Lower Columbia Salmon Recovery
And
Fish & Wildlife Subbasin Plan

Volume II – Subbasin Plan
Chapter D – Elochoman, Skamakowa, Mill, Abernathy and Germany

Grays-Elochoman and Cowlitz Rivers (WRIAS 25-26)

Watershed Management Plan

Chapter 7 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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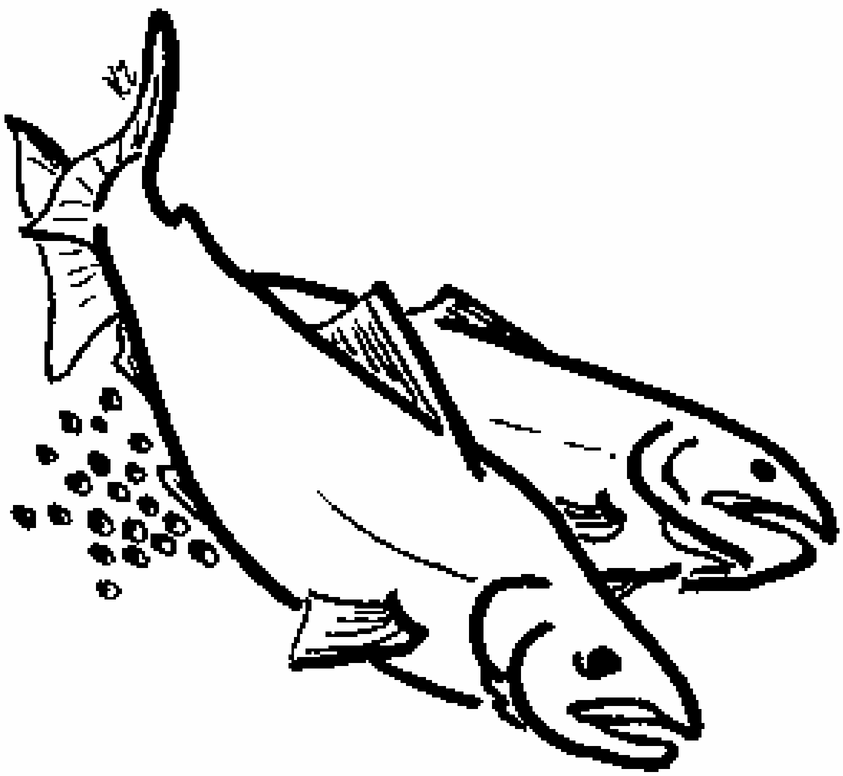


Subbasin Plan Vol. II.D.
Elochoman Subbasin –
Elochoman River and Skamokawa Creek

Contents

1.0 Elochoman / Skamokawa – 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 Elochoman/Skamokawa Watershed describes implementation of the regional approach within these stream systems, 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 Elochoman/Skamokawa Watershed consists of the Elochoman River, Skamokawa Creek, and nearby smaller tributaries to the Columbia River. The watershed is located within the Elochoman Subbasin as defined by the Northwest Power and Conservation Council. The Elochoman Subbasin is one of eleven major subbasins in the Washington portion of the Lower Columbia Region. The Elochoman River and Skamokawa Creek historically supported thousands of fall Chinook, chum, coho and winter steelhead. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook and chum 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 isolated or eliminated by dredging and channel modifications and diking, filling, or draining floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or non-local hatchery fish has reduced productivity. Hydropower operation on the Columbia has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

The Elochoman/Skamokawa Watershed is particularly important to regional recovery of salmon and steelhead because it is one of two major basins in the coastal portion of the ESU. Elochoman/Skamokawa salmon will need to be restored to a high level of viability and steelhead restored to a medium level of viability to meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the basin.

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

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact Elochoman/Skamokawa 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 Elochoman/Skamokawa Watershed 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 Elochoman/Skamokawa Watershed. The following list identifies the most immediate priorities.

1. Manage Forest Lands to Protect and Restore Watershed Processes

The majority of the Elochoman/Skamokawa Watershed is managed for commercial timber production and has experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing fine sediment, and degrading riparian zones. Effects have been magnified due to high rainfall and erodable soils. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Habitat Conservation Plan (state lands) and Forest Practices Rules (private lands) are expected to substantially improve conditions by restoring passage, protecting riparian conditions, reducing fine sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead and coho.

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

The lower and middle mainstem Elochoman River, middle mainstem Skamokawa Creek, and Wilson Creek (Skamokawa tributary) are used for agriculture or rural residences. Levee construction and bank stabilization have heavily impacted fish habitat in these areas. Removing or modifying channel control and containment structures to reconnect the stream and its floodplain will restore normal habitat-forming processes to reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing. These improvements will be particularly beneficial to chum, fall Chinook, and coho. Normal floodplain functions will also help control downstream flooding and provide wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and habitats will be protected through local land use ordinances, partnerships with landowners, and the acquisition of land, where appropriate. Restoration will be achieved by working with willing landowners, non-governmental organizations, conservation districts, and state and federal agencies.

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

The human population in the watershed is relatively low, but it is projected to grow by at least one third in the next twenty years. The local economy is also in transition with reduced reliance on forest products, fisheries, and farming. Population growth will primarily occur in lower river valleys and along the major stream corridors. This growth will result in the conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions. Land-use changes will provide a variety of risks to terrestrial and aquatic habitats. Careful land-use planning will be necessary to protect and restore natural fish populations and habitats and will also present opportunities to preserve the rural character and local economic base of the watershed.

4. Restore Passage at Culverts and Other Artificial Barriers

As many as 10 miles of potentially accessible habitat are blocked by culverts or other barriers (approximately 8 barriers total). The water intake dam for the hatchery on Beaver Creek may limit access and passage issues and opportunities there should be further investigated. Passage restoration projects should focus on cases where it can be demonstrated that there is good potential benefit and reasonable project costs. Further assessment and prioritization of passage barriers is needed throughout the watershed.

5. Address Immediate Risks with Short-term Habitat Fixes

Restoration of normal watershed processes that allow a basin to restore itself over time has proven to be the most effective strategy for long term habitat improvements. However, restoration of some critical habitats may take decades to occur. In the near term, it is important to initiate short-term fixes to address current critical low numbers of some species. Examples in the Elochoman/Skamokawa Watershed include building chum salmon spawning channels and constructing coho overwintering habitat such as alcoves, side channels, and log jams. Benefits of structural enhancements are often temporary but will help bridge the period until normal habitat-forming processes are reestablished.

6. 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 some fishing benefits. The Elochoman River hatchery program will produce and/or acclimate fall Chinook, winter steelhead, and coho for use in the Elochoman Subbasin. Chum and coho will be used to supplement natural production in appropriate areas of the basin and adjacent tributary streams, develop a local broodstock to reestablish historical diversity and life history characteristics, and also to provide fishing enhancement in a manner that does not pose significant risk to natural population rebuilding efforts. The hatchery also acclimates and releases a temporally-segregated hatchery winter steelhead run to mitigate for reduced fishing opportunities on the wild population in the interim until natural productivity is restored.

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

This near-term strategy involves limiting fishery impacts on natural populations to ameliorate extinction risks until a combination of measures can restore fishable natural populations. There is no directed Columbia River or tributary harvest of ESA-listed Elochoman/Skamokawa salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some Elochoman/Skamokawa 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 Elochoman and Skamokawa. Steelhead and chum will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Selective fisheries for marked hatchery steelhead and coho (and fall chinook after mass marking occurs) will be a critical tool for limiting wild fish impacts. State and federal legislative bodies will be encouraged to develop funding necessary to implement mass-marking of fall Chinook, thus enabling a selective fishery with lower impacts on wild fish. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

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

Elochoman and Skamokawa 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. Owing to it’s close proximity, estuary habitat improvements, including restoration of wetlands, will be particularly critical to Elochoman and Skamokawa salmonid populations. 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.

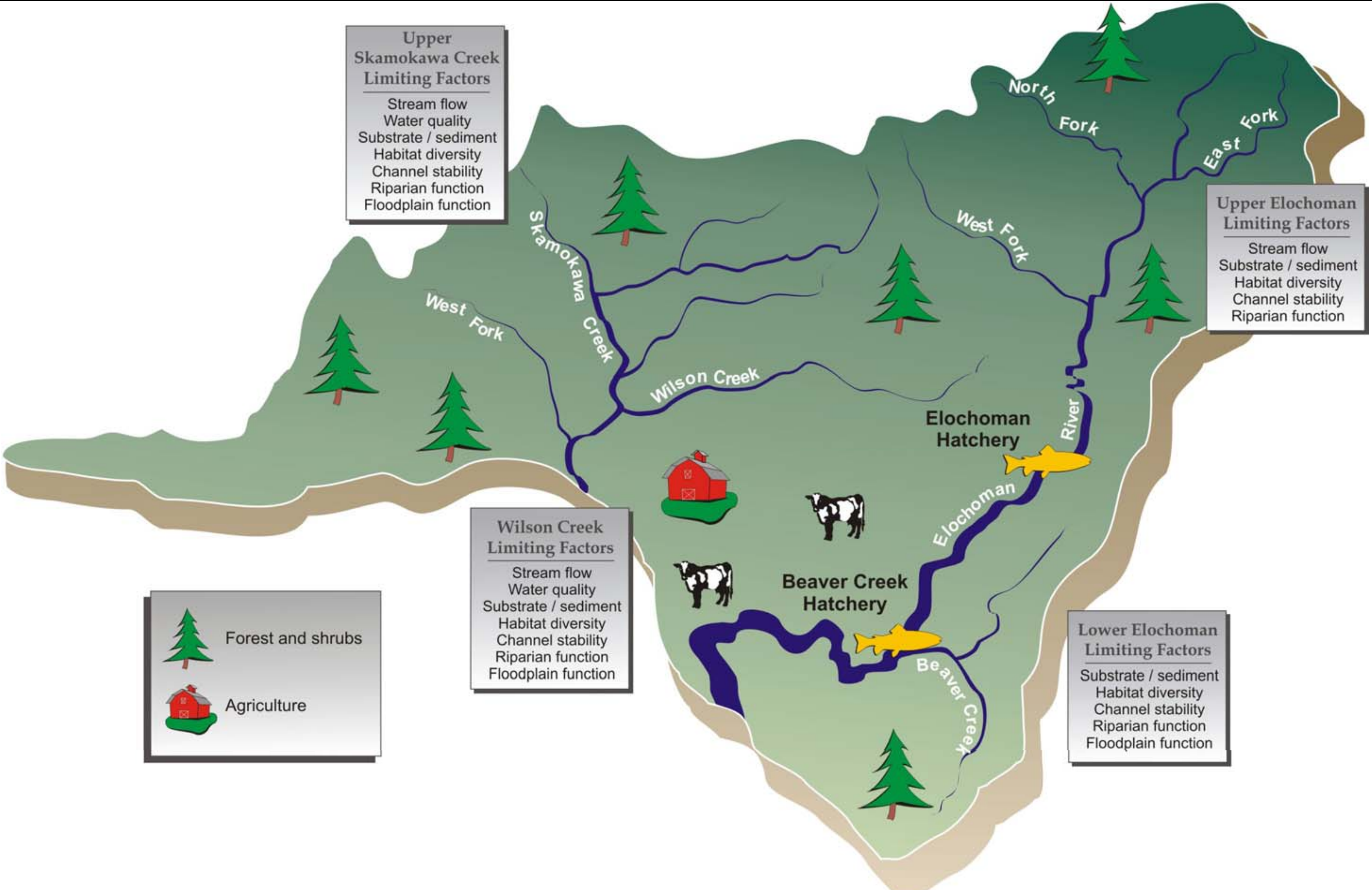


Figure 1. Key features of the Elochoman River and Skamokawa Creek Watersheds including a summary of limiting fish habitat factors in different areas and the status and relative distribution of focal salmonid species.

2.0 Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's Elochoman River and Skamokawa Creek Watersheds. 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 watershed, focal fish species, current conditions, and evaluations of factors affecting focal fish species inside and outside the watershed. This assessment forms the scientific and technical foundation for developing a vision, objectives, strategies, and measures for the watershed. 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*

Streams in the Elochoman/Skamokawa Watershed originate in the Willapa Hills in southwest Lewis County, northeast Cowlitz County, and Wahkiakum County and flow generally south to the Columbia. The watershed area is approximately 163 mi^2. From west to east, the stream systems include Jim Crow Creek, Skamokawa Creek, Brooks Slough, the Elochoman River, and Birnie Creek. The highest elevation lies at the head of the Elochoman watershed at 2,673 feet and the lowest is near sea level on the Columbia. The surface geology is a combination of volcanic and sedimentary materials. Less than 20% of the soils are classified as highly erodible.

3.1.2 *Climate*

The watershed has a typical northwest maritime climate. Summers are dry and cool and winters are mild, wet, and cloudy. Most precipitation falls between October and March, with mean annual precipitation ranging from 45-118 inches with an average mean of 70-85 inches. Snowfall is light and transient owing to the relative low elevation and moderate temperatures. Less than 10% of the watershed area is within the rain-on-snow zone or higher (WDNR data).

3.1.3 *Land Use, Ownership, and Cover*

Forestry is the predominant land use in the Elochoma/Skamokawa Watershed. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Nearly 0% of the forest cover is in late-seral stages, however, as the forest matures, watershed conditions are recovering. Agriculture and residential land use is located along lower alluvial stream segments of the Elochoman River and Skamokawa Creek. Skamokawa and Cathlamet are the two largest population centers. The watershed is primarily in private ownership, as shown in the following chart. The bulk of the private land is industrial forestland and road densities are high. The extent of the road network has important implications for watershed processes such as flow generation, sediment production, and contaminant transport. 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 Elochoman/Skamokawa Watershed is presented in Figure 2 and Figure 3.

A broad agricultural valley extends up the mainstem Skamokawa, West Fork Skamokawa, and Wilson Creek. There are considerable agricultural impacts to fish habitat in these areas, which suffer from non-forested riparian zones and disconnected floodplains. Chum, fall Chinook, and coho utilize these lower valley reaches and are therefore heavily impacted by agricultural land-uses. The upper reaches of the mainstem and all major tributaries are impacted most heavily by forest harvest and the forest road network. Winter steelhead and coho occupy upper watershed reaches, and are therefore affected most by forest practices.

A similar land-use pattern can be found in the Elochoman watershed, with the exception being that the agricultural valley is found primarily only along the mainstem. The species effects are also similar, with agricultural uses having the greatest impact on chum and fall Chinook and forest practices having the greatest effect on winter steelhead and coho.

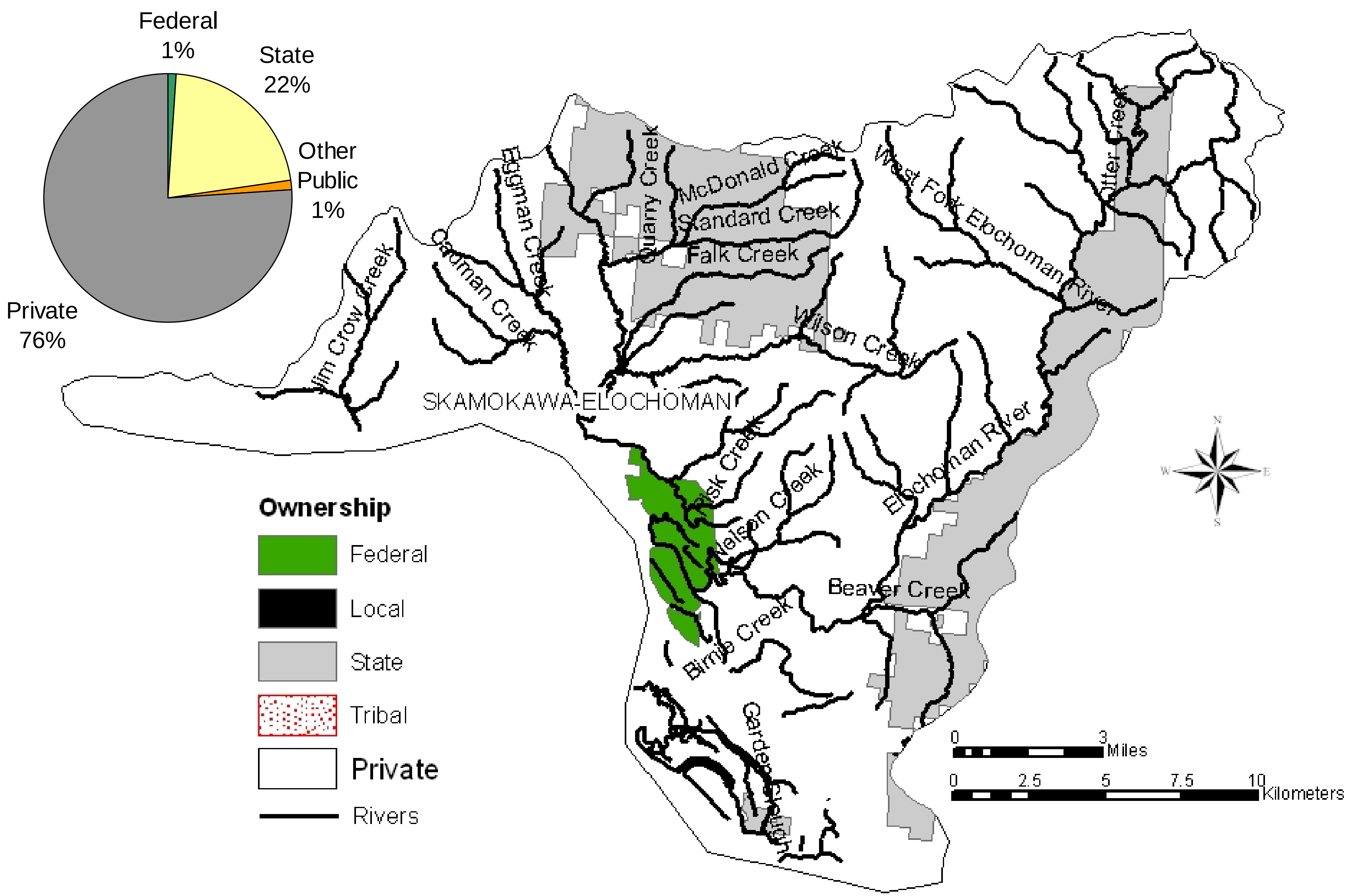


Figure 2. Landownership within the Elochoman/Skamokawa Watershed. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

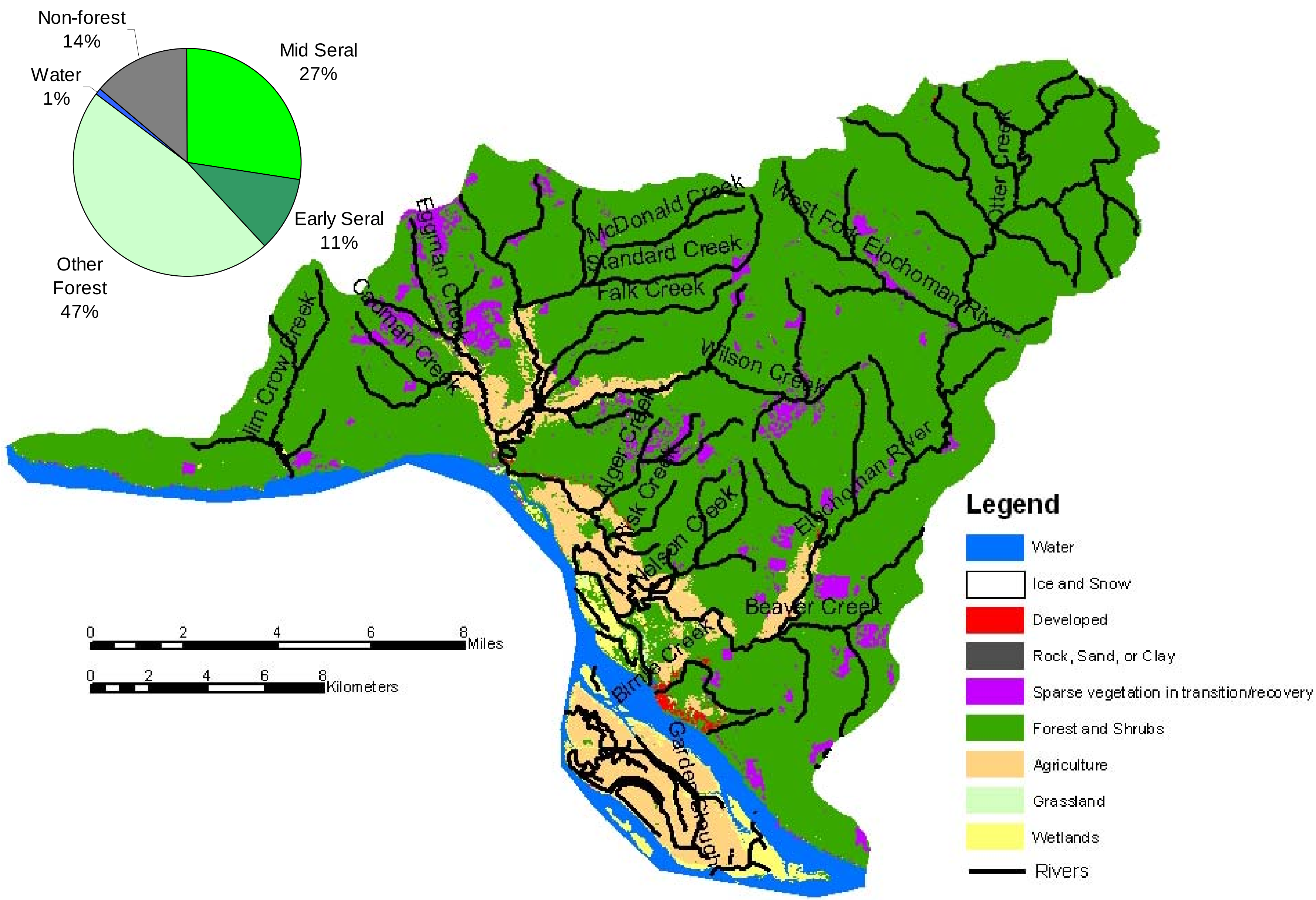


Figure 3. Land cover within the Elochoman/Skamokawa Watershed. Begetation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. 1997. Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

3.1.4 *Development Trends*

Projected population change from 2000-2020 for unincorporated areas in WRIA 25 is 37% (LCFRB 2001). Continued population growth will increase pressures for conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions.

3.2 Focal and Other Species of Interest

Listed salmon, as well as steelhead, and trout species are focal species of this planning effort for the Elochoman/Skamokawa Watershed. 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 Elochoman/Skamokawa Watershed although anadromous species are subject to effects in the Columbia River, estuary, and nearshore ocean. The Elochoman/Skamokawa 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 the Elochoman/Skamokawa Watershed include fall Chinook, chum, coho, and winter steelhead. Bull trout do not occur in the subbasin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table 1). Extinction risks are significant for all focal species – the current health or viability is low for all four anadromous species. Returns of fall Chinook, coho, and winter steelhead include both natural and hatchery produced fish.

Table 1. Status of focal salmond and steelhead populations in the Elochoman/Skamokawa Watershed.

Focal Species	ESA Status	Hatchery Component[1]	Historical numbers[2]	Recent numbers[3]	Current viability[4]	Extinction risk[5]
Fall Chinook	Threatened	Yes	5,000-10,000	100-2,300	Low+	40%
Chum	Threatened	No	15,000-50,000	<200	Low	60%
Coho	Proposed	Yes	15,000-40,000	Unknown	Low	70%
Winter Steelhead	Not Listed	Yes	1,400	200-700	Low+	40%

[1] *Significant numbers of hatchery fish are released in the watershed.*
[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 watershed.*
[4] *Prospects 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..*

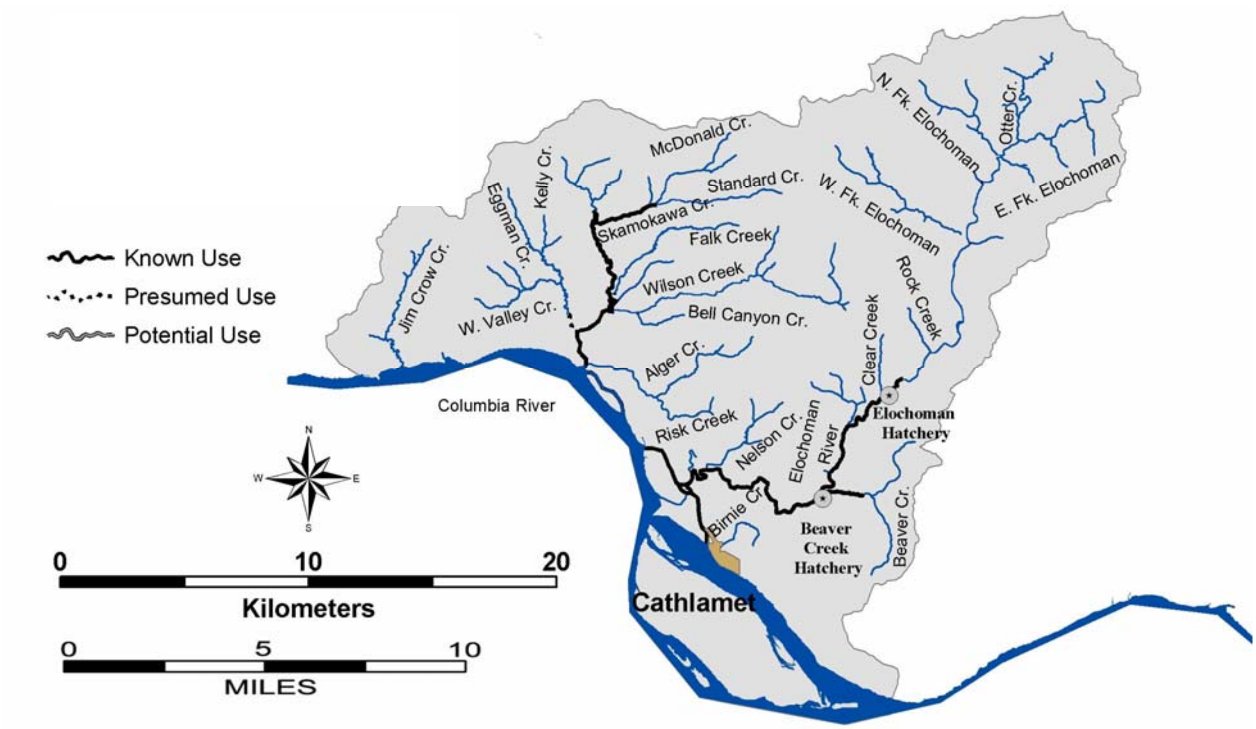
Other species of interest in the Elochoman/Skamokawa Watershed include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

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—Elochoman Subbasin (Elochoman/Skamokawa)*

ESA: Threatened 1999	**SASSI: Elochoman—Healthy; Skamokawa - Depressed 2002**

The historical Elochoman/Skamokawa adult population is estimated from 5,000-10,000 fish. The vast majority of fish returned to the Elochoman River. Current natural spawning returns range from 100-2,300 in the Elochoman River and 50-500 in Skamokawa Creek. The majority of current returns are hatchery origin fish. Spawning occurs in the lower Elochoman from above tidewater (RM 4 to the Elochoman Hatchery (RM 9). Spawning occurs in Skamokawa Creek from Wilson Creek upstream to Standard and McDonald creeks (4.5 miles). Juvenile rearing occurs near and downstream of the spawning areas. Juveniles emerge in early spring and migrate to the Columbia in spring and summer of their first year.



