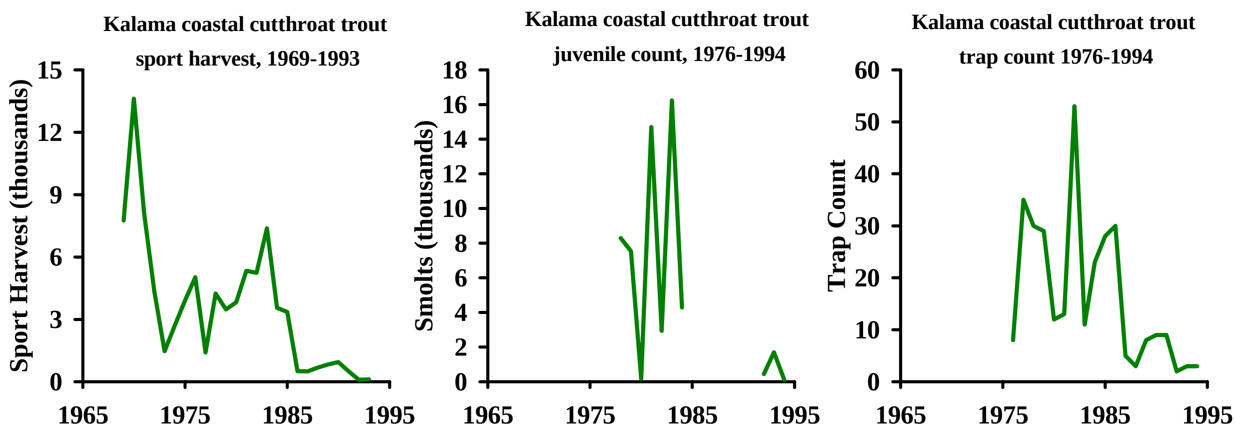
Harvest

- No directed commercial or tribal fisheries target Kalama winter steelhead; incidental mortality currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Treaty Indian harvest does not occur in the Kalama River basin
- Wild winter steelhead sport harvest in the Kalama River from 1977-1999 ranged from 4 to 2,162 (average 610); since 1990, regulations limit harvest to hatchery fish only
- ESA limits fishery impact of wild winter steelhead in the mainstem Columbia River and in the Kalama River as per the Fisheries Management and Evaluation Plan approved by NOAA Fisheries in 2003.

3.2.7 *Cutthroat Trout—Kalama River Subbasin*

ESA: Not Listed	SASSI: Depressed 2000

Coastal cutthroat abundance in the Kalama has not been quantified but the population is considered depressed. Both anadromous and resident forms of cutthroat trout are found in the basin. Counts of adult cutthroat trout at the Kalama Falls fishway and smolt production estimates indicate a declining trend in abundance. Anadromous cutthroat enter the Kalama from July-December and spawn from December through June. Most juveniles rear 2-4 years before migrating from their natal stream. A hatchery cutthroat program was discontinued in 1999.



Distribution

- Anadromous, fluvial and resident forms are present
- Anadromous cutthroat are found in the mainstem Kalama and tributaries below Kalama Falls (RM 10)
- Fluvial and resident fish are present throughout the basin

Life History

- Anadromous, fluvial, and resident life history forms are all present in the basin.
- Anadromous forms enter the watershed from July through December and spawn from December through June.
- Fluvial and resident fish spawn from February through June.

Diversity

- Distinct stock complex based on the geographic distribution of their spawning grounds.
- Genetic sampling has indicated that Kalama River cutthroat are genetically distinct from other lower Columbia River populations

Abundance

- Declining trends in adult counts, smolt estimates, and sport catch data
- Kalama Falls fishway counts ranged from 8 to 53 cutthroat, and averaged 25 fish from 1976 to 1986
- From 1987 to 1995, counts ranged from 2 to 9 fish per year, and averaged 5
- Estimate of smolts produced above Kalama Falls from 1978 through 1984 ranged from 163 to 16,229 with a yearly average of 7,737.
- From 1992 to 1994, the range dropped to 106 to 1667 with an average of 749 smolts

- Average yearly catch of cutthroat from lower Columbia River sport creel census data averaged 4985 fish from 1969-1985, but only 521 fish from 1986-1993
- Wild cutthroat must now be released in the Kalama River sport fisheries
- No population size data for resident forms

Productivity & Persistence

- Kalama anadromous cutthroat productivity decreased in the 1990s, similar to other salmonids

Hatchery

- There is no hatchery production of cutthroat trout in the Kalama River basin.
- Hatchery-produced Chinook, coho and steelhead are released into the Kalama River and tributaries.

Harvest

- Not harvested in ocean commercial or recreational fisheries
- Angler harvest for adipose fin clipped hatchery fish occurs in mainstem Columbia summer fisheries downstream of the Kalama River
- Wild (unmarked) cutthroat trout must be released in Columbia River and Kalama River sport fisheries

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3.2.8 *Other Species*

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

3.3 Subbasin Habitat Conditions

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

3.3.1 *Watershed Hydrology*

Stream flow in the subbasin is a direct result of rainfall, since only a small portion of the basin is above the usual snowline. Peak flows generally correspond with mid-winter rains. Summer low flow typically occurs in August (mean of 306 cubic feet per second [cfs]) and high flows occur in December or January (mean of 2,157 cfs and 2,152 cfs, respectively) (WDW 1990). Mean annual flow from 1953-67 was 1,219 cfs.

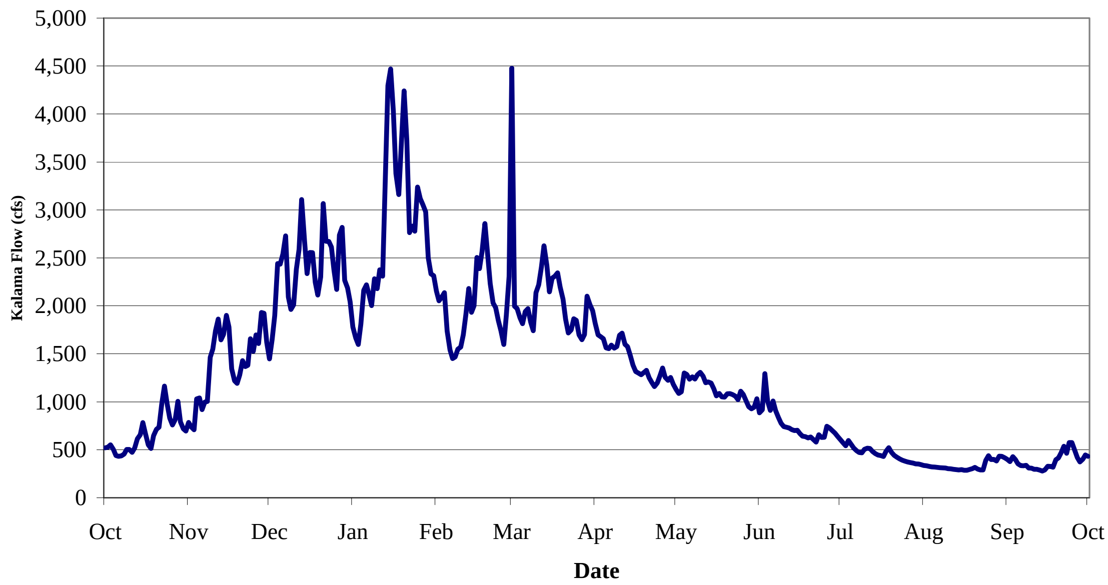

Figure 4. Kalama River hydrograph (1966-1975). Values are daily mean flows. The Kalama exhibits a fall through spring rainfall dominated regime, with flows typically falling below 300 cfs in late summer. Data is from USGS Stream Gage #14223500; Kalama River Below Italian Cr. near Kalama, Wash.

Most private timberland was logged in the 1970s and early 1980s, including riparian areas. These activities, combined with splash dam log transport, poor road construction, and inadequate culverts, served to alter hydrologic and sediment transport processes and limit anadromous fish habitat (Wade 2000). The February 1996 flood caused 39 landslides.

Generation of increased overland flow may occur due to the extensive road network and past vegetation removal due to logging, though this process is assumed to be recovering as a result of logging reductions and improved road building and maintenance. Using vegetation and road conditions, the USFS noted a potential 10% increase of peak flow volumes (compared to undisturbed conditions) in six of eight subbasins (USFS 1996a).

The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that 17 of 18 subwatersheds (7th field) are “impaired” with regards to runoff conditions. Only the highest headwater subwatershed receives a "moderately impaired" rating. High road densities and young forest stands are the primary causes of hydrologic impairment. These conditions create a risk of increased peak flow volumes.

An IFIM study conducted in 1999 on the mainstem by the WDOE found that flows were below optimal for coho and chinook spawning in October, and below optimal for juvenile rearing from mid-June to mid-October (Caldwell 1999). Concern over low flows also exist in Langdon Creek, NF Kalama, Jack Creek, and Wold Creek, where accumulation of coarse sediments at the mouth may increase the potential for subsurface flow and therefore increase the risk of stranding juvenile fish.

Consumptive water use in the subbasin is estimated to increase from the current 308 million gallons per year (mgy) to 523 mgy by 2020. However, current and predicted future surface and groundwater use is believed to have a relatively insignificant impact on stream flows (LCFRB 2001). The Limiting Factors Analysis, on the other hand, suggested that water withdrawal development in the lower basin could be a potential future problem (Wade 2000).

3.3.2 *Passage Obstructions*

Accumulation of sediments at the mouth has created a wide shallow channel that is believed to cause passage problems for migrating fish, especially at low tide. The shallow flow increases susceptibility to predation and elevated water temperatures. The lower Kalama River Hatchery presents a partial barrier to migration up Hatchery (Fallert) Creek during low flows. Culverts, mouth sediment accumulations, and log jams on several tributary creeks are also thought to create potential barriers (Wade 2000).

3.3.3 *Water Quality*

Portions of the lower 10 miles of the Kalama and Hatchery (Fallert) Creek are listed on the state's 303(d) list of impaired water bodies due to exceedance of water temperature standards (WDOE 1998). Of particular concern are elevated temperatures that are believed to occur at the mouth, where sediment accumulations have created a wide, shallow channel. This may present problems for fish migrating during summer low flows. A 1994 water temperature survey by WDFW indicated no temperature exceedances during summer low flow on segments of the middle Kalama. Stream temperatures are not considered a problem on the National Forest portion of the basin except for on Fossil Creek where temperatures have been measured as high as 23ºC (USFS 1996).

Nutrient levels may be low in the upper river (above the falls) due to low steelhead escapement levels and consequent low levels of carcass-derived nutrients. However, carcass supplementation programs have been conducted and may be alleviating nutrient deficiencies (Wade 2000).

3.3.4 *Key Habitat Availability*

A few tributaries to the Kalama have low pool frequencies, which may crowd rearing juveniles into existing pools (WDFW 1998). However, in general, pool availability in most of the basin is considered adequate (Wade 2000).

Few off-channel locations exist on the lower river due to channelization, and 1994 surveys indicated few off-channel habitats in the middle river as well (WDFW 1998). The lack of off-channel areas could potentially limit overwintering habitat for coho, steelhead, and spring chinook.

3.3.5 *Substrate & Sediment*

Surveys conducted by WDFW in 1994, as well as prior data, indicate ongoing concerns with substrate fines throughout the basin. There are also concerns with the accumulation of excessive coarse sediment at the mouths of some tributaries, especially Langdon Creek and the NF Kalama (Wade 2000).

Production of sediment from the subbasin is influenced by highly erodible soils, vegetation removal from logging, and high road densities. The total road density is 5.75 miles/square mile. The Middle Kalama basin, from RM 17 to 32 has a road density of 6.4 miles/square miles (WDFW 1998). National Forest lands in the basin have an average road density of 4.0 miles/square mile and are highly fragmented, with an average of 2.6 road crossings per stream mile. Areas of natural soil instability also exist throughout the basin. The February 1996 floods triggered at least 39 slides in the basin (USFS 1996).

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results show that about half of the basin is either “impaired” or “moderately impaired” with regards to sediment supply. The bulk of the impaired subwatersheds are in the middle elevations. These areas are in private commercial timber production and have high road densities.

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.

3.3.6 *Woody Debris*

Abundance of in-stream LWD is thought to be low throughout the basin, although some large pieces are evident in the mainstem, often as part of log jams. Contributing to these low levels was the practice of removing in-stream wood, which occurred during the heavy logging years of the 1970s and 80s (WDFW 1998). Removal of LWD for firewood is a potential current problem. Lewis County GIS data rates over 87% of the riparian habitat as lacking vegetation and consisting primarily of deciduous species, suggesting low LWD recruitment potential (Wade 2000).

3.3.7 *Channel Stability*

Bank stability is generally considered good throughout the basin. Problems exist on the mainstem just upstream and downstream of Spencer Creek (RM 2.2) but it is unknown whether it is a natural or human induced process. The Watershed Recovery Inventory Project (WDFW 1997) identified mass wasting problems along Hatchery Creek, Wild horse Creek, Gobar Creek, NF Kalama, Lakeview Peak Creek, and Langdon Creek. A large slide on the NF Kalama is stabilizing, however a large slide in the headwaters of Lakeview Peak Creek may be a concern until the feature stabilizes (Wade 2000).

3.3.8 *Riparian Function*

Most of the watershed, including riparian forests, was logged in the late 1960s through the early 1980s. According to an analysis by Lewis County GIS of 1994 and 1996 aerial photos, riparian forests on 85 of the 97.25 miles of anadromous stream channels are lacking riparian vegetation and/or contain mostly deciduous species (Wade 2000).

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, 17 of 18 subwatersheds are rated as "moderately impaired" for riparian conditions, and only the uppermost headwater subwatershed is rated as "functional". Impaired riparian conditions are related to past timber harvests (1960s to 1980s), stream adjacent roads, and development along the lower river.

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.

3.3.9 *Floodplain Function*

Nearly all of the lower floodplain has been disconnected from the river due to dikes, I-5, and development on the Port of Kalama property (Wade 2000).

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 Kalama River 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. Reach specific habitat attributes are rated according to their relative degree of impact on population performance. This level of output is most useful for practitioners who will be developing and implementing specific recovery actions.

3.4.1 *Population Analysis*

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

Habitat-based assessments were completed in the Kalama River subbasin for summer steelhead, winter steelhead, fall Chinook, spring Chinook, chum, and coho. For all modeled populations, productivity has decreased by 62-90% from historical levels, with chum and spring Chinook declining the most (Table 2). Adult abundance trends show similar declines (Figure 5). Model results indicate that adult abundance of Kalama fall Chinook, coho, winter steelhead and summer steelhead has declined by 43-63% from historical levels. Spring Chinook and chum, however, have had the most severe declines in adult abundance, with current estimates at only 8% of historical levels. Species diversity (as measured by the diversity index) has remained constant for both fall Chinook and summer steelhead (Table 2). However, diversity has declined by 9-21% for spring Chinook, chum and winter steelhead, and by 63% for coho (Table 2).

Estimates of current smolt productivity have decreased from historical estimates in all populations (Table 2). Smolt productivity has declined most for winter steelhead and least for chum. However, in the case of chum, this seems counter-intuitive due to the fact that chum adult abundance has declined the most out of the six species. However, this relatively higher smolt productivity is merely an artifact of the way the EDT model calculates productivity. That is, the higher productivity of chum smolts is because Kalama 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 has decreased by 31-46% for fall Chinook, winter steelhead, and summer steelhead, and by 70-83% for spring Chinook, chum, and coho (Table 2).

Model results indicate that restoration of properly functioning habitat conditions (PFC) would benefit all species (Table 2). The most dramatic increase in adult abundance with restoration to PFC would be for chum and coho. Current coho abundance would increase by approximately 113% and current chum abundance by approximately 272%. Smolt numbers are also estimated to increase dramatically for all species, especially for coho, which shows a 343% increase in smolt abundance with restoration of PFC.

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

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	1,581	2,367	2,760	3.3	6.9	8.7	1.00	1.00	1.00	248,620	371,277	463,354	398	772	959
Spring Chinook	413	756	4,862	1.8	3.1	17.2	0.79	1.00	1.00	87,930	175,350	286,925	327	601	809
Chum	1,615	6,014	20,637	2.0	6.5	9.7	0.84	1.00	1.00	901,866	2,573,274	4,323,376	703	997	1,147
Coho	484	1,033	1,306	3.8	8.7	12.5	0.37	1.00	1.00	5,192	23,024	30,151	84	194	283
Winter Steelhead	445	614	885	4.0	9.2	17.2	0.91	0.98	1.00	8,032	10,980	13,309	71	167	265
Summer Steelhead	788	953	1,209	4.5	8.2	13.2	0.99	0.99	0.99	14,657	17,583	21,378	83	150	231

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

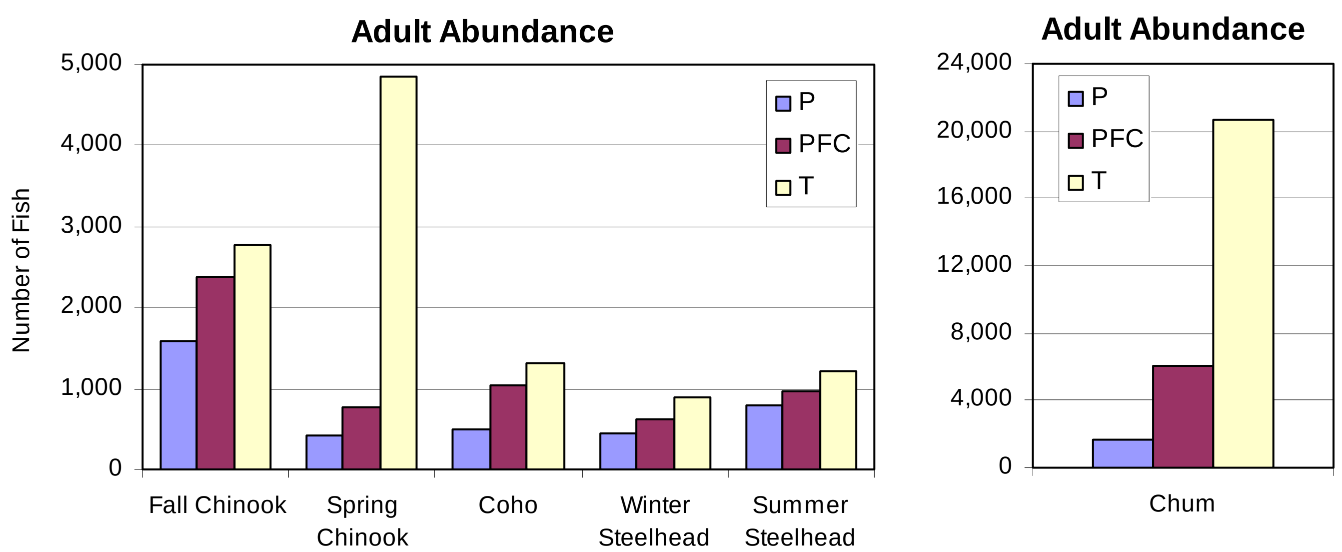

Figure 5. Adult abundance of Kalama fall chinook, spring chinook, coho, winter steelhead, summer steelhead and chum based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

3.4.2 *Stream Reach Analysis*

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

Summer steelhead have the greatest distribution of the Kalama subbasin populations. Only summer steelhead are believed to have regularly passed upstream of the Lower Kalama Falls at RM 10 prior to the installation of a fish ladder. The Upper Kalama River Falls at RM 35 is the upstream limit. Winter steelhead, fall Chinook, spring Chinook, and coho occupy the mainstem and small tributaries downstream of the lower falls. Chum historically occupied the lowest few reaches of the mainstem but their numbers are currently very low. See Figure 6 for a map of EDT reaches within the Kalama subbasin.