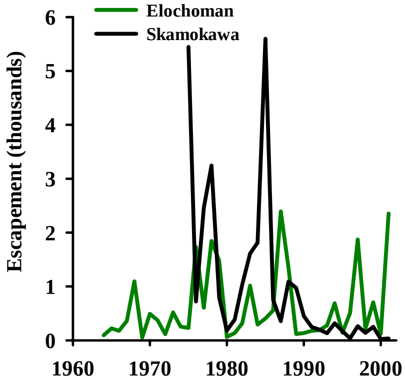
Distribution

- Spawning occurs in the lower mainstem Elochoman between RM 4 and 9 (downstream of the Elochoman Hatchery)
- Spawning occurs in the mainstem Skamokawa from Wilson Creek upstream to Standard and McDonald Creeks (4.5 miles)

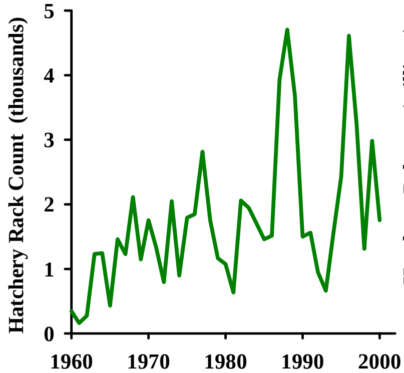
Life History

- Columbia River tule fall chinook migration occurs from mid August to mid September, depending partly on early fall rain
- Natural spawning occurs between late September and late October, peaking in mid-October
- Elochoman fall chinook age ranges from 2-year old jacks to 6-year old adults, with dominant adult ages of 3 and 4 (averages are 46.7% and 38.4%, respectively)
- Fry emerge around early April, depending on time of egg deposition and water temperature; fall chinook fry spend the spring in fresh water, and emigrate in the late spring/summer as sub-yearlings

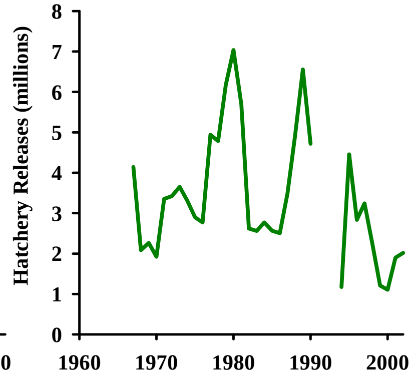
Fall chinook spawner escapement surveys for the Elochoman and Skamokawa Rivers, 1964-2001



Fall chinook Elochoman Salmon Hatchery rack counts, 1960-2000



Fall chinook Elochoman Salmon Hatchery release data, 1967-2002



Diversity

- Considered a tule population in the lower Columbia River Evolutionarily Significant Unit
- Elochoman fall chinook were historically native to the system while the Skamokawa chinook population is likely a result of stray hatchery produced spawners from recent decades
- Allozyme analyses indicate Elochoman fall chinook allele frequencies are similar but distinct from other lower Columbia River fall chinook stocks

Abundance

- In 1951, WDF estimated fall chinook escapement to the Elochoman River was 2,000 fish
- Elochoman River spawning escapements from 1964-2001 ranged from 53 to 2,392 (average 624)
- Skamokawa Creek spawning escapements from 1964-2001 ranged from 25 to 5,596 (average 1,065); natural spawners were primarily hatchery origin strays from other Columbia Basin systems

Productivity & Persistence

- NMFS Status Assessment for the Elochoman River indicated a 0.13 risk of 90% decline in 25 years and a 0.14 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.03
- Juvenile production from natural spawning is presumed to be low
- Skamokawa production is presumed to be very low as most adult spawners can be accounted for as first generation hatchery fish

Hatchery

- Elochoman Hatchery located about RM 9; hatchery completed 1953
- Hatchery releases of fall chinook in the basin began in 1950; release data is displayed for the years 1967-2002
- The current program releases 2 million fall chinook juveniles annually into the Elochoman River; there are no hatchery fish released into Skamokawa Creek
- The majority of recent year natural spawners in the Elochoman River can be accounted for as hatchery produced adults that were passed above a weir in the lower river and spawned naturally (82% hatchery produced spawners estimated in 1997)
- Abernathy Hatchery is not utilized by USFWS as a fishery research facility

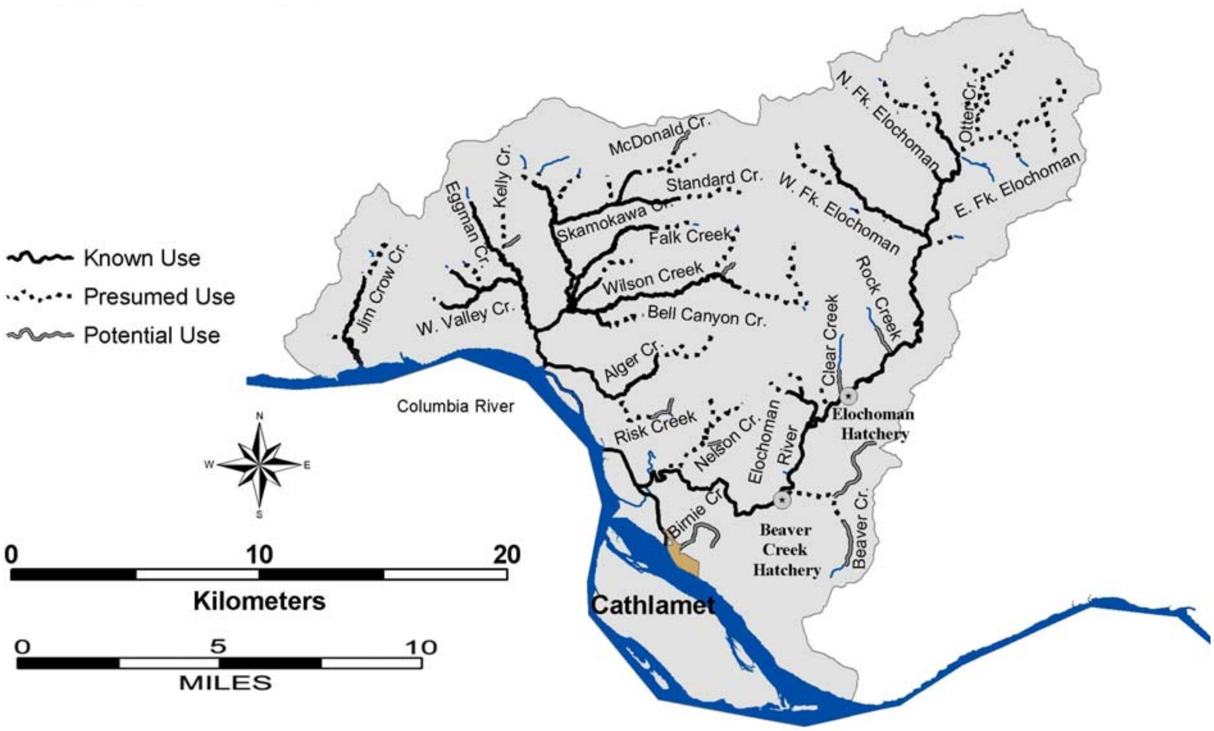
Harvest

- 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
- Lower Columbia tule fall chinook are an important contributor to Washington ocean troll and sport fisheries and to the Columbia River estuary sport fishery
- Columbia River commercial harvest occurs primarily in September, but tule chinook flesh quality is low once the fish move from salt water; the price is low compared to higher quality bright stock chinook
- CWT data analysis of the 1991-94 brood years from the Elochoman Hatchery indicates a total harvest rate of 35% of the Elochoman fall chinook stock
- The majority of the Elochoman fall chinook harvest occurred in Southern British Columbia (34%), Alaska (36%), Washington ocean (11%), and Columbia River (9%) fisheries
- Sport harvest in the Elochoman River averaged 95 fall chinook annually from 1981-1988
- Annual harvest is variable dependent on management response in PSC (U.S./Canada), PFMC (U.S. ocean), and Columbia River Compact Forums
- Ocean and mainstem Columbia harvest of Elochoman fall chinook is limited by an ESA harvest limit of 49% for Coweeman tule fall chinook

3.2.2 *Coho—Elochoman Subbasin (Elochoman/Skamokawa)*

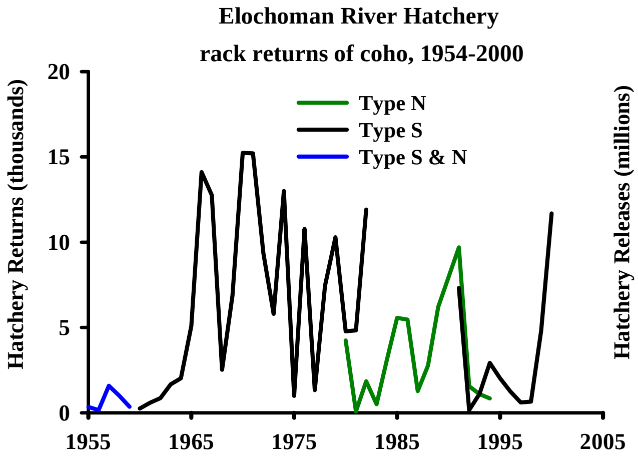
ESA: Candidate 1995	SASSI: Unknown 2002

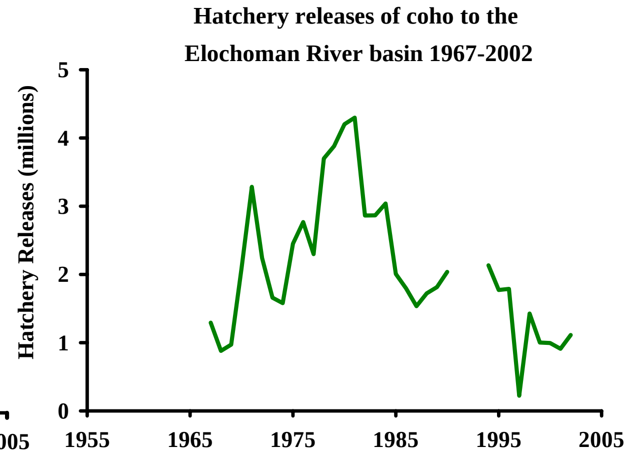
The historical Elochoman/Skamokawa adult population is estimated from 15,000-40,000 fish, with the returns being late stock which spawn from late November to March. Current returns are unknown but assumed to be low. A number of hatchery produced fish spawn naturally. Natural spawning occurs in most areas of the Elochoman Watershed accessible to coho, principally in the upper watershed, in particular the West Fork Elochoman. Duck Creek is an important spawning area in the lower river. In Skamokawa Creek, important spawning areas include the mainstem, and Wilson, Left Fork, Quartz, Standard, and McDonald creeks. Juvenile rearing occurs upstream and downstream of spawning areas. Juveniles rear for a full year in these watersheds before migrating as yearlings in the spring.



Distribution

- Managers refer to early stock coho as Type S due to their ocean distribution generally south of the Columbia River
- Managers refer to late stock coho as Type N due to their ocean distribution generally north of the Columbia River
- Natural spawning is thought to occur in most areas accessible to coho. Duck Creek in the lower watershed is an important coho spawning area, but the majority of the spawning area is in the upper watershed above the Salmon hatchery, in particular the West Fork of the Elochoman
- Coho in the Skamokawa watershed spawn in the mainstem Skamokawa and Wilson, Left Fork, Quartz, Standard, and McDonald Creeks





Life History

- Adults enter the Elochoman River from mid-August 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 late November to 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 spring, spend one year in fresh water, and emigrate as age-1 smolts in the following spring

Diversity

- Late stock coho (or Type N) were historically present in the Elochoman Watershed with spawning occurring from late November into March
- Early stock coho (or Type S) are also present and are currently produced in the Elochoman Hatchery program
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar

Abundance

- Elochoman River wild coho run is a fraction of its historical size
- USFWS surveys in 1936 and 1937 indicated coho presence in all accessible areas of the Elochoman River and its tributaries; 371 coho documented in Elochoman River; coho designated as 'observed' in Skamokawa
- In 1951 WDFW estimated an annual escapement of 2500 late coho to the Elochoman River and 2,000 late coho to Skamakowa Creek
- Hatchery production accounts for most coho returning to Elochoman River

Productivity & Persistence

- Natural coho production is presumed to be very low
- Smolt density model estimated Elochoman Basin production potential of 43,393 smolts

Hatchery

- The Elochoman Hatchery was built in 1953
- The Elochoman Hatchery is currently programmed for an annual release of 550,00 late coho and 360,000 early coho smolts

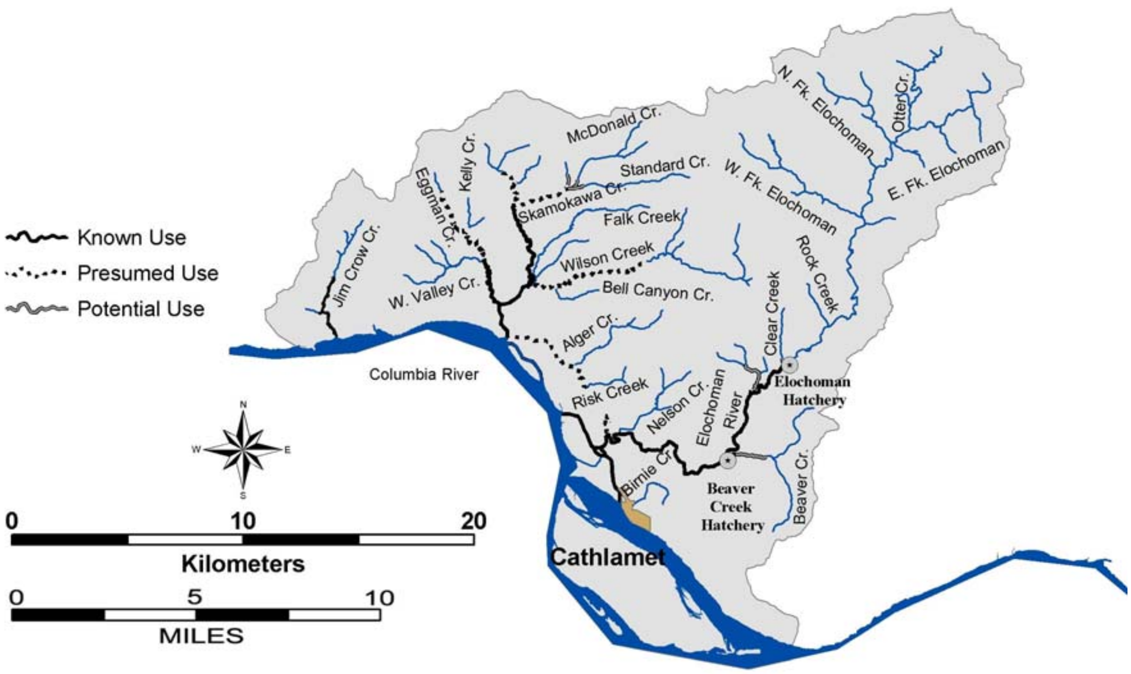
Harvest

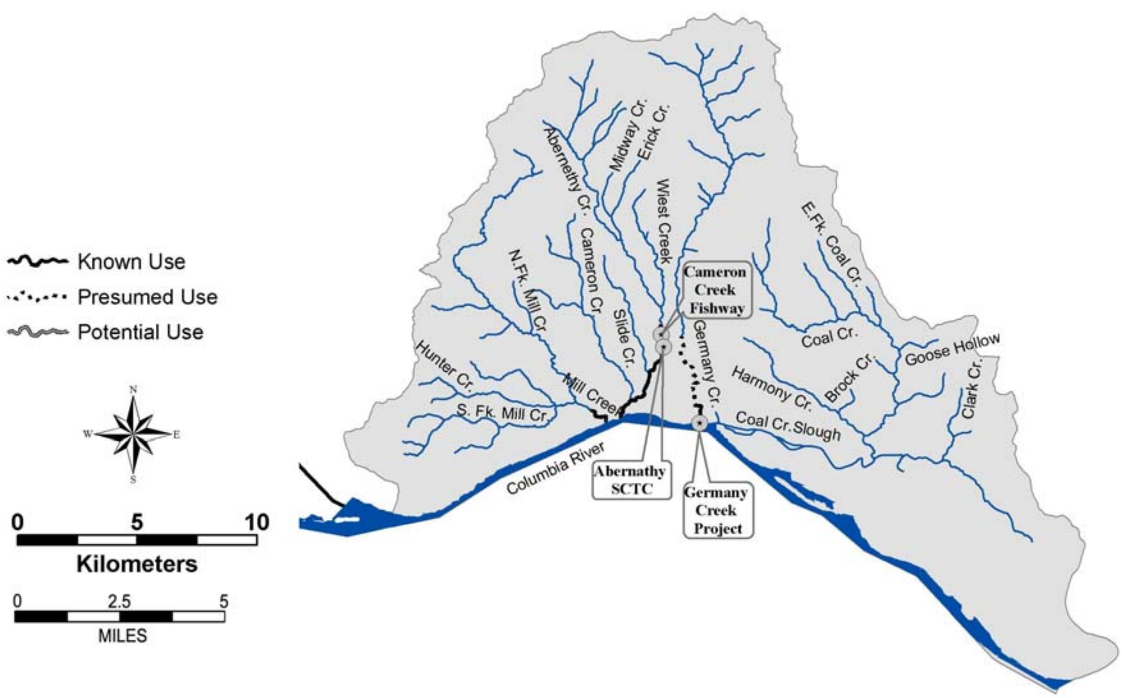
- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial coho fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas 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
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon state listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery Coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho 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
- 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 1,183 coho (1981-1988) were harvested annually in the Elochoman River sport fishery
- CWT data analysis of 1995-97 early coho released from Elochoman Hatchery indicates 49% were captured in a fishery and 51% were accounted for in escapement
- CWT data analysis of 1995-97 brood late coho released from Elochoman Hatchery indicates 61% were captured in a fishery and 39% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 brood Elochoman early coho were distributed between Columbia River (53%), Washington ocean (40%), and Oregon ocean (7%) sampling areas
- Fishery CWT recoveries of 1995-97 brood Elochoman late coho were distributed between Columbia River (59%), Washington ocean (29%), and Oregon ocean (11%) sampling areas

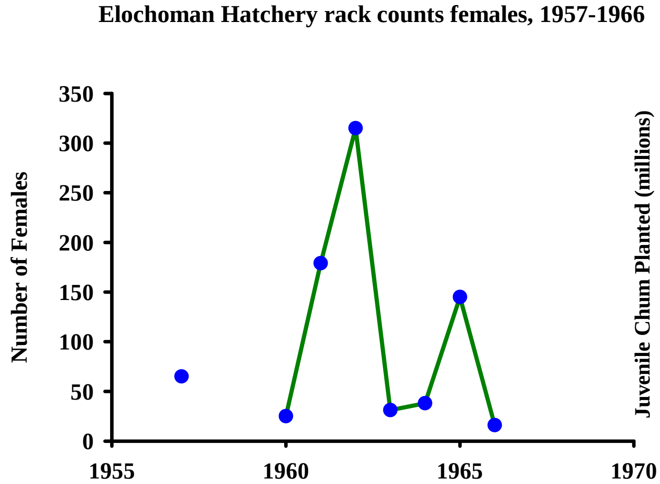
3.2.3 *Chum—Elochoman Subbasin (Elochoman/Skamokawa)*

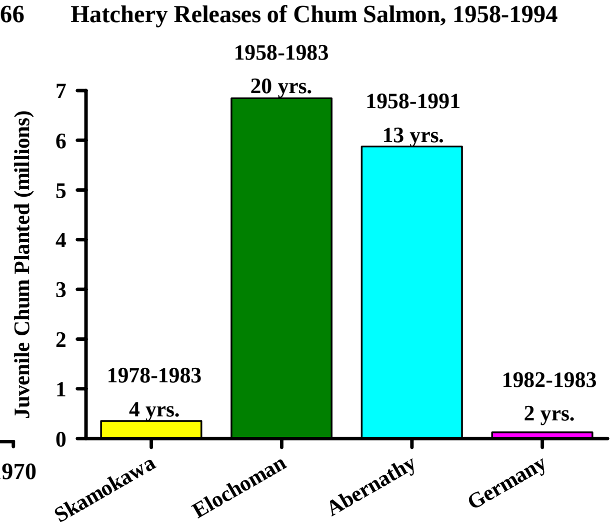
ESA: Threatened 1999	**SASSI: NA**

The historical Elochoman/Skamokawa adult population is estimated from 15,000-50,000 fish. Current returns are about 200 fish or less. Recent year counts have been higher in Skamokawa Creek than in the Elochoman River. Natural spawning primarily occurs in the lower mainstem Elochoman between tidewater and the Elochoman Hatchery and in Skamakowa Creek between tidewater and Standard and McDonald creeks. Jim Crow Creek, which flows directly into the Columbia downstream of Skamokawa Creek, is also an important chum spawning area. Peak spawning occurs in December. Juveniles emerge in the early spring and migrate to the Columbia after a short rearing period.









Distribution

- Spawning occurs in the lower mainstem Elochoman River above tidal influence
- Spawning occurs in the lower 0.4 miles of Abernathy Creek and in the lower parts (above tidewater) of Skamakowa Creek, Mill Creek and Germany Creek

Life History

- Adults enter the Elochoman River, Skamokawa, Mill, Abernathy, and Germany Creeks from mid-October through November; peak spawner abundance occurs in late November
- Dominant age classes of adults are 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts with little freshwater rearing time

Diversity

- Periodic supplementation programs have used Hood Canal and Willipa Bay stocks

Abundance

- In 1936, escapement surveys documented 158 chum in Elochoman River, 92 in Abernathy Creek, and chum were "observed" in Germany Creek and "reported" in Skamokawa River and Mill Creek
- WDF 1951 report estimated escapement of approximately 1,000 chum to the Elochoman River and 3,000 chum to the Skamokawa River; 1973 survey reported "small" run
- In 2002, WDFW estimated an escapement of 14 chum to the Elochoman and 160 to Skamokawa Creek

Productivity & Persistence

- Natural chum production is expected to be low, although it is expected that some chum production continues in these streams
- A 1995 WDF seining operation in Abernathy Creek observed 7 chum juveniles

Hatchery

- Chum fry releases of various stocks occurred from 1958-1983 in the Elochoman River, 1958-1991 in Abernathy Creek, 1978-1983 in Skamokawa Creek, and 1982-1983 in Germany Creek
- Elochoman releases average 340,000 over 20 years, Skamokawa releases averaged 88,000 over four years, Germany Creek releases averaged 62,500 over 2 years, and Abernathy releases averaged 450,000 over 13 years
- Hatchery escapement accounts for most adults returning to the Elochoman

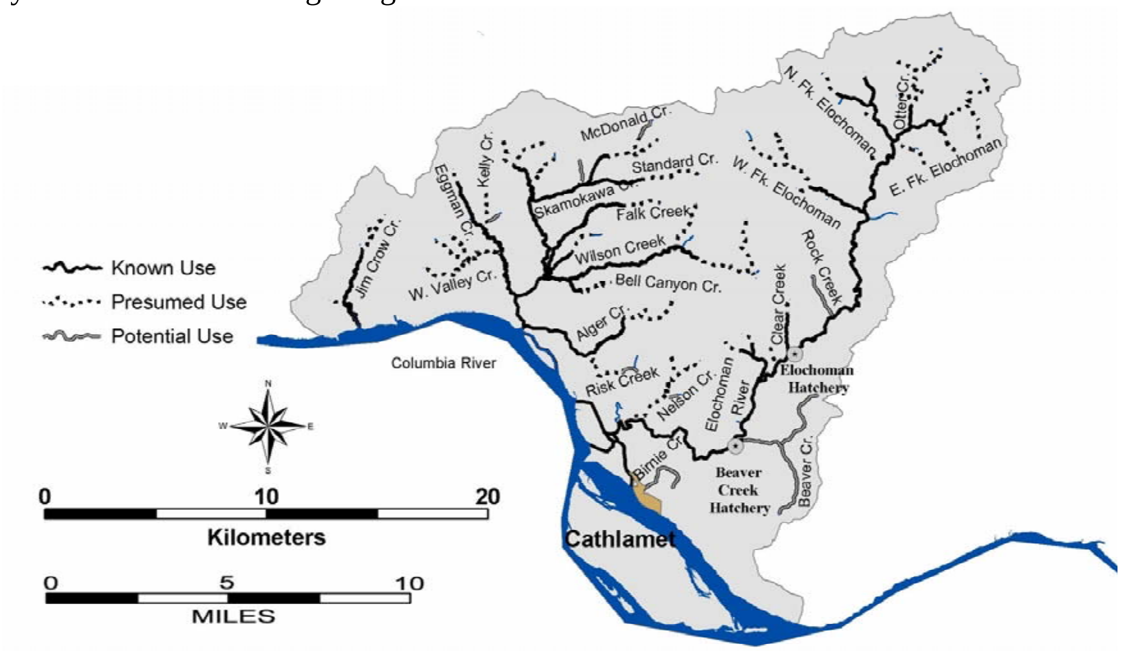
Harvest

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

3.2.4 *Winter Steelhead—Elochoman Subbasin (Elochoman/Skamokawa)*

ESA: Not Warranted	SASSI: Depressed 2002

The historical Elochoman/Skamokawa adult population is estimated to be about 1,400 fish. Current natural spawning returns range from 100-400 in the Elochoman River and 100-300 in Skamokawa Creek. Interaction with Chambers Creek/Beaver Creek stock hatchery steelhead is likely lower due to different spawn timing. Spawning in the Elochoman occurs in the mainstem, West, North, and East Forks, as well as Otter, Rock, Clear, Beaver, and Duck creeks. Spawning in Skamokawa Creek occurs throughout the mainstem, Wilson, Left Fork, Quartz, McDonald, and Standard creeks, as well as several smaller tributaries. Spawning time is March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating to the Columbia River.

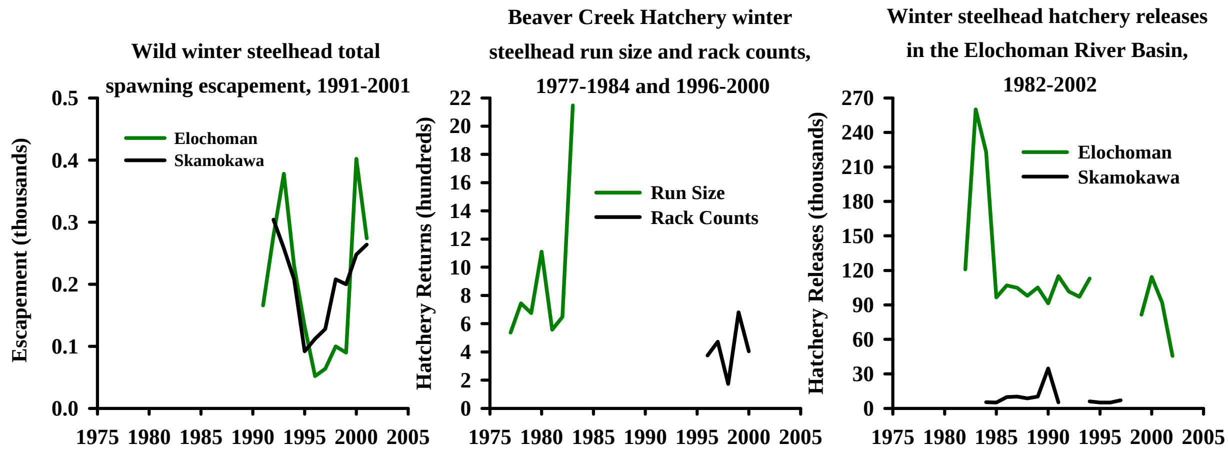


Distribution

- Winter steelhead are distributed throughout the mainstem Elochoman and in the lower reaches of Beaver, Duck, Clear, Rock, and Otter Creeks and the East, North, and West Fork Elochoman
- In the Skamokawa, steelhead are distributed throughout the mainstem Skamokawa, Wilson Left Fork, Quartz, and McDonald Creeks, and smaller tributaries such as Bell Canyon, Pollard, and Standard Creeks

Life History

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



Diversity

- Elochoman and Skamokawa winter steelhead stocks both designated based on distinct spawning distribution
- Concern with wild stock interbreeding with hatchery brood stock from the Elochoman River, Chambers Creek, and the Cowlitz River
- Allele frequency analysis of Elochoman and Skamokawa winter steelhead in 1995 was unable to determine the distinctiveness of this stock compared to other lower Columbia steelhead stocks

Abundance

- In 1936, 7 steelhead were documented in the Elochoman River and steelhead were observed on the Skamokawa during escapement surveys
- Wild winter steelhead average run size in the 1960s was estimated to be about 8,000 fish
- Total escapement counts from 1991-2001 for the Elochoman ranged from 52 to 402 (average 197); redd counts from 1988-1999 ranged from 2.4 to 9.7 redds/mile; escapement goal for the Elochoman is 626 fish
- Total escapement counts from 1992-2001 for the Skamokawa ranged from 92 to 304 (average 202); redd counts from 1992-1999 ranged from 2.6 to 13.5 redds/mile; escapement goal for the Skamokawa is 227 fish

Productivity & Persistence

- Natural production in the basin is thought to be low

Hatchery

- The Elochoman Hatchery, located on the mainstem, produces 90,000 winter steelhead smolts, of which 30,000 are from wild Elochoman River broodstock
- The Beaver Creek Hatchery, located several hundred yards upstream on Beaver Creek (RM 4), produced winter steelhead until closed in 1999; average annual production was 400,000 to 500,000 smolts
- Hatchery winter steelhead have been planted in the Elochoman River Basin since 1955; broodstock from the Elochoman and Cowlitz Rivers and Chambers Creek have been used; release data are displayed from 1983-2001
- Although hatchery winter steelhead constitute the majority of the run, hatchery fish contribute little to natural winter steelhead production in the Elochoman and Skamokawa River watersheds

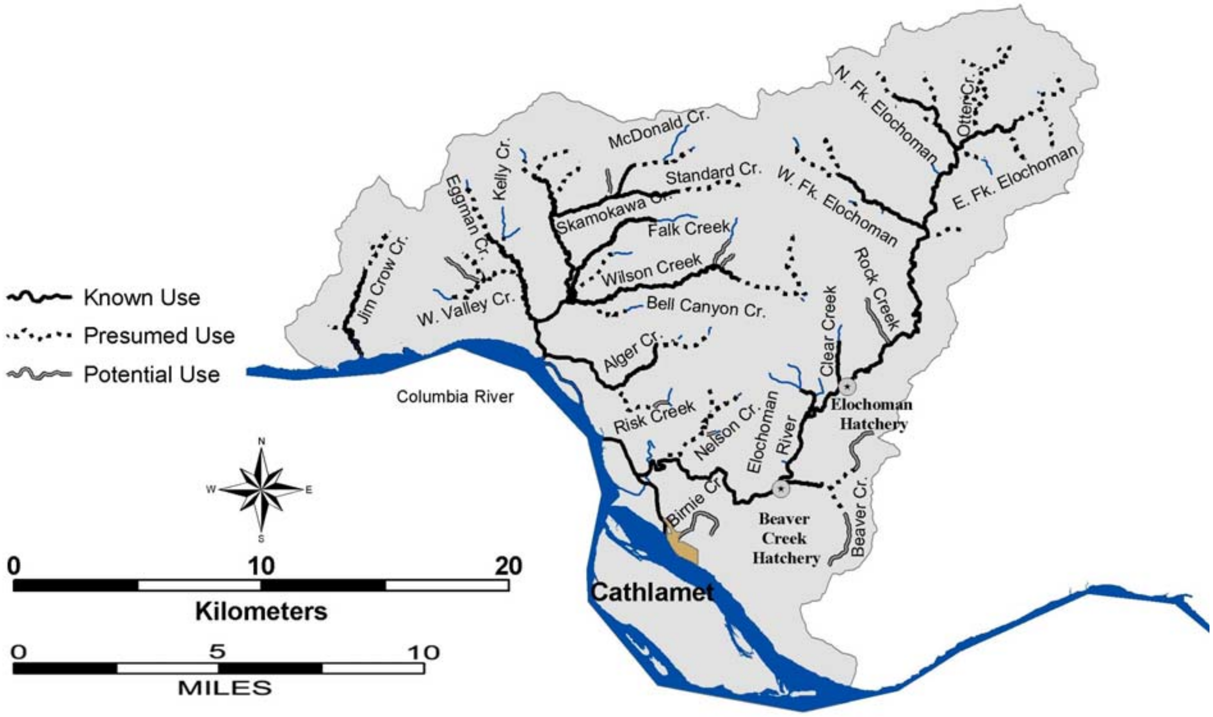
Harvest

- No directed commercial or tribal fisheries target Elochoman or Skamokawa winter steelhead; incidental mortality currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Treaty Indian harvest does not occur in the Elochoman River Subbasin
- Winter steelhead sport harvest (hatchery and wild) in the Elochoman River from 1977-1984 ranged from 2,004 to 4,655; 75% were assumed to be hatchery fish; since 1986, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild winter steelhead in the mainstem Columbia River and in the Elochoman Subbasin

3.2.5 *Cutthroat Trout—Elochoman Subbasin (Elochoman/Skamokawa)*

ESA: Not Listed **SASSI: Depressed**

– Coastal cutthroat abundance in Elochoman/Skamokawa has not been quantified but the population is considered depressed. Cutthroat trout are present throughout the watershed. Both anadromous and resident forms of cutthroat trout are present in the watershed. Anadromous cutthroat enter the Elochoman River and Skamokawa Creek from August to mid April and spawn from January through April. Most juveniles rear 2-3 years before migrating from their natal stream.