High priority reaches for summer steelhead are located in the headwaters (Kalama 17-20) and the middle mainstem (Kalama 6) (Figure 7). The headwater and headwater tributary areas represent important spawning reaches, while the middle mainstem is particularly important for summer adult holding and parr rearing. These important reaches, except for Kalama 6, show a combined preservation and restoration habitat recovery emphasis (Figure 7). Kalama 6 has, by far, the highest preservation potential of any summer steelhead reach.

High priority reaches for winter steelhead also include the middle mainstem (Kalama 6 and 8-10), but due to their slightly more downstream distribution, important reaches also include portions of the lower river (Kalama 4 and 5) (Figure 8). The lower reaches show a habitat restoration emphasis, while the middle reaches show a combined preservation and restoration habitat recovery emphasis (Figure 8).

High priority reaches are similar for fall Chinook (Figure 9), chum (Figure 10), and coho (Figure 11). These reaches are primarily located in the lower sections of the river (Kalama 2-5 and Kalama 1 tidal). For both fall Chinook and chum, these reaches have either a habitat preservation emphasis or a combined preservation and restoration emphasis. However, for coho, these same reaches have a strong restoration potential only.

For spring Chinook, important reaches are found throughout the middle and upper sections of the subbasin (Kalama 8-18) (Figure 12). All these reaches, except for Kalama 8 and 18, have a habitat preservation emphasis. Kalama 8 and 18 show a combined preservation and restoration habitat recovery emphasis (Figure 12).

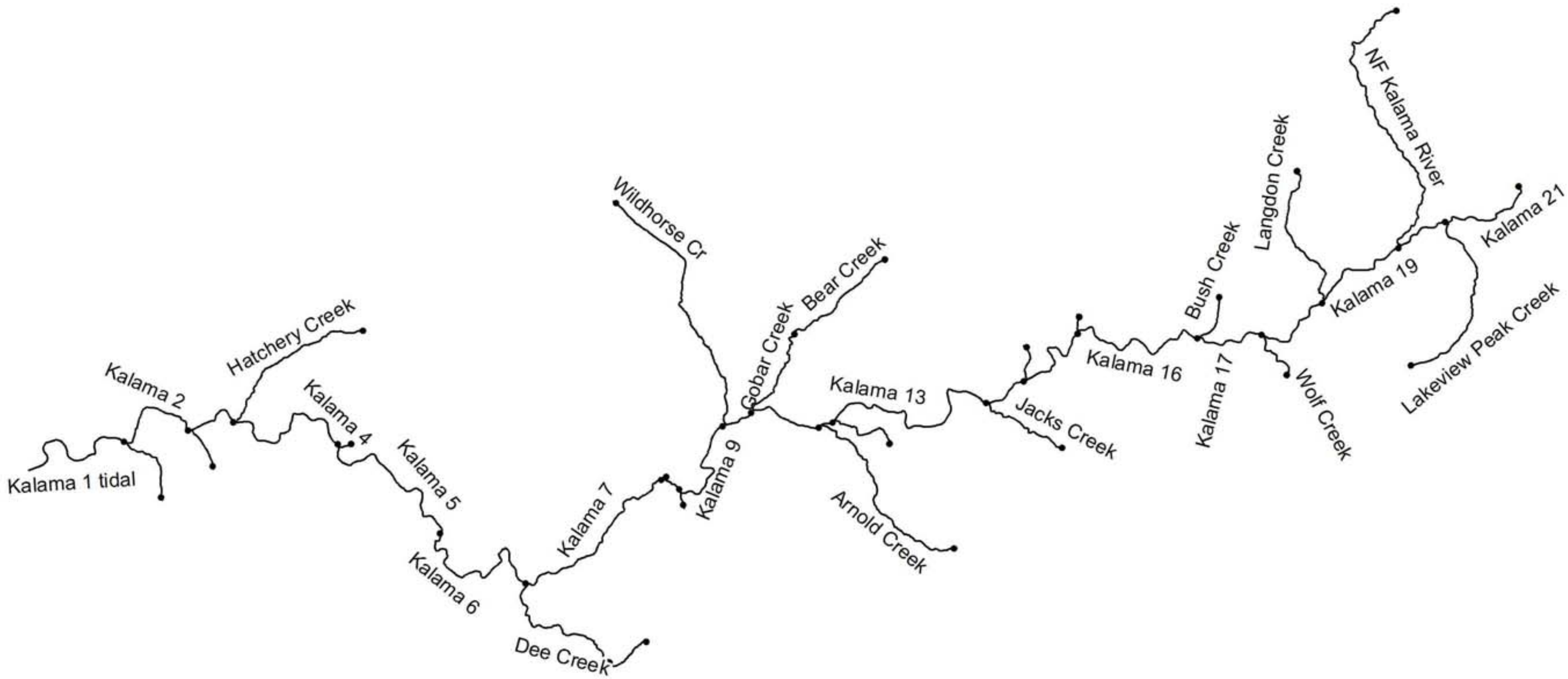

Figure 6. Kalama Subbasin with EDT reaches identified. For readability, not all reaches are labeled.

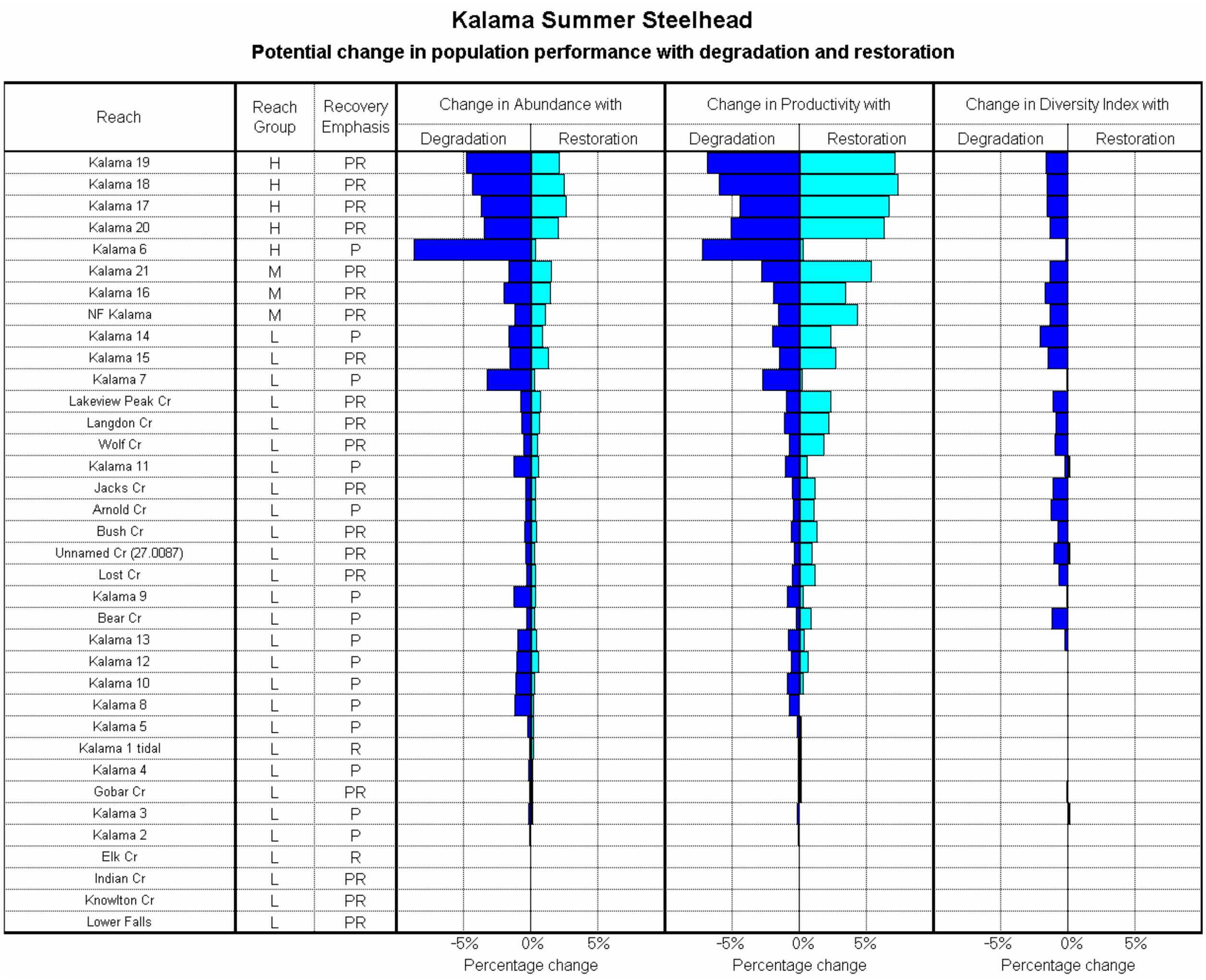

Figure 7. Kalama River subbasin summer steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Some low priority reaches are not included for display purposes.

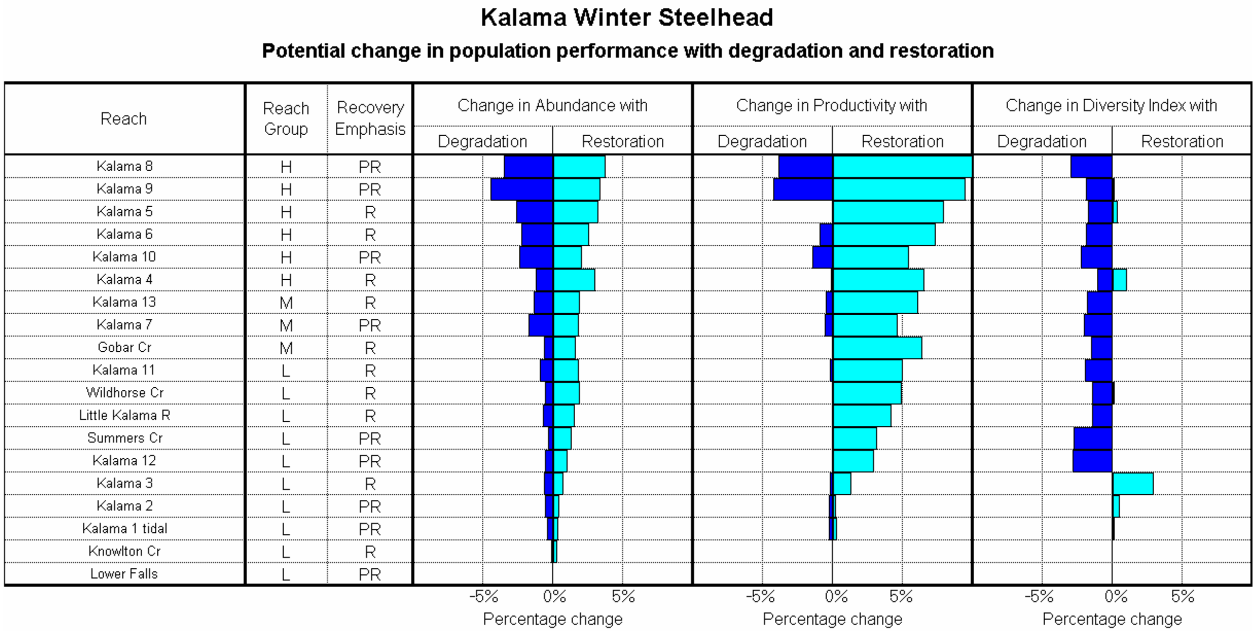

Figure 8. Kalama subbasin winter steelhead ladder diagram.

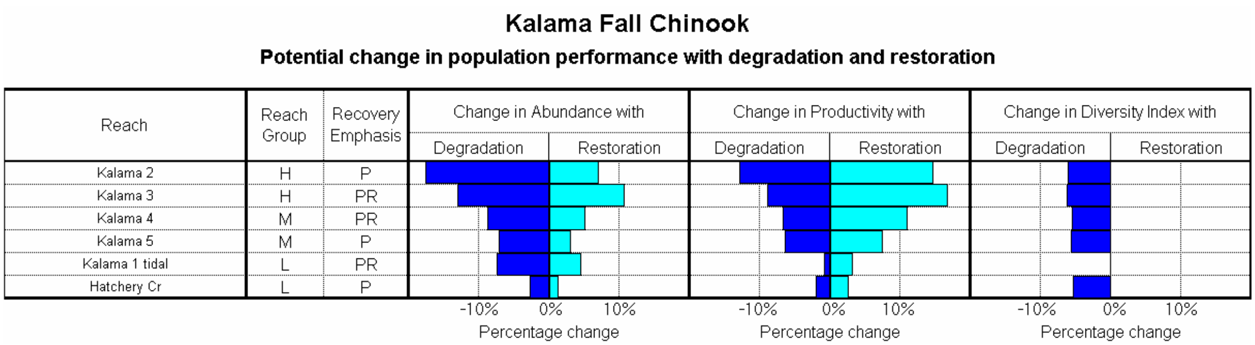

Figure 9. Kalama subbasin fall chinook ladder diagram.

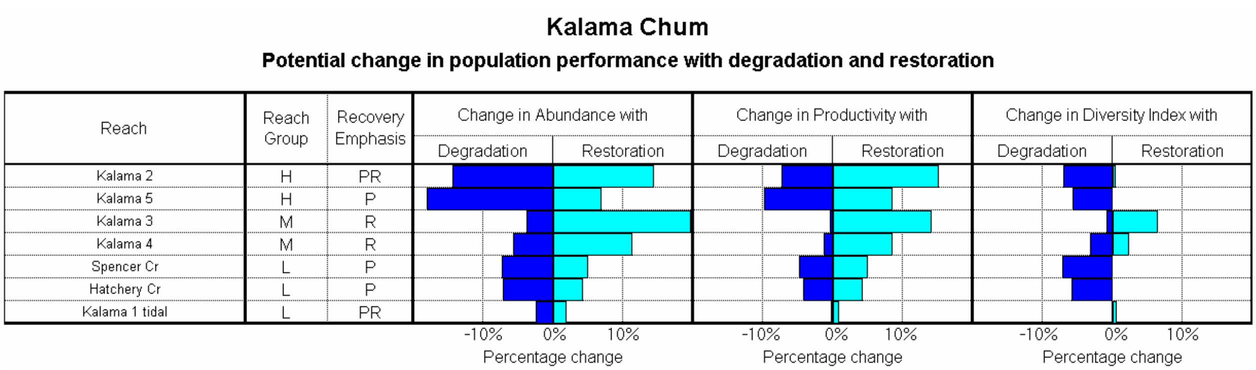

Figure 10. Kalama subbasin chum ladder diagram.

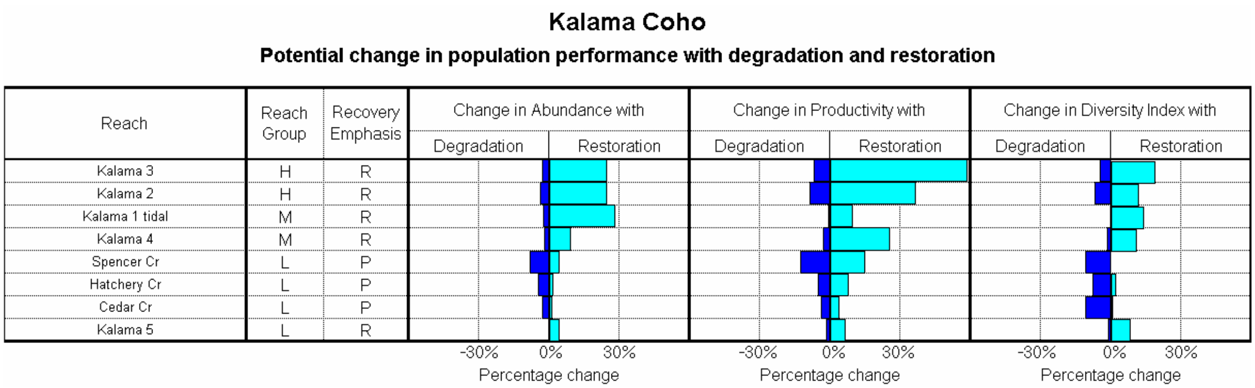

Figure 11. Kalama subbasin coho ladder diagram.

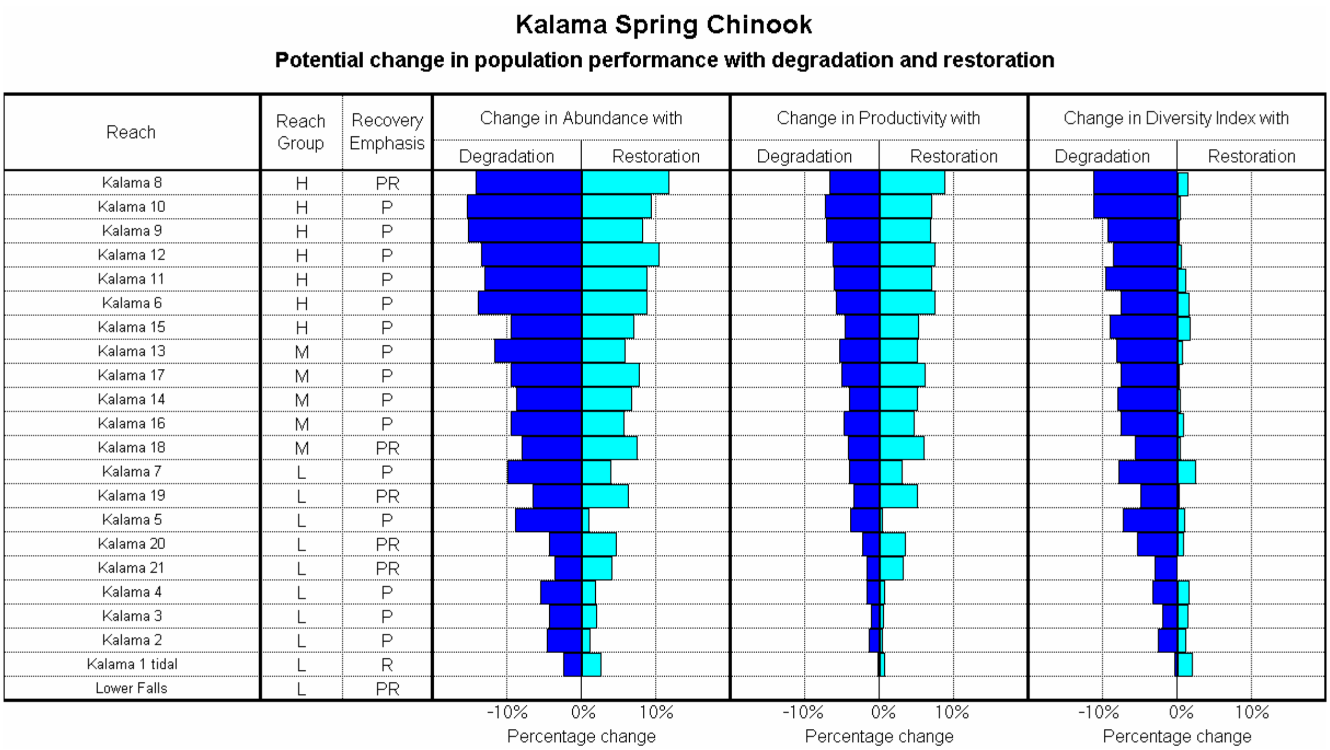

Figure 12. Kalama subbasin spring chinook ladder diagram.

3.4.3 *Habitat Factor Analysis*

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the 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 3.

Table 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*
Kalama Fall Chinook				
most critical	Egg incubation	channel stability, sediment	harassment	
second	Fry colonization	flow, habitat diversity	channel stability, predation, sediment, key habitat	
third	Spawning	habitat diversity, temperature	harassment, predation, sediment	
Kalama Spring Chinook				
most critical	Egg incubation	channel stability, sediment		
second	Fry colonization	habitat diversity, flow		
third	0-age summer rearing	habitat diversity	key habitat	
Kalama Chum				
most critical	Egg incubation	channel stability, sediment	Temperature,	flow
second	Prespawning holding	flow	habitat diversity, temperature	pathogens, harassment, key habitat
third	Fry colonization	habitat diversity, sediment	flow	food
Kalama Coho				
most critical	0-age winter rearing	habitat diversity	channel stability, flow	predation
second	0-age summer rearing	habitat diversity	temperature	channel stability, competition (hatchery), pathogens, predation
third	Egg incubation	channel stability, sediment	harassment, flow	
Kalama Summer Steelhead				
most critical	Egg incubation	sediment	channel stability	
second	0,1-age winter rearing	flow	habitat diversity	channel stability
third	1-age summer rearing	flow, habitat diversity		
Kalama Winter Steelhead				
most critical	Egg incubation	sediment, temperature	harassment, pathogens, channel stability	
second	1-age summer rearing	habitat diversity	competition (hatchery), flow, pathogens, temperature	predation
third	0,1-age winter rearing	habitat diversity	channel stability, flow	

The key summer steelhead reaches in the headwaters and headwater tributaries are affected by degraded habitat diversity, sediment, and flow conditions, with lesser impacts due to channel stability and key habitat quantity (Figure 13). Degraded conditions affecting habitat diversity are attributable to low instream large wood quantities and young riparian forests. Sediment and flow conditions are related to the intense timber harvests that have occurred in this basin and the associated road network. Many upper basin subwatersheds have over 6 miles of road per square mile. These are some of the highest road densities in the region. Vegetation conditions are also poor, with most of the upper basin forests in stand initiation or early-seral stages. In four out of eight upper subwatersheds assessed in the 1996 Upper Kalama Watershed Analysis (USFS 1996), peak flows were estimated to be elevated over historical levels due to vegetation and road conditions. Channel stability conditions are related to flow alterations and degraded riparian forests. The food resource has been affected by the removal of overhanging tree canopies. Minor predation and competition impacts are related to an ongoing steelhead reproductive success study in the watershed.

Restoration of winter steelhead habitat should focus on the middle mainstem, middle tributaries, and the lower river reaches. The primary degraded attributes in these areas include sediment, habitat diversity, and flow (Figure 14). Once again, sediment and flow conditions are related to logging and road densities. Road densities are very high in the middle mainstem and tributary subwatersheds. The Lower Gobar Creek subwatershed has one of the highest road densities of any forested subwatershed in the region, with 7.4 miles of road per square mile. Non-vegetated or shrub vegetated (i.e. stand initiation) forestland makes up 74% of this subwatershed.

High priority reaches for fall Chinook (Figure 15), chum (Figure 16) and coho (Figure 17) are similar. As such, so are the restoration priorities, which include impacts from fine sediment, habitat diversity, key habitat, and channel stability. Upper basin logging and road densities contribute to elevated fine sediment levels. A lack of large wood, artificial confinement, and degraded riparian forests contribute to poor channel stability and habitat diversity conditions.

Model results indicate that restoration of spring chinook habitat should focus primarily on improving sediment, habitat diversity, channel stability, and flow issues (Figure 18). The cause of these impacts are similar to those mentioned above.

Kalama Summer Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Kalama 19	Moderate	High							High	High						Moderate
Kalama 18	Moderate	High							High	High						Moderate
Kalama 17	Moderate	High							High	High						Moderate
Kalama 20	Moderate	High							High	High						Moderate
Kalama 6	Low	Moderate							Low	Low	Low			Low		Low Positive
Kalama 21	Moderate	High							High	High						Moderate
Kalama 16	Moderate	High							Moderate	High						Moderate
NF Kalama	Moderate	Moderate	Low			Low			Moderate	High	Low					High Positive
Kalama 14	Low	High							Moderate	High						High Positive
Kalama 15	Moderate	High							Moderate	High						Moderate
Kalama 7	Low	Moderate							Low	Low						
Lakeview Peak Cr	Low	Moderate	Low						Moderate	Moderate	Low					Low Positive
Langdon Cr	Low	Moderate	Low						Moderate	High	Low					Low Positive
Wolf Cr	Low	Moderate	Low						Moderate	Moderate	Low					Low Positive
Kalama 11	Low	Moderate		Low		Low			Moderate		Low					
Jacks Cr	Low	Moderate	Low						Moderate	Moderate	Low					
Arnold Cr	Low	Moderate	Low						Moderate	Moderate	Low					
Bush Cr	Low	Moderate	Low						Moderate	High	Low					Low Positive
Unnamed Cr (27.0087)	Low	Moderate	Low						Low	Moderate	Low					Low Positive
Lost Cr	Low	Moderate	Low						Moderate	Moderate	Low					Low Positive
Kalama 9	Low	Moderate		Low		Low			Low	Low				Low		Low Positive
Bear Cr	Low	Moderate	Low						Low	Moderate	Low					
Kalama 13	Low	Moderate							Low	Low						
Kalama 12	Low	Moderate		Low		Low			Low		Low					
Kalama 10	Low	Moderate		Low		Low			Low							
Kalama 8	Low	Moderate							Low							
Kalama 5	Low	Low		Low					Low					Low		Low
Kalama 1 tidal		Low		Low					Low	Low						Moderate
Kalama 4	Low	Low		Low					Low							
Gobar Cr		Low		Low					Low							
Kalama 3		Low														
Kalama 2		Low														
Elk Cr		Low							Low							
Indian Cr																
Knowlton Cr																
Lower Falls																

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

Figure 13. Kalama River subbasin summer 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. Some low priority reaches are not included for display purposes.

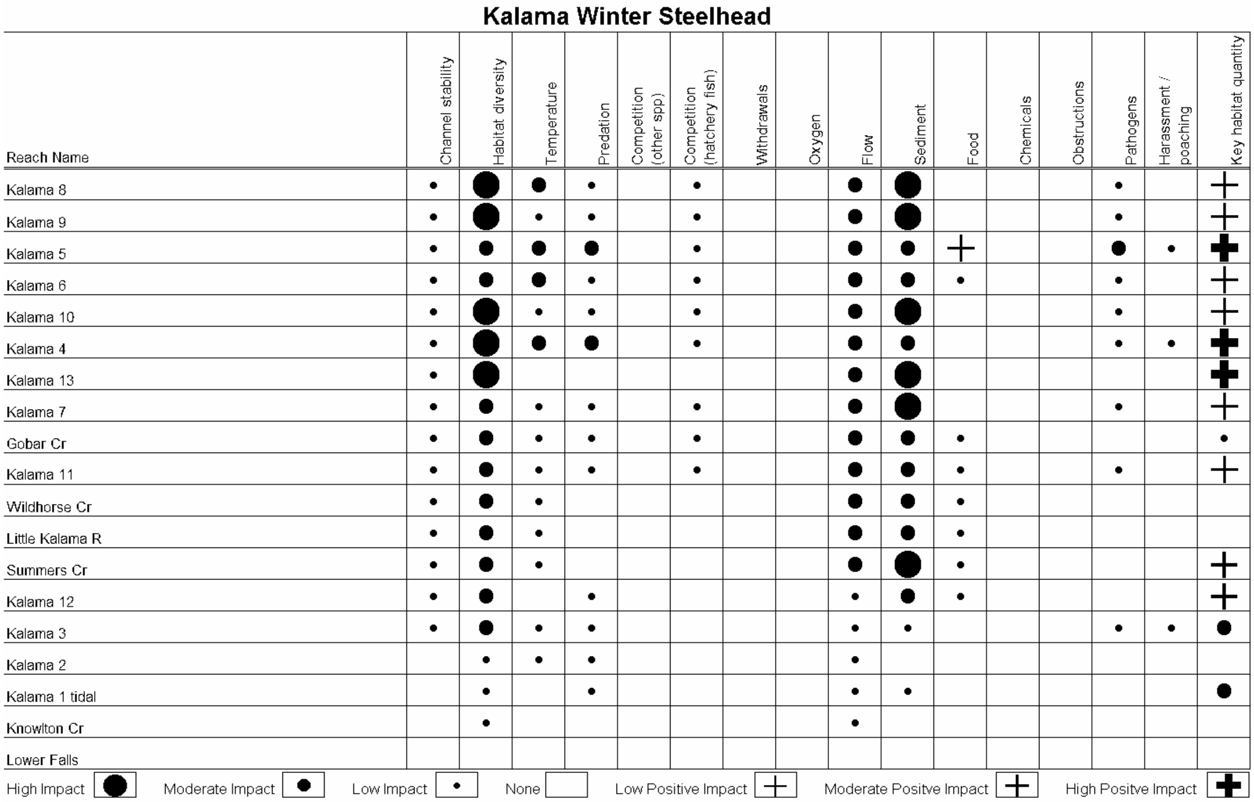

Figure 14. Kalama subbasin winter steelhead habitat factor analysis diagram.

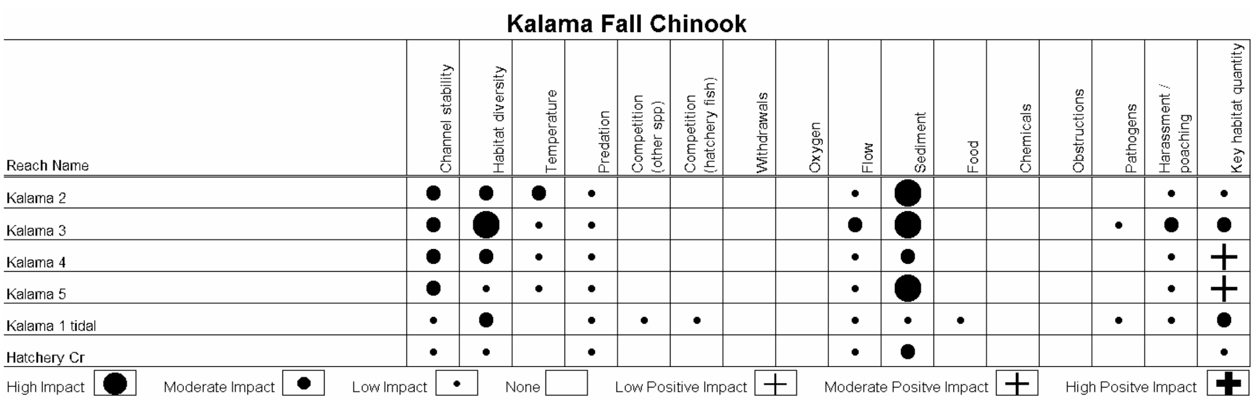

Figure 15. Kalama subbasin fall Chinook habitat factor analysis diagram.

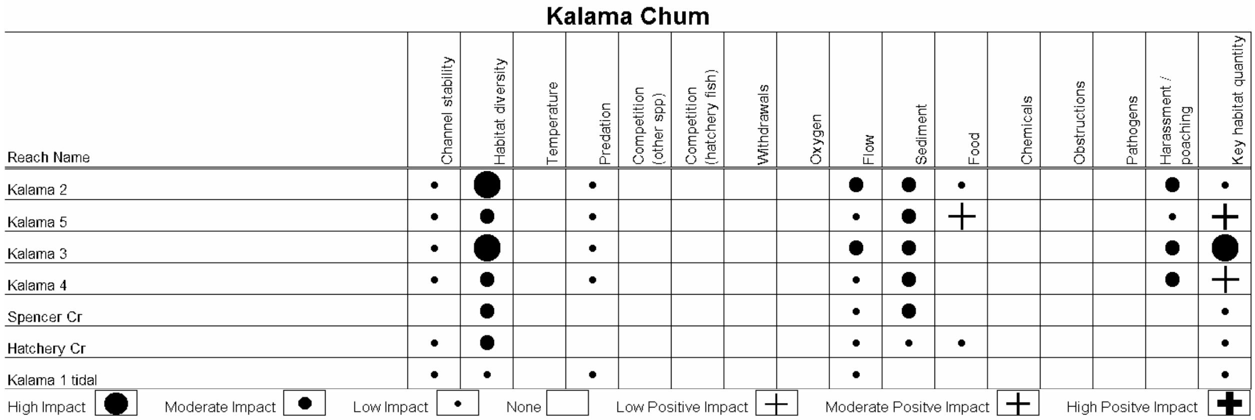

Figure 16. Kalama subbasin chum habitat factor analysis diagram.

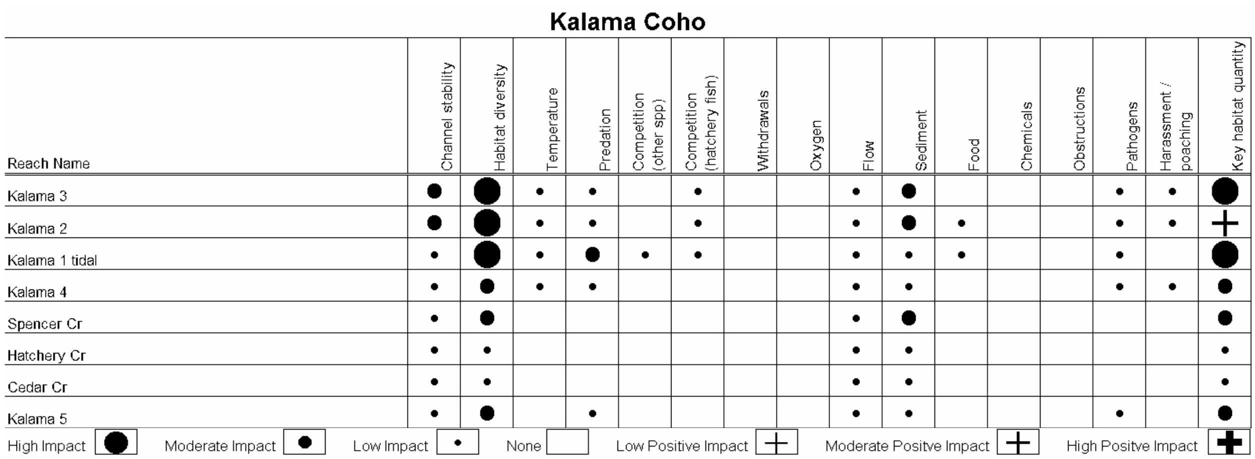

Figure 17. Kalama subbasin coho habitat factor analysis diagram.