Distribution

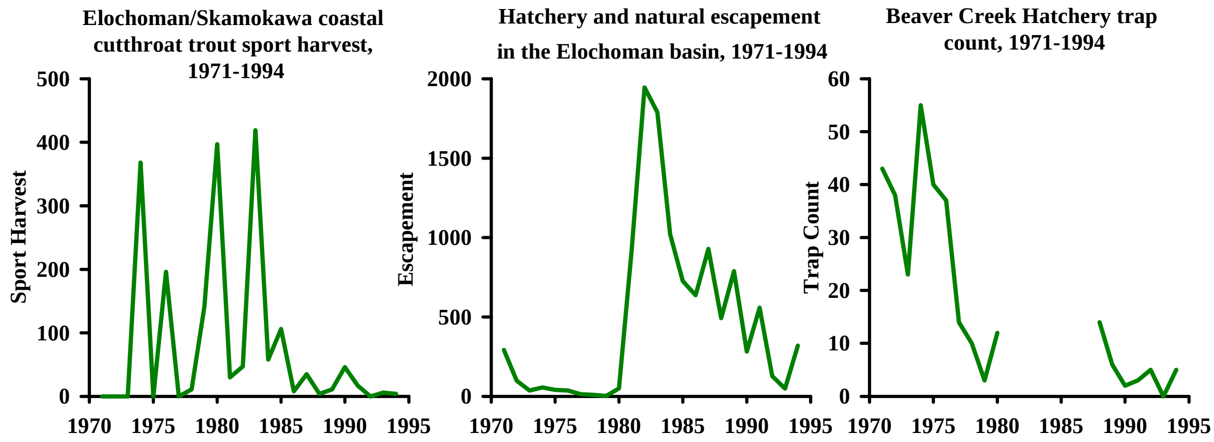
- Anadromous forms have access to most of the Elochoman except at Beaver Creek, where a weir blocks passage; at Duck Creek, where a falls blocks entry; and upper tributary reaches where gradients may limit access during high flows
- Anadromous cutthroat have access to all Skamokowa tributaries
- Resident forms are documented throughout the systems

Life History

- Anadromous, resident and fluvial forms are present
- Anadromous river entry is from July through April
- Anadromous spawning occurs from December through June

Diversity

- The two drainages are defined as one stock due to their proximity, similar characteristics, and lack of biological data to distinguish them
- Genetic analysis has been conducted on samples taken at Beaver Creek Hatchery
- No significant genetic difference from Cowlitz stock
- Significant differences from Kalama and Lewis River collections



Abundance

- Beaver Creek Hatchery trap counts of unmarked fish originally included some unmarked hatchery origin fish
- By 1990 all hatchery releases were adipose-clipped
- From 1990-94 the annual number of unmarked returns has been no more than 5 fish, and has averaged 3 fish
- Long term decline in Columbia River sport catch from mouth to RM 48
- Declining trend in total hatchery returns from 1982-1994
- Spike in sea-run cutthroat numbers in the early 1980s likely related to strays from the Cowlitz Basin due to eruption of Mt. St. Helens
- No abundance information is available for resident life history forms

Hatchery

- Beaver Creek Hatchery (RM 6) released steelhead and anadromous cutthroat until its closure in 1999
- From 1989-1993 an average of 34,620 sea-run cutthroat smolts were released annually
- Elochoman Hatchery (RM 9) produces coho, winter steelhead, and fall Chinook

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 Elochoman River
- Wild Elochoman and Skamokawa Creek cutthroat (unmarked fish) must be released in mainstem Columbia, Elochoman and Skamokawa Creek sport fisheries

3.2.6 *Other Species*

Pacific lamprey – Information on lamprey abundance is limited and does not exist for the Elochoman/Skamania population. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have also declined in the Elochoman/Skamania. 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 Watershed Habitat Conditions

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

Peak flows are associated with fall and winter rains and low flows typically occur in late summer (Figure 4). Flow in the Elochoman averaged 375 cfs during the period of record (1941-1971), with a maximum of 8,530 cfs and a minimum of 9.8 cfs. The Elochoman is used as a domestic water supply for the Town of Cathlamet. The intake is located at approximately RM 4. There are currently no stream gages operating on any of the major streams in the watershed.

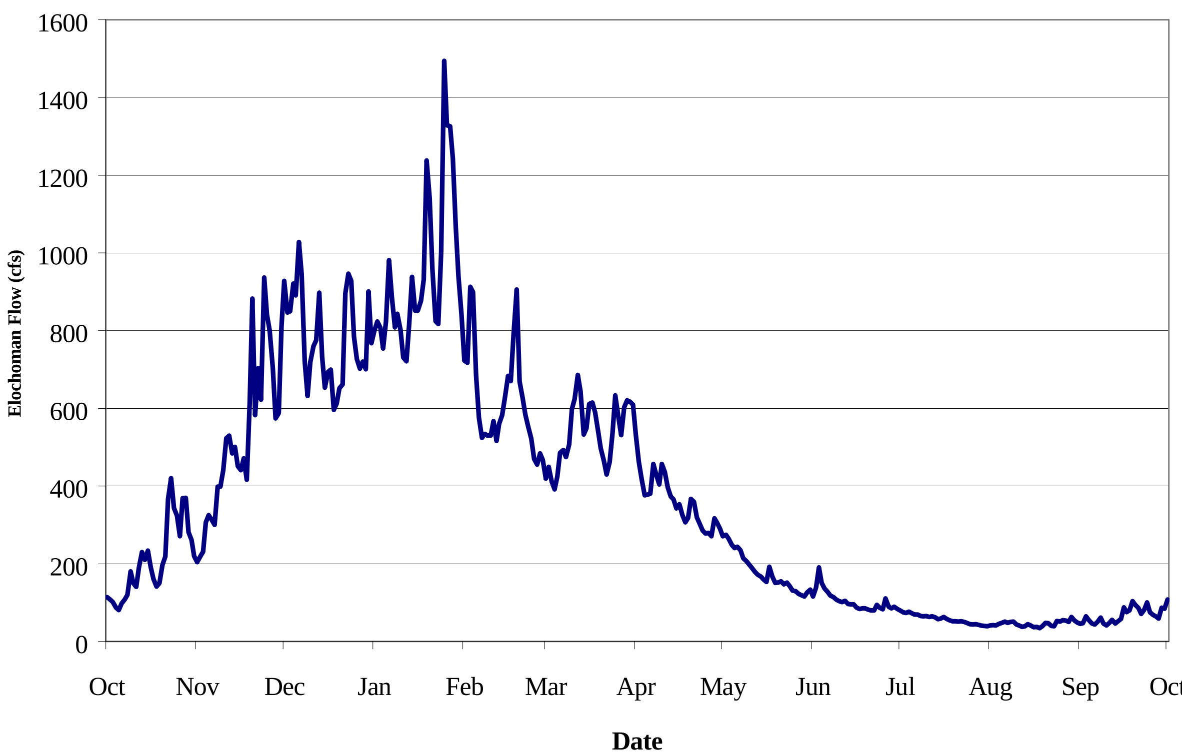


Figure 4. Elochoman River hydrograph (1962-1971). Elochoman River flows exhibit a fall through spring rainfall dominated regime, with flows less than 50 cfs common in late summer. USGS Stream Gage #14247500; Elochoman River near Cathlamet, Wash

There has been a significant decrease in vegetative cover in the Elochoman/Skamokawa Watershed, with potential impacts to runoff properties. Approximately 72% of the watershed is either in early-seral stage forests, is cultivated land, or is developed land. Late-seral stage forests are virtually non-existent. High road densities are also a concern, with road densities greater than 5 miles/mi^2 throughout most of the watershed. Forest and road conditions have potentially altered flow regimes. The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that 23 of 31 subwatersheds in the watershed are 'impaired' with regards to runoff conditions; the remainder are 'moderately impaired'. These results are similar to those from a peak flow risk assessment conducted by Lewis County GIS (2000), which revealed 'impaired' conditions in 6 of 7 watersheds. Only the North Elochoman Watershed Administrative Unit (WAU) had a rating of 'likely impaired'.

Low flow assessments were conducted on several streams in the watershed in 1997 and 1998 using the Toe-Width method (Caldwell et al. 1999). These assessments indicate that all of the watersheds may suffer from a lack of adequate flows for fish. On Wilson Creek (Skamokawa tributary) flows were adequate for salmon and steelhead rearing in the fall but were inadequate for salmon spawning. On the Elochoman at the Steel Bridge, flows were below suitable for spawning on October 1 but were adequate by November 1. Flows became less than suitable for summer rearing by July 1.

Future surface and groundwater demand in the watershed has been projected to increase by as little as 1% in the Coal Creek/Longview Slough watershed and as much as 12.8% in the Elochoman watershed over the next 20 years. The effect of withdrawals on stream flow is expected to be low on a subbasin scale (LCFRB 2001).

3.3.2 *Passage Obstructions*

No passage barriers have been identified on Jim Crow Creek. Culverts and tidegates block 10% of presumed anadromous habitat on Skamokawa Creek. A tidegate and a few culverts need assessment on Alger and Risk Creeks. A pump station on Risk Creek blocks 1.4 miles of habitat. There are several culvert barriers on Birnie Creek. A fish screen associated with a high school fish-rearing pond has been a problem at the mouth of Birnie Creek in the past but efforts have been taken to correct the problem. There are many passage barriers associated with culverts in the Elochoman watershed. The hatchery intake near Beaver Creek may also be a problem (Wade 2002).

3.3.3 *Water Quality*

WCD temperature monitoring in the summer of 2000 recorded excursions beyond the state standard of 18ºC[1] in the Upper Skamokawa and Wilson Creek (Skamokawa tributary). Temperatures in lower Wilson Creek regularly exceeded the standard in August. An assessment of water quality by the Washington State Department of Ecology (WDOE) in response to a 1975 fish kill found elevated fecal coliform levels that were likely related to human and animal sources. Nevertheless, the fish kills were ultimately attributed to high fish numbers causing critically low dissolved oxygen levels. WCD monitoring of surface water and shallow

[1] 18°C (64°F) is the state standard for Class A streams; 16°C (61°F) is the state standard for Class AA streams.

groundwater in 1997 revealed elevated fecal coliform and nitrate levels. The source was believed to be septic systems and agricultural practices (Wade 2002).

The Elochoman was listed on the State's 303(d) list of impaired water bodies due to exceedance of temperature standards (WDOE 1998). Water temperature monitoring by WDFW on the Elochoman at the hatchery has recorded numerous excursions beyond temperature criteria. WCD monitoring in the summer of 2000 revealed that temperatures in the Lower Elochoman regularly exceed 18ºC in August and the first half of September. Monitoring in the Upper Elochoman and tributaries revealed cooler temperatures with no exceedance of state standards (Wade 2002).

3.3.4 *Key Habitat Availability*

Information on side channel habitats is lacking in the Jim Crow and Skamokawa watersheds. Qualitative information from stream survey notes indicates that these systems are comprised primarily of single-thread channels with few side channels. Diking, roads/railroads, and channel incision in agricultural areas limit side channel development in the Elochoman watershed, however, some portions of the Elochoman, in particular the West Fork, have abundant side channels. In a few areas, the presence of side channels appears to be related to the accumulation of sediments behind large log jams, but these side channels are believed to be transient (Wade 2002).

Pool habitat is considered poor in Jim Crow, the Skamokawa, and the Elochoman watersheds. Information is lacking for Alger, Risk, and Birnie Creeks. In Jim Crow Creek, 83% of surveyed reaches were given a "poor" pool habitat designation by the WCD. The few good pools were associated with beaver activity and the delivery of small diameter wood. In the Skamokawa and Elochoman watersheds pool habitat was less prevalent in the lower reaches where agriculture uses dominate and was more prevalent in the upper forested reaches. Pools were often associated with log jams (Wade 2002).

3.3.5 *Substrate & Sediment*

The majority (67%) of surveyed reaches (WCD surveys) on Jim Crow and Fink Creeks rated poor for substrate fines (>17% fines <0.85 mm). The Skamokawa watershed also has poor substrate fine conditions. This is attributed to steep slopes underlain with sedimentary rock that is prone to landslides (Ludwig 1992). The Wilson Creek and West Fork Skamokawa watersheds have the highest and second highest mass failure rates per square mile in Wahkiakum County, respectively (Waterstrat 1994). The lower reaches of the mainstem and tributaries tend to have the highest levels of fines. Levels of fines decrease as gradient increases. In the Elochoman watershed, substrate fine conditions are highly variable. Fines are generally high in the mainstem and in the lower reaches of tributaries. Gravel content increases as gradient increases. Especially high numbers of reaches in the Nelson Creek and North Fork Elochoman have elevated substrate fine conditions (WCD surveys, Wade 2002).

High road densities and naturally unstable soils create a risk of elevated sediment supply from hillslopes. Road density in the Jim Crow watershed is a high 5.14 mi/mi^2; however, Waterstrat (1994) reported that most of the roads are well-established and adequately designed, with few failures, thus limiting sediment delivery to streams. The Skamokawa watershed has a road density greater than 4 mi/mi^2 and is composed of steep slopes with sedimentary rock that is prone to landslides. The watershed has 2 watersheds with the highest mass failure rates in the county (Waterstrat 1994). These processes likely result in elevated volumes of sediment delivered to stream channels. In the Elochoman watershed, forest practices have contributed to many mass failures, however, road erosion is probably responsible for most of the sediment delivery to streams (WDNR 1996).

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results suggest that nearly all (15 of 17) of the subwatersheds in the Elochoman subbasin are “moderately impaired” with respect to landscape conditions that influence sediment supply. Three subwatersheds are rated as “impaired” and three are rated as “functional”. The greatest impairments are located close to Longview. High road densities and naturally unstable soils are the primary drivers of the sediment supply impairment.

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*

WCD surveys rated 97% of the Jim Crow watershed as poor for LWD (<0.2 pieces/meter). Some woody debris was found in middle valley reaches but it was of small diameter. Most delivery was believed to occur through windfall. The Skamokawa watershed was also mostly rated as poor for LWD. Where wood does exist it is typically small and deciduous. There are some log jams in places. Standard and McDonald Creeks have good LWD and recruitment potential, however, some areas have no wood whatsoever. The Elochoman had over 85% of reaches rated as poor. LWD is non-existent in many reaches and the number of large (“key”) pieces is declining. Most of the wood that does exist is in jams. The majority of reaches with decent LWD quantities are in the upper reaches. The West Fork Elochoman watershed has a few segments with good LWD conditions (WDNR 1996).

3.3.7 *Channel Stability*

The Jim Crow and Skomokawa watersheds generally have good bank stability conditions. WCD surveys in the mid 1990s revealed that over 90% of the reaches on the mainstem Skamokawa had less than 10% actively eroding streambanks. Surveys in 1991 in the middle reaches of the Skamokawa revealed that 28% of surveyed banks were eroding; 34% in areas of agricultural use (Ludwig 1992). Bank erosion is high in agricultural land due to incision, alluvial soils, and a lack of vegetation on the streambanks. Bank stability in the Elochoman watershed is generally good. There is some road related erosion on the mainstem and some erosion problems on the West Fork and on Nelson Creek and its tributaries. Mass wasting events are seen as the bigger problem in the Elochoman watershed. In the West Fork, mass wasting is often associated with roads. In the North Elochoman basin, 205 of 383 surveyed landslides were related to forest practices activities (WDNR 1996).

3.3.8 *Riparian Function*

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, 2 of the 17 subwatersheds in the Elochoman Subbasin are rated as ‘impaired’ for riparian function and 15 are rated as ‘moderately impaired. Thus, none of the subwatersheds in the Elochoman/Skamokawa watershed are rated as ‘functional’. The greatest impairments are located in and around the Longview, WA metropolitan area. Results from the IWA are consistent with impaired conditions that were identified throughout the subbasin in surveys conducted by the WCD.

Riparian conditions were evaluated by the WCD according to buffer widths and riparian composition. The Jim Crow, Skamokawa, and Elochoman watersheds have 94.5%, 74%, and 78% of surveyed riparian areas in "poor" condition, respectively. Nearly all of the watersheds are at least 95% commercial and state timberland and were heavily harvested in the mid 20th century (Waterstrat 1994). In most cases, poor riparian areas are found in the lower river segments due to the impacts of agriculture, livestock grazing, roads, and diking on buffer widths and species composition. Upper reaches tend to suffer from young timber stands, and to a lesser extent, high deciduous composition. Poor riparian conditions in the Elochoman watershed have also been attributed to mass wasting and debris flows (WDNR 1996). The WCD is working with landowners to improve riparian conditions.

3.3.9 *Floodplain Function*

The Skamokawa has been diverted from its natural meandering channel into a straightened channel from its mouth to RM 1.7. From RM 1.7 to 6.6 it is entrenched as it flows through agricultural land. The lower reaches of tributaries have been diked and are also entrenched in areas of agricultural use. Alger Creek has been diked along the first 1,700 feet. A project is underway by the Columbia Land Trust to improve floodplain connectivity in this reach. The Elochoman is diked for the first 1.4 miles and the lower part of the tributary Nelson creek is also diked and incised. Stream adjacent roads and railroads limit floodplain connectivity on the lower mainstem Elochoman and the lower portions of lower mainstem tributaries. There is high entrenchment within areas of agricultural use. Floodplain connectivity improves in the upper watershed. Entrenchment from splash damming is apparent on the middle reaches of the Elochoman (Wade 2002).

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

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

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 for fall Chinook, chum, coho, and winter steelhead in the Elochoman and Skamokawa watersheds. In the Elochoman, adult productivity for all four species has been reduced to 17-25% of historical levels (Table 2). Declines in adult abundance level have also been significant for all species (Figure 5), with the greatest decline seen for chum and coho. Current adult abundance of chum and coho is estimated at only 6% and 15% of historical levels, respectively. Abundance of both fall Chinook and winter steelhead in the Elochoman has declined by approximately 60% (Figure 5). Diversity (as measured by the diversity index) has remained steady for fall Chinook, but has declined by 20-50% for winter steelhead, coho and chum (Table 2).

Smolt productivity numbers in the Elochoman have declined by 46-76% for all four species (Table 2), though losses have not been as great as for adult productivity, suggesting that out of basin factors are contributing to losses in adult productivity. Declines in smolt abundance levels have been greatest for chum and coho (84% and 78% decrease respectively), but losses have also occurred for fall Chinook and winter steelhead smolts (40% and 49% decrease respectively) (Table 2).

Adult productivity declines in the Skamokawa watershed have also been severe, with current levels only one quarter of historical levels for chum, winter steelhead and coho (Table 3). Fall Chinook adult productivity has declined by 50% (Table 3). Current adult chum and coho abundance is estimated at only 13-21% of historical levels, respectively (Figure 6). While not as severe as chum and coho, the decline in abundance of adult winter steelhead and fall chinook is such that current levels are estimated at 60% and 27% of historical levels (Figure 6). Diversity (as measured by the diversity index) of all species has been fairly well maintained, though chum, winter steelhead, and coho have experienced some loss (Table 3).

Reductions in smolt productivity and abundance in the Skamokawa have been similar to those in the Elochoman, though to a slightly lesser degree. Smolt productivity has declined by 36-66%, and abundance has decreased by 26-70% (Table 3). Productivity losses were greatest for coho, and abundance losses have been greatest for chum.

Model results indicate that restoration of PFC conditions in both of the watersheds would produce substantial benefits. Adult returns for chum would benefit the most, with runs increasing to 2-3 times current levels (Table 2 and Table 3). Similarly, fall Chinook, winter steelhead, and coho returns would increase by 65-185%. Smolt abundance levels would benefit at similar rates, with chum smolts benefiting the most (Table 2 and Table 3).

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

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	T[1]
Fall Chinook	1,479	2,172	3,769	3.1	7.1	12.4	1.00	1.00	1.00	182,410	263,921	304,153	328	719	903
Chum	515	2,619	7,821	1.6	6.3	9.2	0.80	1.00	1.00	263,160	1,026,242	1,693,571	612	992	1,141
Coho	1,315	4,014	8,786	3.7	9.4	21.0	0.47	0.86	0.96	27,015	91,351	125,124	78	205	312
Winter Steelhead	335	574	850	3.8	10.7	20.1	0.80	0.89	0.96	6,265	10,328	12,391	68	186	283

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

Table 3. Skamokawa Creek— 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	581	762	795	4.2	6.9	8.7	1.00	1.00	1.00	95,719	130,225	129,940	509	826	1,024
Chum	1,125	3,269	8,499	2.3	6.0	9.3	0.94	1.00	1.00	564,503	1,277,833	1,898,123	739	994	1,148
Coho	1,081	1,773	5,099	5.2	10.2	22.4	0.79	0.84	0.91	19,736	38,648	54,514	116	235	347
Winter Steelhead	206	268	515	5.2	10.1	20.1	0.91	1.00	1.00	2,513	3,414	4,115	76	135	174

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

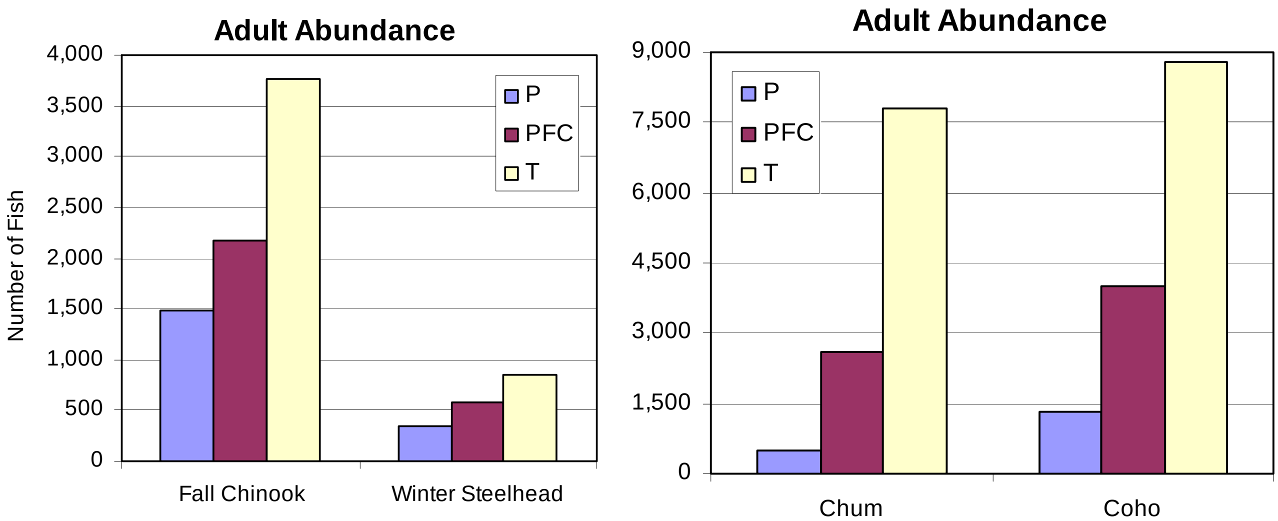


Figure 5. Adult abundance of Elochoman fall Chinook, winter steelhead, chum and coho based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

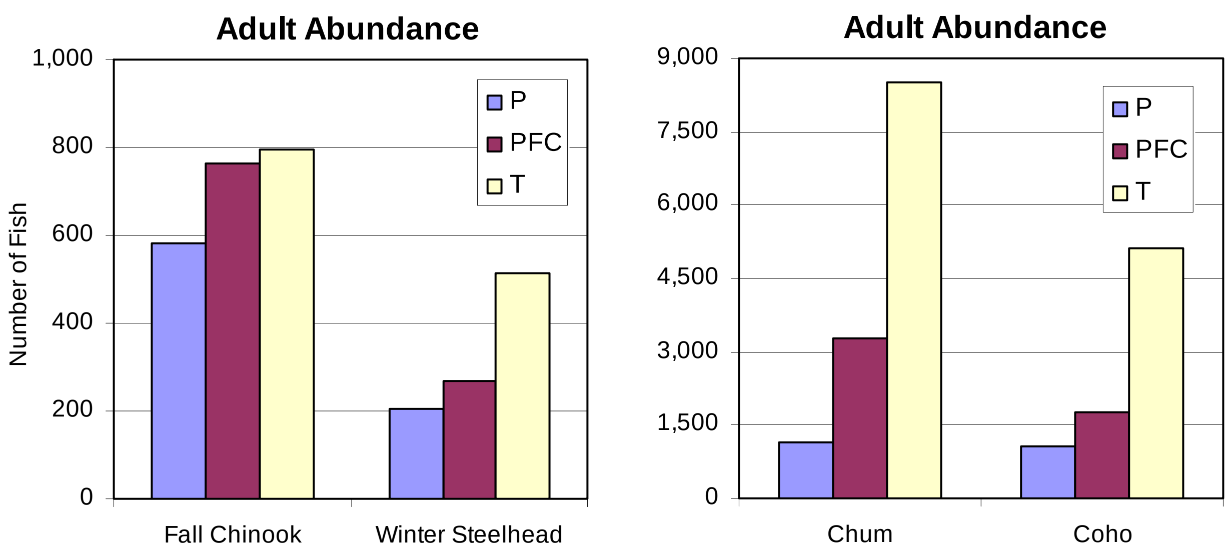


Figure 6. Adult abundance of Skamokawa fall Chinook, chum, winter steelhead and coho based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

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/watershed. EDT reaches for the Elochoman/Skamokawa Watershed are displayed in Figure 7.

High priority reaches for fall Chinook (Figure 8) and chum (Figure 10) are found primarily in select areas of the lower and mid Elochoman (Elochoman 4, 6, 7 and 10 for fall Chinook and Eloch 3 and 4 for chum). All high priority reaches for fall Chinook have a combined preservation and restoration emphasis. For chum, Eloch 3 has a combined preservation and restoration emphasis while Eloch 4 has a restoration only emphasis.

For coho in the Elochoman Watershed, high priority reaches include multiple areas in the lower and mid mainstem Elochoman (Elochoman 4-6, 10 and 13) (Figure 9). Some smaller tributaries also rank as high priority for coho (Rock 1, Clear 1 and 3, and Duck 1). All mainstem reaches show a restoration emphasis, while the smaller tributaries have either a preservation or a combined preservation and restoration emphasis.

Winter steelhead are distributed throughout the Elochoman Watershed including the mainstem and the tributaries of Beaver, Duck, Clear, Rock and Otter creeks and the East, North, and West Fork Elochoman. Fall Chinook are found in the lower mainstem between river miles 4 and 9. Chum distribution is primarily in the lower mainstem above tidal influence. Coho are suspected to use most of the watershed that is accessible, but primary spawning areas include the upper watershed and the West Fork Elochoman.

High priority areas for winter steelhead in the Elochoman include middle and upper mainstem reaches (Elochoman 8, 10, 11 and 13) and the lowest reaches of the West Fork Elochoman (WF Elochoman 1 and 2) (Figure 11). Some smaller tributaries also rank as high priority for steelhead (Rock 1, Beaver 2, and Clear 1 and 3). Each of the mainstem reaches (with the exception of Eloch 13), and both WF Elochoman 1 and 2 have a restoration emphasis. Eloch 13, however, has a combined preservation and restoration emphasis. The majority of the mainstem tributaries have a preservation emphasis. The reach with the highest preservation emphasis for steelhead is Rock 1.

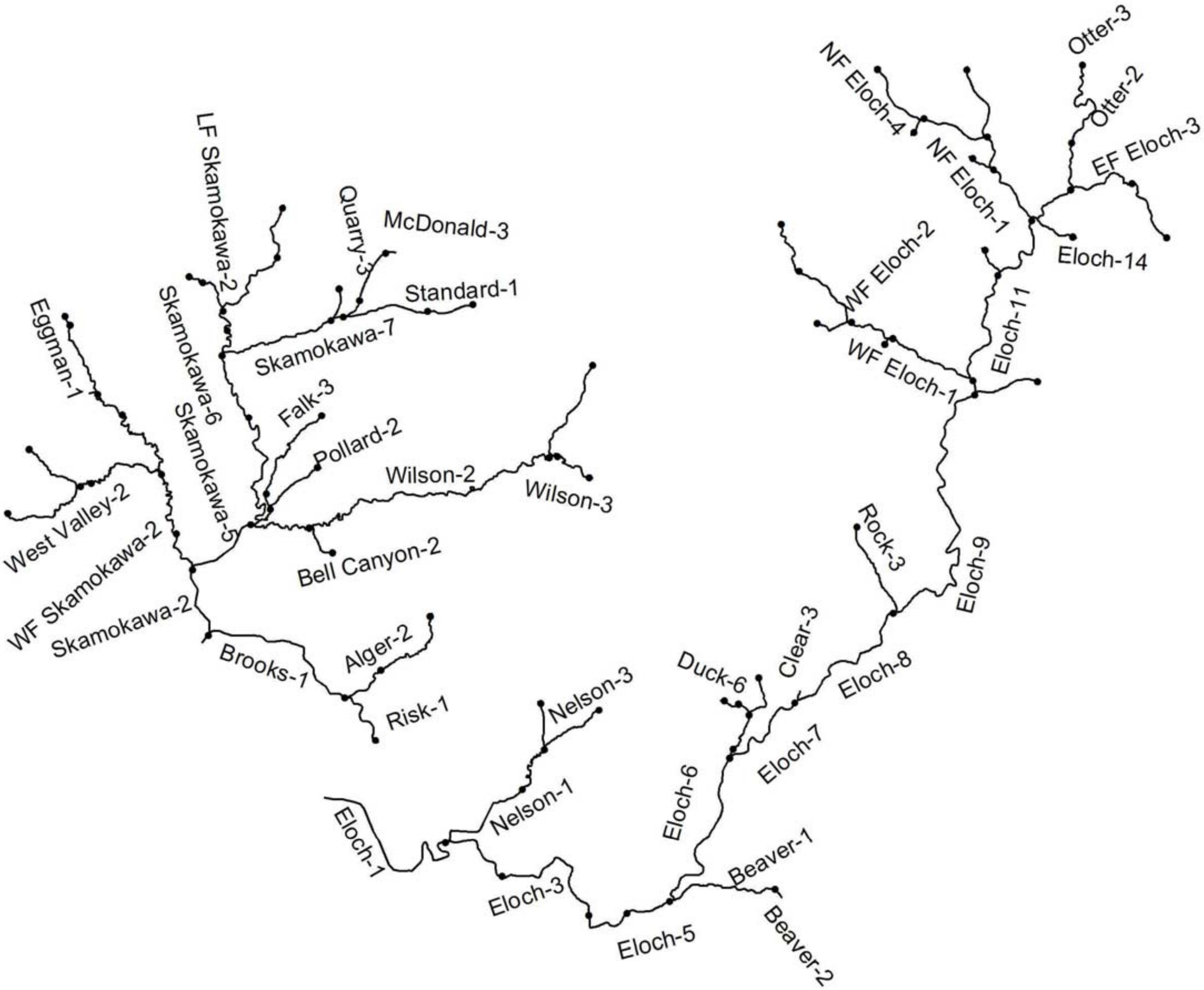


Figure 7. Elochoman / Skamokawa Watershed with EDT reaches identified. For readability, not all reaches are labeled.