Kalama Spring Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Kalama 8	Moderate	Moderate	Moderate			Low			Low	High						Low Positive
Kalama 10	Moderate	High	Moderate			Low			Moderate	High						
Kalama 9	Moderate	Moderate	Low			Low			Low	High						
Kalama 12	Moderate	High	Low			Low			Moderate	High	Low					Low
Kalama 11	Moderate	High	Low			Low			Moderate	High	Low					
Kalama 6	Moderate	Moderate	Moderate			Low			Low	High	Low			Low		Low
Kalama 15	Moderate	Moderate							Low	High						Moderate
Kalama 13	Moderate	Moderate							Low	High						Low Positive
Kalama 17	Moderate	High							Moderate	High						Low
Kalama 14	Moderate	Moderate							Low	High						
Kalama 16	Moderate	Moderate							Low	High						Moderate
Kalama 18	Moderate	High							Moderate	High						Low
Kalama 7	Moderate	Moderate	Low						Low	High						
Kalama 19	Moderate	Moderate							Low	High						Low Positive
Kalama 5		Low		Low					Low					Low		Low
Kalama 20	Moderate	Moderate							Low	High						Low
Kalama 21	Moderate	Moderate							Low	High						Low Positive
Kalama 4	Low	Moderate	Low	Low		Low			Low					Low		Low
Kalama 3	Low	Moderate	Low	Low		Low			Low					Low	Low	Low
Kalama 2		Low	Low	Low		Low										
Kalama 1 tidal	Low	Moderate	Low	Low		Low								Low	Low	Low
Lower Falls																

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

Figure 18. Kalama subbasin spring chinook habitat factor analysis diagram.

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.

Subwatersheds in the Kalama basin can be organized into three groups: upstream mainstem and tributary subwatersheds upstream of and including Elk Creek; lower mainstem subwatersheds between Elk Creek and the Little Kalama River; and the tidally influenced Kalama mainstem and the Little Kalama River including Hatchery Creek. IWA results for the Kalama River watershed are shown in Table 4. A reference map showing the location of each subwatershed in the basin is presented in Figure 19. Maps of the distribution of local and watershed level IWA results are displayed in Figure 20.

3.5.1 *Hydrology*

Current Conditions.— Hydrologic conditions in the upper Kalama mainstem and tributary subwatersheds are uniformly rated as impaired at both local and watershed levels, with the exception of moderately impaired conditions in the Kalama headwaters (40102). Many of the impaired subwatersheds have a high percentage of total area in the rain-on-snow zone (>50%), making them susceptible to an increase in peak runoffs. Mature forest cover in these and contributing subwatersheds is low (~25% on average) and road densities are high, averaging over 6 mi/sq mi.

Hydrologic conditions in the middle mainstem group of subwatersheds are impaired at the local level due to high road densities (averaging 7 mi/sq mi) and only 22% mature forest coverage. These subwatersheds are also all impaired at the watershed level.

The lower Kalama subwatersheds are all rated as impaired for local and watershed level hydrologic conditions. The lower mainstem subwatersheds have some of the highest streamside road densities in the Kalama Basin. The area transitions from predominantly steep terrain in private timber lands to a low lying alluvial valley entering the Columbia River. Agricultural, residential, and commercial development predominate here along the I-5 corridor. The lower reaches of the Kalama River have been channelized and disconnected from the floodplain, which can exacerbate the effects of impaired hydrologic conditions.

Predicted Future Trends.— Low levels of public land ownership, low levels of mature forest cover, high road densities, and the likelihood of timber harvest occurring on areas of land coming into rotation suggest that hydrologic conditions will trend stable throughout the Kalama River watershed over the next 20 years. In the upper Kalama mainstem group of subwatersheds, mature forest cover in these and contributing subwatersheds averages only 25%. Road densities are high, averaging over 6 mi/sq mi. Due to the high percentage of active timber lands, high road densities, and low mature forest coverage, the predicted trend is for hydrologic conditions in the upper Kalama mainstem group of subwatersheds to remain in impaired condition over the next 20 years.

Land ownership in the middle mainstem group of subwatersheds is similarly predominated by private timber holdings, with residential and some agricultural development present along the mainstem. Road densities are similarly high, approaching 7 mi/sq mi, and mature forest cover is low, averaging 15%. Given these conditions, and the likelihood that timber harvest activities are likely to continue and road densities are likely to remain high for the foreseeable future, the predicted trend is for hydrologic conditions to remain impaired in these key subwatersheds.

The lower Kalama mainstem group of subwatersheds faces a more complex set of problems than upstream areas. The lower mainstem has been channelized and disconnected from its floodplain, which exacerbates hydrologic impacts caused by conditions in upstream areas of the watershed. Growth pressures in the lower mainstem area are increasing along the I-5 corridor. Given the existing high road densities, the potential for timber harvest on public and private lands, and the potential for future development in low-lying areas, hydrologic conditions in this subwatershed are predicted to remain impaired over the next 20 years, with increasing sources of degradation. It is important to note, however, that while local conditions may continue to degrade, the watershed level hydrologic conditions will be driven by the cumulative conditions in the remainder of the watershed.

Table 4. IWA results for the Kalama River Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
40201	I	M	M	I	M	40101, 40102, 40103, 40202
40202	I	M	M	I	M	40101, 40102, 40103
40301	I	I	M	I	M	40101, 40102, 40103, 40201, 40202, 40302, 40303, 40304
40302	I	M	M	I	M	40101, 40102, 40103, 40201, 40202, 40303, 40304
40303	I	M	M	I	M	40101, 40102, 40103, 40201, 40202
40401	I	F	M	I	M	40101, 40102, 40103, 40201, 40202, 40301, 40302, 40303, 40304, 40402, 40403
40402	I	M	M	I	M	40403
40501	I	M	M	I	M	40101, 40102, 40103, 40201, 40202, 40301, 40302, 40303, 40304, 40401, 40402, 40403, 40502, 40503, 40505
40502	I	F	M	I	M	40101, 40102, 40103, 40201, 40202, 40301, 40302, 40303, 40304, 40401, 40402, 40403, 40503, 40504, 40505
40503	I	F	M	I	M	40101, 40102, 40103, 40201, 40202, 40301, 40302, 40303, 40304, 40401, 40402, 40403
40504	I	F	M	I	F	none
40505	I	M	M	I	M	none
40101	I	F	M	I	M	40102
40102	M	F	F	M	F	none
40103	I	M	M	I	M	none
40304	I	M	M	I	M	none
40403	I	F	M	I	F	none
40601	I	M	M	I	M	none

Notes:
[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 19. Map of the Kalama basin showing the location of the IWA subwatersheds.

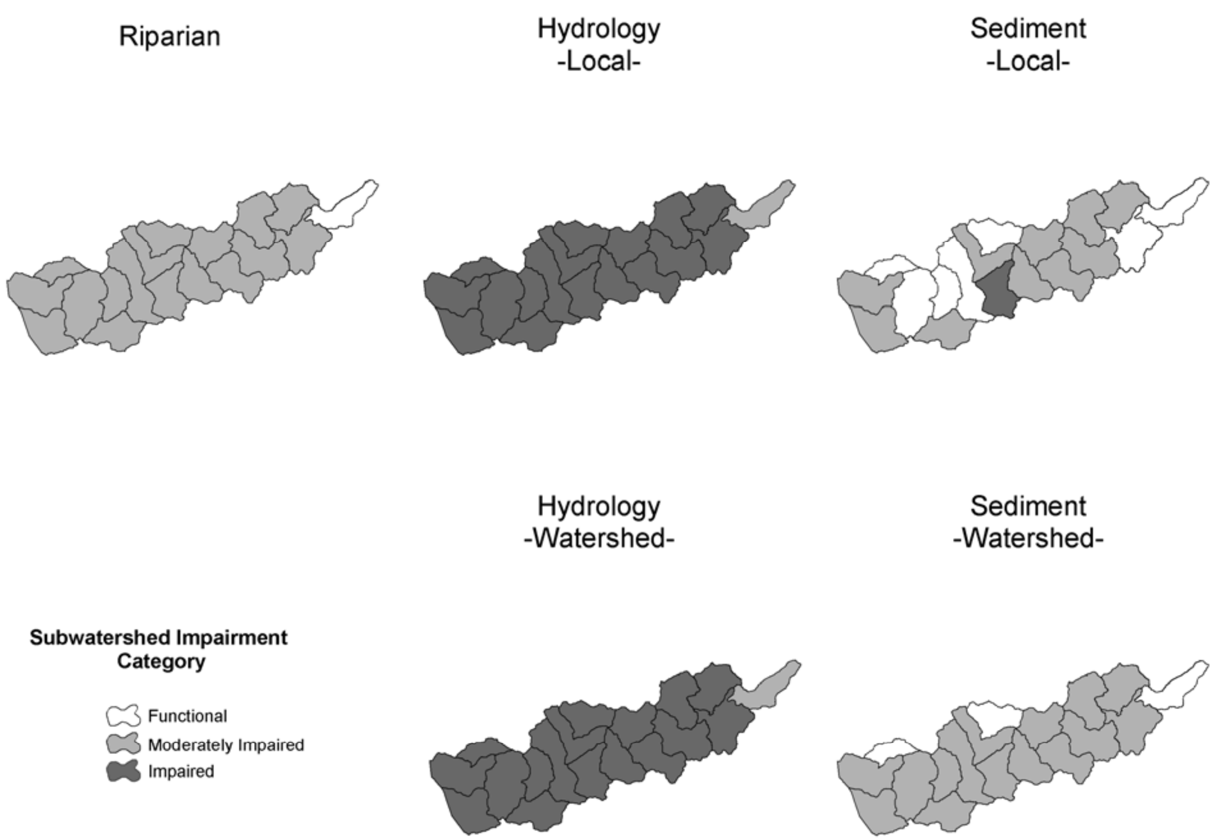

Figure 20. IWA subwatershed impairment ratings by category for the Kalama Subbasin

3.5.2 *Sediment Supply*

Current Conditions.-- Most current sediment problems are associated with large sediment and bedload deposits caused by past forest practices, including indiscriminate logging around and through streams, the use of splash dams to transport logs, and poor road and culvert construction (WDW 1990). In addition to these land use issues, the eruption of Mt. St. Helens created some debris flows and deposits in headwaters areas that are vulnerable to future erosion. While the natural erodability of the Kalama River watershed is relatively low (ranging from 3 to 21 on a scale of 0-126), the combination of historical and current land uses contribute to widespread impairment in the watershed.

Sediment conditions in the upper mainstem grouping of subwatersheds are generally rated as moderately impaired for sediment at the local level, with functional conditions present in the upper mainstem (40101) and the headwaters (40102). Watershed level sediment conditions reflect upstream influences, with moderately impaired ratings found in all subwatersheds except the headwaters.

Sediment conditions in the middle mainstem grouping of subwatersheds vary at the local level. Sediment conditions are rated as locally functional in the Gobar Creek headwaters (40403), the Kalama mainstem/Wild Horse Creek (40401), and the Kalama mainstem/Sommers Creek (40503). In contrast, conditions in the mainstem Kalama/Arnold Creek (40301) are rated as impaired at the local level. Remaining subwatersheds are rated as moderately impaired. Watershed level sediment conditions indicate the likelihood of strong upstream influences on sediment conditions, with all subwatersheds in this grouping rated as moderately impaired, except for the Gobar Creek headwaters.

The downstream group of subwatersheds are mixed in terms of sediment conditions. Mainstem subwatersheds 40502 and 40501 are rated functional and moderately impaired at the local level, respectively. The Little Kalama drainage (40505) is rated moderately impaired at the local level, while the other lower mainstem tributary, Hatchery Creek (40504), is rated functional. Watershed level conditions in the mainstem are moderately impaired in all subwatersheds, reflecting the influence of sediment conditions in upstream subwatersheds.

Predicted Future Trends.-- While the natural erodability of the Kalama River watershed is relatively low (ranging from 3 to 21 on a scale of 0-126), the combination of historical and current land uses contribute to widespread impairment in sediment processes in the watershed. State and federal forest practice regulations have led to a reduction of sediment delivery over the past decade, and a general improvement in sediment conditions in the Kalama mainstem. Future trends in sediment conditions throughout the watershed are predicted to be generally stable, with some gradual improvement. High road densities and the likelihood of regular timber harvest rotations will be an ongoing source of sediment loading to stream channels, but these impacts will be reduced in the future as the influence of more effective forestry and road management practices expands.

It is important to note that IWA results do not necessarily represent the influence of catastrophic events on sediment conditions. For example, mass wasting problems identified in Wild Horse Creek (40401) and Gobar Creek (40402) are known to contribute to sediment loading in these drainages and in downstream areas. The low percentage of mature forest coverage (16-35%) and high road densities in these subwatersheds increases the potential for erosion and mass-wasting associated with large rain-on-snow events such as occurred in 1996.

Sediment delivery to the lower Kalama mainstem is dependent upon the cumulative actions in the Kalama watershed as well as channelization and development of the floodplain for agriculture, residential, and industrial uses. The increase growth pressures along the I-5 corridor suggest an upward trend in road density, expansion of urbanization, and reduced agriculture. Sediment delivery to this portion of the watershed is of particular interest because bar formation at the river mouth may present a barrier to fish passage at some times of the year. Sediment conditions in this area of the watershed are predicted to trend towards gradual improvement as conditions improve in upstream areas of the watershed. These gains may be offset if significant development of the floodplain and adjacent areas of the lower river continues to occur.

3.5.3 *Riparian Condition*

Current Conditions.— Riparian conditions in the Kalama River watershed are strongly influenced by past land use activities. Most of the watershed, including riparian forests, was logged in the late 1960s through the early 1980s, and many areas are in the early stages of recovery. Recovery in some areas is limited by moderate to high streamside road densities and residential development along the Kalama mainstem. Riparian conditions are rated as moderately impaired throughout the majority of the Kalama River watershed, with functional conditions occurring only in the Kalama River headwaters.

Predicted Future Trends.— Riparian conditions throughout the middle and upper Kalama River watershed are expected to trend towards gradual improvement in most areas over the next 20 years as natural recovery of vegetation progresses. Vegetation recovery may be impeded along the mainstem and adjacent to some tributaries where residential development and streamside roads are present.

The lower Kalama River mainstem and tributaries pose a more complex problem. Almost the entire floodplain of the lower Kalama River has been disconnected from the river by the construction of dikes and levees. Channelization in these downstream subwatersheds limits the potential for riparian recovery. In addition, development pressure along the I-5 corridor is expected to grow. Collectively, these forces are expected to result in a trend towards continuing degradation of riparian vegetation over the next 20 years.

3.6 Other Factors and Limitations

3.6.1 *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 Kalama subbasin and discusses their potential effects.

Fallert Creek and Kalama Falls Hatcheries

There are two hatcheries operating in the Kalama basin. Fallert Creek Hatchery (since 1895) operates in conjunction with Kalama Falls Hatchery (since 1959) to produce fall Chinook, spring Chinook, coho, and winter and summer steelhead for harvest opportunity. Gobar Pond (RM 19) is used to acclimate steelhead and spring Chinook smolts prior to release.

Fall Chinook are derived from Kalama stock and there have been few transfers of outside fall Chinook stock into Kalama Basin hatcheries. Spring Chinook are primarily Kalama origin with some history of transfers from Cowlitz Hatchery. Both early and late coho are produced from the Kalama hatcheries. The main threats from the salmon hatchery programs are domestication of natural fall Chinook and coho and potential ecological interactions between the hatchery and natural juvenile salmon.

Hatchery produced steelhead include Skamania summer, Cowlitz and Beaver Creek winters, as well as steelhead originating from Kalama wild summer and winter brood stock. Skamania and Beaver Creek hatchery steelhead are a composite stock and are genetically different from the naturally produced steelhead in the Kalama. The main threats from hatchery steelhead are potential domestication of the naturally-produced steelhead as a result of adult interactions or ecological interactions between natural juvenile salmon and hatchery released juvenile steelhead and mixed stock fishery incidental impact on wild steelhead.

Table 5. Current Kalama subbasin hatchery production.

Hatchery	Release Location	Fall Chinook	Early Coho	Late Coho	Winter Steelhead	Summer Steelhead
Fallert Creek	Kalama	2,500,000	350,000			30,000
Kalama Falls	Kalama	2,500,000		350,000	45,000 45,000(wild)	60,000(wild)

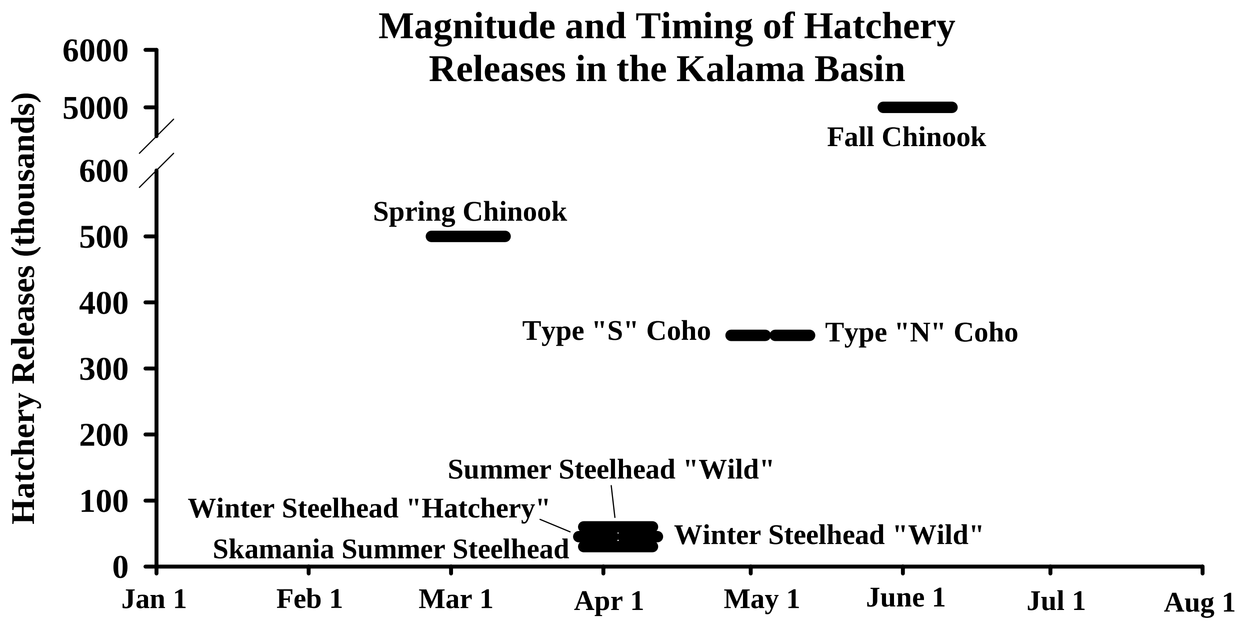

Figure 21. Magnitude and timing of hatchery releases in the Kalama River basin by species, based on 2003 brood production goals.

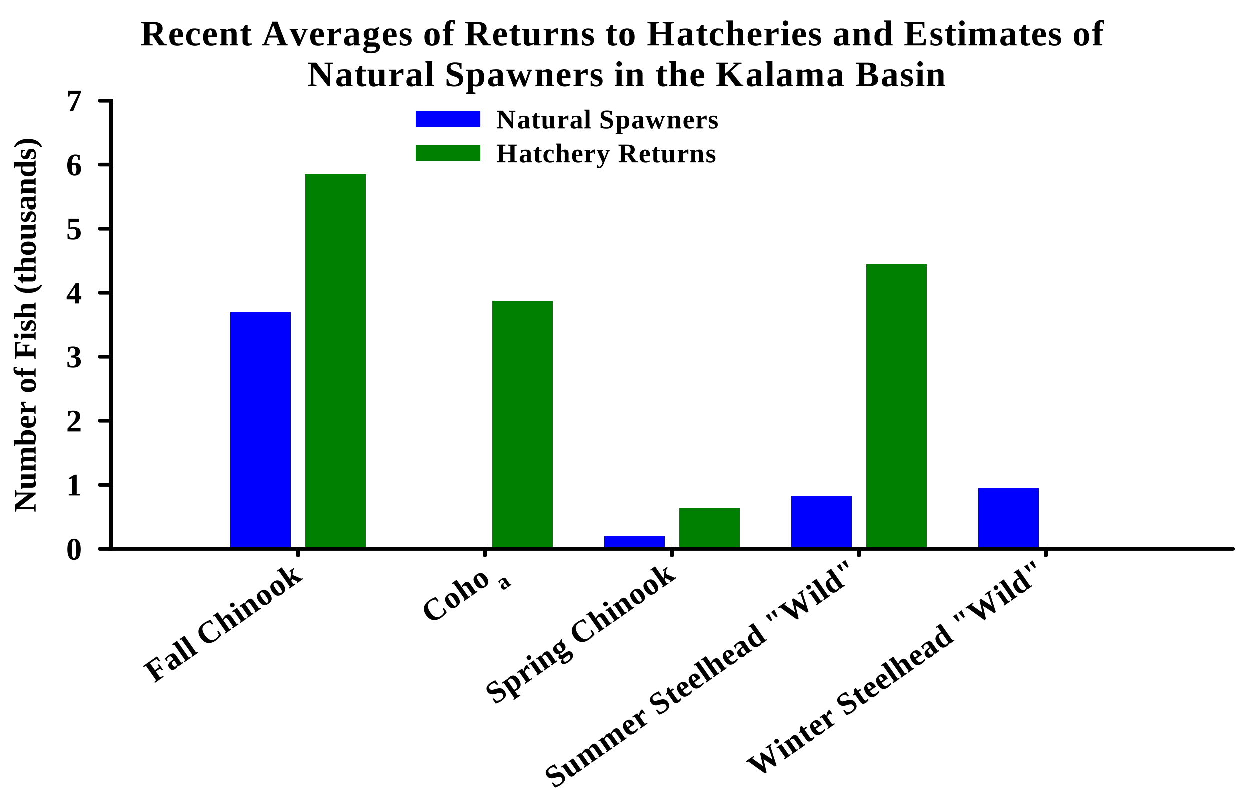

Figure 22. Recent average hatchery returns and estimates of natural spawning escapement in the Kalama River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from the period 1992 to the present, except for Kalama wild summer steelhead, which represents the 1988–99 average. Calculation of each average utilized a minimum of 5 years of data, except for Kalama wild winter steelhead, which only includes 2000 escapement data.

[a] A natural stock for this species and basin has not been identified based on populations in WDFW's 2002 SASSI report; to date, escapement data are not available

Hatchery Effects

Genetics— Historically, fall Chinook broodstock have been almost exclusively obtained from Kalama native fall Chinook. Outside transfers have been extremely rare, low in numbers, and have not occurred since 1981. Kalama hatchery fall Chinook have been a common donor for several other lower Columbia hatchery programs. Genetic analysis of Kalama River Hatchery fall Chinook indicated that they were significantly different from most other lower Columbia River tule fall Chinook stocks and were most similar to Cowlitz Hatchery fall Chinook.

Broodstock for the spring Chinook hatchery program is almost entirely from native Kalama fish, although Cowlitz spring Chinook have been used to some degree. Genetic analysis of Kalama Falls Hatchery spring Chinook in 1990 indicated that they are genetically similar to, but distinct from, Cowlitz Hatchery and Lewis River spring Chinook and are significantly different from other lower Columbia River spring Chinook stocks.

Broodstock for the early- and late-run coho salmon hatchery programs comes from adults returning to the hatchery. In years when insufficient numbers of adults have escaped to the hatchery to satisfy broodstock needs, early- and late-run coho eggs have been obtained from Toutle (early stock) or Cowlitz (late stock) hatcheries.

Broodstock for the former summer and winter steelhead hatchery programs in the Kalama basin likely came from a mixture of lower Columbia River steelhead stocks. Wild summer and winter steelhead were present in the basin prior to release of Cowlitz River and Beaver Creek Hatchery stocks, which began as early as 1938. In the late 1980s, an estimated 40% of returning naturally produced adults had at least one hatchery parent; however, the wild stock appears to have retained genetic traits of adaptive value relative to the transplanted hatchery stocks. Broodstock for the current "wild" summer and winter steelhead hatchery programs come from naturally spawned steelhead that voluntarily enter the Kalama Falls Hatchery trap. No adipose fin-clipped or dorsal fin-stubbed adults are used for broodstock in these programs. The goal for both summer and winter steelhead is to develop a wild broodstock consistent with the natural production and provide for harvest. Broodstock for hatchery stock early winter steelhead are obtained from returns to Kalama Falls Hatchery and the hatchery stock summer steelhead is obtained from Skamania Hatchery. Neither winter nor summer hatchery stock steelhead are passed above Kalama Falls Hatchery to the steelhead natural spawning habitat.

Interactions—Hatchery production accounts for the majority of fall Chinook returning to the Kalama River. A weir is placed annually in the lower river to collect broodstock for the hatchery program. Hatchery and natural production are not distinguishable by external marking. A portion of the return is collected for hatchery broodstock and a portion is passed above the weir to spawn naturally. The number of natural spawners is usually dependent on the total returns, after egg-take requirements are met (Figure 22). Juvenile fall Chinook may compete with other juvenile salmonids for food and space. This competition is likely minimized by releasing fall Chinook smolts that are ready to emigrate. Also, hatchery and wild fish interactions are less likely for fall Chinook released from the Fallert Creek Hatchery than for releases from the Kalama Falls Hatchery, because the emigration distance within the basin is shorter.

Hatchery strays from the Kalama Hatchery program account for most spring Chinook spawning in the Kalama River; wild fish abundance is generally low (Figure 22). Juvenile production from natural spawning is presumed to be low. Spring Chinook juveniles may compete with other salmonids for food and space. However, release is timed for smolting, which should minimize time in the watershed and minimize interactions with wild juveniles.

Hatchery production accounts for most coho salmon returning to the Kalama River (Figure 22). Juvenile production from natural spawning is presumed to be low. Because few adult wild coho are present, the potential for interaction between wild/hatchery coho adults is likely low. Competition from hatchery coho smolts on other juvenile salmonids is a concern in the Kalama River basin. However, because smolts are released volitionally after smoltification and migrate out of the basin rapidly, competition with other salmonids in the Kalama River is likely minimized. Hatchery coho smolts rarely residualize (0.002%) so there is little concern about ongoing competition with resident fish. Additionally, predation by coho smolts on juvenile fall Chinook may be occurring (as documented in the Lewis River), but is minimized if the hatchery smolts emigrate rapidly.

In past years,, a significant portion of natural steelhead spawners in the Kalama River were hatchery-produced (70-80%) and hatchery and wild fish may have competed for suitable spawning sites. There is less opportunity for early winter hatchery steelhead and wild winter steelhead adults to interact because of spawn time differences, however there is more potential for summer hatchery steelhead to interact with wild winter steelhead because there is potential for overlap in the spawn time. Genetic mixing is still minimized by spatial and temporal segregation; further, hatchery steelhead are not passed upstream of Kalama Falls.

Research on the Kalama indicates that the success of hatchery summer steelhead producing adult offspring was approximately 12% that of wild fish. With the former steelhead hatchery programs, the potential existed for competition from hatchery summer and winter steelhead smolts on other salmonids in the system for food and space but competition was likely minimal because steelhead were released as rapidly emigrating smolts, and relatively few summer and winter steelhead were released annually. As the new "wild" steelhead hatchery programs continue, as described above, wild/hatchery fish interactions will be difficult to define as the distinction between hatchery and wild fish becomes unclear.

One unexpected benefit from the steelhead programs is the data generated on coastal cutthroat trout, a candidate species for ESA listing. Various life stages of cutthroat trout are captured during adult and smolt trapping operations, which provide valuable data on run timing, size, sex, spawner abundance, and smolt production levels.

Water Quality/Disease— Most water for the Kalama River Hatchery complex comes directly from the Kalama River. A seasonal creek regarded as pathogen-free, is also used for incubation and early rearing. All water quality parameters are monitored under the hatchery's NPDES permit. A third pathogen-free water source was recently developed as a supplement and emergency backup for incubation and early rearing. Fungus is controlled during the incubation stage by a 1,667-ppm drip of formalin for 15 minutes daily. Egg mortalities are removed by hand picking. Disease monitoring is continuous, and the area fish health specialist visits monthly and advises on disease treatments. Fish are checked by the area fish health specialist before release.

Mixed Harvest— The purpose of the Kalama River Hatchery complex fall Chinook program is to provide harvest opportunities to mitigate for fall Chinook salmon lost as a result of hydroelectric development in the lower Columbia River basin. Historically, exploitation rates of hatchery and wild fall Chinook likely were similar. Fall Chinook are an important target species in ocean and Columbia River commercial and recreational fisheries, as well as tributary recreational fisheries. CWT data analysis of the 1992–1994 brood years of Kalama Hatchery fall Chinook indicate a 32% exploitation rate on fall Chinook; 68% of the adult return was accounted for in escapement. Exploitation of wild fish during the same period likely was similar. Current hatchery and wild fall Chinook harvest rates remain similar and are constrained by ESA harvest limitations.

A goal of the Kalama spring Chinook hatchery program is to provide harvest opportunities to mitigate for spring Chinook salmon lost as a result of hydroelectric development. All hatchery smolts are now adipose fin-clipped to allow for selective harvest. Historically, exploitation rates of hatchery and wild spring Chinook likely were similar. Spring Chinook are an important target species in Columbia River commercial and recreational fisheries, as well as tributary recreational fisheries. CWT data analysis of the 1989–1994 brood years from the Fallert Creek Hatchery indicate a 32% exploitation rate on spring Chinook; 68% of the adult return was accounted for in escapement. Most of the harvest occurred in the Kalama River sport fishery. In recent years, selective fisheries in the mainstem Columbia and in the Kalama have increased harvest of Kalama River hatchery spring Chinook while maintaining lower rates on wild fish; the mainstem Columbia spring Chinook sport fishery was re-opened in April–May 2001 (since closure beginning in 1977) because of the ability to selectively harvest hatchery fish and release wild fish. The lower Columbia River commercial fishery has also been extended into late March under selective fishery regulations.

The purpose of the coho salmon program at the Kalama River Hatchery complex is to produce lower Columbia River late (Type-N) and early (Type-S) coho that will contribute to the Pacific Ocean and Columbia River basin commercial and sport fisheries while providing adequate escapement for hatchery broodstock. All hatchery smolts are now adipose fin-clipped to allow for selective harvest. Historically, naturally produced coho from the Columbia River were managed like hatchery fish and subjected to similar exploitation rates. Ocean and Columbia River combined harvest of Columbia River-produced coho ranged from 70% to over 90% during 1970–1983. Ocean fisheries were limited beginning in the mid-1980s and Columbia River commercial fisheries were temporally adjusted in the early 1990s to protect several wild coho stocks. Columbia River coho exploitation rates during 1997 and 1998 averaged 48.8%. With the advent of selective sport fisheries for adipose-fin clipped fish in 1998, exploitation of wild coho is much lower than in 1997-1998, while hatchery fish can be harvested at a higher rate. Kalama wild coho are beneficiaries of ESA harvest constraints for Oregon coastal natural coho in ocean fisheries and for Oregon lower Columbia natural coho in Columbia River fisheries

A goal of the summer and winter steelhead hatchery programs at the Kalama complex is to mitigate for summer and winter steelhead lost as a result of Columbia River basin hydroelectric development. Fisheries that may benefit from these programs include lower Columbia and Kalama River sport fisheries, although no patterns of adult returns have been established for the new "wild" broodstock programs. Mainstem Columbia River sport fisheries became selective for hatchery steelhead in 1984 and Washington tributaries became selective during 1986–1992 (except the Toutle in 1994). Current selective harvest regulations in the lower Columbia and tributary sport fisheries have targeted hatchery steelhead and limited harvest of wild winter and summer steelhead to less than 10% (6% in the Kalama River fishery).

Passage— Adult collection facilities at the Kalama Falls Hatchery consist of a step and pool ladder system; adults volitionally enter the trap. Captured adults are transferred via tanker truck to sorting ponds and held for broodstock collection. Returning adult salmonids that do not enter the hatchery ladder system encounter lower Kalama Falls just upstream of the hatchery; the falls block migration of most salmonids, although steelhead are able to negotiate the falls under certain water conditions. Captured spring Chinook that exceed broodstock needs are released above lower Kalama Falls to utilize spawning habitat between lower and upper Kalama Falls. Summer and winter steelhead beyond broodstock needs are returned to the river below lower Kalama Falls to provide for recreational harvest opportunities until mid-November and February 1, respectively. After those dates, excess fish are utilized for local food banks or landlocked lake fisheries. A weir is placed in the lower Kalama River in the fall to capture fall Chinook broodstock. A significant portion of the fall Chinook return is passed above the weir to naturally spawn. Coho and steelhead are small enough to pass through the weir and continue upstream migration.

Supplementation— The new "wild" summer and winter steelhead hatchery programs have as their primary goal the development of a wild broodstock program to return adults to the sport fishery and serve as a risk management tool, maintaining wild broodstock in case of a catastrophic event that negatively effects the natural population. Only native Kalama wild broodstock is being used for these programs. The programs are being monitored and evaluated intensely to identify potential risks to natural production.

Biological Risk Assessment

The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC related plans on the Cowlitz River and Lewis River; and 4) the federally mandated Artificial Production Review and Evaluation (APRE) process. 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 developed the Benefit-Risk Assessment Procedure (BRAP) to provide that framework. 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:

Policy Framework

- Assess population status of wild populations
- Develop risk tolerance profiles for all stock conditions
- Assign risk tolerance profiles to all stocks

Risk Assessment

- Conduct risk assessments for all hatchery programs
- Identify appropriate management actions to reduce risk

Following the identification of risks through the assessment process, a strategy is developed to describe a general approach for addressing those risks. Building upon those strategies, program-specific actions and an adaptive management plan are developed as the final steps in the WDFW framework for hatchery reform.

Table 6 identifies hazards levels associated with risks involved with hatchery programs in the Kalama River Basin. Table 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 6. Preliminary BRAP for hatchery programs affecting populations in the Kalama River Basin.