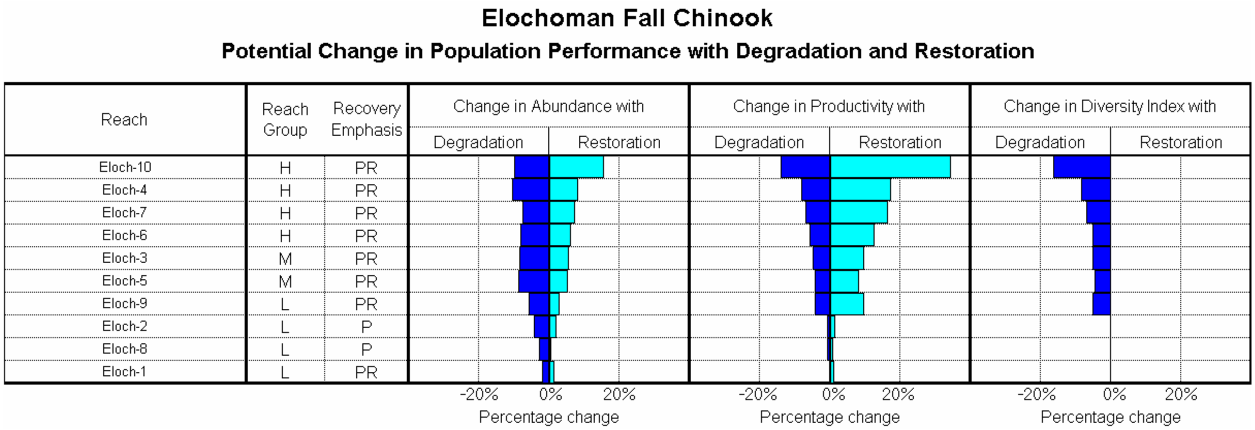


Figure 8. Elochoman fall chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Some low priority reaches are not included for display purposes.

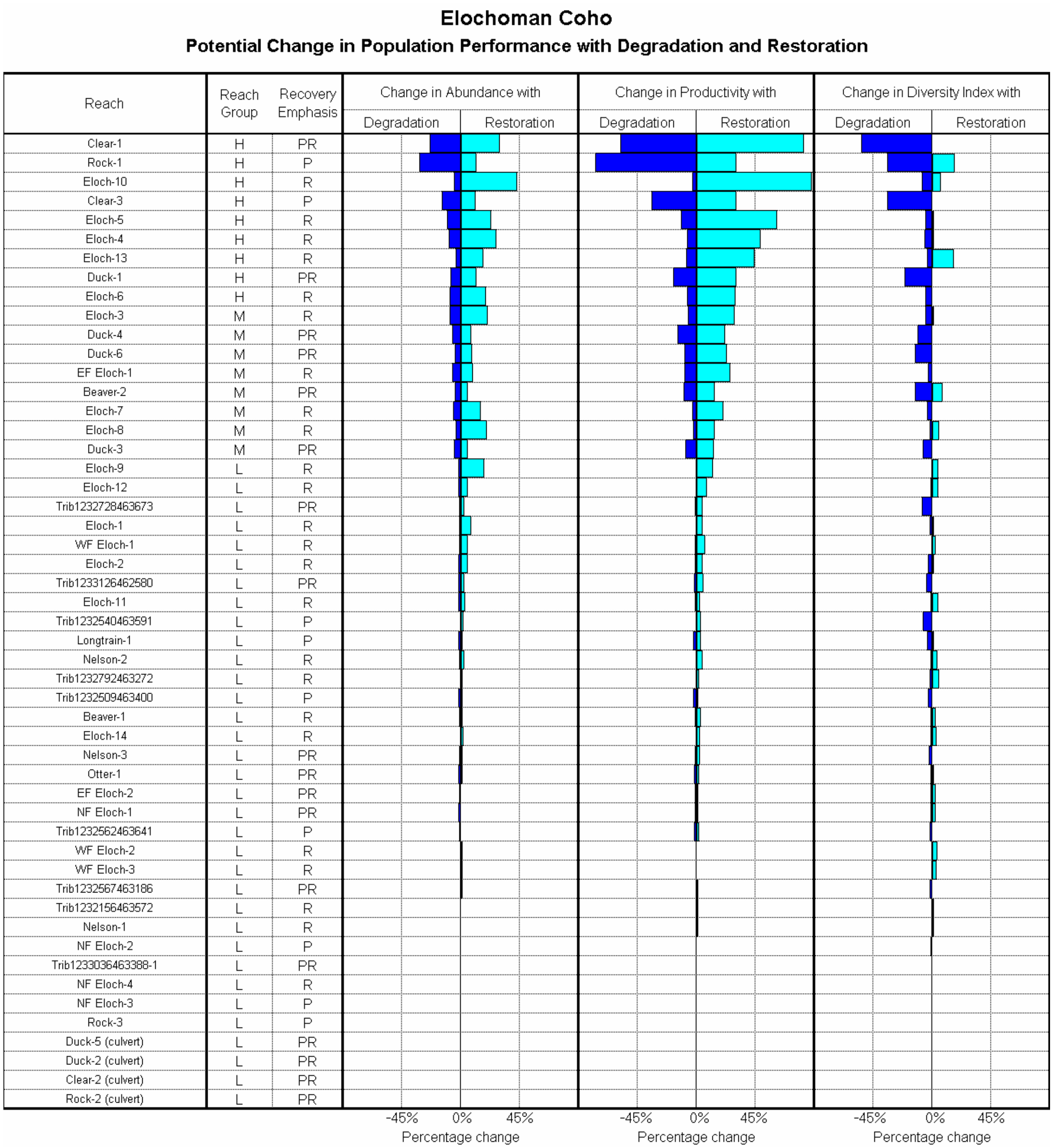


Figure 9. Elochoman coho ladder diagram.

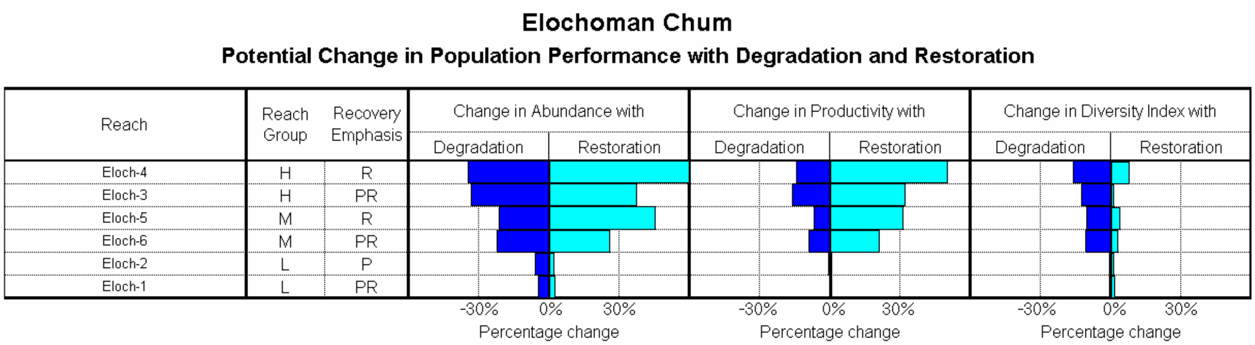


Figure 10. Elochoman chum ladder diagram.

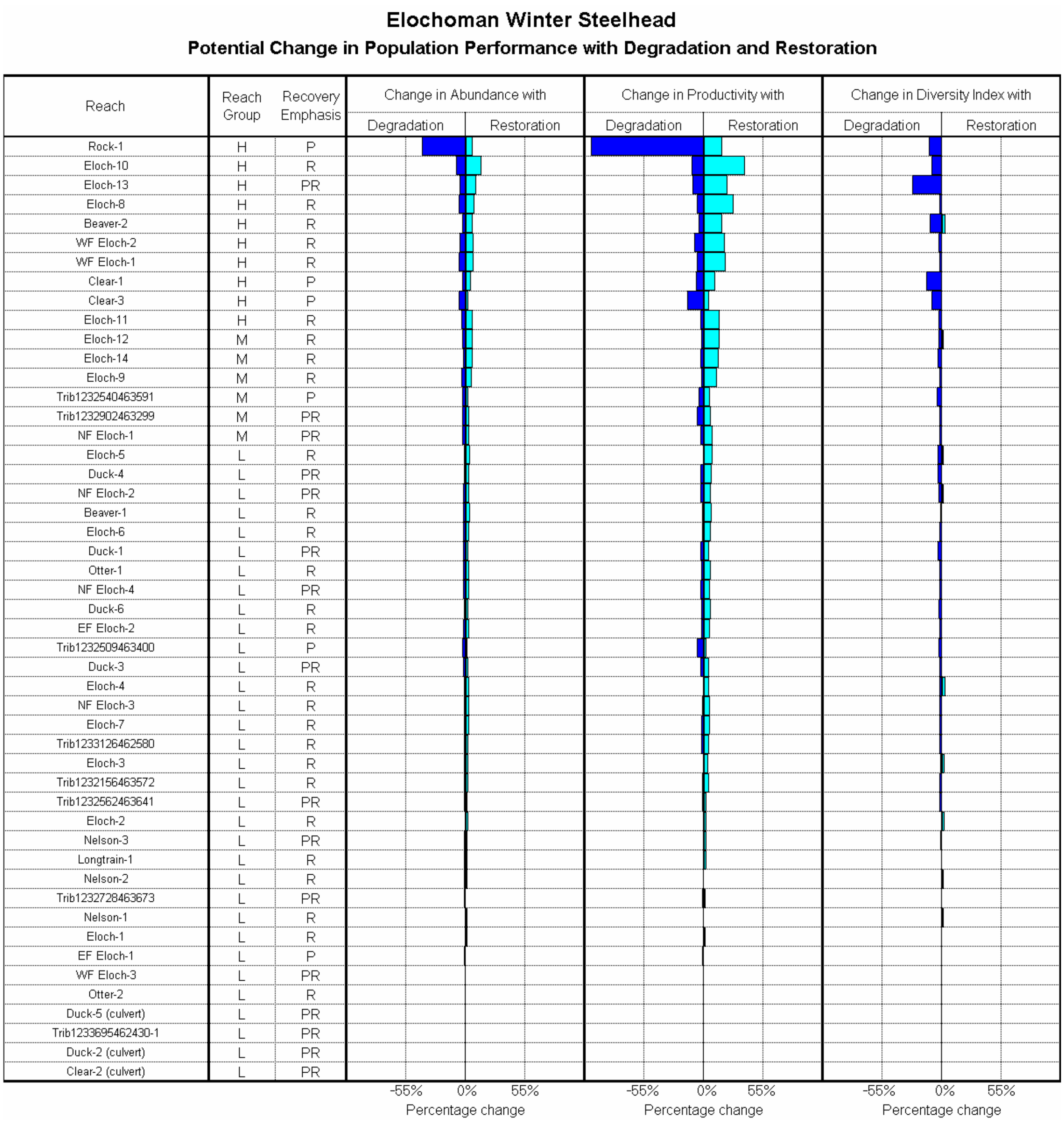


Figure 11. Elochoman River Watershed winter steelhead ladder diagram.

In the Skamokawa, winter steelhead are found in the mainstem and in numerous tributaries. Fall Chinook spawning is mainly between Wilson Creek and Standard and McDonald Creeks, a length of approximately 4.5 miles. Chum spawning in the Skamokawa is exclusively in the lowest reaches. Coho spawning in the Skamokawa is in the mainstem and in Wilson, Left Fork, Quartz, Standard, and McDonald Creeks. (See Figure 7 for a map of stream reaches with high value restoration and preservation reaches labeled).

For both fall Chinook (Figure 12) and chum (Figure 14), the high priority reaches are generally located in the area between Falk Creek and Standard Creek (Skamokawa 5 and 8 for ChF, and Skamokawa 5 and 6 for chum). All high priority reaches for both species show a preservation emphasis, with Skamokawa 5 possibly having the greatest potential from preservation.

Coho in the Skamokawa have high priority reaches located primarily in the mid to upper areas of the watershed (Skamokawa 5 and 6, LF Skamokawa 2, McDonald 3, Wilson 3, and West Valley 2) (Figure 14). Each of these reaches, except McDonald 3, show a combined preservation and restoration recovery emphasis. Reach Skamokawa 6 is estimated to have the greatest potential for preservation and restoration.

High priority reaches for winter steelhead in the Skamokawa watershed include the middle areas of the mainstem (Skamokawa 7 and 8), McDonald 1, and two middle reaches of Wilson Creek (Wilson 3 and 4) (Figure 15). All high priority reaches, except for Wilson 3, show a combined preservation and restoration emphasis. The reach with the highest restoration and preservation emphasis is Skamokawa 8.

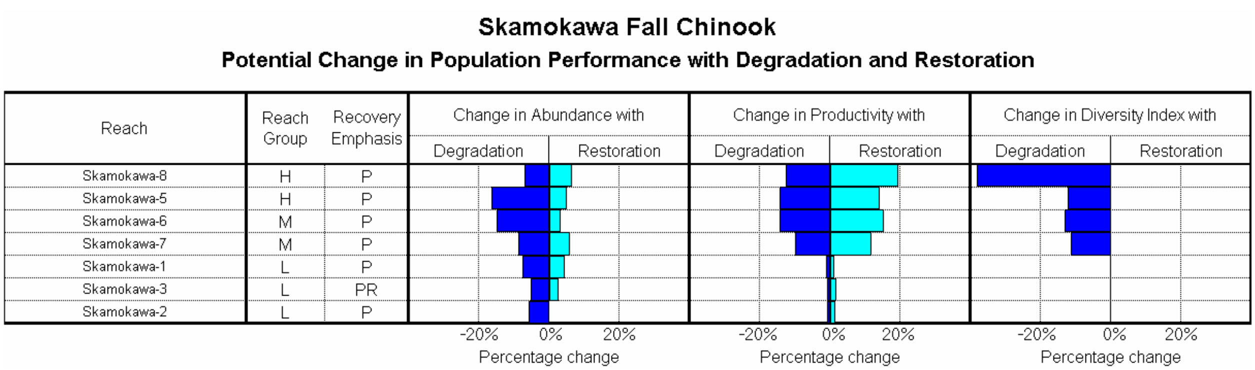


Figure 12. Skamokawa fall Chinook ladder diagram.

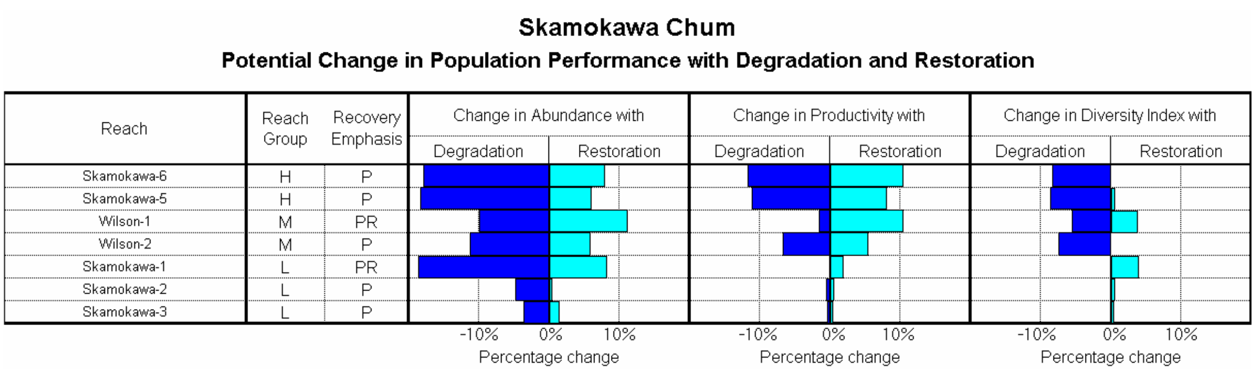


Figure 13. Skamokawa chum ladder diagram

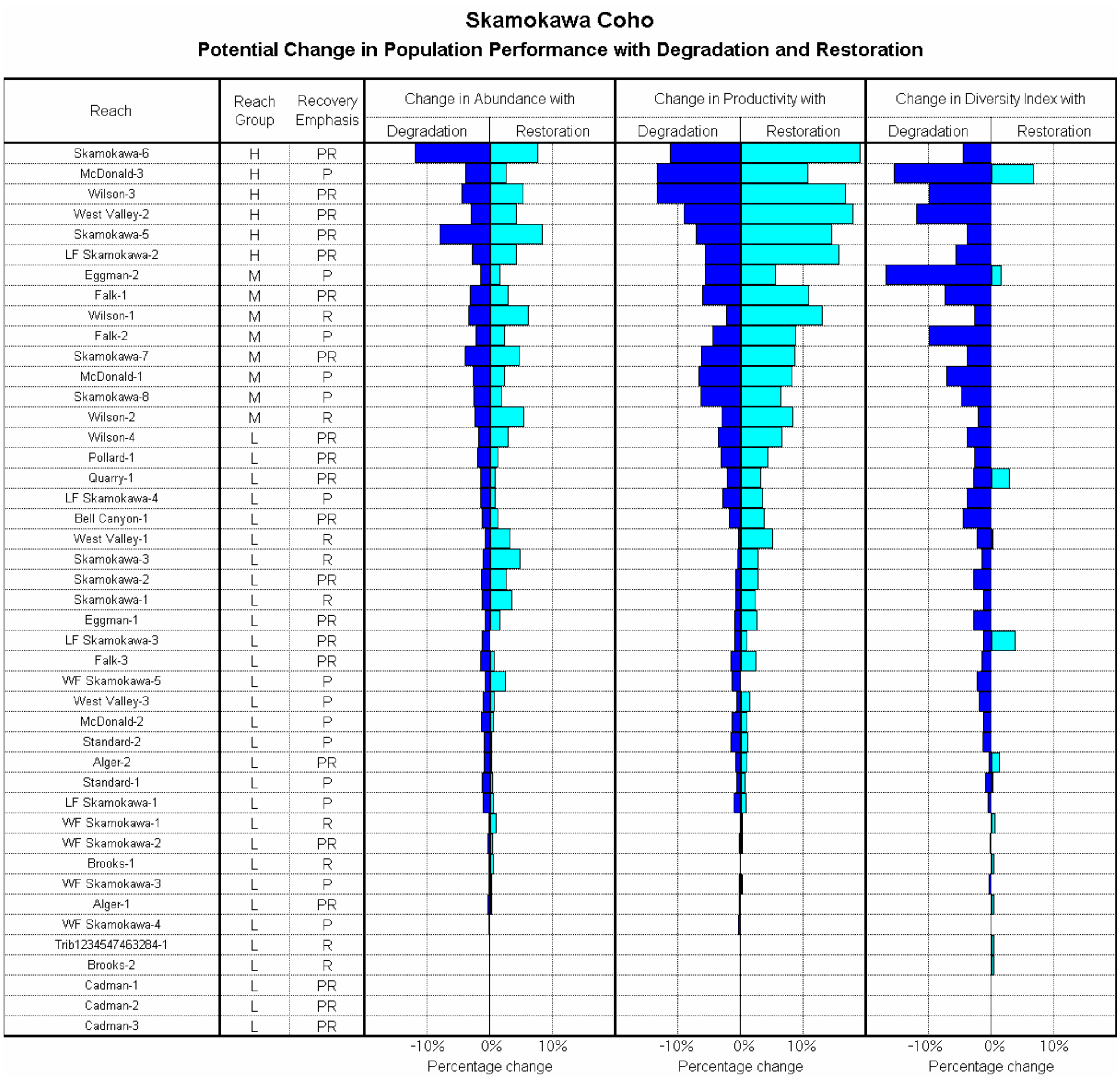


Figure 14. Skamokawa coho ladder diagram.

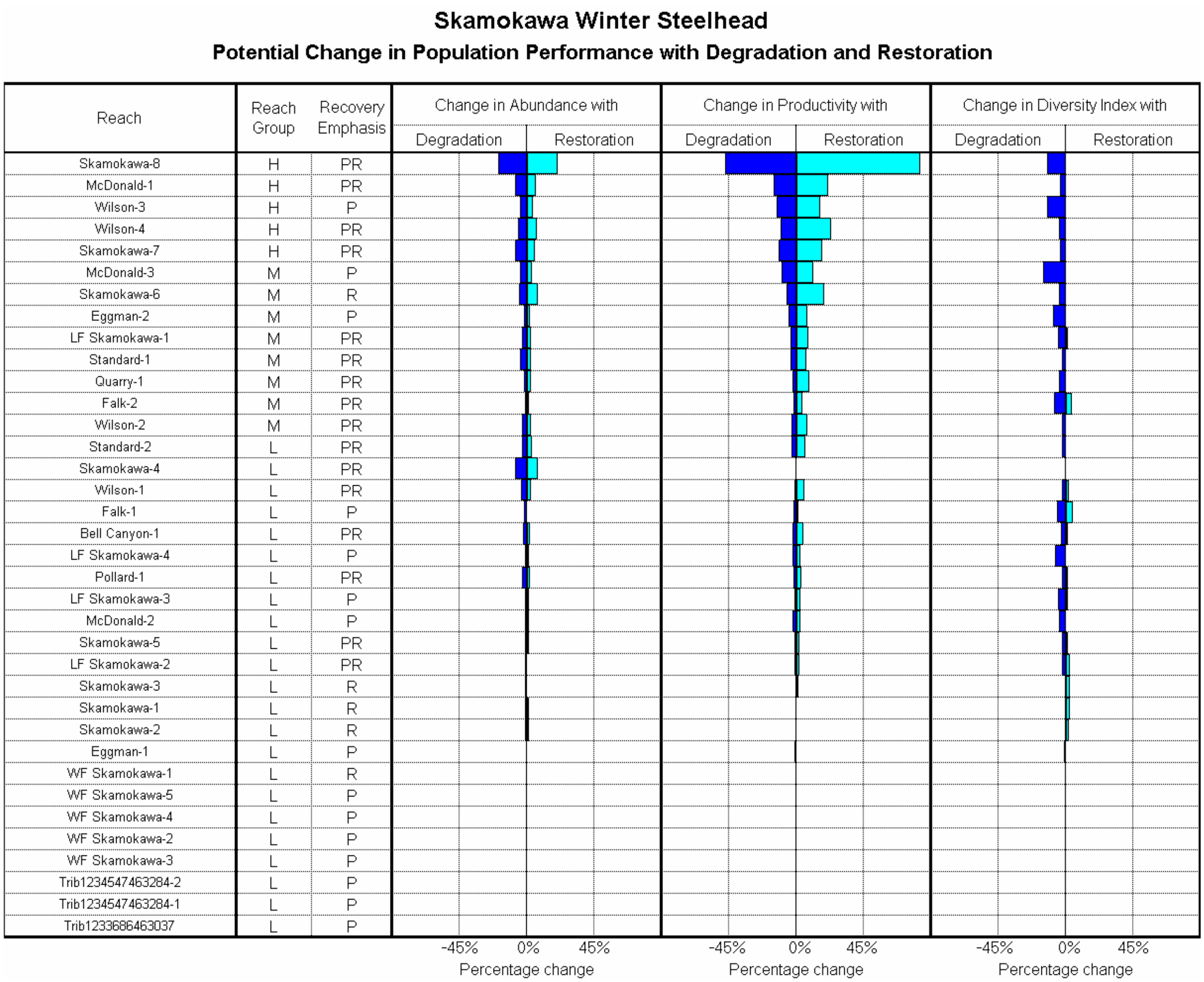


Figure 15. Skamokawa Watershed winter steelhead ladder diagram.

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 the Elochoman and Skamokawa in Table 4 and Table 5

Table 4. Summary of the primary limiting factors affecting life stages of focal salmonid species. Results are summarized from Elochoman River EDT Analysis.

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
Elochoman Fall Chinook				
most critical	Egg incubation	sediment, channel stability	harassment	
second	Spawning	habitat diversity	sediment	harassment, predation
third	Fry colonization	habitat diversity	flow, predation	food, channel stability
Elochoman Chum				
most critical	Egg incubation	sediment	channel stability	harassment
second	Prespawning holding	habitat diversity, harassment, predation	sediment	key habitat
third	Spawning	harassment	habitat diversity, predation, sediment	flow
Elochoman Coho				
most critical	Egg incubation	sediment, channel stability		
second	0-age winter rearing	habitat diversity	channel stability, flow	
third	0-age summer rearing	habitat diversity	predation, temperature	
Elochoman Winter Steelhead				
most critical	Egg incubation	sediment	channel stability	temperature
second	Fry colonization	habitat diversity	channel stability, flow	
third	0-age summer rearing	habitat diversity	flow	temperature, pathogens, channel stability

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

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

The consumer reports diagrams have also been summarized to show the relative importance of habitat factors by reach. The summary figures are referred to as habitat factor analysis diagrams and are displayed for each species below. The reaches are ordered according to their combined restoration and preservation rank. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to historical conditions.

Fall Chinook restoration reaches in the Elochoman are generally between Beaver Creek and the West Fork Elochoman. These reaches have been degraded by sedimentation, decreased habitat diversity, predation, and decreased channel stability (Figure 16). Flow impacts are related to upper watershed vegetation and road conditions. Over half of the North Elochoman WAU is in early-seral, non-forest, or other cover types, while none of the watershed is in the late-seral stage. Riparian vegetation conditions may also be leading to increased temperatures. Entrenchment in the mainstem has altered flow, reduced habitat diversity, and reduced channel stability. Habitat diversity has also been reduced by diking, roads, railroads, and agricultural practices. Lack of LWD has precluded the formation of pools. Road density in the watershed is approximately 4 mi/mi^2, which likely contributes to increased fine sediments and altered flow regimes. WDNR (1996) cited road erosion as a primary culprit in delivery of fines to the Elochoman. Predation concerns arise because of the presence of the Elochoman hatchery. Hatchery releases can trigger migration of wild fish in the “pied piper” effect while increasing the attraction of predators.

Important chum restoration reaches are in the lower mainstem below Duck Creek. These reaches have been impacted primarily by sediment, habitat diversity, predation, and harassment/poaching (Figure 17). Harvest concerns, related to harassment and poaching, are primarily due to the take of wild fish while fishing for returning hatchery fish. With the exception of predation effects, Impacts result from causes described in the fall Chinook discussion.

Primary coho restoration reaches are scattered throughout the Elochoman, primarily below the West Fork Elochoman. The most important restoration reaches have been negatively affected by reduced habitat diversity, sediment, loss of key habitat, reduced channel stability, altered flow, and predation (Figure 18). All of these impacts are related to causes described for the other three species. These causes include land use practices and hatchery impacts

Key winter steelhead restoration reaches in the Elochoman River are located in both mainstem and tributaries areas between Clear Creek and the North Fork Elochoman. These reaches have degraded sediment, habitat diversity, flow regimes and channel stability (Figure 19). With the exception of predation effects, Impacts result from causes described in the fall Chinook discussion.

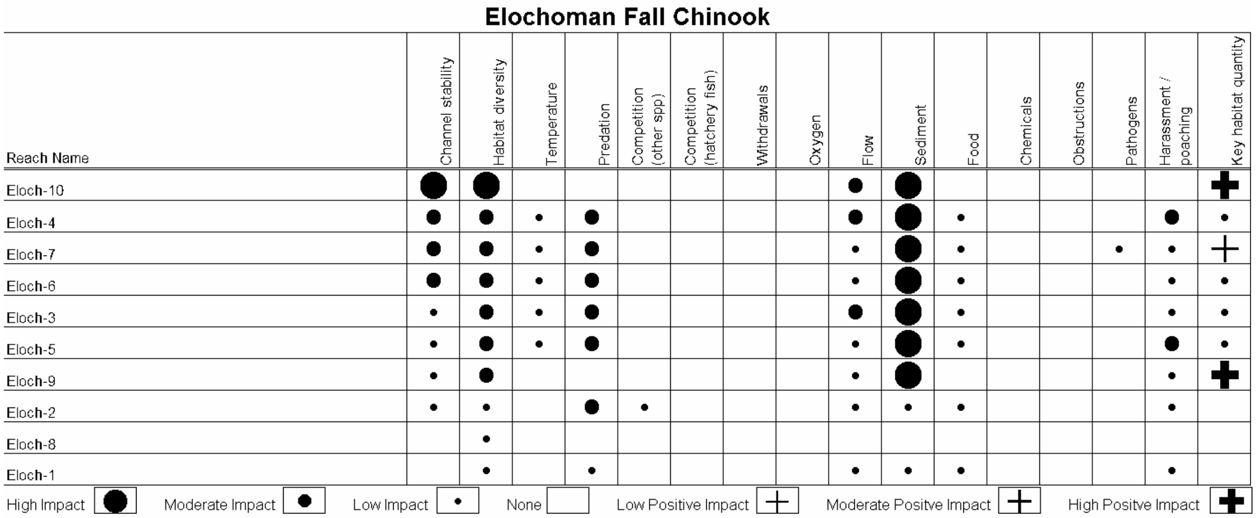


Figure 16. Elochoman fall Chinook habitat factor analysis. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

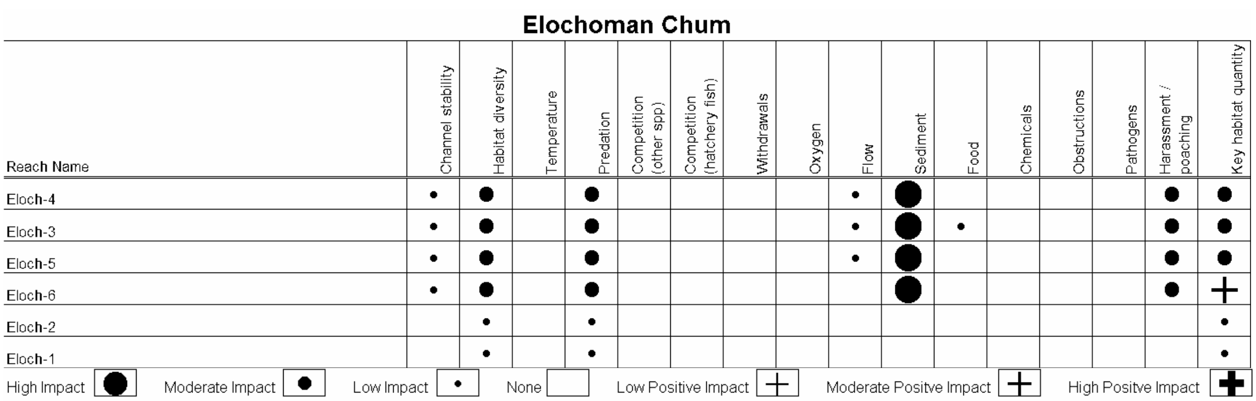


Figure 17. Elochoman chum habitat factor analysis.