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

	Hatchery Program		Risk Assessment of Hazards											
			Genetic			Ecological			Demographic		Facility			
Kalama Population	Name	Release (millions)	Effective Population Size	Domestication	Diversity	Predation	Competition	Disease	Survival Rate	Reproductive Success	Catastrophic Loss	Passage	Screening	Water Quality
Fall Chinook	Kalama Falls Fall Chinook	2.500	○	●	○	○	?	○	○	?	○	○	○	○
	Fallert Ck. Hatchery	2.500	○	●	○	○	?	○	○	?	○	●	●	○
	Kalama Coho Type S	0.350				?	?	○				○	○	○
	Kalama Coho Type N	0.350				?	?	○				○	○	○
	Kalama S. Steelhead 1+	0.030				?	?	○				○	○	○
	Kalama Wild S. Steelhead 1+	0.060				?	?	○				○	○	○
	Kalama Sp. Chinook 1+	0.500				?	?	○				○	○	○
	Kalama Wild W. Steelhead 1	0.045				?	?	○				○	○	○
	Kalama Early W. Steelhead 1	0.045				?	?	○				○	○	○
Spring Chinook	Kalama Falls Fall Chinook	2.500				○	?	○				○	○	○
	Fallert Ck. Hatchery	2.500				○	?	○				●	●	○
	Kalama Coho Type S	0.350				?	?	○				○	○	○
	Kalama Coho Type N	0.350				?	?	○				○	○	○
	Kalama S. Steelhead 1+	0.030				?	?	○				○	○	○
	Kalama Wild S. Steelhead 1+	0.060				?	?	○				○	○	○
	Kalama Sp. Chinook 1+	0.500	○	●	○	?	?	○	○	?	○	○	○	○
	Kalama Wild W. Steelhead 1	0.045				?	?	○				○	○	○
	Kalama Early W. Steelhead 1	0.045				?	?	○				○	○	○
Chum	Kalama Falls Fall Chinook	2.500				?	○	○				○	○	○
	Fallert Ck. Hatchery	2.500				?	○	○				○	○	○
	Kalama Coho Type S	0.350				?	○	○				○	○	○
	Kalama Coho Type N	0.350				?	○	○				○	○	○
	Kalama S. Steelhead 1+	0.030				?	○	○				○	○	○
	Kalama Wild S. Steelhead 1+	0.060				?	○	○				○	○	○
	Kalama Sp. Chinook 1+	0.500				?	○	○				○	○	○
	Kalama Wild W. Steelhead 1	0.045				?	○	○				○	○	○
	Kalama Early W. Steelhead 1	0.045				?	○	○				○	○	○
Summer Steelhead	Kalama Falls Fall Chinook	2.500				○	?	○				●	○	○
	Fallert Ck. Hatchery	2.500				○	?	○				●	●	○
	Kalama Coho Type S	0.350				?	?	○				○	○	○
	Kalama Coho Type N	0.350				?	?	○				○	○	○
	Kalama S. Steelhead 1+	0.030				?	?	○				○	○	○
	Kalama Wild S. Steelhead 1+	0.060	○	○	○	?	?	○	○	?	○	○	○	○
	Kalama Sp. Chinook 1+	0.500				?	?	○				○	○	○
	Kalama Wild W. Steelhead 1	0.045				?	?	○				○	○	○
	Kalama Early W. Steelhead 1	0.045				?	?	○				○	○	○
Winter Steelhead	Kalama Falls Fall Chinook	2.500				○	?	○				○	○	○
	Fallert Ck. Hatchery	2.500				○	?	○				●	●	○
	Kalama Coho Type S	0.350				?	?	○				○	○	○
	Kalama Coho Type N	0.350				?	?	○				○	○	○
	Kalama S. Steelhead 1+	0.030				?	?	○				○	○	○
	Kalama Wild S. Steelhead 1+	0.060				?	?	○				○	○	○
	Kalama Sp. Chinook 1+	0.500				?	?	○				○	○	○
	Kalama Wild W. Steelhead 1	0.045	○	○	○	?	?	○	○	?		○	○	○
	Kalama Early W. Steelhead 1	0.045	○	○	?	?	?	○				○	○	○

Table 7. Preliminary strategies proposed to address risks identified in the BRAP for Kalama River Basin populations

Kalama Population	Hatchery Program: Name	Hatchery Program: Release (millions)	Risk Assessment of Hazards — Address Genetic Risks: Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Address Ecological Risks: Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Address Demographic Risks: Culture Procedure	Research/ Monitoring	Address Facility Risks: Reliability	Improve Passage	Improve Screening	Pollution Abateme
Fall Chinook	Kalama Falls Fall Chinook	2.500		●	●	●							●				
	Fallert Ck. Hatchery	2.500		●	●	●							●		●	●	
	Kalama Coho Type S	0.350						●	●		●						
	Kalama Coho Type N	0.350						●	●		●						
	Kalama S. Steelhead 1+	0.030						●	●		●						
	Kalama Wild S. Steelhead 1+	0.060						●	●		●						
	Kalama Sp. Chinook 1+	0.480						●	●		●						
	Kalama Wild W. Steelhead 1+	0.045						●	●		●				—	—	
	Kalama Early W. Steelhead 1+	0.045						●	●		●						
Spring Chinook	Kalama Falls Fall Chinook	2.500						●	●		●						
	Fallert Ck. Hatchery	2.500						●	●		●				●	●	
	Kalama Coho Type S	0.350						●	●		●						
	Kalama Coho Type N	0.350						●	●		●						
	Kalama S. Steelhead 1+	0.030						●	●		●						
	Kalama Wild S. Steelhead 1+	0.060						●	●		●						
	Kalama Sp. Chinook 1+	0.480						●	●		●						
	Kalama Wild W. Steelhead 1+	0.045		●	●	●		●	●		●						
	Kalama Early W. Steelhead 1+	0.045						●	●		●						

Impact Assessment

The potential significance of negative hatchery impacts within the subbasin on natural populations was estimated with a simple index based on: 1) intra-specific effects resulting from depression in wild population productivity that can result from interbreeding with less fit hatchery fish and 2) inter-specific effects resulting from predation of juvenile salmonids of other species. The index reflects only a portion of net hatchery effects but can provide some sense of the magnitude of key hatchery risks relative to other limiting factors. Fitness effects are among the most significant intra-specific hatchery risks and can also be realistically quantified based on hatchery fraction in the natural spawning population and assumed fitness of the hatchery fish relative to the native wild population. Predation is among the most significant inter-specific effects and can be estimated from hatchery release numbers by species. This index assumed that equilibrium conditions have been reached for the hatchery fraction in the wild and for relative fitness of hatchery and wild fish. This simplifying assumption was necessary because more detailed information is lacking on how far the current situation is from equilibrium. The index does not consider the numerical benefits of hatchery spawners to natural population numbers, ecological interactions between hatchery and wild fish other than predation, or out-of-basin interactions, all of which are difficult to quantify. Appendix E contains a detailed description of the method and rationale behind this index.

The indexed potential for negative impacts of hatchery spawners on wild population fitness in the Kalama River subbasin is quite low (2.5%) for chum since no hatchery chum have been released in the basin since 1983. The fitness impact is similarly low (3.5%) for summer steelhead where broodstock are naturally-derived and the program is operated for fishery enhancement purposes. Fitness impact potential is substantially greater for fall (20%) and spring (45%) Chinook and coho (29%) hatchery releases in the Kalama River. Interspecific impacts from predation are estimated to be 1% or less for all species.

Table 8. Presumed reductions in wild population fitness as a result of natural hatchery spawners and survival as a result of interactions with other hatchery species for Kalama River salmon and steelhead populations.

Population	Annual releases[a]	Hatchery fraction[b]	Fitness category[c]	Assumed fitness[d]	Fitness impact[e]	Interacting releases[f]	Interspecies impact[g]
Fall Chinook	5,000,000	0.67	2	0.7	0.20	1,380,000	0.07
Spring Chinook	500,000	0.90	3	0.5	0.45	--	--
Chum	0[h]	0.25	1	0.9	0.025	680,000	0.034
Coho	700,000[i]	0.98	2	0.7	0.29	1,380,000	0.02
Summer steelhead	90,000	0.35	1	0.9	0.035	0	0
Winter steelhead	90,000[j]	0	1	0.9	0	0	0

[a] Annual release goals.
[b] Proportion of natural spawners that are first generation hatchery fish.
[c] Broodstock category: 1 = derived from native local stock, 2 = domesticated stock of native local origin, 3 = originates from same ESU but substantial divergence may have occurred, 4 = out-of-ESU origin or origin uncertain
[d] Productivity of naturally-spawning hatchery fish relative to native wild fish prior to significant hatchery influence. Because population-specific fitness estimates are not available for most lower Columbia River populations, we applied hypothetical rates comparable to those reported in the literature and the nature of local hatchery program practices.
[e] Index based on hatchery fraction and assumed fitness.
[f] Number of other hatchery releases with a potential to prey on the species of interest. Includes steelhead, spring chinook and coho for fall chinook and coho. Includes steelhead and spring chinook for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.
[h] Hatchery chum salmon have not been released in the basin since 1983.
[i] The Fallert Creek Hatchery goal is 350,000 early coho (type S); the Kalama Falls Hatchery goal is 350,000 late coho (type N).
j Includes 45,000 each of hatchery and late wild stocks. The winter steelhead program changed focus in 1998 1999; only wild steelhead are collected for brood stock.

3.6.2 *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, these affects 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.

Current fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table 9). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced spring Chinook, coho, and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

Table 9. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Spring Chinook	13	5	1	1	2	**22**	53	65
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
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

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 NOAA Fisheries for management of Coweeman naturally-spawning fall Chinook. Some tributary sport fisheries are closed to the retention of Chinook to protect naturally produced fall Chinook populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Harvest of lower Columbia River spring Chinook occurs in commercial and recreational fisheries in the ocean and Columbia River as well as recreational fisheries in the Kalama. In recent years, Columbia River commercial and recreational fisheries and Kalama River recreational fisheries have been selective for adipose fin-clip marked spring Chinook, allowing marked hatchery spring Chinook to be retained and requiring unmarked wild spring Chinook to be released. This management action has significantly reduced fishery impacts to wild spring Chinook

Fishery impact 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 Kalama River sport fisheries. Chum are impacted incidental to fisheries directed at late coho and winter steelhead.

Harvest of Kalama coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River as well as recreational fisheries in the Kalama. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish, as well as federal ESA limits pertaining to Oregon coastal natural coho and Oregon state ESA limits pertaining to lower Columbia 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 harvestable stocks and reduce recreational trips to communities which provide access to fishing, resulting in significant economic consequences to those communities.

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

3.6.3 *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 Kalama populations to those of most other subbasin salmonid populations. Effects are likely to be greater for chum and fall and spring 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).

3.6.4 *Hydropower Construction and Operation*

There are no hydro-electric dams in the Kalama River Basin. However, Kalama species are affected by changes in 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 and spring 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.

3.6.5 *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.

3.6.6 *Ocean Conditions*

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

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

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

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

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 23 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Kalama Basin salmon and steelhead. Impact values were developed for a base period corresponding to species listing dates. This depiction is useful for identifying which factors are most significant for each species and where improvements might be expected to provide substantial benefits. Larger pie slices indicate greater significance and scope for improvement in an impact for a given species. These numbers also serve as a working hypothesis for factors limiting salmonid numbers and viability.

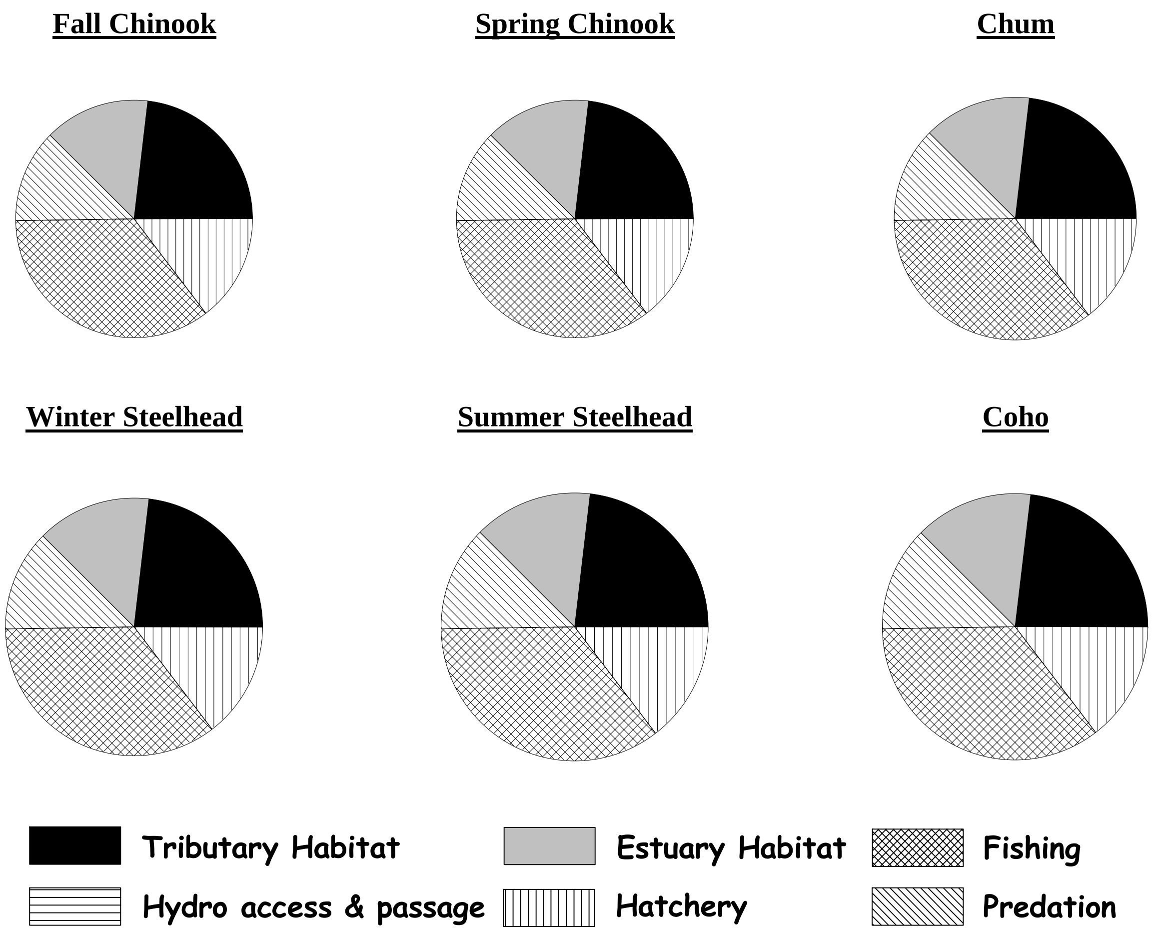

Figure 23. Relative contribution of potentially manageable impacts on Kalama River salmonid populations.

This assessment indicates that current salmonid status is the result of large impacts distributed among several factors. No single factor accounts for a majority of effects on all species. Thus, substantial improvements in salmonid numbers and viability will require significant improvements in several factors. Harvest accounts for the largest relative impact on all species. Loss of tributary habitat quality and quantity is also relatively important for all species. Loss of estuary habitat quality and quantity and impacts of hatcheries and predation are moderate for all species. Hydrosystem access and passage impacts appear to be relatively minor for all species.

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

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

4.0 Key Programs and Projects

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

4.1 Federal Programs

4.1.1 *NOAA Fisheries*

NOAA Fisheries 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. NOAA administers the ESA under Section 4 (listing requirements), Section 7 (federal actions), and Section 10 (non-federal actions).

4.1.2 *US 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.

4.1.3 *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.

4.1.4 *United States Forest Service*

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

4.1.5 *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.

4.1.6 *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.

4.2 State Programs

4.2.1 *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.

4.2.2 *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).

4.2.3 *Washington Department of Ecology*

The Department of Ecology (DOE) 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 ACOE Permits.

4.2.4 *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.

4.2.5 *Interagency Committee for Outdoor Recreation*

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 Interagency Committee for Outdoor Recreation, provides funding assistance for a broad range of land protection, park development, preservation/conservation, and outdoor recreation facilities.

4.2.6 *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.

4.3 Local Government Programs

4.3.1 *Cowlitz County*

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

4.3.2 *City of Kalama*

The City of Kalama adopted their Comprehensive Plan in 1994 and is currently in the process of updating it. Natural resource impacts are managed primarily through critical areas protections.

4.3.3 *Cowlitz / Wahkiakum Conservation District*

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

4.4 Non-governmental Programs

4.4.1 *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.

4.4.2 *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.

4.5 NPCC Fish & Wildlife Program Projects

There are no NPCC Fish & Wildlife Program Projects in the Kalama Subbasin.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Restoration	Wild Horse Creek Bridge	Kalama
Study	Kalama Assessment	Kalama

5.0 Management Plan

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 Kalama Subbasin will play a key role in the regional recovery of salmon and steelhead. Natural populations of fall Chinook, spring Chinook, winter steelhead and summer steelhead 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 and 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 Kalama Subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Kalama Basin 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.

5.2 Biological Objectives

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

Focal populations in the Kalama Subbasin are targeted to improve to a level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels. The Kalama Subbasin was identified as one of the most significant areas for salmon recovery among Washington Cascade subbasins based on fish population significance and realistic prospects for restoration. Recovery goals call for restoring Chinook and steelhead populations to a high or very high viability level. This level will provide for a 95% or better probability of population survival over 100 years. Coho recovery goals call for medium viability levels providing a 75-95% probability of persistence over 100 years. Recovery goals for chum are low, providing for a 40-75% chance of survival 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 Kalama Subbasin although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the subbasin.

Table 10. Current viability status of Kalama populations and the biological objective status that is necessary to meet the recovery criteria for the Coastal strata and the lower Columbia ESU.

	ESA	Hatchery	Current		Objective	
Species	Status	Component	Viability	Numbers	Viability	Numbers
Fall Chinook	Threatened	Yes	Low+	3,800-20,000	High[P]	1,300
Spring Chinook	Threatened	Yes	Very Low	50-600	High[P]	1,400
Chum	Threatened	No	Very Low	<150	Low[C]	150-1,100
Coho	Proposed	Yes	Low	Unknown	Medium[C]	300
Summer Steelhead	Threatened	Yes	Low+	200-2,300	High[P]	700
Winter Steelhead	Threatened	Yes	Med+	500-2,300	High+[P]	600-700

P = priority population in recovery scenario
C = contributing population in recovery scenario
S = stabilizing population in recovery scenario

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 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 models) or a recruit per spawner rate (EDT models). Corresponding improvements in spawner numbers, juvenile outmigrants, population spatial structure, genetic and life history diversity, and habitat are implicit in productivity improvements.

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

Table 11 identifies population and factor-specific improvements consistent with the biological objectives for this subbasin. Per factor increments are less than the population net because factor affects are compounded at different life stages and density dependence is largely limited to freshwater tributary habitat. For example, productivity of Kalama River fall Chinook must increase by 30% to reach population viability goals. This requires impact reductions equivalent to a 7% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts on fall Chinook must decrease from a 43% to a 39% impact in order to achieve the required 7% increase in tributary habitat from the current 57% of the historical potential to 61% of the historical potential.

Table 11. Productivity improvements consistent with biological objectives for the Kalama subbasin.