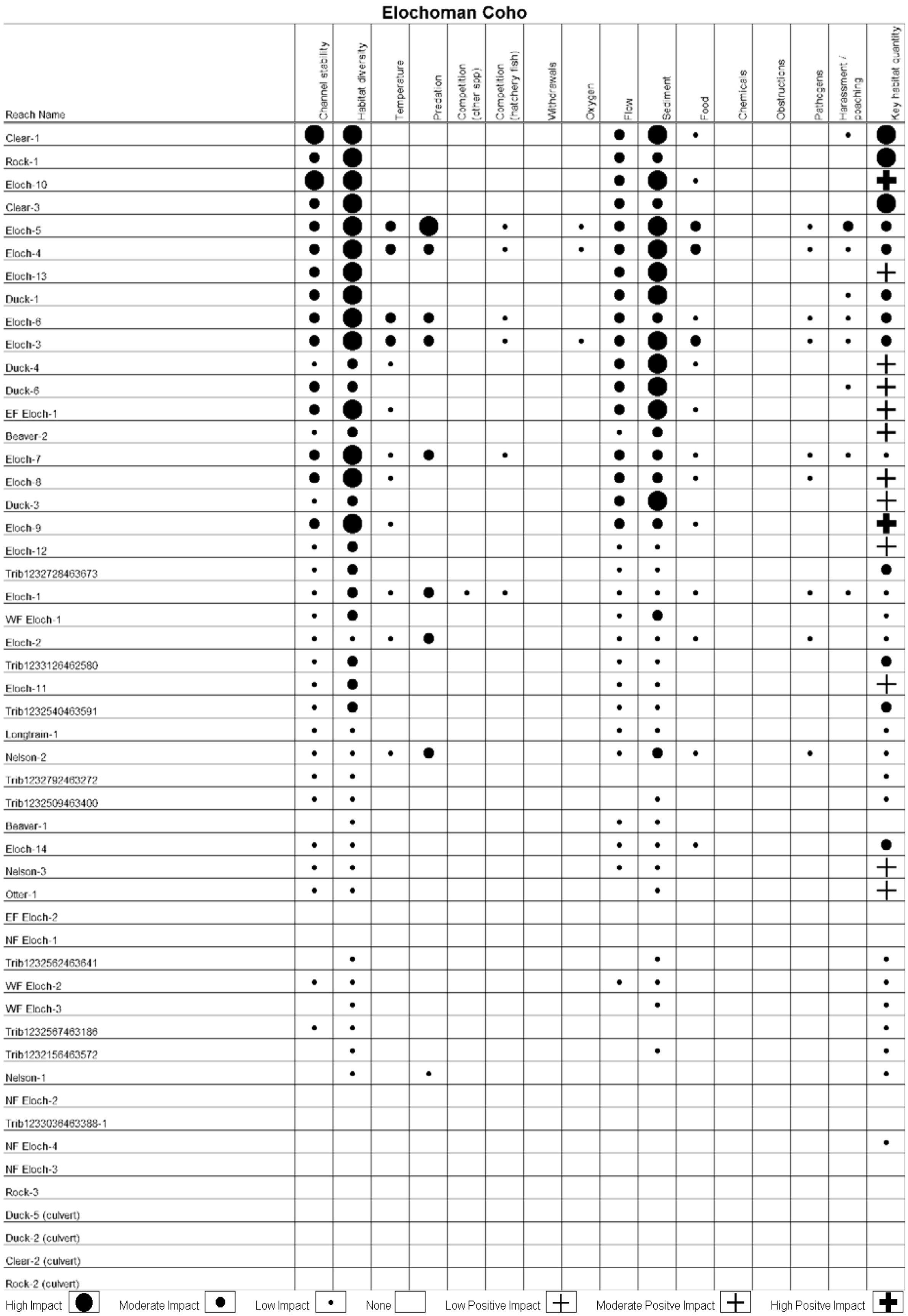


Figure 18. Elochoman coho habitat factor analysis.

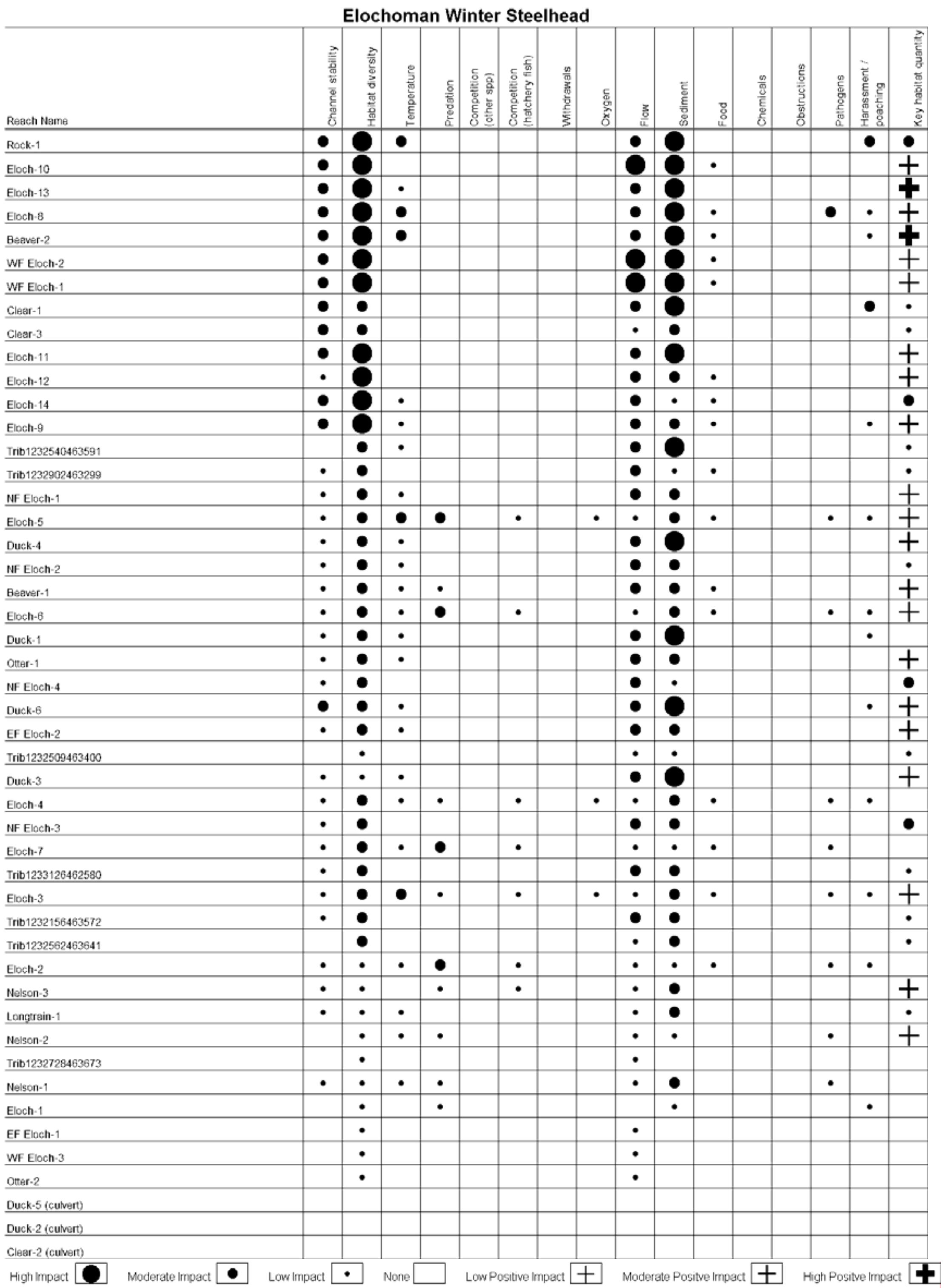


Figure 19. Elochoman River Watershed winter steelhead habitat factor analysis diagram.

Fall Chinook restoration reaches are in the mainstem Skamokawa between Falk Creek and Quarry Creek. These reaches have been impacted by decreased habitat diversity, sedimentation, decreased food availability, and loss of key habitat (Figure 20). None of the vegetative cover in the watershed is in the late-seral stage, while 74% is in the early-seral, non-forest or other stage. This vegetation condition combined with a high road density has potentially altered the flow regime, increased sedimentation, and increased summer temperatures. Habitat diversity in the watershed is not well quantified, but qualitative reports indicate that important restoration reaches are deficient of side channels. Sedimentation is exacerbated by steep slopes in the watershed underlain with sedimentary rock prone to landslides (Ludwig 1992 as cited in Wade 2002). These important restoration reaches lack LWD because of historical land use practices and stream management. The loss of LWD has reduced habitat diversity and key habitat.

There are two important chum restoration areas in the Skamokawa Watershed. The first is in the mainstem Skamokawa, and the other is in lower Wilson Creek. Both sections are influenced primarily by the loss of habitat diversity and increased sediment (Figure 21). These impacts are the result of the same causes as those described in the fall Chinook discussion.

Primary coho restoration reaches are spread throughout the mainstem Skamokawa and in various smaller tributaries. These reaches have been negatively affected by numerous impacts, including sediment, reduced habitat diversity, loss of key habitat, reduced food, altered flow, and temperature regime impairment (Figure 22). These impacts are the result of the same causes as those described in the fall Chinook discussion. These causes are generally related to watershed management and land use practices.

Key restoration reaches for winter steelhead in the Skamokawa are in the mainstem just upstream and downstream of the LF Skamokawa, as well as in Wilson and McDonald Creeks. These reaches are degraded in numerous ways including sediment, flow, habitat diversity, temperature, food availability, and key habitat (Figure 23). These impacts are the result of the same causes as those described in the fall Chinook discussion.

Skamokawa Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Skamokawa-8	High Impact	Moderate Impact	Low Impact						Low Impact	High Impact	Low Impact					High Impact
Skamokawa-5	Low Impact	Moderate Impact	Moderate Impact	Low Impact	Low Impact				Moderate Impact	High Impact	Moderate Impact					High Positve Impact
Skamokawa-6	Moderate Impact	Moderate Impact	Low Impact		Low Impact				Low Impact	High Impact	Moderate Impact					High Positve Impact
Skamokawa-7		Moderate Impact	Moderate Impact	Low Impact					Moderate Impact	High Impact	Moderate Impact					High Impact
Skamokawa-1	Low Impact	Moderate Impact	Low Impact	Moderate Impact	Low Impact	Low Impact			Low Impact	Moderate Impact	Moderate Impact				Low Impact	
Skamokawa-3	Low Impact	Moderate Impact	Low Impact	Moderate Impact	Low Impact				Low Impact	Moderate Impact	Moderate Impact					Moderate Impact
Skamokawa-2																

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

Figure 20. Skamokawa fall chinook habitat factor analysis.

Skamokawa Chum

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
Skamokawa-6	Moderate Impact	High Impact	Low Impact						Low Impact	High Impact	Low Impact					High Positve Impact
Skamokawa-5	Low Impact	High Impact	Low Impact						Low Impact	High Impact	Low Impact					High Positve Impact
Wilson-1	Low Impact	High Impact							Low Impact	High Impact	Low Impact				Low Impact	Low Positive Impact
Wilson-2	Low Impact	High Impact							Low Impact	High Impact	Low Impact					Moderate Impact
Skamokawa-1	Low Impact	Moderate Impact		Moderate Impact	Low Impact				Moderate Impact	Low Impact	Moderate Impact				Low Impact	Moderate Impact
Skamokawa-2		Low Impact		Low Impact							Low Impact					Low Positive Impact
Skamokawa-3		Low Impact		Low Impact	Low Impact				Low Impact	Low Impact	Low Impact					Moderate Impact

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

Figure 21. Skamokawa chum habitat factor analysis.

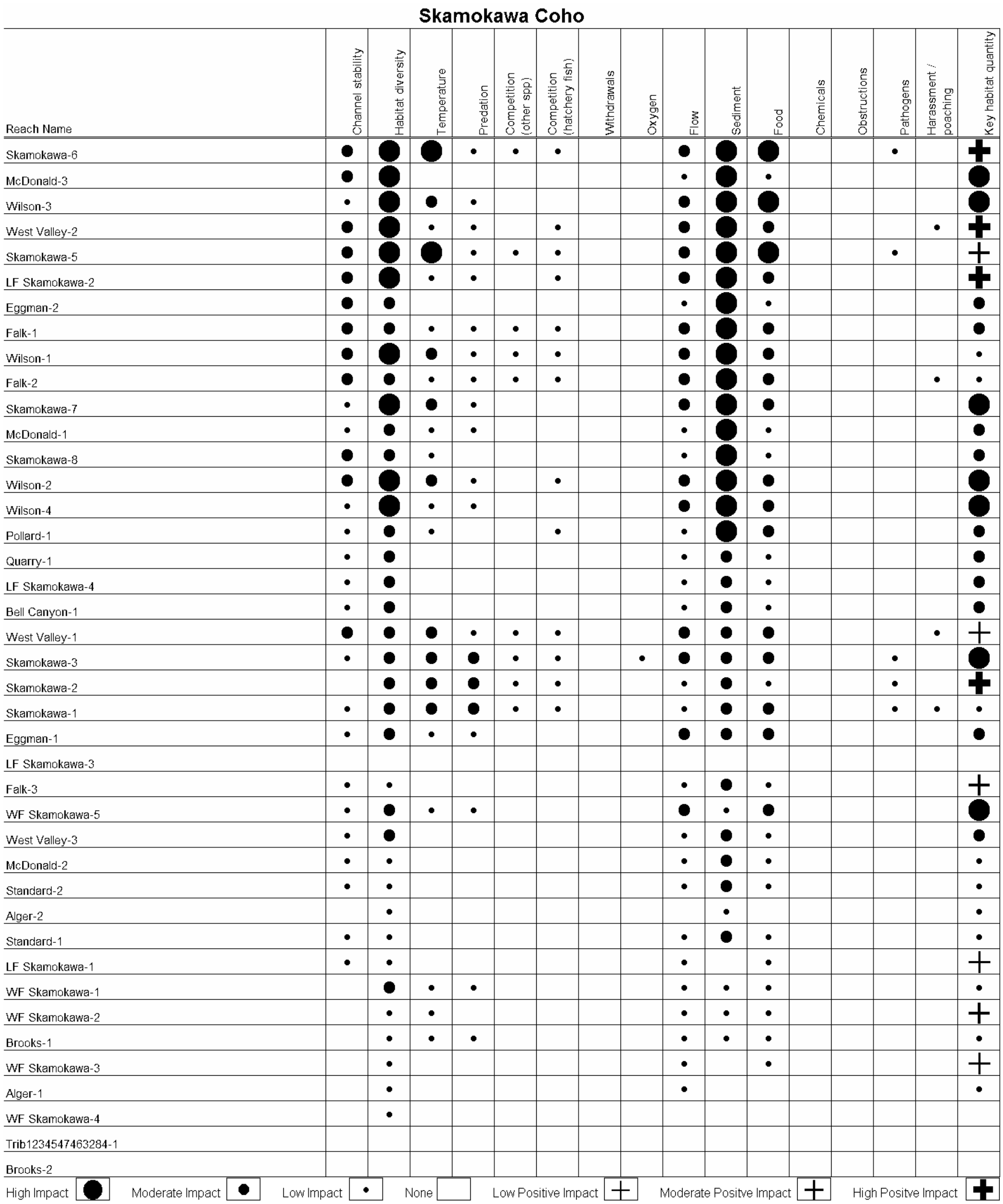


Figure 22. Skamokawa coho habitat factor analysis.

Skamokawa Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Skamokawa-8	Moderate	High	High	Moderate					High	High	High			Moderate		High
McDonald-1	Low	Moderate	High	Moderate					Moderate	High	Moderate			Low		Moderate
Wilson-3		Low	Moderate	Moderate					Moderate	High	Moderate			Low		Moderate
Wilson-4		High	Moderate	Moderate					High	High	Moderate			Low		High
Skamokawa-7			High	Moderate					Moderate	High	Moderate			Low		Moderate
McDonald-3	Low	Moderate	Low	Low					Moderate	High	Low					Moderate
Skamokawa-6	Moderate	High	High	Low	Low	Low			Moderate	High	Moderate			Moderate		Low Positive
Eggman-2		Moderate	Low						Moderate	High	Low					Moderate
LF Skamokawa-1	Low	Moderate	Low	Low		Low			Moderate	Moderate	Low			Low		Low Positive
Standard-1		Moderate	Low	Low					Moderate	High	Moderate			Low		Moderate
Quarry-1	Low	Moderate	Low	Low					Moderate	High	Low					Moderate
Falk-2	Low	Moderate	Low						Low	Moderate	Low					
Wilson-2	Low	Moderate	Moderate	Low		Low			Moderate	High	Moderate			Low		Low
Standard-2	Low	Moderate	Low	Low					Moderate	High	Moderate					Moderate
Skamokawa-4		Low	High	Moderate	Low	Low			Moderate	Low	Moderate			Moderate		
Wilson-1	Low	Moderate	Moderate	Low	Low	Low			Moderate	Moderate	Low			Low		Low Positive
Falk-1	Low	Low	Low						Low	Moderate	Low					
Bell Canyon-1	Low	Moderate	Low						Moderate	High	Low					Moderate
LF Skamokawa-4	Low	Low	Low						Low	High	Low					Low
Pollard-1		Low	Moderate			Low			Moderate	High	Moderate			Low		Moderate
LF Skamokawa-3	Low	Moderate	Low						Low	Moderate	Low					Low
McDonald-2		Low	Low						Low	High	Low					Low
Skamokawa-5		Low	Low						Low	Low	Low			Low		Low Positive
LF Skamokawa-2		Low							Low	Low						Low Positive
Skamokawa-3		Low	Low	Low					Low	Low						Low
Skamokawa-1		Moderate		Low					Low	Moderate	Low				Low	
Skamokawa-2		Low	Low	Low					Low	Low						Low Positive
Eggman-1		Low							Low		Low					
WF Skamokawa-1		Low		Low					Low	Low						
WF Skamokawa-5																
WF Skamokawa-4																
WF Skamokawa-2																
WF Skamokawa-3																
Trib1234547463284-2																
Trib1234547463284-1																
Trib1233686463037																

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

Figure 23. Skamokawa winter steelhead habitat factor analysis.

3.5 Watershed Process Limitations

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

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

The Skamokawa-Elochoman watershed is a composite watershed that incorporates two primary stream drainages, Skamokawa Creek and Elochoman River. Other important drainages include Jim Crow Creek, Alger Creek, Risk Creek, and Nelson Creek. For the purpose of the IWA analysis, the Skamokawa-Elochoman watershed is divided into 17 LCFRB recovery planning subwatersheds. IWA results for the Skamokawa-Elochoman watershed are shown in Table 6. A reference map showing the location of each subwatershed in the basin is presented in Figure 24. Maps of the distribution of local and watershed level IWA results are displayed in Figure 25.

3.5.1 *Hydrology*

Current Conditions.— Local and watershed level hydrologic ratings are identical in the Elochoman-Skamokawa basin. Conditions are rated impaired in the downstream subwatersheds of the Elochoman (60401, 60201 and 60204), the West Fork Elochoman (60101) and in the headwaters Elochoman (60103). The middle and upper Elochoman (60202 and 60102) and Beaver Creek (60203) are rated moderately impaired. Hydrologic conditions in the Skamokawa drainage are rated as impaired in all subwatersheds except the headwaters (60301).

The Elochoman drainage as a whole averages 50% mature forest cover, with Beaver Creek (60203) and the upper mainstem Elochoman (60102 and 60202) collectively approaching 60%. The remaining subwatersheds in the drainage range between 13% and 47% mature forest cover. Road densities in the drainage are generally high, ranging from 3.2 to over 6 mi/mi^2. Of particular concern are impairment ratings in headwaters areas in the East Fork and West Fork (60103 and 60101). These subwatersheds are higher elevation with significant area in the rain-on-snow zone (55% and 17%, respectively). The East Fork headwaters are borderline in terms of road density and forest cover thresholds for hydrology, suggesting that conditions in this watershed are closer to moderately impaired.

The majority of land-use in the Elochoman drainage is timber production on private timber lands. Only two subwatersheds have significant area in public ownership. These are

Beaver Creek (60203) and the middle mainstem Elochoman (60202), which are 72% and 48% WDNR lands, respectively. Remaining subwatersheds are predominantly in private timber lands.

Local and watershed level hydrologic conditions in the Skamokawa drainage are rated impaired except in the headwaters of the Skamokawa in McDonald and Standard Creeks (60301), which is rated as moderately impaired. The Skamokawa drainage is the lower elevation large drainage in the watershed, with only the headwaters and upper Wilson Creek (60301 and 60307) having significant area in the rain-on-snow zone (32% and 17%, respectively).

Only limited areas of the Skamokawa drainage have hydrologically mature forest coverage, averaging only 17% across all subwatersheds. Only the McDonald Creek/Standard Creek drainage (60301) has significant mature forest coverage (53%). Road densities are moderately high, with a range of 3.2 to over 5.2 mi/mi^2. Collectively, these factors account for the distribution of impaired ratings in the watershed. The majority of this drainage (70%) is in private lands, primarily timber holdings. The remaining public lands are held by WDNR in the uplands, and in NWR lands at the river mouth.

The generally impaired ratings for hydrology in the watershed are corroborated by acknowledged problems with watershed hydrology. Both the Skamokawa and Elochoman drainages have peak flow and low flow issues characteristic of altered hydrologic patterns. These changes are associated with an increase in the drainage network density due to forest roads, and loss of hydrologically mature forest cover.

Hydrologic conditions in estuarine subwatersheds (60305, 60401 and 60402) are rated moderately impaired to impaired. These ratings are primarily driven by lack of forest cover and higher road densities in these lowland areas, and downstream effects from the remainder of the watershed. However, it is important to note that these areas are more strongly influenced by the hydrology and tidal fluctuations of the Columbia River than by watershed level effects. In addition, the hydrologic condition of these subwatersheds are fundamentally affected by the draining and channelization of floodplain areas for agricultural development. Actual hydrologic conditions in these subwatersheds are less likely to be accurately predicted by the IWA than those in upstream subwatersheds.

Predicted Future Trends.— Given the high proportion of watershed area in active forest lands, high road densities, and young forest, and given the likelihood of continuing harvest rotations, hydrologic conditions in the Elochoman and Skamokawa drainages are predicted to trend stable (i.e., moderately impaired to impaired) over the next 20 years.

The estuarine portion of the watershed (60305, 60401 and 60402) is expected to trend stable with respect to hydrologic conditions due to the extent of development and the presence of extensive NWR lands.

Table 6. IWA results for the Skamokawa-Elochoman Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
60101	I	M	M	I	M	none
60102	M	M	M	M	M	60101, 60103
60103	I	M	M	I	M	none
60201	I	M	M	I	M	60101, 60102, 60103, 60202, 60203
60202	M	M	M	M	M	60101, 60102, 60103
60203	M	M	M	M	M	none
60204	I	M	M	I	M	60101, 60102, 60103, 60201, 60202, 60203
60301	M	M	M	M	M	none
60302	I	M	M	I	M	60301
60303	I	M	M	I	M	none
60304	I	M	M	I	M	none
60305	I	M	M	I	M	none
60306	I	F	M	I	M	60301, 60302, 60303, 60307
60307	I	M	M	I	M	none
60308	I	M	M	I	M	60304
60401	I	M	I	I	M	60101, 60102, 60103, 60201, 60202, 60203, 60204
60402	M	F	I	M	F	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.
.

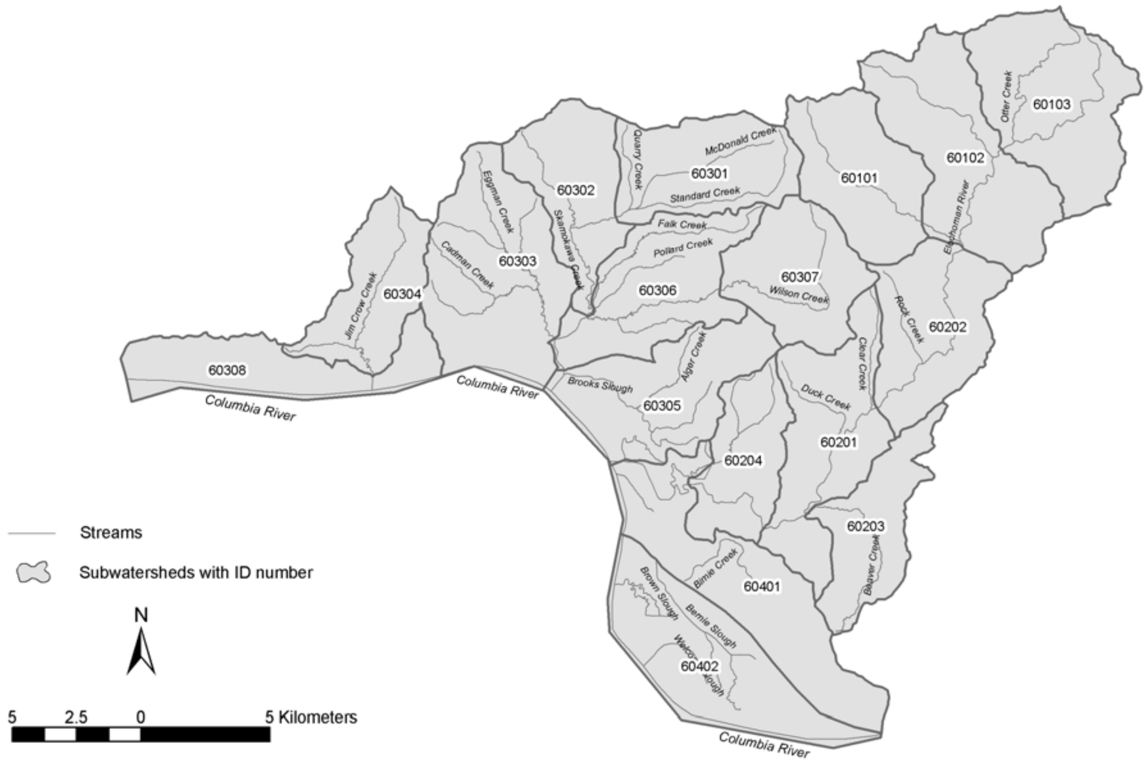


Figure 24. Map of the Elochoman/Skamokawa Watershed showing the location of the IWA subwatersheds.

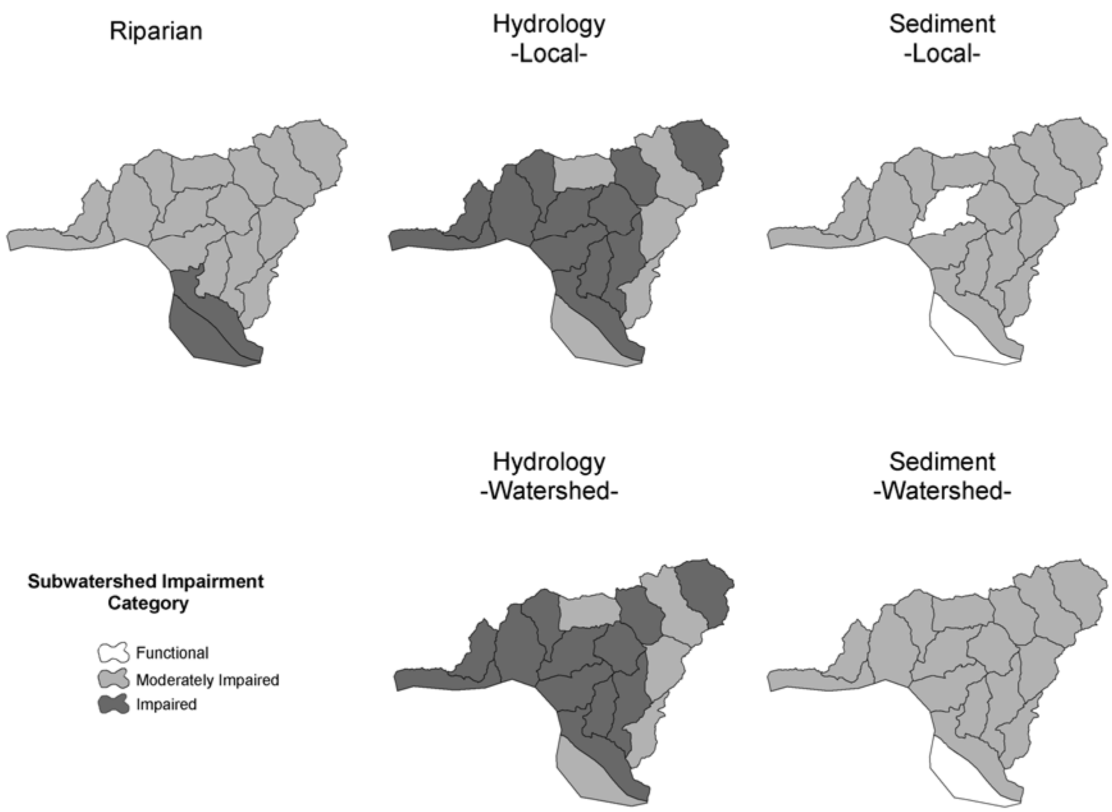


Figure 25. IWA subwatershed impairment ratings by category for the Elochoman/Skamokawa Watershed.

3.5.2 *Sediment Supply*

Current Conditions.— Local sediment conditions are uniformly rated moderately impaired in the Elochoman drainage, with the exception of the lower Elochoman/Bernie Creek subwatershed (60402). A similar situation exists in the Skamokawa drainage, where all the subwatersheds are classified as moderately impaired at the local level, with the exception of the lower Skamokawa River (60306), which is rated functional. The watershed level results are nearly identical to the local level results. An exception is the lower Skamokawa subwatershed (60306), which is rated moderately impaired for sediment at the watershed level (versus functional at the local level). In this case, factors potentially affecting sediment conditions in the Wilson Creek headwaters (60307) and the upper Skamokawa (60302) are extensive enough to have potential downstream effects.

In the Elochoman Watershed, riparian zones are generally degraded due to historical and current land use practices, which in combination with degraded hydrologic conditions is a source of widespread bank and channel erosion (Wade 2002). High road densities in upland areas are also significant sources of sediment loading, particularly when located on sensitive slopes in areas with extensive timber harvest. The North Elochoman Watershed Analysis identified shallow rapid landslides associated with forest practices and high road densities as major contributors of fine sediment to the stream system (WDNR 1996). The IWA results generally corroborate the findings of the watershed analysis.

Despite the acknowledged problems with sediment in the drainage, the natural erodability rates for these subwatersheds are relatively low in comparison with the remainder of the LCR. Erodability ratings in the Elochoman drainage range from 7-27 (on a scale of 0-126), with only two exceeding a rating of 20. The fact that sediment loading is an ongoing problem in the basin despite the relatively low erodability in the drainage suggests numerous widespread chronic sources of sedimentation. Road densities in the Elochoman are generally high, ranging from 3.2 to over 6 mi/mi^2, with five of seven subwatersheds exceeding 4.5 mi/mi^2. Streamside road densities are generally low (<0.2 miles/stream mile), but stream crossing densities are high. Crossing densities range from 2.0-4.8 crossings/stream mile, with five of seven subwatersheds having over 3 crossings/stream mile. Culvert failures at stream crossings are potentially large sources of sediment delivery.

The causes and sources of sediment problems in the Skamokawa drainage are similar to those for the Elochoman. Sediment loading is an acknowledged problem for fish habitat in the Skamokawa drainage. Bank erosion and numerous mass-wasting problems occur in areas with alluvial deposits where past timber harvest and agricultural activities have removed protective riparian vegetation (Wade 2002). The generally degraded hydrologic conditions present in the watershed exacerbate this effect.

Watershed level ratings for sediment conditions are uniformly rated as moderately impaired throughout the Skamokawa drainage, based on the intersection of roads, steep slopes and erodable geology types. Natural erodability rates in the drainage are low to moderate (11-29 on a scale of 0-126), with the least erodable areas in bedrock zones in the headwaters. The remainder of the drainage is in the moderately erodable range. This natural instability, combined with extensive road construction and timber management, has led to substantial sediment loads and unstable, aggrading stream channels. Much of the sediment originated from past forest practices, including indiscriminate logging around and through streams, the use of splash dams to transport logs, and poor road construction (WDW 1990).

Forest road densities in the Skamokawa drainage are relatively high, ranging from 3.2 to 6.1 mi/mi^2. In contrast, streamside road densities are low (0.03-0.13 miles/mile of stream). Stream crossing densities range from low to moderate (1.3-3.6 crossings/stream mile). In combination, these factors suggest that the current high road densities and history of land use are primary drivers of sediment problems. Local bank and channel erosion caused by degraded hydrologic conditions is also likely to contribute to sediment delivery.

Sediment conditions in estuary subwatersheds (60305, 60401 and 60402) are affected by sediment delivery from the upper watershed. However, sediment conditions in these tidally influenced areas of the watershed are more strongly influenced by tidal fluctuations and the hydrology of the mainstem Columbia. Due to this dominant influence, IWA results are not expected to predict actual sediment conditions in these subwatersheds as accurately as for upstream subwatersheds.

Predicted Future Trends.— In the Elochoman and Skamokawa Watersheds, timber harvests on private forest lands are likely to continue for the foreseeable future. Because the forest road network will be maintained to support these activities, road related indicators (road density, streamside road density, and stream crossing density) are expected to remain relatively constant. Based on this information, the trend in sediment conditions is expected to remain relatively constant over the next 20 years, with the potential for some improvement if old roads are replaced using improved road design and management.

Given the extent of development and the presence of extensive NWR lands in the estuarine portion of the watershed, hydrologic conditions are expected to trend stable, following general trends for the remainder of the watershed..

3.5.3 *Riparian Condition*

Current Conditions.— Riparian conditions are rated moderately impaired to impaired throughout the majority of the Skamokawa-Elochoman watershed. Impaired ratings are concentrated in the lowland estuary subwatersheds (60401, 60402) where extensive floodplain and side channel habitat has been disconnected from most of the lower river mainstems and tributaries by diking and agricultural conversion. The riparian rating for these subwatersheds also reflects a natural tendency towards less coniferous vegetation. Information is lacking on the quantity and quality of floodplain, side channel, estuary, or wetland habitats in the watershed, and the loss of these habitats due to various land use activities (Wade 2002).

Predicted Future Trends.— Riparian conditions throughout most of the watershed are expected to improve over time due to improved forest practices that aim to protect riparian areas. In the lower mainstem and estuarine areas of the watershed, the potential for riparian recovery is relatively limited due to the extent of channelization. Therefore, riparian conditions are generally predicted to trend stable. Tidal water areas at the mouth of the Skamokawa and Jim Crow Creek (60304 and 60405) are being managed as wildlife refuges. Actual conditions in these areas are not accurately reflected by the riparian ratings which average conditions over the entire subwatershed. Riparian conditions in these subwatersheds should trend towards improvement 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 Elochoman/Skamokawa Watershed and discusses their potential effects. Historically, two hatcheries operated in the watershed: the Elochoman Hatchery and the Beaver Creek Hatchery. The Beaver Creek Hatchery (since 1957) reared early-run winter steelhead for distribution to several lower Columbia basins until it was closed in 1999. The Elochoman Hatchery still operates in the watershed.

The Elochoman Hatchery

The Elochoman Hatchery (since 1954) produces winter and summer steelhead, fall Chinook, and coho for harvest opportunity (Table 7). The winter steelhead program includes both a composite stock from Beaver Creek Hatchery and a local stock program. The summer steelhead are Skamania stock. The Elochoman Hatchery also provides coho for net pen rearing and harvest in Steamboat Slough and winter steelhead for release into the Coweeman River. There are no hatchery fish released into Skamokawa Creek. 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. The main threats from the Elochoman Hatchery salmon programs are domestication of natural fall Chinook and coho and potential ecological interactions between hatchery and natural juvenile salmon.

Table 7. Current Elochoman/Skamokawa Watershed hatchery production.

Hatchery	Release Location	Fall Chinook	Early Coho	Late Coho	Local Winter Steelhead	Winter Steelhead	Summer Steelhead
Elochoman	Elochoman	2,000,000	418,000	512,000	30,000	90,000[1/]	30,000
	Coweeman					20,000	
	Steamboat Slough		200,000				

1/ Includes 60,000 Beaver Creek stock and 30,000 wild Elochoman stock.

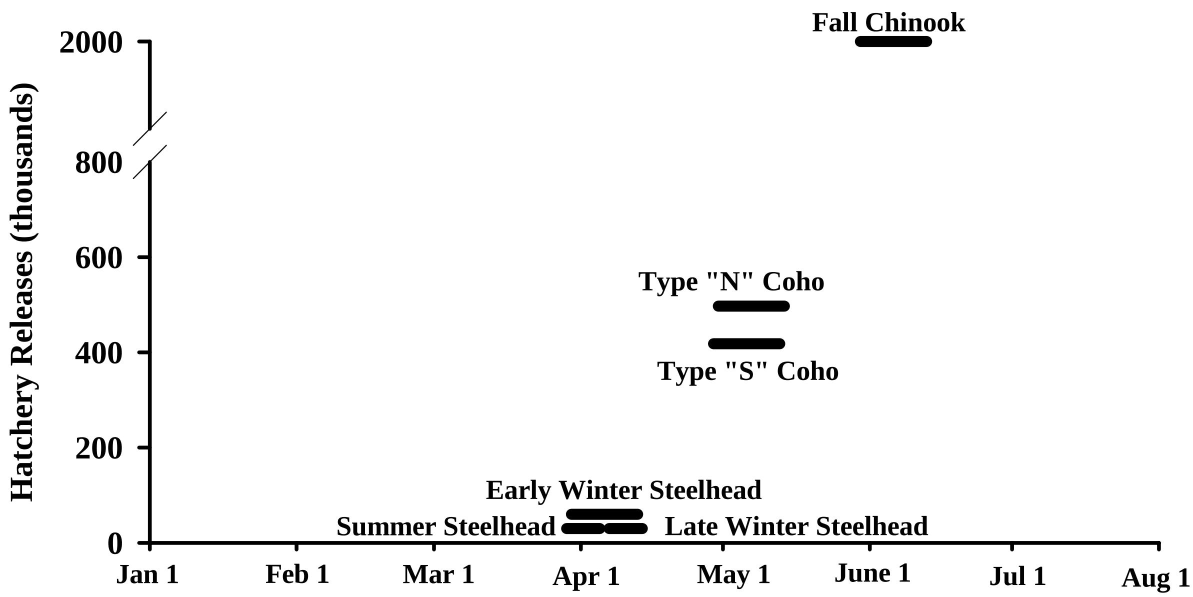


Figure 26. Magnitude and timing of hatchery releases in the Deep River, Grays River, and Elochoman basins by species, based on 2003 brood production goals.

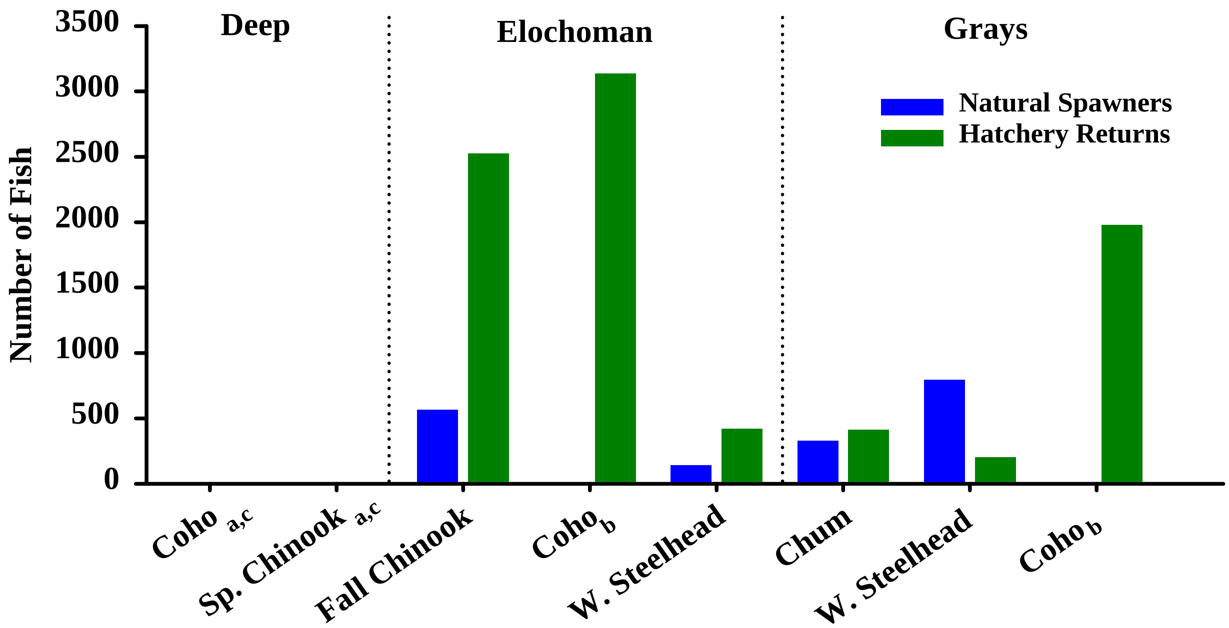


Figure 27. Recent average hatchery returns and estimates of natural spawning escapement in the Deep, Grays, and Elochoman River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present. Calculation of each average utilized a minimum of 5 years of data.

Biological Risk Assessment

The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC related plans on the Cowlitz River and Lewis River; 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 8 identifies hazards levels associated with risks involved with hatchery programs in the Elochoman Basin. Table 9 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 8. Preliminary BRAP for hatchery programs affecting populations in the Elochoman/Skamokawa River Watershed.

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

Elochoman/ Skamakawa Population	Hatchery Program: Name	Release (millions)	Genetic: Effective Population Size	Genetic: Domestication	Genetic: Diversity	Ecological: Predation	Ecological: Competition	Ecological: Disease	Demographic: Survival Rate	Demographic: Reproductive Success	Facility: Catastrophic Loss	Facility: Passage	Facility: Screening	Facility: Water Quality
Fall Chinook	Elochoman Fall Chinook	2.000	○	●	○	○	?	○	○	?	○	●	●	○
	Elochoman Coho Type N 1+	0.497	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
	Elochoman Coho Type S 1+	0.418	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
	Elochoman W. Steelhead 1+	0.090	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
	Elochoman S. Steelhead 1+	0.030	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
Winter Steelhead	Elochoman Fall Chinook	2.000	▒	▒	▒	○	?	○	▒	▒	▒	●	●	○
	Elochoman Coho Type N 1+	0.497	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
	Elochoman Coho Type S 1+	0.418	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
	Elochoman W. Steelhead 1+	0.090	○	○	?	?	?	○	▒	▒	▒	●	●	○
	Elochoman S. Steelhead 1+	0.030	▒	▒	▒	?	?	○	▒	▒	▒	●	●	○
Chum	Elochoman Fall Chinook	2.000	▒	▒	▒	?	○	○	▒	▒	▒	●	●	○
	Elochoman Coho Type N 1+	0.497	▒	▒	▒	?	○	○	▒	▒	▒	●	●	○
	Elochoman Coho Type S 1+	0.418	▒	▒	▒	?	○	○	▒	▒	▒	●	●	○
	Elochoman W. Steelhead 1+	0.090	▒	▒	▒	?	○	○	▒	▒	▒	●	●	○
	Elochoman S. Steelhead 1+	0.030	▒	▒	▒	?	○	○	▒	▒	▒	●	●	○

Table 9. Preliminary strategies proposed to address risks identified in the BRAP for Elochoman/Skamokawa River populations.

	Hatchery Program		Risk Assessment of Hazards														
			Address Genetic Risks					Address Ecological Risks				Address Demographic Risks		Address Facility Risks			
Elochoman/ Skamakawa Population	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abateme
Fall Chinook	Elochoman Fall Chinook	2.000		●	●	●							●		●	●	
	Elochoman Coho Type N 1+	0.497						●	●		●				●	●	
	Elochoman Coho Type S 1+	0.418						●	●		●				●	●	
	Elochoman W. Steelhead	0.090						●	●		●				●	●	
	Elochoman S. Steelhead	0.030						●	●		●				●	●	

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 Elochoman River subbasin is quite low (2.5%) for chum as hatchery programs for chum have been discontinued in the subbasin. The fitness impact is similarly low for winter steelhead where hatchery and wild fish are segregated by differences in spawn timing (competition effects are not assessed). Fitness impact potential is greater for the Chinook program (34%) and for coho (50%). However, the high incidence of fall Chinook and coho hatchery spawners suggests that the fitness of natural and hatchery fish is now probably quite similar and natural populations might decline substantially without continued hatchery subsidy under current habitat conditions. Interspecific impacts from predation are estimated to be 5% for chinook and 1% or less for other species.

Table 10. 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 Elochoman 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	2,000,000	0.69	3	0.5	0.34	1,050,000	0.05
Chum	0[h]	0.25	1	0.9	0.025	120,000	0.006
Coho	930,000[i]	0.99	3	0.5	0.50	1,050,000	0.01
Winter steelhead	90,000[j]	0.09	4	0.3	0.065	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 and coho for fall Chinook and coho. Includes steelhead 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] Elokomin Hatchery goals include 418,000 early coho (type S) and 512,000 late coho (type N).
[j] The Elochoman River winter steelhead hatchery program at the Beaver Creek Hatchery stopped releasing smolts in 1999; hatchery returns were expected to significantly diminish starting with the 2001 return. The Elokomin Salmon Hatchery started a ‘wild’ winter steelhead program in 2000 to replace the previous program with indigenous stock (30,000 smolts per year). An additional 60,000 hatchery fish are released per year for fisheries. An additional 30,000 summer steelhead are released each year.
[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 and coho for fall chinook and coho. Includes steelhead for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.
[h] Number refers to fall chinook hatchery program underway to restore a naturally producing population in the Chinook River. The Grays River fall chinook hatchery program stopped releasing smolts in 1998; hatchery returns were expected to significantly diminish starting with the 2002 return.
[i] Releases include 300,000 in the Grays River to supplement natural production and 147,500 to restore a Chinook River population.
[j] Comprised of early coho (type S) released in the Grays, Deep, and Chinook Rivers from the Grays River and Sea Resources Hatcheries.

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, this can result in fewer spawners and can alter age, size, run timing, fecundity, and genetic characteristics. Fewer spawners result in fewer eggs for future generations and diminish marine-derived nutrients delivered via dying adults, now known to be significant to the growth and survival of juvenile salmon in aquatic ecosystems. The degree to which harvest-related limiting factors influence productivity varies by species and location.

Most harvest of wild Columbia River salmon and steelhead occur 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 11). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced coho and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

Table 11. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60
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 in-basin sport fisheries are closed to the retention of Chinook to naturally spawning populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

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

Harvest of Elochoman/Skamokawa 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 Elochoman River. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish.

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

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

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

3.6.4 *Hydropower Construction and Operation*

There are no hydro-electric dams in the Elochoman/Skamokawa Watershed. However, Elochoman/Skamokawa 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 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 28 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Elochoman/Skamokawa Watershed 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.

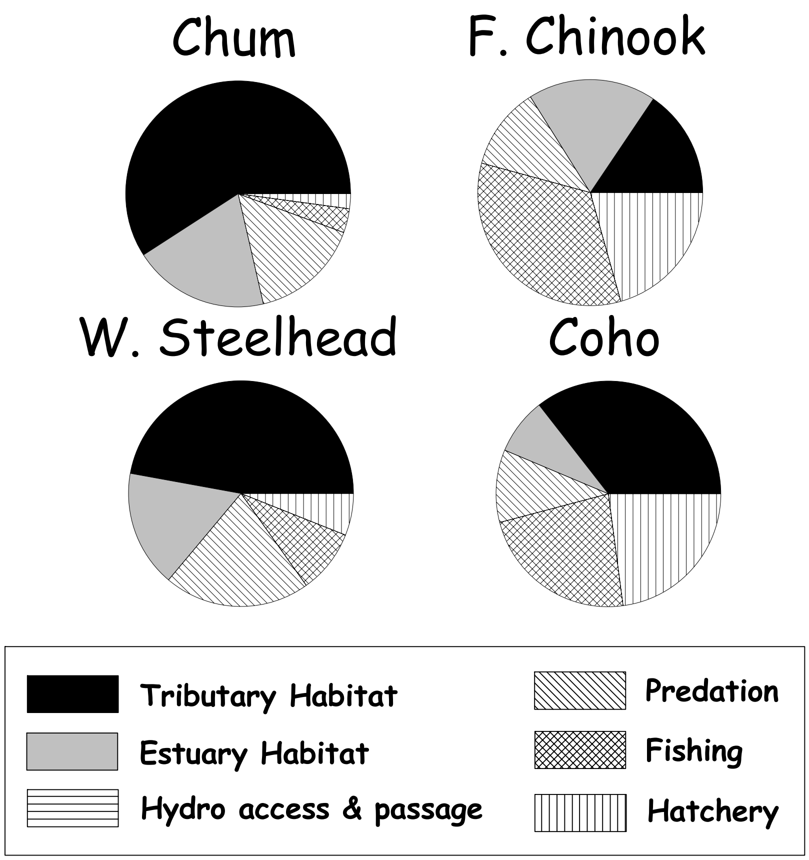


Figure 28. Relative contribution of potentially manageable impacts on Elochoman/Skamokawa salmonid populations.

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. Loss of tributary habitat quality and quantity accounts for the largest relative impact on chum, coho and winter steelhead; fall Chinook are moderately affected by loss of tributary habitat relative to other factors. Loss of estuary habitat quality and quantity is also moderately important for all species, but less so for coho. Harvest has a sizeable effect on fall Chinook, but is relatively minor for chum and winter steelhead; harvest impact on coho is intermediate. Hatchery impacts are substantial for fall Chinook and coho, and relatively low for chum and winter steelhead. Predation impacts are moderate for all species with chum and winter steelhead being slightly more impacted by predation than fall Chinook and coho .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. Tributary and estuary habitat impacts are the differences between the pre-development historical baseline and current conditions. Hydro impacts identify the percentage of historical habitat blocked by impassable dams and the mortality associated with juvenile and adult passage of other dams. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries. Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in its relative significance. Methods and data for these analyses are detailed in Appendix E.

Potentially-manageable human impacts were estimated for each factor based on the best available scientific information. Proportions are standardized to a total of 1.0 for plotting purposes. The index is intended to illustrate order-of-magnitude rather than fine-scale differences. Only the subset of factors we can potentially manage were included in this index – natural mortality factors beyond our control (e.g. naturally-occuring 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 basin. These descriptions provide a context for descriptions of specific actions and responsibilities in the management plan portion of this subbasin plan. More detailed descriptions of these programs and projects can be found in the Comprehensive Program Directory (Appendix C).

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 Magnuson-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 *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.

4.1.5 *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 *Wahkiakum County*

Wahkiakum County is not planning under the State's Growth Management Act in its Comprehensive Planning process. Wahkiakum County manages natural resources primarily through its Critical Areas Ordinance.

4.3.2 *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 *Columbia River Estuary Study Taskforce*

The Columbia River Estuary Study Taskforce (CREST) is a council of local governments. CREST developed the Columbia River Estuary Regional Management Plan, which was adopted in local comprehensive plans and shoreline master programs. This plan contains an inventory of physical, biological and cultural characteristics of the estuary. Based on data needs identified during the development of the plan, Congress authorized and funded the Columbia River Estuary Data Development Program (CREDDP). This program provided a wealth of information that is still used by the local governments and by state and federal agencies in resource planning.

4.4.3 *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 Elochoman/Skamokawa Basin.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
	Birnie Creek Una Road Fish Passage	Elochoman/Skamakowa

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 Elochoman/Skamokawa Watershed will play a key role in the regional recovery of salmon and steelhead. Natural populations of fall Chinook, winter steelhead, chum, and coho will be restored to high levels of viability by significant reductions in human impacts throughout the lifecycle. Salmonid recovery efforts will provide broad ecosystem benefits to a variety of subbasin fish and wildlife species. Recovery will be accomplished through a combination of improvements in subbasin, Columbia River mainstem, and estuary habitat conditions as well as careful management of hatcheries, fisheries, and ecological interactions among species.

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

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

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

Columbia Basin hydropower effects on Elochoman/Skamokawa Watershed salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Elochoman/Skamokawa 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 Elochoman/Skamokawa Watershed 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, 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 Elochoman/Skamokawa Watershed 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 Elochoman/Skamokawa Watershed was identified as one of the most significant areas for salmon recovery among Washington coastal subbasins based on fish population significance and realistic prospects for restoration. Recovery goals call for restoring fall Chinook, chum, and coho populations to a high viability level. This level will provide for a 95% or better probability of population survival over 100 years. Recovery goals call for restoring winter steelhead populations to medium viability levels which will provide for a 75-95% probability 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 Elochoman/Skamokawa Watershed although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the watershed.

Table 12. Current viability status of Elochoman/Skamokawa 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+	100-2,300	High^{P}	1,400
Winter Steelhead	Threatened	Yes	Low+	200-700	Medium^{C}	150-600
Chum	Threatened	No	Low	<200	High^{P}	1,100
Coho	Candidate	Yes	Low	Unknown	High^{P}	600

P = primary 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 role of the population in the recovery scenario. Productivity is defined as the inherent population replacement rate and is typically expressed by models as a median rate of population increase (PCC model) or a recruit per spawner rate (EDT model). Corresponding improvements in spawner numbers, juvenile outmigrants, population spatial structure, genetic and life history diversity, and habitat are implicit in productivity improvements.

Improvement targets were developed for each impact factor based on desired population productivity improvements and estimates of potentially manageable impacts (see Section 3.7). Impacts are estimates of the proportional reduction in population productivity associated with human-caused and other potentially manageable impacts from stream habitats, estuary/mainstem habitats, hydropower, harvest, hatcheries, and selected predators. Reduction targets were driven by regional strategy of equitably allocating recovery responsibilities among the six manageable impact factors. Given the ultimate uncertainty in the effects of recovery actions and the need to implement an adaptive recovery program, this approximation should be adequate for developing order-of-magnitude estimates to which recovery actions can be scaled consistent with the current best available science and data. Objectives and targets will need to be confirmed or refined during plan implementation based on new information and refinements in methodology.

The following table (Table 13) identifies population and factor-specific improvements consistent with the biological objectives for this watershed. 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 Elochoman River and Skamokawa Creek fall Chinook must increase by 30% to reach population viability goals. This requires impact reductions equivalent to an 8% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts must decrease from a 34% to a 29% impact to achieve the required 8% increase in tributary habitat form the current 66% of the historical potential to 71% of the historical potential.

Table 13. Productivity improvements consistent with biological objectives for the Elochoman/Skamokawa Watershed.

Species	Net increase	Per factor	Baseline impacts Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Fall Chinook	30%	8%	0.34	0.32	0.00	0.20	0.59	0.36
Chum	50%	7%	0.80	0.26	0.00	0.21	0.05	0.03
Coho	na	na	na	na	na	na	na	na
Winter Steelhead	10%	4%	0.52	0.18	0.00	0.23	0.10	0.07

5.4 Tributary Habitat

Habitat assessment results were synthesized in order to develop specific prioritized measures and actions that are believed to offer the greatest opportunity for species recovery in the watershed. 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 the 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 29 and each component is presented in detail in the sections that follow.

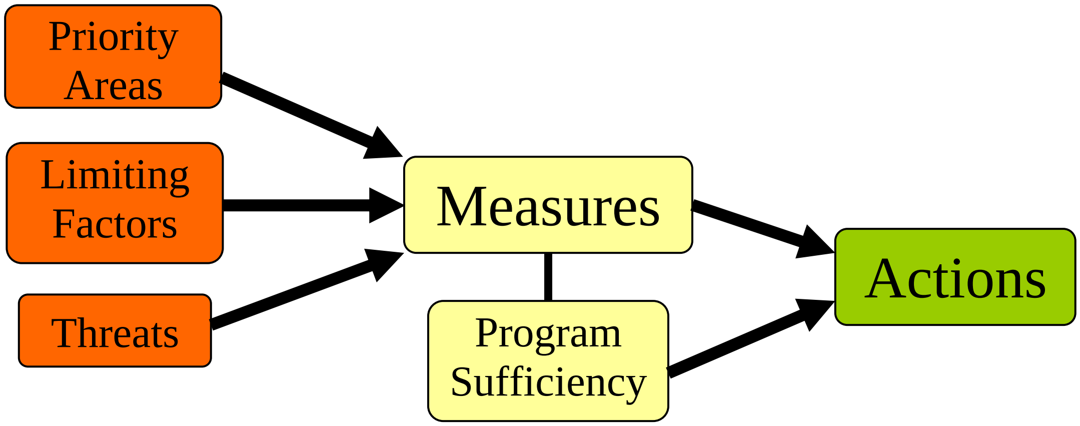


Figure 29. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Areas, Limiting Factors and Threats*

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

Summary

Decades of human activity in the Elochoman/Skamokawa Watershed 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 Elochoman/Skamokawa Watershed 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 watershed. 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 14.

- **Upper Skamokawa & tributaries** *(reaches Skamokawa 4-8; LF Skamokawa 2; McDonald 1,3; Falk 1-2)* – The upper Skamokawa and tributaries provide potentially productive habitat for all species. These reaches are heavily impacted by agriculture and rural residential development. Effective recovery measures will include riparian reforestation, cattle exclusion fencing, and floodplain re-connection.
- **Wilson Creek** *(reaches Wilson 1-4)* – Wilson Creek primarily supports winter steelhead and coho. These reaches are heavily impacted by agriculture and rural residential development. Effective recovery measures will include riparian reforestation, cattle exclusion fencing, and floodplain re-connection.
- **Lower Elochoman & tributaries** *(reaches Elochoman 3-7; Clear Creek 1-3; Duck 1-6)*– The lower Elochoman and the lower reaches of mainstem tributaries have been impacted by agriculture and rural residential development. Effective recovery measures will involve riparian and floodplain restoration.

- **Upper Elochoman & tributaries** *(reaches Elochoman 8-14; WF Elochoman 1-2; NF Elochoman 1; EF Elochoman 1)* – Winter steelhead make the greatest use of upper Elochoman reaches. These reaches are predominantly impacted by forest practices occurring in the upper watershed. Effective recovery of these reaches will involve watershed-wide recovery of runoff and sediment supply function.