Species	Net increase	Per factor	Baseline impacts					
			Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Fall Chinook	30%	7%	0.43	0.27	0.00	0.24	0.65	0.27
Spring Chinook	--	--	0.92	0.20	0.00	0.31	0.53	0.45
Chum	30%	2%	0.92	0.51	0.00	0.24	0.05	0.03
Coho	na	na	na	na	na	na	na	na
Summer Steelhead	10%	8%	0.35	0.04	0.00	0.24	0.10	0.04
Winter Steelhead	50%	28%	0.50	0.13	0.00	0.24	0.10	0.04

5.4 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 24 and each component is presented in detail in the sections that follow.

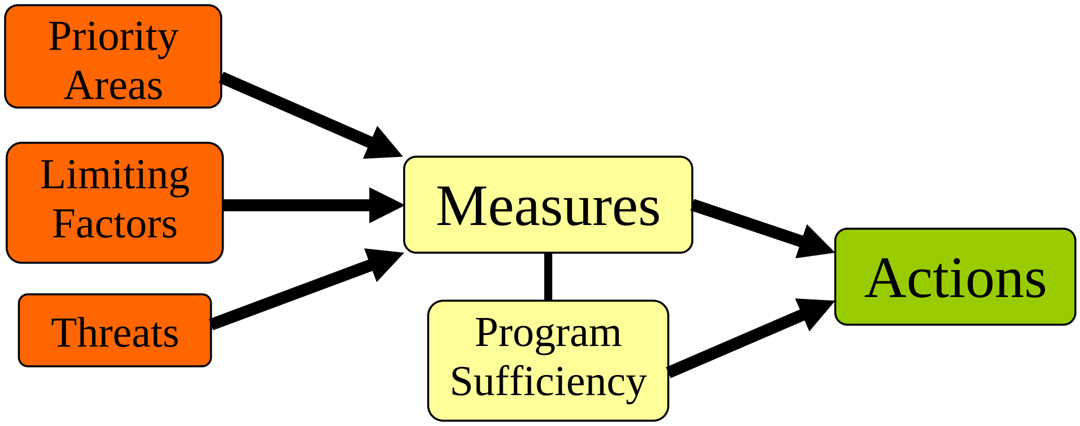

Figure 24. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Habitat Factors and Areas*

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

Summary

Decades of human activity in the Kalama River Subbasin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall Chinook, stream habitat conditions within the Kalama Subbasin 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 12.

- **Lower Kalama mainstem** *(reaches Kalama 2-6)* – The lower Kalama mainstem from the mouth to Dee Creek contains productive habitat for fall Chinook, chum, and coho. These reaches are primarily impacted by forest practices, though agriculture and rural development affect riparian areas and floodplains in the lower 2 reaches. The most effective recovery measures will involve riparian and floodplain restoration in reach Kalama 2 and 3, as well as addressing basin-wide forest and road conditions.
- **Middle Kalama mainstem & tributaries** *(reaches Kalama 8-12; Gobar Creek)* – The middle Kalama and major tributaries contain productive habitats for steelhead and spring Chinook. Coho, fall Chinook, and chum do not typically ascend lower Kalama Falls to access these habitats. Forestry is the dominant land use along these reaches. Stream-adjacent roadways impact riparian function. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions.
- **Upper Kalama mainstem & tributaries** *(reaches Kalama 15-21; NF Kalama River)* – The upper Kalama mainstem and tributaries are used primarily by summer steelhead.

These reaches are heavily impacted by forest practices. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions.

Table 12. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the lower Kalama mainstem (LM), middle Kalama mainstem & tributaries (MK), and the upper Kalama mainstem & tributaries (UK). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors	LM	MK	UK
Habitat connectivity			
Blockages to stream channel habitats	✓	✓	
Habitat diversity			
Lack of stable instream woody debris	✓	✓	✓
Altered habitat unit composition	✓	✓	✓
Loss of off-channel and/or side-channel habitats	✓		
Riparian function			
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 change	✓	✓	✓
Substrate and sediment			
Excessive fine sediment	✓	✓	✓
Embedded substrates	✓	✓	✓

Threats	LM	MK	UK
Agriculture/grazing			
Clearing of vegetation	✓		
Riparian grazing	✓		
Floodplain filling	✓		
Rural development			
Clearing of vegetation	✓		
Floodplain filling	✓		
Roads – riparian/floodplain impacts	✓		
Forest practices			
Timber harvests – impacts to sediment supply	✓	✓	✓
Timber harvests – impacts to runoff	✓	✓	✓
Riparian harvests	✓	✓	✓
Forest roads – impacts to sediment supply	✓	✓	✓
Forest roads – impacts to runoff	✓	✓	✓
Forest roads – riparian / floodplain impacts		✓	✓

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 13. Reach tier designations for this basin are included in Table 14. Reach tiers and subwatershed groups are displayed on a map in Figure 25. A summary of reach- and-subwatershed-scale limiting factors is included in Table 15.

Table 13. 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 14. Reach Tier designations in the Kalama River Subbasin.

Tier 1	Tier 2	Tier 3	Tier 4
Kalama 10 Kalama 11 Kalama 12 Kalama 15 Kalama 17 Kalama 18 Kalama 19 Kalama 2 Kalama 20 Kalama 3 Kalama 4 Kalama 5 Kalama 6 Kalama 8 Kalama 9	Gobar Creek Kalama 13 Kalama 14 Kalama 16 Kalama 21 Kalama 7 NF Kalama River	Kalama 1 tidal	Arnold Creek Bear Creek Bush Creek Cedar Creek Elk Creek Hatchery Creek Indian Creek Jacks Creek Knowlton Creek Lakeview Peak Creek Langdon Creek Little Kalama River Lost Creek Lower Falls Spencer Creek Summers Creek Unnamed Creek (27.0087) Wildhorse Cr Wolf Creek

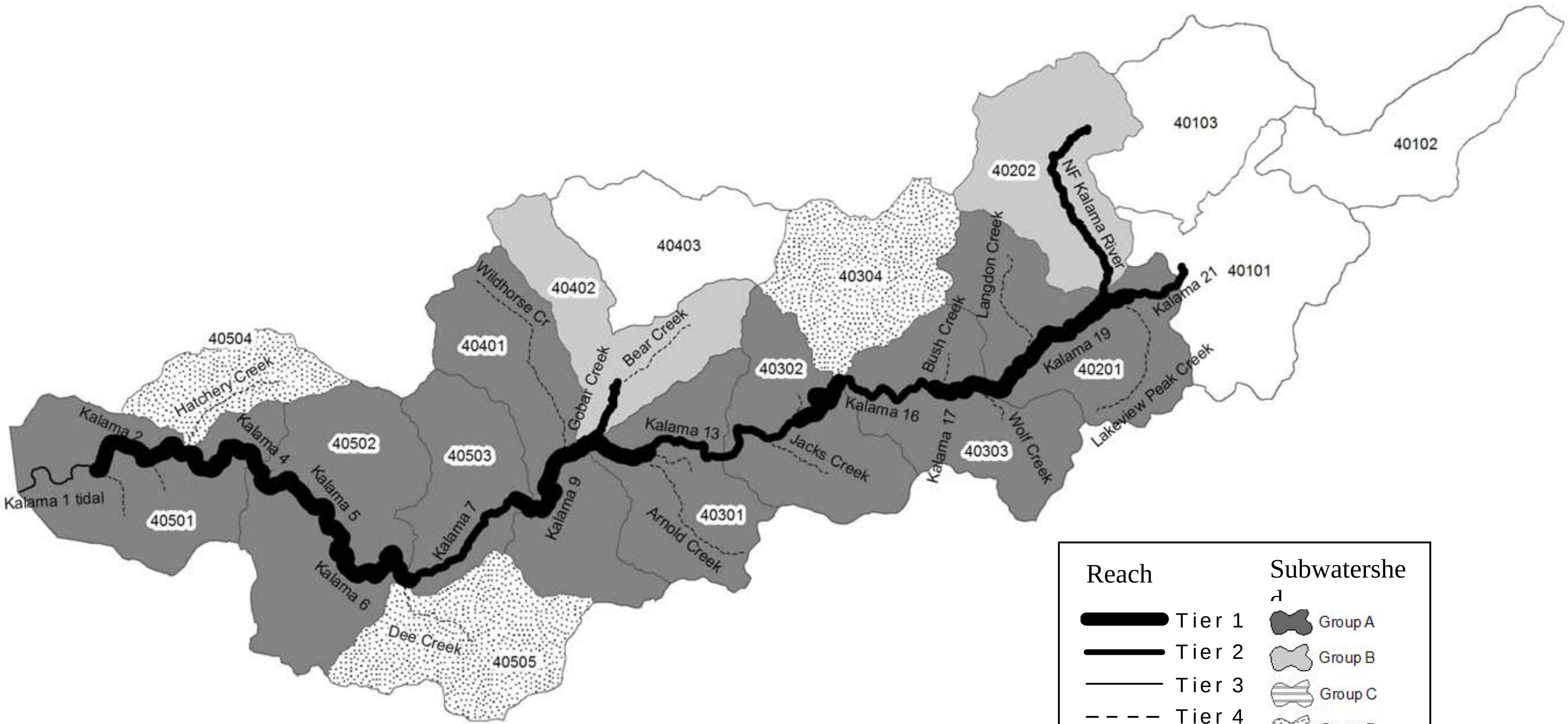

Figure 25. Reach tiers and subwatershed groups in the Kalama Basin. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities at the reach scale are useful for identifying stream corridor recovery measures. Priorities at the subwatershed scale are useful for identifying watershed process recovery measures. Watershed process recovery measures for stream reaches will need to occur within the surrounding (local) subwatershed as well as in upstream contributing subwatersheds.

Table 15. Summary Table of reach- and subwatershed-scale limiting factors in priority areas. The table is organized by subwatershed groups, beginning with the highest priority group. Species-specific reach priorities, critical life stages, high impact habitat factors, and recovery emphasis (P=preservation, R=restoration, PR=restoration and preservation) are included. Watershed process impairments: F=functional, M=moderately impaired, I=impaired. Species abbreviations: ChS=spring Chinook, ChF=fall Chinook, StS=summer steelhead, StW=winter steelhead.

Sub-watershed Group	Subwatershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Restoration or preservation emphasis	Watershed processes (local): Hydrology	Watershed processes (local): Sediment	Watershed processes (local): Riparian	Watershed processes (watershed): Hydrology	Watershed processes (watershed): Sediment
A	40503	Kalama 7 Kalama 8 Summers Creek	StS	none				I	F	M	I	M
			StW	Kalama 8	egg incubation summer rearing winter rearing	habitat diversity sediment	PR					
			ChS	Kalama 8	spawning egg incubation fry colonization	sediment	PR					
	40502	Kalama 5 Kalama 6 Lower Falls Indian Creek	StS	Kalama 6	summer rearing winter rearing adult holding	none	P	I	F	M	I	M
			StW	Kalama 5 Kalama 6	egg incubation fry colonization summer rearing winter rearing	none	R					
			ChS	Kalama 6	spawning egg incubation fry colonization	sediment	P					
			ChF	none								
			Chum	Kalama 5	spawning egg incubation fry colonization adult holding	none	P					
			Coho	none								
	40501	Kalama 1 tidal Kalama 2 Kalama 3 Kalama 4 Spencer Creek Cedar Creek	StS	none				I	M	M	I	M
			StW	Kalama 4	spawning egg incubation fry colonization summer rearing winter rearing	habitat diversity	R					
			ChS	none								
			ChF	Kalama 2 Kalama 3	spawning egg incubation fry colonization adult holding	habitat diversity sediment	PR					
			Chum	Kalama 2	spawning egg incubation fry colonization adult holding	habitat diversity	PR					
			Coho	Kalama 2 Kalama 3	spawning egg incubation fry colonization summer rearing winter rearing adult migrant	habitat diversity key habitat quantity	R					
	40401	Kalama 10 Kalama 9 Wildhorse Creek Knowlton Creek	StS	none				I	F	M	I	M
			StW	Kalama 10 Kalama 9	egg incubation summer rearing winter rearing	habitat diversity sediment	PR					
			ChS	Kalama 10 Kalama 9	egg incubation fry colonization summer rearing	habitat diversity sediment	P					
	40303	Bush Creek Kalama 16 Kalama 17 Wolf Creek	StS	Kalama 17	egg incubation summer rearing winter rearing	habitat diversity flow sediment	PR	I	M	M	I	M
			ChS	none								
	40302	Jacks Creek Kalama 14 Kalama 15 Lost Creek	StS	none				I	M	M	I	M
			ChS	Kalama 15	egg incubation fry colonization summer rearing	sediment	P					
	40301	Arnold Creek Kalama 11 Kalama 12 Kalama 13 Unnamed Creek	StS StW ChS	none none Kalama 11 Kalama 12	egg incubation fry colonization summer rearing	habitat diversity sediment	P	I	I	M	I	M
	40201	Kalama 18 Kalama 19 Kalama 20 Kalama 21 Lakeview Peak Creek Langdon Creek	StS	Kalama 18 Kalama 19 Kalama 20	egg incubation summer rearing winter rearing adult holding	habitat diversity flow sediment	PR	I	M	M	I	M
			ChS	none								
B	40402	Bear Creek Gobar Creek	StS	none				I	M	M	I	M
			StW	none								
	40202	North Fork Kalama River	StS	none				I	M	M	I	M
D	40505	Little Kalama River	StW	none				I	M	M	I	M
	40504	Hatchery Creek	ChF	none				I	F	M	I	F
			Chum	none								
			Coho	none								
	40304	Elk Creek	StS	none				I	M	M	I	M

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the Kalama necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin (Section 3.0) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the Kalama Subbasin are presented in priority order in Table 16. 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 a discussion in Program Sufficiency and Gaps.

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

5.4.3 *Habitat Actions*

The prioritized measures and associated gaps are used to develop specific Actions for the subbasin. These are presented in Table 17. 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 16. Prioritized measures in the Kalama River Subbasin.

#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	Reaches Kalama 2-6 provide important current and potential habitat for fall chinook, chum, coho, and winter steelhead. These reaches are located in mixed-use areas that have experienced increasing rural residential development within the stream corridor. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation
Reaches: Kalama 2-6
2nd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NOAA Fisheries	ESA Section 7 and Section 10	✓	
US Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program, Aquatic Lands Authorization	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Cowlitz County	Comprehensive Planning		✓
City of Kalama	Comprehensive Planning, Water Supply Program		
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat protection programs		✓
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, DNR Aquatic Lands Authorization, and local government ordinances. Riparian areas within private timberlands are protected through the Forest Practices Rules (FPR) administered by WDNR. The FPRs came out of an extensive review process and are believed to adequately protect riparian areas with respect to stream shading, bank stability, and LWD recruitment. The program is new, however, and careful monitoring of the effect of the regulations is necessary, particularly effects on subwatershe hydrology and sediment delivery. Land-use conversion and development are increasing in the lowermost 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, agriculture, or open-space to residential use has the potential to increase impairment of aquatic habitat, particularly when residential development is paired with flood control measures. Local government can limit potentially harmful land-use conversions by thoughtfully directing growth through comprehensive planning and tax incentives, by providing consistent protection of critical areas across jurisdictions, and by preventing development in floodplains. In cases where programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary.

#2 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage 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 • Development – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded throughout the basin due to past intensive timber harvest and road building. Hillslope processes in portions of the lower basin have been impacted by rural residential development and agriculture. Limiting additional degradation will be necessary to prevent further habitat impairment.

Priority Locations

1st- Functional subwatersheds contributing to Tier 1 or 2 reaches (functional for sediment *or* flow according to the IWA – local rating)
Subwatersheds: 40504, 40502, 40503, 40401, 40403, 40101, 40102
2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing or to Tier 1 or 2 reaches
Subwatersheds: 40501, 40505, 40402, 40302, 40304, 40303, 40202, 40201, 40103
3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 40301, 40601

Key Programs

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

Program Sufficiency and Gaps

Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands (open-space and developed), local government comprehensive planning is the primary nexus for protection of hillslope processes. Local governments can control impacts through zoning that protects existing uses, through stormwater management ordinances, and through tax incentives to prevent forest and open-space lands from becoming developed. These protections are especially important in the lower Kalama Basin due to expanding growth.

#3- Restore degraded hillslope processes on forest, agriculture, and developed lands

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Upgrade or remove problem forest roads B. Reforest heavily cut areas not recovering naturally C. 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 • Development – impacts to water quality and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded throughout the basin as a result of past intensive timber harvest and road building. Rural residential development and agriculture have impacted hillslope processes in portions of the lower basin. Hillslope processes must be addressed for reach-level habitat recovery to occur.

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. impaired or impaired for sediment *or* flow according to IWA-local rating)
Subwatersheds: All subwatersheds except 40601

2nd- Moderately impaired or impaired subwatersheds contributing to other reaches
Subwatersheds: 40601 (Burris Creek basin south of Kalama basin)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules, Habitat Projects	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Cowlitz County	Stormwater Management		✓
City of Kalama	Stormwater Management		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

Forest management programs including the Northwest Forest Plan (federal 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. Restoring existing developed and farmed lands can involve retrofitting buildings 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, requiring Best Management Practices through permitting and ordinances, and increasing available funding for entities to conduct restoration projects.

#4 - 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 residential development	All species	Recovery of riparian vegetation is necessary throughout the basin in both forest and mixed-use areas. Much of this recovery is expected to occur passively on forest lands due to required protection of riparian buffers. Active measures, such as hardwood-to-conifer conversion, may be necessary in some areas. The increasing abundance of exotic and invasive species is of particular concern. Riparian restoration projects are relatively inexpensive and are often supported by landowners.

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration programs		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, 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 Forest Practices Rules or the State forest lands HCP. Other lands receive variable levels of protection and passive restoration through the local government comprehensive plans. Many degraded riparian zones in developed, open-space/agriculture, or transportation corridors 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.

#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 14 miles of potentially accessible habitat are blocked by culverts or other barriers (approximately 15 barriers total). The Kalama Hatchery on Hatchery (Fallert) Creek is a potential passage barrier. The blocked habitat is believed to be marginal in most cases. Passage restoration projects should focus on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Hatchery Creek, Summers Creek, Knowlton Creek
2nd- Other small tributaries with blockages

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, Family Forest Fish Passage, State Forest Lands HCP		✓
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Washington Department of Transportation / WDFW	Fish Passage Program		✓
Cowlitz County	Roads		✓
City of Kalama	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 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 floodplain function and channel migration processes in the mainstem and major tributaries

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Set back, breach, or remove artificial confinement structures	• Bed and bank erosion • Altered habitat unit composition • Restricted channel migration • Disrupted hyporheic processes • Reduced flood flow dampening • Altered nutrient exchange processes • Channel incision • Loss of off-channel and/or side-channel habitat • Blockages to off-channel habitats	• Floodplain filling • Channel straightening • Artificial confinement	Chum, fall chinook, coho	Significant degradation of floodplain function and channel migration processes have occurred over the years in the private, mixed-use lands along the lower mainstem. This area is primarily in agriculture/open-space and rural residential uses and is experiencing increasing development pressure as nearby population centers expand. There are feasibility issues with implementation due to private lands, existing infrastructure already in place, potential flood risk to property, and large expense. Floodplain degradation in other portions of the basin is mostly related to stream adjacent roads.

Priority Locations

1st- Tier 1 reaches with hydro-modifications (obtained from EDT ratings)
Reaches: Kalama 2-4, 18 & 20
2nd- Tier 2 reaches with hydro-modifications
Reaches: Kalama 21; NF Kalama River; Gobar Creek
3rd- Other reaches with hydro-modifications
Reaches: Kalama 1 tidal; Langdon Creek; Wildhorse Creek; Spencer Creek

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Cowlitz County	Habitat Projects		✓
Port of Kalama	Management of Port Property at Mouth of Kalama River		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
WDNR	Aquatic Lands Authorization	✓	

Program Sufficiency and Gaps

There currently are no programs or policy in place that set forth strategies for restoring floodplain function and channel migration processes in the Kalama Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. The level of floodplain and CMZ impairment in the Lower Kalama and the importance of these processes to listed fish species put an increased emphasis on restoration. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs 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.

#7 - Restore channel structure and stability

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

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, agencies, landowners	Habitat Projects		✓
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration programs		✓

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.

#8 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve flows during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Kalama Basin have been identified as part of Watershed Planning for WRIA 27 (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
WRIA 27/28 Watershed Planning Unit	Watershed Planning	✓	
City of Kalama	Water Supply Program		✓
Washington Department of Ecology	Water Resources Program		✓

Program Sufficiency and Gaps

The Water Resources Program of the WDOE, 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 WDOE through a collaborative process. The current status of the planning effort is to adopt a watershed plan in December 2004. Instream flow management in the Kalama Basin 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. Water supply for the City of Kalama is through a Ranney Well in the lower Kalama. Ecology should implement the recommendations of the WRIA 27/28 Watershed Planning Unit as it relates to instream flow management.

#9 – Restore degraded water quality

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Increase riparian shading B. Decrease channel width-to-depth ratios C. Reduce delivery of chemical contaminants to streams D. Address leaking septic systems	• Bacteria • Altered stream temperature regime • Chemical contaminants	• Timber harvest – riparian harvests • Leaking septic systems • Clearing of vegetation due to development • Chemical contaminants from developed lands	• All species	The lower Kalama is listed on the draft 2002/2004 303(d) list as having temperature impairment. Hatchery Creek is listed as being a concern for temperature impairment. The lower Kalama is also listed as a concern for fecal coliform bacteria impairment potentially originating from leaking septic systems in areas of concentrated residential development. Bacteria contamination is more of a human health concern than a fish health concern. The remainder of the basin is believed to be in good condition with respect to water quality. Water temperatures are generally very cool in the middle and upper mainstem due to groundwater inputs throughout the canyon.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 draft list)
Reaches: Kalama 2 (temperature)
2nd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration programs, Centennial Clean Water Program		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Cowlitz County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

The WDOE Water Quality Program manages the State 303(d) list of impaired water bodies. There is one temperature listing in the lower Kalama River and a couple of areas of concern for temperature and bacteria (WDOE 2004). A temperature Water Quality Clean-up Plan (TMDL) will be required by the WDOE and it is anticipated that the TMDL will adequately set forth strategies to address the temperature impairment in the lower river. It will be important that the strategies specified in the TMDL are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin.

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

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore historical off-channel and side-channel habitats where they have been eliminated B. Create new channel or off-channel habitats (i.e. spawning channels)	• Loss of off-channel and/or side-channel habitat	• Floodplain filling • Channel straightening • Artificial confinement	chum coho	There has been significant loss of off-channel and side-channel habitats, especially along the lower mainstem that has been channelized. This has 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 mainstem
Reaches: Kalama 1 tidal; Kalama 2-4
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		✓
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. 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 17. Habitat actions for the Kalama Subbasin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
Kal 1. 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, 3, 4, 5 & 9	High: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Kal 2. Expand standards in local governments 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	Cowlitz County, City of Kalama	1 & 2	Medium: Private lands. Applies primarily to lands in the lower basin in rural residential and forestland uses	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
Kal 3. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of lands to developed uses through zoning regulations and tax incentives	Expansion of existing program or activity	Cowlitz County, City of Kalama	1 & 2	Medium: Private lands. Applies primarily to lands in the lower basin in rural residential and forestland uses	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
Kal 4. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Cowlitz County, City of Kalama, WDOE	1	Low: Private lands. Applies to lands in lowland areas in the lower basin in rural residential and forestland uses	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
Kal 5. Conduct floodplain restoration where feasible along the lower mainstem that has experienced channel confinement. Build partnerships with the Port of Kalama and other landowners and provide financial	New program or activity	NRCS, C/W CD, NGOs, WDFW, LCFRB, USACE, Port of Kalama	4, 5, 6, 7 & 8	Low: Lower mainstem Kalama	High: Restoration of floodplain function, CMZ function, habitat diversity, and habitat availability	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]
incentives						
Kal 6. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, City of Kalama	8	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
Kal 7. 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, C/W CD, LCFEG	3, 4, 5, 6, 7, 9 & 10	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
Kal 8. 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, 3, 4, 5 & 9	Low: Small private timberland owners	High: Reduction in road-related fine sediment delivery; restoration and preservation of fish access to habitats	Medium
Kal 9. 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: Private lands. Applies primarily to riparian, floodplain, and wetland areas in the lower basin in rural residential and forestland uses	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
Kal 10. 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, C/W CD, WDNR, WDFW, LCFEG, Cowlitz County	All measures	Medium: Private lands. Applies primarily to lands in the lower basin in rural residential and forestland uses	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
Kal 11. 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, Cowlitz County, WSDOT, LCFEG	5	Medium: As many as 14 miles of stream are blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	High

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
Kal 12. 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, C/W CD, LCFEG	10	Low: Lower mainstem Kalama	High: Increased habitat availability for spawning and rearing	Low
Kal 13. 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	Low: State timber lands in the Eloch-Skam Watershed (approximately 21% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats.	Medium
Kal 14. 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, C/W CD, LCFEG	1 & 4	Low: Greatest risk is in lower basin agriculture and residential areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
Kal 15. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	Expansion of existing program or activity	Cowlitz County, C/W CD	9	Low: Private rural residential lands in lower basin	Medium: Protection and restoration of water quality (bacteria)	Low
Kal 16. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed management	Expansion of existing program or activity	Cowlitz County, Kalama	1, 3, 4, & 9	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

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the Kalama River Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery 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. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the Kalama River Basin are displayed by species in Table 18. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 18. Summary of natural production and fishery enhancement strategies to be implemented in the Kalama River Basin.

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

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

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 and will be key indicators of natural population status within the ESU. This strategy is not included for the Kalama subbasin.

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

Hatchery/Natural isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of spring and fall Chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This strategy would be included in actions for winter and summer steelhead in the upper Kalama Basin. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations.

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

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

The two hatcheries in the Kalama Basin will be operated to include natural production enhancement strategies for Kalama natural fall Chinook, winter steelhead, and summer steelhead. The Kalama River Hatchery Complex will continue to support steelhead, Chinook, and coho fisheries with hatchery releases in the Kalama Basin (Table 19). There are two new hatchery conservation programs added to the three existing conservation programs at the Kalama Hatchery Complex.

Table 19. A summary of conservation and harvest strategies to be implemented through Kalama River Hatchery programs.

		Stock
Natural Production Enhancement	Supplementation	Spring Chinook√
	Hatch/Nat Conservation [1/]	Kalama Fall Chinook√
	Isolation	Kalama Winter Steelhead 2/
		Kalama Summer steelhead 2/
	Broodstock development	Kalama Late Winter Steelhead √
		Kalama Wild Summer Steelhead
Fishery Enhancement	In-basin releases (final rearing at Kalama)	Kalama Early Coho
		Kalama Late Coho
		Kalama Fall Chinook
		Kalama Winter Steelhead
		Skamania Summer Steelhead
	Out of Basin Releases (final rearing at Kalama)	

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

5.5.2 *Hatchery Measures and Actions*

Hatchery strategies and measures are focused on evaluating and reducing biological risks consistent with the recovery strategies identified for each natural population. Artificial production programs within Kalama River River facilities have been evaluated in detail through the WDFW Benefit-Risk Assessment Procedure (BRAP) relative to risks to natural populations. The BRAP results were utilized to inform the development of these program actions specific to the Kalama River Basin (Table 20). These hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NOAA fisheries approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the Kalama River Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 20. Regional hatchery actions from Volume I, Chapter 7 with potential implementation actions in the Kalama Subbasin

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
Unique conservation strategy is developed for Kalama fall chinook based on status of natural population and biological relationship between natural and hatchery populations. Options may include integration and/or segregation strategies over time as developed to meet recovery objectives. Actions may include: • Deliberate and consistent infusion of natural produced adults into the hatchery program. • Manage the existing weir in the lower Kalama River to separate hatchery and natural produced fish to control proportions of hatchery and natural fish on the spawning grounds (above Modrow Bridge) and in the hatchery. Matrix system developed to determine annual distribution of wild and hatchery adults based on hatchery/wild biological relationship and annual abundance	**Conservation management strategy implemented for fall Chinook natural and hatchery production *Eliminate outside basin transfers of fall and chinook eggs or fry for release into the Kalama basin	Kalama Hatchery fall Chinook	Kalama fall Chinook	Domestication,Diversity Abundance	• In-breeding • Non-local genetic traits	• Increased genetic diversity in natural and hatchery populations • Improved productivity and increased abundance in the natural produced Kalama fall Chinook population • Hatchery production is managed consistent with natural population recovery objectives and to provide harvest opportunity.
• Continue to mass mark steelhead and coho hatchery releases to provide the means to identify hatchery fish for selective fisheries and to distinguish between hatchery and wild fish in the Kalama basin Establish a mass marking program for fall Chinook to enable selective fishing options and to accomplish action 1.	*Adipose fin-clip mark hatchery released coho and steelhead. **Adipose fin-clip mark hatchery released fall Chinook	Kalama Hatchery coho, steelhead, and fall Chinook.	Kalama winter and summer steelhead. Kalama coho, and Kalama fall Chinook	Domestication,Diversity, Abundance	• In-breeding • Harvest	• Maintain lower harvest impacts for natural Kalama coho and steelhead compared to hatchery production • Provide the opportunity to develop fishing regulations which accomplish a lower harvest impact for wild Kalama fall Chinook compared to Kalama Hatchery fall Chinook. • Enable visual identification of hatchery and wild returns to provide the means to account for and manage the natural and wild escapement consistent with biological objectives
• Pass a portion of hatchery adult returns upstream of the Kalama Falls Hatchery to spawn naturally in the upper watershed • Develop an adult spring Chinook handling protocol to determine the number of fish to pass upstream. Integrate hatchery and wild broodstock in the future after wild production is established	**Kalama hatchery facilities utilized to supplement natural spring Chinook	Kalama Hatchery spring Chinook	Kalama spring Chinook	Abundance, spatial distribution	• low numbers of natural spawners and distribution into the upper watershed habitat	• Sufficient numbers of adults maintained in the hatchery program to assure stock stability • Provide adult spawners to increase natural production in the upper watershed • A future integrated hatchery and wild program providing harvest opportunity

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Hatchery produced steelhead, coho, and fall Chinook will be scheduled for release during the time when the maximum numbers of fish are smolted and prepared to emigrate rapidly. releases • Juvenile rearing strategies will be implemented to provide a fish growth schedule which coincides with an optimum release time for hatchery production success and to minimize time spent in the Kalama River	*Juvenile release strategies to minimize impacts to natural populations	Kalama Hatchery steelhead, coho, and fall Chinook	Kalama fall Chinook, chum, and coho	Predation, Competition	• Hatchery smolt residence time in the Kalama River.	• Minimal residence time of hatchery released juvenile resulting in reduced ecological interactions between hatchery and wild juvenile. Displacement of natural fall Chinook from preferred habitat by larger hatchery fall Chinook will be minimized. • Improved survival of wild juveniles, resulting in increased productivity and abundance
• Adequate function of the existing weir in the lower Kalama River to enable efficient accounting and sorting of hatchery and wild fall Chinook and passage of steelhead and coho • Adequate function of the ladder and trap at Kalama Falls Hatchery to enable efficient collection of hatchery steelhead, spring Chinook, and coho. Provide passage for wild winter and summer steelhead and spring Chinook. Hatchery effluent discharge complies with NPDES permit monitoring requirements. Fish health monitored and treated as per co-mangers fish health policy	**Evaluate facility operations	All species	All species	Access, Habitat quality, genetic integrity	• Fish barriers, • water quality, sorting efficiency	• Ability to implement integrated hatchery and natural brood stock programs by efficient collection systems. • Access to natural spawning habitats for natural returning fish • Hatchery fish disease controlled and water quality standards upheld to avoid impact to habitat quality in the Elcohoman River downstream of the hatchery.
• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes • Performance standards developed for each actions with measurable criteria to determine success or failure Adaptive Management applied to adjust or change actions as necessary	** Monitoring and evaluation, adaptive management	All species	All species	Hatchery production performance, Natural production performance	• All of above	• Clear standards for performance and adequate monitoring programs to evaluate actions. • Adaptive management strategy reacts to information and provides clear path for adjustment or change to meet performance standard

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

5.6 Harvest

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

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

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

Fishery actions specific to the subbasins are addressed through the Washington State Fish and Wildlife sport fishing regulatory process. This public process includes an annual review focused on emergency type regulatory changes and a comprehensive review of sport fishing regulations which occurs every two years. This regulatory process includes development of fishing rules through the Washington Administrative Code (WAC) which are focused on protecting weak stock populations while providing appropriate access to harvestable populations. The actions consider the specific circumstances in each area of each subbasin and respond with rules that fit the relative risk to the weak populations in a given time and area of the subbasin. Following is a general summary of the fishery actions specific to the Kalama River (Table 21). More complete details can be found in the WDFW Sport Fishing Rules Pamphlet.

Table 21. Summary of sport fishing regulatory and protective actions in the Kalama River

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

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in the Regional Recovery and Subbasin Plan Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. Harvest actions with significant application to the Kalama Subbasin populations are summarized Table 22.

Table 22. Harvest actions from Volume I, Chapter 7 with significant application to the Kalama Subbasin populations

Action	Description	Responsible Parties	Programs	Comments
**F.A12	Monitor chum handle rate in winter steelhead and late coho tributary sport fisheries.	WDFW	Columbia Compact	State agencies would include chum incidental handle assessments as part of their annual tributary sport fishery sampling plan.
**F.A8	Develop a mass marking plan for hatchery tule Chinook for tributary harvest management and for naturally-spawning escapement monitoring.	WDFW, NOAA, USFWS, Col. Tribes	U.S. Congress, Washington Fish and Wildlife Commission	Provides the opportunity to implement selective tributary sport fishing regulations in the Kalama watershed. Recent legislation passed by Congress mandates marking of all Chinook, coho, and steelhead produced in federally funded hatcheries that are intended for harvest. Details for implementation are currently under development by WDFW, ODFW, treaty Indian tribes, and federal agencies.
*F.A13	Monitor and evaluate commercial and sport impacts to naturally-spawning steelhead in salmon and hatchery steelhead target fisheries.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Includes monitoring of naturally-spawning steelhead encounter rates in fisheries and refinement of long-term catch and release handling mortality estimates. Would include assessment of the current monitoring programs and determine their adequacy in formulating naturally-spawning steelhead incidental mortality estimates.
*F.A14	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.
*F.A20	Maintain selective sport fisheries in ocean, Columbia River, and tributaries and monitor naturally-spawning stock impacts.	WDFW, NOAA, ODFW, USFWS	PFMC, Columbia Compact, BPA Fish and Wildlife Program, WDFW Creel	Mass marking of lower Columbia River coho and steelhead has enabled successful ocean and freshwater selective fisheries to be implemented since 1998. Marking programs should be continued and fisheries monitored to provide improved estimates of naturally-spawning salmon and steelhead release mortality.

* Extension or improvement of existing action
** New action

5.7 Hydropower

No hydropower facilities exist in the Kalama subbasin, hence, no in-basin hydropower actions are identified. Kalama River 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.

5.8 Mainstem and Estuary Habitat

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

5.9 Ecological Interactions

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

5.10 Monitoring, Research, & Evaluation

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

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

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

Table 23. Summary of the biological monitoring plan for the Kalama River populations.

Kalama: Lower Columbia Biological Monitoring Plan						
Monitoring Type	**Fall Chinook**	**Chum**	**Coho**	**Winter Steelhead**	**Summer Steelhead**	**Spring Chinook**
Routine	AA	AA	AA	AA	AA	AA
Intensive						
Level 1	✓			×	×	✓
Level 2				×	×	
Level 3				×	×	

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

Table 24. Summary of the habitat monitoring plan for the Kalama River populations.

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

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

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