Table 14. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the upper Skamokawa and tributaries (US), Wilson Creek (WC), lower Elochoman and tributaries (LE), and the upper Elochoman and tributaries (UE). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors	US	WC	LE	UE
Habitat connectivity				
Blockages to channel habitats			✓	
Habitat diversity				
Lack of stable instream woody debris	✓	✓	✓	✓
Altered habitat unit composition	✓	✓	✓	✓
Loss of off-channel and/or side-channel habitats	✓	✓	✓	
Channel stability				
Bed and bank erosion	✓	✓		✓
Channel down-cutting (incision)	✓	✓		
Mass wasting				✓
Riparian function				
Reduced stream canopy cover	✓	✓	✓	✓
Reduced bank/soil stability	✓	✓	✓	✓
Exotic and/or noxious species	✓	✓	✓	
Reduced wood recruitment	✓	✓	✓	✓
Floodplain function				
Altered nutrient exchange processes	✓	✓	✓	
Reduced flood flow dampening	✓	✓	✓	
Restricted channel migration	✓	✓	✓	
Disrupted hyporheic processes	✓	✓	✓	
Stream flow				
Altered magnitude, duration, or rate of change	✓	✓	✓	✓
Water quality				
Altered stream temperature regime	✓	✓	✓	
Excessive turbidity	✓	✓		
Bacteria	✓	✓	✓	
Substrate and sediment				
Excessive fine sediment	✓	✓	✓	✓
Embedded substrates	✓	✓	✓	✓

Threats	US	WC	LE	UE
Agriculture / grazing				
Clearing of vegetation	✓	✓	✓	
Riparian grazing	✓	✓	✓	
Floodplain filling	✓	✓	✓	
Rural development				
Clearing of vegetation	✓	✓	✓	
Floodplain filling	✓	✓	✓	
Roads – riparian/floodplain impacts	✓	✓	✓	
Increased watershed imperviousness	✓	✓	✓	
Leaking septic systems	✓	✓	✓	
Forest practices				
Timber harvests –sediment supply impacts	✓	✓	✓	✓
Timber harvests – impacts to runoff	✓	✓	✓	✓
Riparian harvests			✓	✓
Forest roads – impacts to sediment supply	✓	✓	✓	✓
Forest roads – impacts to runoff	✓	✓	✓	✓
Forest roads – riparian/floodplain impacts			✓	✓
Splash-dam logging (historical)			✓	
Channel manipulations				
Bank hardening	✓	✓	✓	
Channel straightening	✓	✓	✓	
Artificial confinement	✓	✓	✓	

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 this watershed, reach rankings for all of the modeled populations were combined, using population designations as a weighting factor. Population designations for this watershed 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 15. Reach tier designations for this watershed are included in Table 16. Reach tiers and subwatershed groups are displayed on a map in Figure 30. A summary of reach- and subwatershed-scale limiting factors is included in Table 17.

Table 15. 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 16. Reach Tiers in the Elochoman/Skamokawa Watershed

Tier 1	Tier 2	Tier 3	Tier 4	
Clear-1	Beaver-2	LF Skamokawa-1	Alger-1	Otter-2
Clear-3	Duck-3	Quarry-1	Alger-2	Pollard-1
Duck-1	Duck-4	Standard-1	Beaver-1	Rock-2 (culvert)
Eloch-10	Duck-6		Bell Canyon-1	Rock-3
Eloch-13	EF Eloch-1		Brooks-1	Skamokawa-1
Eloch-3	Eggman-2		Brooks-2	Skamokawa-2
Eloch-4	Eloch-11		Cadman-1	Skamokawa-3
Eloch-5	Eloch-12		Cadman-2	Skamokawa-4
Eloch-6	Eloch-14		Cadman-3	Standard-2
Eloch-7	Eloch-8		Clear-2 (culvert)	Trib1232156463572
LF Skamokawa-2	Eloch-9		Duck-2 (culvert)	Trib1232509463400
McDonald-3	Falk-1		Duck-5 (culvert)	Trib1232562463641
Rock-1	Falk-2		EF Eloch-2	Trib1232567463186
Skamokawa-5	McDonald-1		Eggman-1	Trib1232728463673
Skamokawa-6	NF Eloch-1		Eloch-1	Trib1232792463272
Skamokawa-8	Skamokawa-7		Eloch-2	Trib1233036463388-1
West Valley-2	Trib1232540463591		Falk-3	Trib1233126462580
Wilson-3	Trib1232902463299		LF Skamokawa-3	Trib1233686463037
	WF Eloch-1		LF Skamokawa-4	Trib1233695462430-1
	WF Eloch-2		Longtrain-1	Trib1234547463284-1
	Wilson-1		McDonald-2	Trib1234547463284-2
	Wilson-2		Nelson-1	West Valley-1
	Wilson-4		Nelson-2	West Valley-3
			Nelson-3	WF Eloch-3
			NF Eloch-2	WF Skamokawa-1
			NF Eloch-3	WF Skamokawa-2
			NF Eloch-4	WF Skamokawa-3
			Otter-1	WF Skamokawa-4
				WF Skamokawa-5

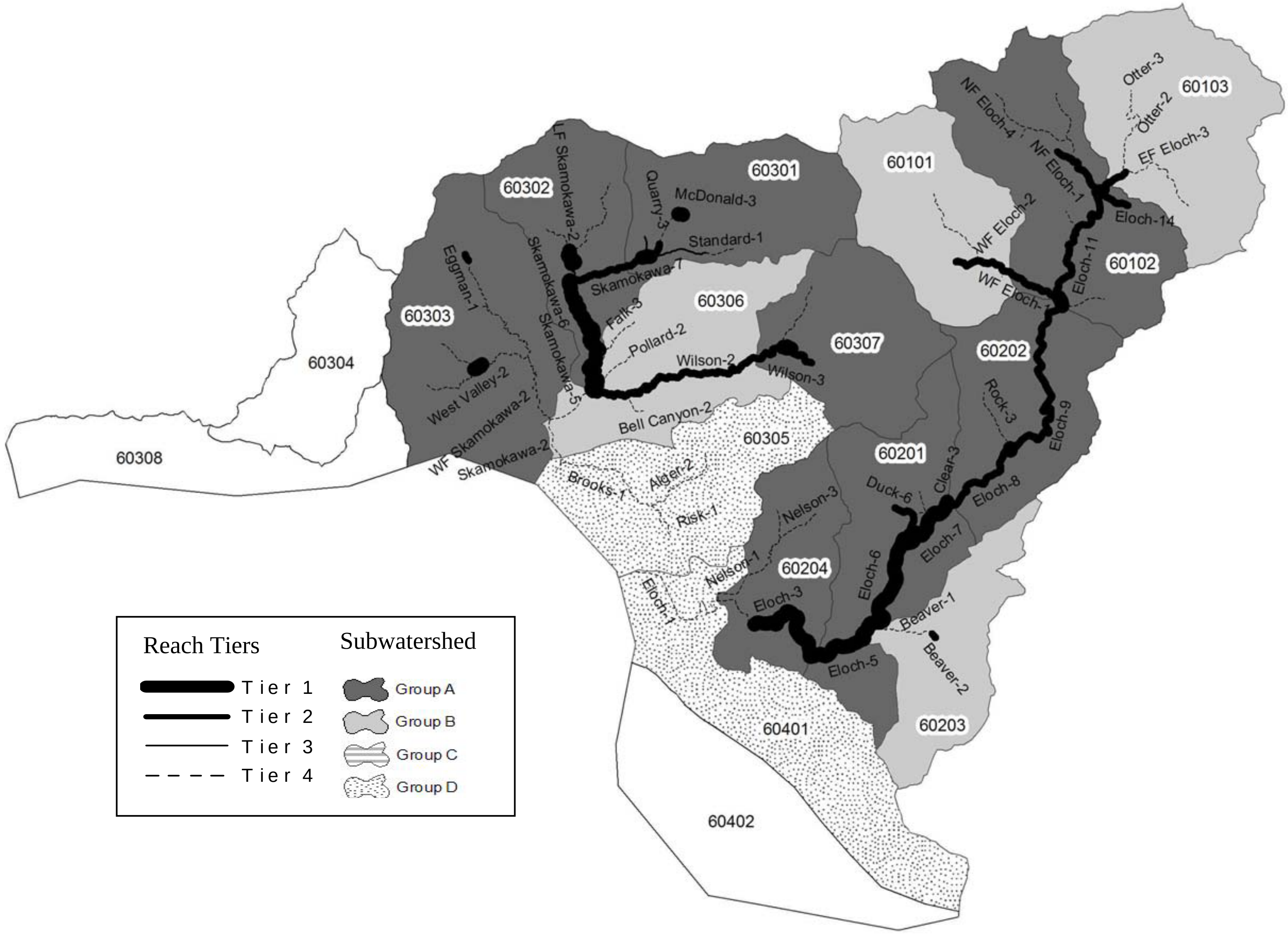


Figure 30. Reach tiers and subwatershed groups in the Elochoman/Skamokawa Watershed. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities 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 17. 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.

Skamokawa

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local) Hydrology	Watershed processes (local) Sediment	Watershed processes (local) Riparian	Watershed processes (watershed) Hydrology	Watershed processes (watershed) Sediment
A	60307	Trib1233686463037 Wilson-3 Wilson-4	Coho	Wilson-3	egg incubation fry colonization summer rearing	habitat diversity sediment food key habitat quantity	PR	I	M	M	I	M
			StW	Wilson-3 Wilson-4	egg incubation fry colonization summer rearing winter rearing adult holding	habitat diversity flow sediment key habitat quantity	PR					
	60303	Cadman-1 Cadman-2 Cadman-3 Eggman-1 Eggman-2 West Valley-1 West Valley-2 West Valley-3 WF Skamokawa-1 WF Skamokawa-2 WF Skamokawa-3 WF Skamokawa-4 WF Skamokawa-5	Coho	West Valley-2	spawning egg incubation summer rearing winter rearing	habitat diversity sediment	PR	I	M	M	I	M
			StW	none								
	60302	LF Skamokawa-1 LF Skamokawa-2 LF Skamokawa-3 LF Skamokawa-4 Skamokawa-5 Skamokawa-6 Skamokawa-7 Trib1234547463284-1 Trib1234547463284-2	ChF	Skamokawa-5	egg incubation fry colonization adult holding	sediment	P	I	M	M	I	M
			Chum	Skamokawa-6 Skamokawa-5	spawning egg incubation adult holding	habitat diversity sediment	P					
			Coho	Skamokawa-6 LF Skamokawa-2 Skamokawa-5	egg incubation fry colonization summer rearing winter rearing	habitat diversity temperature sediment food	PR					
			StW	Skamokawa-7	egg incubation summer rearing	temperature sediment	PR					
	60301	McDonald-1 McDonald-2 McDonald-3 Quarry-1 Skamokawa-8 Standard-1 Standard-2	ChF	Skamokawa-8	spawning egg incubation fry colonization adult holding	channel stability sediment	P	M	M	M	M	M
			Coho	McDonald-3	spawning egg incubation fry colonization summer rearing winter rearing adult holding	habitat diversity sediment key habitat quantity	P					
			StW	Skamokawa-8 McDonald-1	egg incubation fry colonization summer rearing	habitat diversity temperature flow sediment food key habitat quantity	PR					
B	60306	Bell Canyon-1 Falk-1 Falk-2 Falk-3 Pollard-1 Skamokawa-2 Skamokawa-3 Skamokawa-4 Wilson-1 Wilson-2	All	none				I	F	M	I	M
D	60305	Alger-1 Alger-2 Brooks-1 Brooks-2 Skamokawa-1	All	none				I	M	M	I	M

Elochoman

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local) Hydrology	Watershed processes (local) Sediment	Watershed processes (local) Riparian	Watershed processes (watershed) Hydrology	Watershed processes (watershed) Sediment
A	60202	Eloch-5 Eloch-6 Rock-1 Rock-3	ChF	Eloch-6	egg incubation fry colonization adult holding	sediment	PR	M	M	M	M	M
			Chum	none								
			Coho	Eloch-5 Eloch-6 Rock-1	spawning fry colonization egg incubation summer rearing winter rearing adult holding	habitat diversity temperature sediment key habitat quantity	PR					
			StW	Rock-1	spawning egg incubation fry colonization adult holding	habitat diversity sediment	P					
	60201	Clear-1 Clear-3 Duck-1 Duck-3 Duck-4 Duck-6 Eloch-2 Eloch-4 Trib1233126462580	ChF	Eloch-4	spawning egg incubation fry colonization	sediment	PR	I	M	M	I	M
			Chum	Eloch-4	spawning egg incubation adult holding	sediment	PR					
			Coho	Clear-1 Clear-3 Duck-1 Eloch-4	spawning fry colonization egg incubation summer rearing juvenile (age-0) migrant winter rearing adult holding		PR					
			StW	Clear-1 Clear-3	egg incubation fry colonization adult holding	sediment	P					
	60102	Eloch-10 Eloch-11 Eloch-12 Eloch-13 Eloch-14 Eloch-7 Eloch-8 Eloch-9 NF Eloch-1 NF Eloch-2 NF Eloch-3 NF Eloch-4 Trib1232509463400 Trib1232540463591 Trib1232562463641 Trib1232567463186 Trib1232728463673 WF Eloch-1	ChF	Eloch-10 Eloch-7	spawning egg incubation fry colonization adult holding	channel stability habitat diversity sediment	PR	M	M	M	M	M
			Coho	Eloch-10 Eloch-13	egg incubation fry colonization summer rearing winter rearing		R					
			StW	Eloch-10 Eloch-11 Eloch-13 Eloch-8 WF Eloch-1	egg incubation fry colonization summer rearing winter rearing	habitat diversity flow sediment	PR					
	60204	Eloch-2 Eloch-3 Longtrain-1 Nelson-1 Nelson-2 Nelson-3 Trib1233695462430-1	ChF	none				I	M	M	I	M
			Chum	Eloch-3	spawning egg incubation adult holding	sediment	PR					
			Coho	none								
			StW	none								
B	60203	Beaver-1 Beaver-2	Coho	none				M	M	M	M	M
			StW	Beaver-2	spawning egg incubation fry colonization summer rearing	habitat diversity sediment	R					
	60101	Trib1232792463272 Trib1232902463299 Trib1233036463388-1 WF Eloch-2 WF Eloch-3	Coho	none				I	M	M	I	M
			StW	WF Eloch-2	egg incubation fry colonization summer rearing winter rearing	habitat diversity flow sediment	R					
	60103	EF Eloch-1 EF Eloch-2 Otter-1 Otter-2 Trib1232156463572	Coho	none				I	M	M	I	M
			StW	none								
D	60401	Eloch-1	All	none				I	M	I	I	M

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the Elochoman/Skamokawa subbasin and necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this watershed (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 Elochoman/Skamokawa Watershed are presented in priority order in Table 18. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the watershed. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

Following the list of priority locations is a list of the programs that are the most relevant to the measure. Each program is qualitatively evaluated as to whether it is sufficient or needs expansion with respect to the measure. This exercise provides an indication of how effectively the measure is already covered by existing programs, policy, or projects; and therefore indicates where there is a gap in measure implementation. This information is summarized in a discussion of the 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 have been adjusted for the specific circumstances occurring in the Elochoman/Skamokawa Watershed. 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 watershed. These are presented in Table 19. Actions are different than the measures in a number of ways: 1) actions have a greater degree of specificity than measures, 2) actions consider existing programs and are therefore not based strictly on biophysical conditions, 3) actions refer to the agency or entity that would be responsible for carrying out the action, and 4) actions are related to an expected outcome with respect to the biological objectives. Actions are not presented in priority order, but instead represent the suite of activities that are all necessary for recovery of listed species. The priority for implementation of these actions must consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table 18. Prioritized measures for the Elochoman/Skamokawa Watershed.

#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	Streams in upper elevations have been heavily impacted by past riparian timber harvests and splash-dam logging. Stream channel conditions within the broad agricultural valley in the middle and lower Skamokawa and Wilson Creek have been heavily impacted by agricultural practices. Reaches in agricultural areas along the lower and middle Elochoman have also received significant alteration. 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 (agriculture, rural residential) at risk of further degradation
Reaches: Skamokawa 4-8; LF Skamokawa 2; Falk 1-2; Wilson 1-4; Elochoman 3-7; Duck 1, 3, 4, 6; Clear Cr 1,3
2nd- Remaining Tier 1 and 2 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, State Forest Practices, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Wahkiakum County	Comprehensive Planning		✓
Town of Cathlamet	Comprehensive Planning, Water Supply		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agriculture Land Habitat Protection Programs		✓
Noxious Weed Control Boards (State and County level)	Noxious weed control		✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements		✓

Program Sufficiency and Gaps

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

#2 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage agricultural practices to minimize impacts to sediment supply processes, runoff regime, and water quality C. Manage growth and development to minimize impacts to sediment supply processes, runoff regime, and water quality	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes • Development – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest and road building. Lowland hillslope processes have been impacted by 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 IWA – local rating)
Subwatersheds: 60306

2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 60303, 60302, 60301, 60101, 60102, 60103, 60307, 60202, 60201, 60204, 60203

3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 60304, 60308, 60401, 60305

4th- All remaining subwatersheds
Subwatersheds: 60402

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
Town of Cathlamet	Comprehensive Planning		✓
Wahkiakum County	Comprehensive Planning		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agriculture 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 (agriculture and developed), local government comprehensive planning is the primary nexus for protection of hillslope processes. Local governments can control impacts through zoning that protects open-space, through stormwater management ordinances, and through tax incentives to prevent agricultural and forest lands from becoming developed. There are few to no regulatory protections of hillslope processes that relate to agricultural practices; such deficiencies need to be addressed through local or state authorities. Protecting hillslope processes on agricultural lands would also benefit from the expansion of technical assistance and landowner incentive programs (NRCS, Conservation Districts).

#3- Restore degraded hillslope processes on forest and agricultural lands with an emphasis on sediment supply processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Upgrade or remove problem forest roads B. Reforest heavily cut areas not recovering naturally C. Employ agricultural Best Management Practices with respect to contaminant use, erosion, and runoff	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest and road building. According to EDT, the sediment impact to egg incubation is the greatest limiting factor for all species in the Elochoman and Skamokawa Basins. Sediment supply processes must be addressed for reach-level habitat recovery to be successful.

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. Impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: 60303, 60302, 60301, 60101, 60102, 60103, 60307, 60202, 60201, 60204, 60203, 60306

2nd- Moderately impaired or impaired subwatersheds contributing to other reaches
Subwatersheds: 60304, 60308, 60305, 60401

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, State Forest Practices	✓	
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Wahkiakum County	Stormwater Management		✓
Town of Cathlamet	Stormwater Management		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural Lands Habitat Restoration Programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

Forest management programs including the new Forest Practices Rules (private timber lands) and the WDNR HCP (state timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements 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 agricultural lands occurs relatively infrequently and there are no programs that specifically require restoration in these areas. Restoring existing agricultural lands can involve retrofitting facilities with new materials, replacing existing systems, and adopting new management practices. 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 landowners to conduct restoration projects.

#4 - Restore floodplain function and channel migration processes in lowland mixed-use areas along the major streams

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Set back, breach, or remove artificial confinement structures	• Bed and bank erosion • Altered habitat unit composition • Restricted channel migration • Disrupted hyporheic processes • Reduced flood flow dampening • Altered nutrient exchange processes • Channel incision • Loss of off-channel and/or side-channel habitat • Blockages to off-channel habitats	• Floodplain filling • Channel straightening • Artificial confinement	Chum, fall chinook, coho	There has been significant degradation of floodplain connectivity and constriction of channel migration zones in the agricultural valleys of the Elochoman, Skamokawa, and Wilson Creek. Removal of confining structures would restore floodplain and CMZ function as well as facilitate the creation of off-channel and side channel habitats. There are feasibility issues with implementation due to private lands, existing infrastructure already in place, potential flood risk to property, and large expense.

Priority Locations

1st- Tier 1 reaches in mixed-use areas with hydro-modifications (obtained from EDT ratings)
Reaches: Elochoman 3-4, 6-7; Skamokawa 5-6; Clear 3; Duck 1; Wilson 3
2nd- Tier 2 reaches in mixed-use areas with hydro-modifications
Reaches: Elochoman 8, 12; Skamokawa 7; Wilson 1, 2, 4; Beaver 2
3rd- Other reaches with hydro-modifications
Reaches: Alger 1-2; Beaver 1, 6; Brooks 1; Elochoman 1-2; Kelly 2; Nelson 1; NF Eloch 2-4; Risk 4; Skamokawa 1-4; West Valley 1; WF Skamokawa 1-2; Wilson 5-6

Key Programs

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

Program Sufficiency and Gaps

There currently are no programs that set forth strategies for restoring floodplain function and channel migration processes in the Elochoman and Skamokawa Basins. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners 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. The USACE is conducting a Lower Columbia River Ecosystem Restoration Study which may identify and assess potential floodplain restoration projects in the lower Elochoman/Skamokawa Basin.

#5 - Restore riparian conditions throughout the basin

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

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, State Forest Practices	✓	
WDFW	Habitat Program		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agriculture Lands Habitat Restoration Programs		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed 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 Wahkiakum County and the Town of Cathlamet's Comprehensive Plan. Many degraded riparian zones in agricultural, rural residential, or transportation corridors will not passively restore with existing regulatory protections and will require active measures. Riparian restoration in these areas may entail livestock exclusion, tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Exclude livestock from riparian areas B. Increase riparian shading C. Decrease channel width-to-depth ratios D. Reduce delivery of chemical contaminants to streams E. Address leaking septic systems	• Altered stream temperature regime • Bacteria • Chemical contaminants	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to rural development and agriculture • Leaking septic systems • Chemical contaminants from agricultural and developed lands	All species	There are known impairments to stream temperature and fecal coliform bacteria in the basin. Bacteria is more of a human health concern than a fish health concern. Excluding livestock from riparian areas is particularly important in the heavily grazed lowland areas. Leaking septic systems may be contributing to bacteria levels in some areas. The degree of impact of agricultural pollutants is unknown and needs further assessment.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 draft list)
Reaches: Elochoman 3-4 (temperature); Skamokawa 5 (temperature); Wilson 1-2 (temperature)
2nd- Other reaches with 303(d) listings
Reaches: Skamokawa 3 (temperature)
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, State Forest Practices	✓	
WDFW	Habitat Program		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural Land Habitat Restoration Programs, Centennial Clean Water Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Wahkiakum 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 are several listed stream segments in the Elochoman Subbasin for temperature and there are a few segments listed as concern for fecal coliform bacteria impairment (WDOE 2004). Water Quality Clean-up Plans (TMDLs) that address the temperature impairments are required by the WDOE and it is anticipated that the TMDLs will adequately set forth strategies to address the temperature concerns in the basin. It will be important that the strategies specified in the TMDLs are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns, however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin, especially regarding agricultural pollutants.

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

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

Priority Locations

Lower basin alluvial reaches (lower Skamokawa Creek; lower WF Skamokawa; Wilson Creek; lower and middle Elochoman)

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.

#8 – 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 10 miles of potentially accessible habitat are blocked by culverts or other barriers (approximately 8 barriers total). The blocked habitat is believed to be marginal in most cases. The water intake dam for the hatchery on Beaver Creek is believed to be a partial barrier. 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- Beaver 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		✓
Wahkiakum County	Roads		✓

Program Sufficiency and Gaps

The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Past efforts have corrected major blockages 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.

#9 - 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. Most areas of bank instability are located in the agricultural middle valley of the Skamokawa River and Wilson Creeks. Bio-engineered approaches that rely on structural as well as vegetative measures are the most appropriate. These projects have a high risk of failure if causative factors are not adequately addressed.

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	Agriculture 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. Projects are likely to occur 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.

#10 – 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 in tributaries during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Elochoman Subbasin have been identified as part of Watershed Planning for WRIA 25 (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 25/26 Watershed Planning Unit	Watershed Planning	✓	
Town of Cathlamet	Water Supply	✓	
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 this planning effort is to adopt a watershed plan by December 2004. Instream flow management in the Elochoman Subbasin will be conducted using the recommendations of the WRIA 25/26 Planning Unit, which is coordinated by the LCFRB. Draft products of the WRIA 25/26 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the planning unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies. Ecology should follow the recommendations of the WRIA 25/26 Watershed Planning Unit in terms of instream flow management.

Table 19. Habitat actions for the Elochoman/Skamokawa Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[2]	Expected Biophysical Response[3]	Certainty of Outcome[4]
Eloch-Skam 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, 5, 6, & 8	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
Eloch-Skam 2. Expand standards in local government comprehensive plans to afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Wahkiakum County, Town of Cathlamet, Pacific County	1 & 2	Medium: Private lands. Applies primarily to lands in the lower basin in agriculture, 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
Eloch-Skam 3. Prevent floodplain impacts from development through land use controls and Best Management Practices	New program or activity	Wahkiakum County, WDOE, Town of Cathlamet	1	Medium: Private lands currently in agriculture or timber production in lowland areas.	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
Eloch-Skam 4. Seize opportunities to conduct voluntary floodplain restoration on lands being phased out of agricultural production. Survey landowners, build partnerships, and provide financial incentives	New program or activity	NRCS/WCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 6, 7, &, 9	Medium: Middle mainstem Skamokawa, lower WF Skamokawa, Wilson Creek, lower and middle mainstem Elochoman	High: Restoration of floodplain function, CMZ function, habitat diversity, and habitat availability.	High
Eloch-Skam 5. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of agriculture and timber lands to developed uses through zoning regulations and tax incentives	Expansion of existing program or activity	Wahkiakum County, Town of Cathlamet, Pacific County	1 & 2	Medium: Private lands. Applies primarily to lands in the lower basin in agriculture, 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
Eloch-Skam 6. 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	Wahkiakum County, Town of Cathlamet	1, 3, 5, & 6	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
Eloch-Skam 7. 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/WCD, LCFEG	7	Medium: Lower mainstem Elochoman and Skamokawa Creeks	High: Increased habitat availability for spawning and rearing	Medium
Eloch-Skam 8. Implement the prescriptions of the WRIA 25/26 Watershed Planning Unit	Activity is currently in	WDOE, WDFW, WRIA 25/26 Planning Unit,	10	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other	Medium

[2] Relative amount of basin affected by action
[3] Expected response of action implementation
[4] 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[2]	Expected Biophysical Response[3]	Certainty of Outcome[4]
regarding instream flows	place	Town of Cathlamet			aquatic biota.	
Eloch-Skam 9. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS/WCD, LCFEG	3, 4, 5, 6, 7, 8, & 9	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality (temperature and bacteria), LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
Eloch-Skam 10. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 3, 5, 6, & 8	Low: Small private timberland owners	High: Reduction in road-related fine sediment delivery; preservation of fish access to habitats	Medium
Eloch-Skam 11. 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: Mixed-use lands at risk of degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
Eloch-Skam 12. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS/WCD, WDNR, WDFW, Wahkiakum County, Town of Cathlamet	All measures	Medium: Private lands. Applies primarily to lands in the lower basin in agriculture, rural residential, and forestland uses	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
Eloch-Skam 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	Medium: State timber lands in the Eloch-Skam Watershed (approximately 21% of the basin area)	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats.	Medium
Eloch-Skam 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/WCD, LCFEG	1 & 5	Medium: 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
Eloch-Skam 15. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	Expansion of existing program or activity	Wahkiakum County, WCD	6	Low: Private agricultural and rural residential lands in lower basin	Medium: Protection and restoration of water quality (bacteria)	Low
Eloch-Skam 16. 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, Wahkiakum County, WSDOT, LCFEG	8	Low: As many as 10 miles of stream are blocked by artificial barriers	Low: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	High

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the Elochoman/Skamokawa Watershed 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 for fishery benefits. The recovery strategy includes a mixture of conservation programs and mitigation programs. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the Elochoman/Skamokawa Watershed are displayed by species in Table 20. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 20. Summary of natural production and fishery enhancement strategies to be implemented in the Elochoman/Skamokawa Watershed.

		Species					
		Fall Chinook	**Spring Chinook**	**Coho**	**Chum**	**Winter Steelhead**	**Summer Steelhead**
Natural Production Enhancement	**Supplementation**			✓	✓		
	Hatch/Nat Conservation [1/]	✓					
	Isolation					✓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/ Isolated area for winter steelhead is in upper watershed upstream of the Elochoman Hatchery

Conservation-based hatchery programs include strategies and actions which are specifically intended to enhance or protect production of a particular wild fish population within the watershed. 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 subbasins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These refugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural population on fitness and our ability to measure natural population productivity and will be key indicators of natural population status within the ESU. This strategy is not proposed for the Elochoman/Skamokawa 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 coho and chum in the Elochoman/Skamokawa Watershed.

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 for winter steelhead in the upper Elochoman River Watershed upstream of the Elochoman Hatchery and could be considered in the future for coho. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations.

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

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

The Elochoman River Hatchery will be operated to include natural production enhancement strategies for chum and coho in the Elochoman River, Skamokawa Creek, and coastal tributaries The Elochoman River Hatchery will continue to support fall Chinook, coho, and summer and winter steelhead fisheries with hatchery releases in the Elochoman Watershed, and also facilitate Gray River early coho. This plan adds six new conservation programs at the Elochoman Hatchery facility (Table 21).

Table 21. A summary of conservation and harvest strategies to be implemented through Elochoman River Hatchery programs.

		Stock
Natural Production Enhancement	Supplementation	Eloch/Skam Coho√
		Eloch/Skam Coho √
		Coastal Trib Coho √
		Coastal Trib Chum √
	Hatch/Nat Conservation [1]/	Elochoman Fall Chinook
	Isolation	Elochoman Winter Steelhead 2/
	Broodstock development	Elochoman late Coho √
		Eloch/Skam Chum√
		Elochoman Late Winter Steelhead
Fishery Enhancement	In-basin releases (final rearing at Elochoman)	Elochoman Early Coho
		Elochoman Late Coho
		Elochoman Fall Chinook
		Elohcoman Winter Steelhead
		Lewis River Summer Steelhead
	Out of Basin Releases (final rearing at Elochoman)	Steamboast Slough Net Pens: Grays River Early Coho
		Coweeman River: Elochoman Winter Steelhead

[1]/ May include integrated and/or isolated strategy over time.
2/isolation occurs in the upper watershed upstream of the Elochoman Hatchery.
√ 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 conservation strategies identified for each natural population. Artificial production programs within Elochoman 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 Elochoman/Skamokawa Watershed (Table 22). The subbasin plan hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NOAA fisheries approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the Elochoman River hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 22. Regional hatchery actions from Volume I, Chapter 7 with potential implementation actions in the Elochoman Subbasin.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
Unique conservation strategy is developed for Elochoman 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. Measures may include: • Deliberate and consistent infusion of natural produced adults into the hatchery program. • Control proportions of hatchery and natural fish on the spawning grounds and in the hatchery. • Matrix system developed to determine annual distribution of wild and hatchery adults based on biological relationship and annual abundance	**Conservation management strategy implemented for fall Chinook natural and hatchery production. **Eliminate outside basin transfers of fall Chinook eggs or fry for release into the Elochoman basin	Elochoman Hatchery fall Chinook	Elochoman 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 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 Elochoman 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	Elochoman Hatchery coho, steelhead, and fall Chinook.	Elochoman winter and summer steelhead. Elochoman coho Elochoman fall Chinook	Domestication, Diversity, Abundance	• In-breeding • Harvest	• Maintain lower harvest impacts for natural Elochoman coho and steelhead compared to hatchery production • Provide the opportunity to develop fishing regulations which accomplish a lower harvest impact for wild Elochoman fall chinook compared to Elochoman 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
• Develop a coho brood stock using the latest (December-January) arriving late hatchery coho. Utilize production from	**Elochoman Hatchery facilities	Elochoman Hatchery late coho, and	Coastal coho; Coastal chum	Abundance,	• Low numbers of natural	• Development of a hatchery brood stock similar to the late returning historical populations in the

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
the existing programs and new late program to supplement wild production in coastal tributaries and for harvest. • Develop a chum brood stock utilizing natural returns to Skamokawa Creek or other appropriate coastal populations dependent on assessment of genetic similarity. Utilize broodstock for supplementation and risk management.	(including Beaver Creek) utilized for supplementation and enhancement of natural coho and chum populations	space for chum.	(Excluding the Grays and Chinook river populations)	Spatial distribution	spawners • Ecologically appropriate natural brood stock •	coastal region. Improve abundance and distribution of natural produced coho. • Establish an appropriate chum brood stock to supplement and manage risks to extreme low abundance of local populations. Increase abundance and distribution of coastal chum populations.
• Hatchery produced steelhead, coho, and fall Chinook will be scheduled for release during the time when the maximum numbers of fish are smolted and prepared to emigrate rapidly. • Juvenile rearing strategies will be implemented to provide a fish growth schedule which coincides with an optimum release time for hatchery production success and to minimize time spent in the Elochoman	*Juvenile release strategies to minimize impacts to natural populations	Elochoman Hatchery steelhead, coho, and fall Chinook	Elochoman fall Chinook, chum, and coho	Predation, Competition	• Hatchery smolt residence time in the Elochoman 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
• The Elochoman tidewater weir will be evaluated and adjusted if necessary to enable efficient collection of target fish and release/or passage of non-target fish. • Adequate function of diversion weir at the hatchery site to enable efficient collection of broodstock and control mix of hatchery and wild steelhead and coho in upper watershed. • Hatchery effluent discharge complies with NPDES permit monitoring requirements. Fish health monitored and treated as per co-managers fish health policy. • Maintain and repair Elochoman	*Evaluate facility operations	All species	All species	Access, Habitat quality,	• Fish barriers, • water quality, • In-take screens	• 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 Elochoman River downstream of the hatchery. • Elochoman Hatchery in-take screens are maintained, repaired, or replaced to minimize impacts to wild juvenile salmonids.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
Hatchery in-take screens.						
• 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 Elochoman/Skamokawa watershed (Table 23). More complete details can be found in the WDFW Sport Fishing Rules Pamphlet.

Table 23. Summary of regulatory and protective fishery actions in the Elochoman/Skamokawa Watersheds

Species	General Fishing Actions	Explanation	Other Protective Fishing Actions	Explanation
Fall Chinook	Open for fall Chinook in the Elochoman	Hatchery fish are produced for harvest. Hatchery fish are not mass marked	Night closures, gear restrictions, and closures near traps	Protection of fall chinook in areas of high concentration
chum	Closed to retention	Protects natural chum. Hatchery chum are not produced for harvest	Skamokawa Creek closed to all salmon	Further protects chum in Skamokawa Creek. Hatchery salmon are not released in Skamokawa Creek
coho	Retain only adipose fin-clip marked coho	Selective fishery for hatchery coho, unmarked wild coho must be released	Upper Elochoman , small tributaries, and Skamokawa Creek closed to salmon	Protects wild spawners. Hatchery coho released in lower Elochoman and not in Skamokawa Creek.
Winter steelhead	Retain only adipose fin-clip marked steelhead	Selective fishery for hatchery steelhead, unmarked wild steelhead must be released	Steelhead and trout fishing closed in the spring and minimum size restrictions in affect	Spring closure Protects adult wild steelhead during spawning and minimum size protects juvenile steelhead

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

Table 24. Regional harvest actions from Volume I, Chapter 7 with significant application to the Elochoman/Skamokawa Watershed 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 Elochoman 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 dams or hydropower facilities exist in the Elochoman/Skamokawa watershed; hence, no in-basin hydropower actions are identified. Elochoman/Skamokawa 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

Elochoman/Skamokawa anadromous fish populations will also benefit from regional recovery strategies and measures identified to address habitat conditions and threats in the Columbia River mainstem and estuary. Regional recovery plan strategies involve: 1) avoiding large scale habitat changes where risks are known or uncertain, 2) mitigating small-scale local habitat impacts to ensure no net loss, 3) protecting functioning habitats while restoring impaired habitats to functional conditions, 4) striving to understand, protect, and restore habitat-forming processes, 5) moving habitat conditions in the direction of the historical template which is presumed to be more consistent with restoring viable populations, and 6) improving understanding of salmonids 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 and steelhead with other elements of the ecosystem. Regional strategies and measures pertaining to exotic or non-native species, effects of salmon on system productivity, and native predators of salmon are detailed and discussed at length in 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 t 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 Elochoman/Skamokawa subbasin.

Table 25. Summary of the biological monitoring plan for the Elochoman/Skamokawa subbasin.

Elochoman/Skamokawa: Lower Columbia Biological Monitoring Plan						
Monitoring Type	Fall Chinook	Chum	Coho	Winter Steelhead		
Routine	AA	AA	AA	AA		
Intensive						
Level 1	✓	✓1/	✓	✓		
Level 2	✓		✓	✓		
Level 3	✓					

1/ Skamokawa Creek
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 26. Summary of the habitat monitoring plan for the Elochoman/Skamokawa subbasin.

Elochoman/Skamokawa : 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	Moderate	Stream Gage-Poor IFA-Poor	WDOE-Poor USGS-Poor Temperature-Good
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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Subbasin Plan Vol. II.D.
Elochoman Subbasin -
Mill, Abernathy and Germany Creeks

Contents

1.0 Mill, Abernathy and Germany Creeks – 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. Mill, Abernathy, and Germany Creeks are located in the Elochoman Subbasin as defined by the Northwest Power and Conservation Council (NPCC). These stream systems are referred to collectively as the M-A-G Watershed throughout this document. The plan for this watershed describes implementation of the regional approach within this watershed, 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), NPCC, federal agencies, state agencies, tribal nations, local governments, and others.

The M-A-G Watershed historically supported thousands of salmon and winter steelhead. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook and chum 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 isolated or eliminated by dredging and channel modifications and diking, filling, or draining floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or non-local hatchery fish has reduced productivity. Hydropower operation on the Columbia has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

Salmon and steelhead populations in Mill, Abernathy and Germany creeks will need to be restored to a medium to 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 watershed.

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

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact M-A-G 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 M-A-G Watershed 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 M-A-G Watershed. The following list identifies the most immediate priorities.

1. Manage Forest Lands to Protect and Restore Watershed Processes

The majority of the Mill, Abernathy, and Germany watersheds are managed for commercial timber production and have experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing fine sediment, and degrading riparian zones. Effects have been magnified due to high rainfall and erodable soils. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources’ Habitat Conservation Plan (state lands) and Forest Practices Rules (private lands) are expected to substantially improve conditions by restoring passage, protecting riparian conditions, reducing fine sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead and coho.

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

Most lower and middle mainstem and tributary stream reaches are used for agriculture or rural residences. Dike building and bank stabilization have heavily impacted fish habitat in these areas. Removing or modifying channel control and containment structures to reconnect the stream and its floodplain will restore normal habitat-forming processes to reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing. These improvements will be particularly beneficial to chum, fall Chinook, and coho. Normal floodplain functions will also help control downstream flooding and provide wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and habitats will be protected through local land use ordinances, partnerships with landowners, and the acquisition of land, where appropriate. Restoration will be achieved by working with willing landowners, non-governmental organizations, conservation districts, and state and federal agencies.

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

The human population in the watershed is relatively low, but it is projected to grow by at least one third in the next twenty years. The local economy is also in transition with reduced reliance on forest products, fisheries, and farming. Population growth will primarily occur in lower river valleys and along the major stream corridors. This growth will result in the conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions. Land-use changes will provide a variety of risks to terrestrial and aquatic habitats. Careful land-use planning will be necessary to protect and restore natural fish populations and habitats and will also present opportunities to preserve the rural character and local economic base of the watershed.

4. Address Immediate Risks with Short-term Habitat Fixes

Restoration of normal watershed processes that allow a basin to restore itself over time has proven to be the most effective strategy for long term habitat improvements. However, restoration of some critical habitats may take decades to occur. In the near term, it is important to initiate short-term fixes to address current critical low numbers of some species. Examples in the M-A-G Watershed include building chum salmon spawning channels and constructing coho overwintering habitat such as alcoves, side channels, and log jams. Benefits of structural enhancements are often temporary but will help bridge the period until normal habitat-forming processes are reestablished.

5. 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 some fishing benefits. There are no production hatcheries operating in the M-A-G Watershed.

6. 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 salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some salmon and steelhead originating from Mill, Abernathy, and Germany creeks 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 Mill, Abernathy and Germany creeks. Steelhead and chum will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Selective fisheries for marked hatchery steelhead and coho (and fall Chinook after mass marking occurs) will be a critical tool for limiting wild fish impacts. State and federal legislative bodies will be encouraged to develop funding necessary to implement mass-marking of Fall Chinook, thus enabling a selective fishery with lower impacts on wild fish. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

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

Mill, Abernathy and Germany salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the watershed. 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. Owing to it’s close proximity, estuary habitat improvements including restoration of wetlands, will be particularly critical to M-A-G salmonid populations. 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.

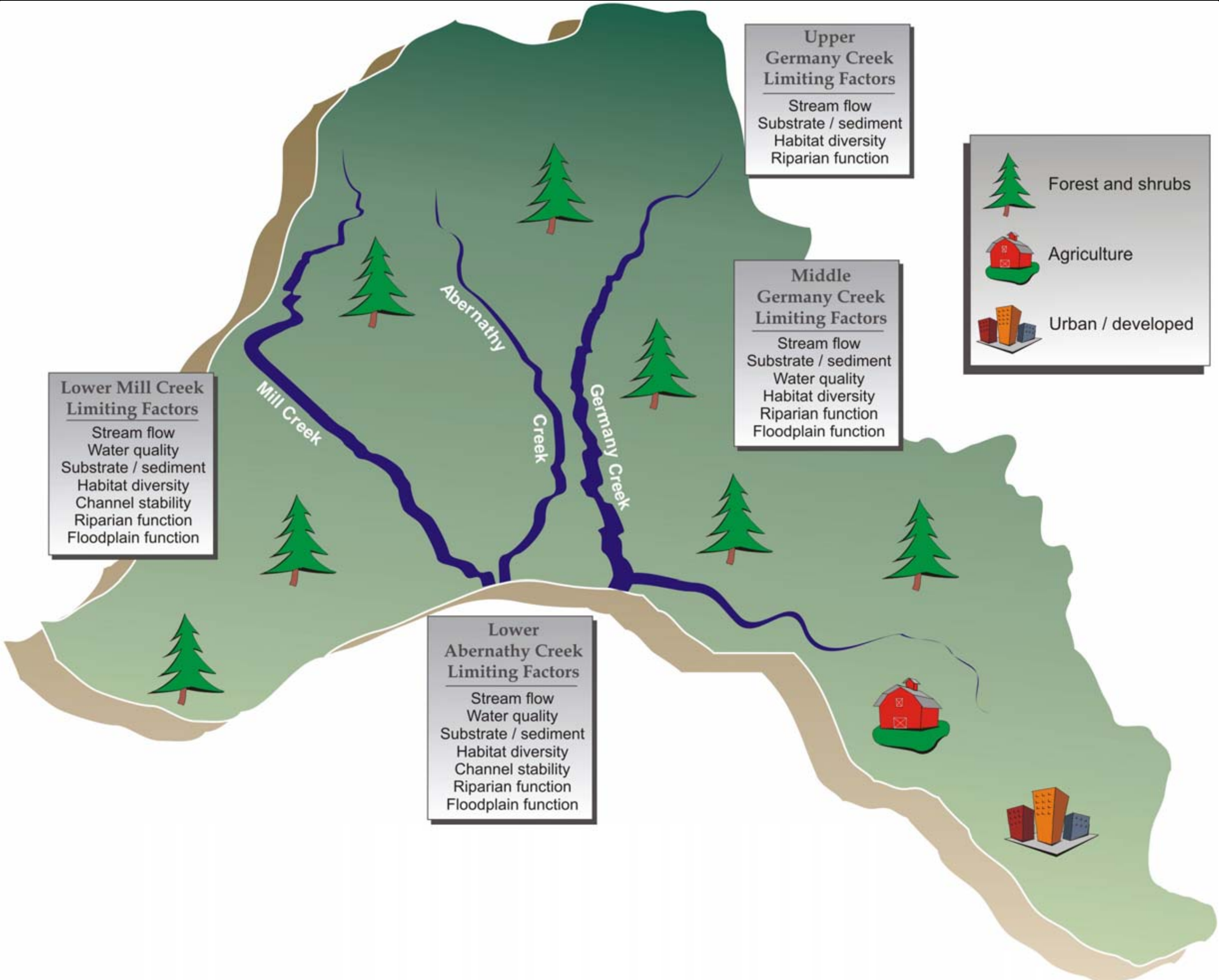


Figure 1. Key features of the Mill, Abernathy and Germany Creek stream systems including a summary of limiting fish habitat factors in different areas.

2.0 Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's Mill, Abernathy and Germany Creeks. 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 watershed, 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 vision, objectives, strategies, and measures for these watersheds within the Elochoman Subbasin. 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 M-A-G Watershed comprises the eastern half of the Elochoman Subbasin as defined by the Northwest Power and Conservation Council. For the purposes of this analysis, the M-A-G Watershed includes, from west to east, Mill Creek, Abernathy Creek, Germany Creek, Fall Creek, Coal Creek, Clark Creek, and the Longview Ditch network. The M-A-G Watershed comprises approximately 152 square miles, primarily in Cowlitz County with the remainder in Wahkiakum County. The watershed is part of WRIA 25.

The Mill/Abernathy/Germany Watershed is primarily a low elevation system, comprised primarily of volcanic (85%) and sedimentary and metamorphic rocks (13%). Twelve of the fourteen subwatersheds are comprised of low elevation, headwater and tributary subwatersheds; mostly in areas of low natural erodability (average rating is 11 on a scale of 0-126). Moderate-sized, low elevation stream reaches drain the other two subwatersheds.

3.1.2 *Climate*

The watershed has a typical northwest maritime climate. Summers are dry and cool and winters are mild, wet, and cloudy. Most precipitation falls between October and March, with mean annual precipitation ranging from 45-118 inches with an average mean of 70-85 inches. Snowfall is light and transient owing to the relative low elevation and moderate temperatures. Less than 10% of the watershed area is within the rain-on-snow zone or higher (WDNR data).

3.1.3 *Land Use, Ownership, and Cover*

Forestry is the predominant land use in the Mill/Abernathy/Germany Watershed. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Nearly 0% of the forest cover is in late-seral stages, however, as the forest matures, watershed conditions are recovering. Agriculture and residential land use is located along lower alluvial stream segments of Mill, Abernathy, and Germany Creeks. The watershed is primarily in private ownership, as shown in the following chart. The bulk of the private land is industrial forestland and road densities are high. The extent of the road network has important implications for watershed processes such as flow generation, sediment production, and contaminant transport. 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 Mill/Abernathy/Germany Watershed is presented in Figure 2 and Figure 3.

3.1.4 *Development Trends*

Projected population change from 2000-2020 for unincorporated areas in WRIA 25 is 37% (LCFRB 2001). Continued population growth will increase pressures for conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions.

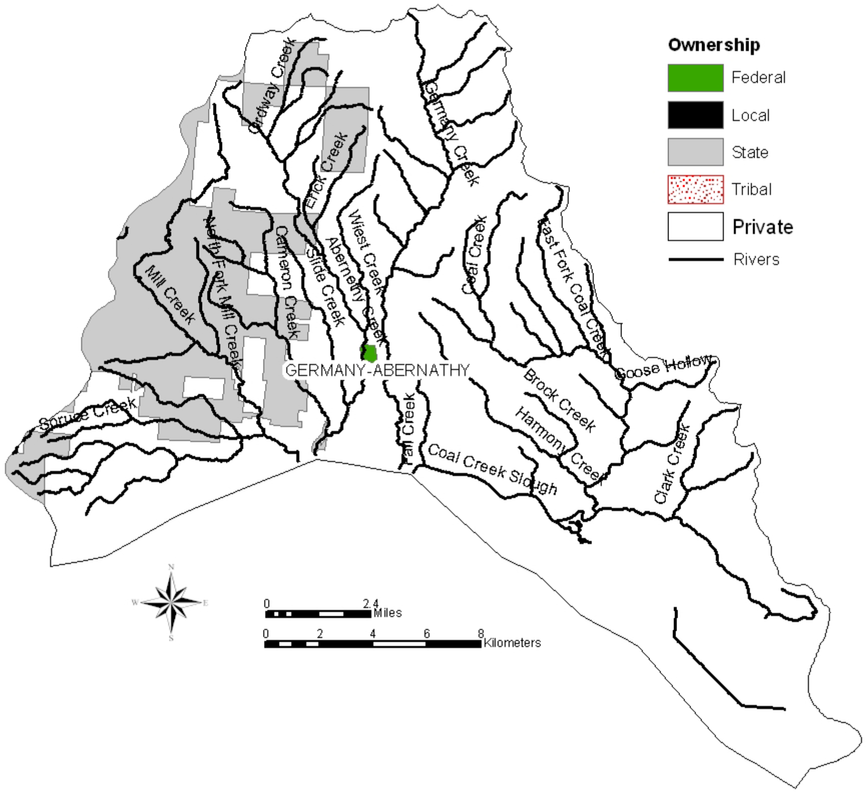


Figure 2. Landownership within the Mill/Abernathy/Germany Watershed. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

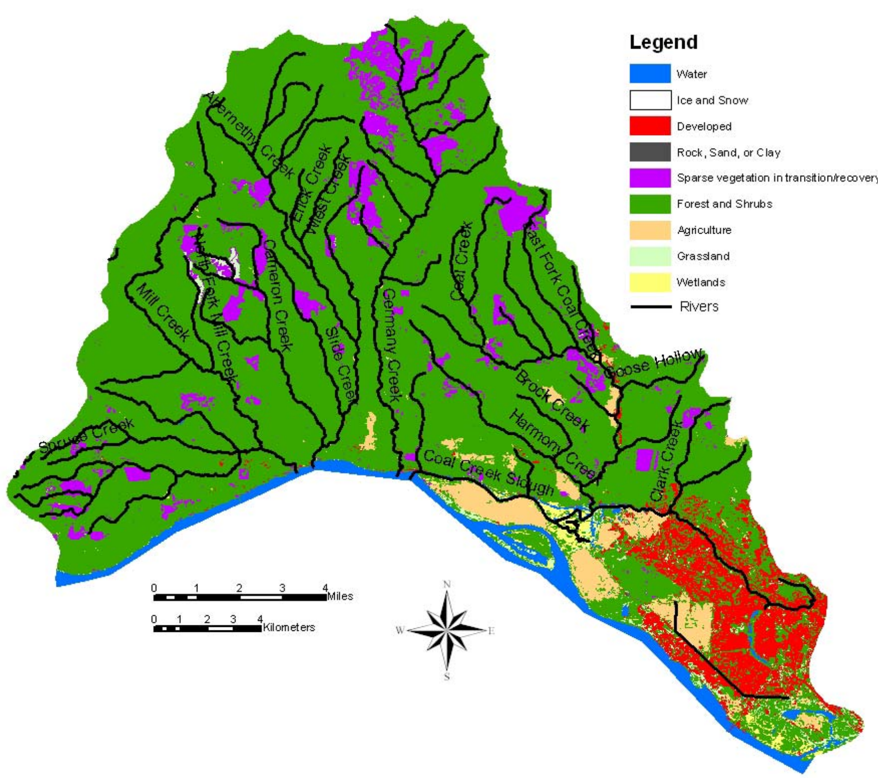


Figure 3. Land cover within the Mill/Abernathy/Germany Watershed. Data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal and Other Species of Interest

Listed salmon, as well as steelhead, and trout species are focal species of this planning effort for the Mill/Abernathy/Germany Watershed. 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 Mill/Abernathy/Germany Watershed although anadromous species are subject to effects in the Columbia River, estuary, and nearshore ocean. The Mill/Abernathy/Germany 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 Mill/Abernathy/Germany watersheds include chum, coho, winter steelhead, and fall chinook. 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 current health or viability ranges from very low for coho to low for chum, fall Chinook, and winter steelhead. Returns of coho and winter steelhead include both natural and hatchery produced fish.

Table 1. Status of focal salmond and steelhead populations in the Mill/Abernathy/Germany Watershed.

Focal Species	ESA Status	Hatchery Component[1]	Historical numbers[2]	Recent numbers[3]	Current viability[4]	Extinction risk[5]
Fall Chinook	Threatened	No	5,000-7,500	300-4,000	Low	50%
Chum	Threatened	No	6,500-40,000	50-100	Low+	70%
Coho	Proposed	Yes	10,000-30,000	Unknown	Very Low	60%
Winter Steelhead	Not Listed	Yes	2,000	50-500	Low+	40%

[1] Significant numbers of hatchery fish are released in the watershed.
[2] Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA rough calculations..
[3] Approximate current annual range in number of naturally-produced fish returning to the watershed.
[4] Prospects 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

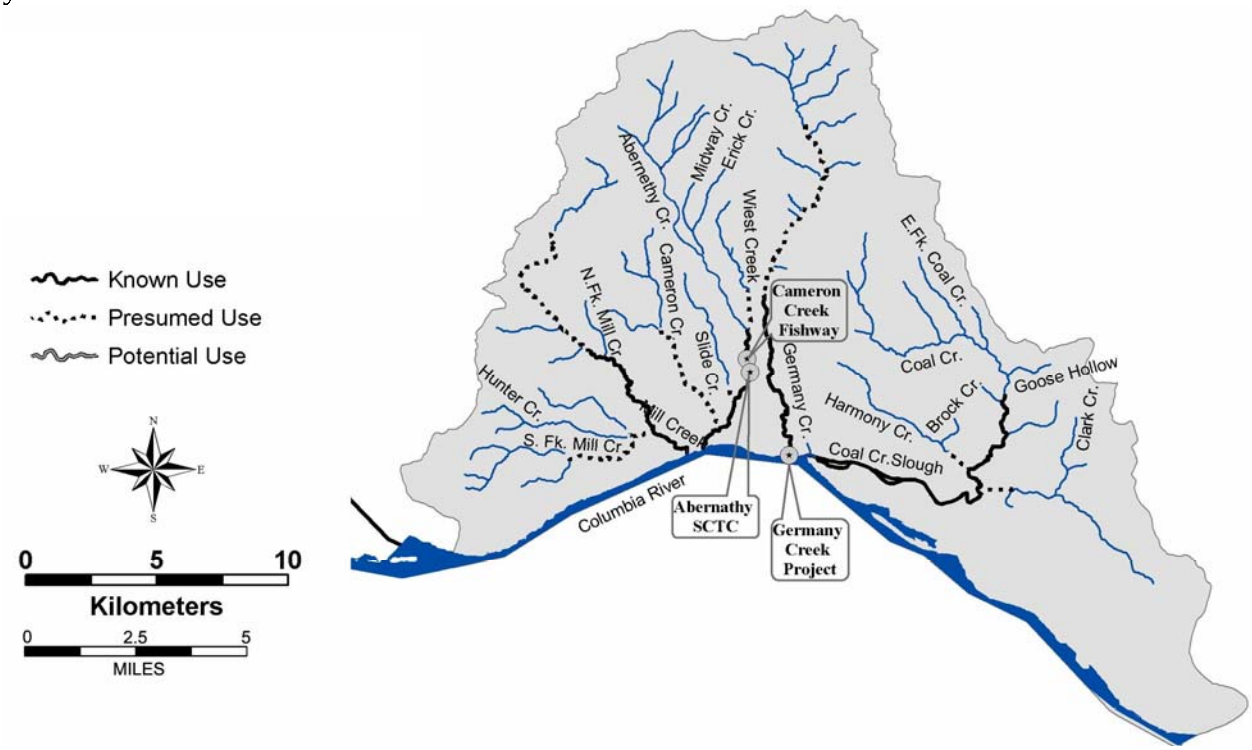
Other species of interest in the Mill/Abernathy/Germany Watershed include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

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— Mill/Abernathy/Germany*

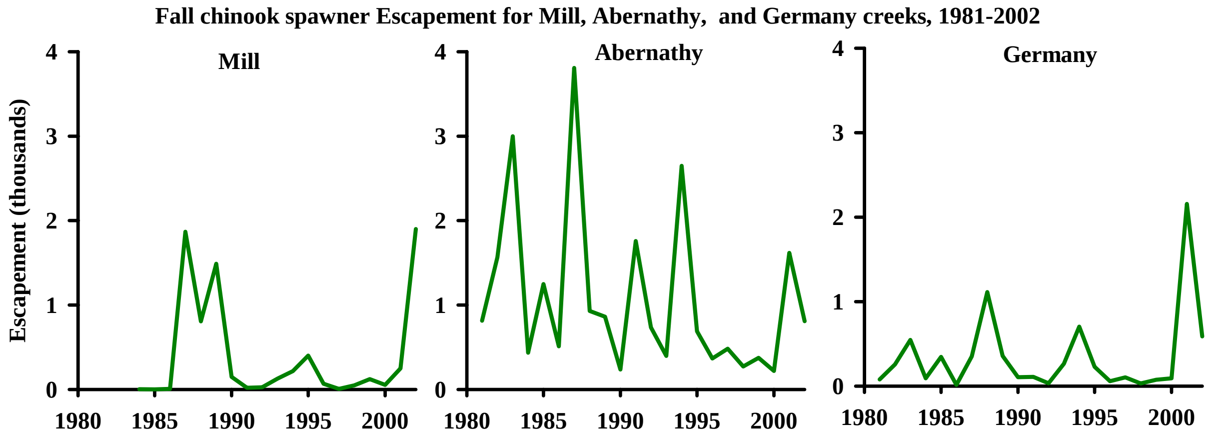
ESA: Threatened 1999	SASSI: Mill/Germany - Depressed 2002; Abernathy - Healthy 2002

The historical combined adult population in Mill, Abernathy, and Germany creeks is estimated from 5,000-7,500 fish. There is some question as to the historical significance of fall Chinook in these basins compared to other species. Current returns range from 300-4,000. The Abernathy fall Chinook hatchery program was discontinued, with the final adult hatchery returns in 1997. Spawning is concentrated in the lower 2 miles of Mill Creek, and the lower 3 miles of Abernathy and Germany creeks. Juvenile rearing occurs near and downstream of the spawning area. Juveniles emerge in early spring and migrate to the Columbia in spring and summer of their first year.



Distribution

- Spawning in Mill Creek occurs from the Mill Creek Bridge downstream to the mouth (2 miles)
- Spawning in Abernathy Creek occurs from the Abernathy Creek NFH to the mouth (3 miles)
- Spawning in Germany Creek occurs from the mouth to 3.5 miles upstream



Life History

- Columbia River fall Chinook migration occurs from mid August to early September, depending partly on early fall rain
- Natural spawning occurs between late September and mid October, usually peaking in early October
- Age ranges from 2-year old jacks to 6-year old adults, with dominant adult ages of 3 and 4 (averages are 39.9% and 43.4%, respectively); sexually mature 1-year old males have been found in Abernathy and Germany Creeks
- Fry emerge around early April, depending on time of egg deposition and water temperature; fall Chinook fry spend the spring in fresh water, and emigrate in the late spring/summer as sub-yearlings
- Based on life history and run timing, fall Chinook in these creeks resemble Spring Creek Hatchery stock more then lower Columbia fall Chinook

Diversity

- Considered a tule fall Chinook population in the lower Columbia River Evolutionarily Significant Unit
- Records indicate that fall Chinook may not have been present historically in these tributaries. Natural spawning returns have been highly influenced by Spring Creek Hatchery stock released from Abernathy hatchery during 1974-94
- Mill, Abernathy, and Germany Creek stocks designated based on distinct spawning distribution
- Allele frequencies of Abernathy Creek Chinook from 1995, 1997, and 1998 were significantly different from other lower Columbia River Chinook stocks, except Kalama Hatchery fall Chinook

Abundance

- Fall Chinook may not be native to Mill, Abernathy, or Germany Creeks; hatchery production and straying has contributed heavily to returns
- Mill Creek spawning escapements from 1986-2002 ranged from 2 to 1,900 (average 409)
- Abernathy Creek spawning escapement from 1981-2002 ranged from 200 to 3,807 (average 1,081)

- Germany Creek spawning escapement from 1981-2002 ranged from 15 to 2,158 (average 340)
- WDFW captured 910 fall Chinook juveniles in ten seining trips to Abernathy Creek in 1995

Productivity & Persistence

- NMFS Status Assessment for Mill Creek indicated a 0.53 risk of 90% decline in 25 years and a 0.77 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.4
- NMFS Status Assessment for Abernathy Creek indicated a 0.01 risk of 90% decline in 25 years and a 0.17 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0
- NMFS Status Assessment for Germany Creek indicated a 0.09 risk of 90% decline in 25 years and a 0.15 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0
- Juvenile production from natural spawning is presumed to be low

Hatchery

- The Abernathy Creek NFH released about 1 million fall Chinook per year over a 21 year period (1974-1994); another 15,278,638 fall Chinook were released in Abernathy Creek from 1960-1977 from other hatchery programs; broodstock largely derived from Spring Creek NFH Chinook
- The Abernathy Creek NFH fall Chinook program was discontinued in 1995 because of federal funding cuts

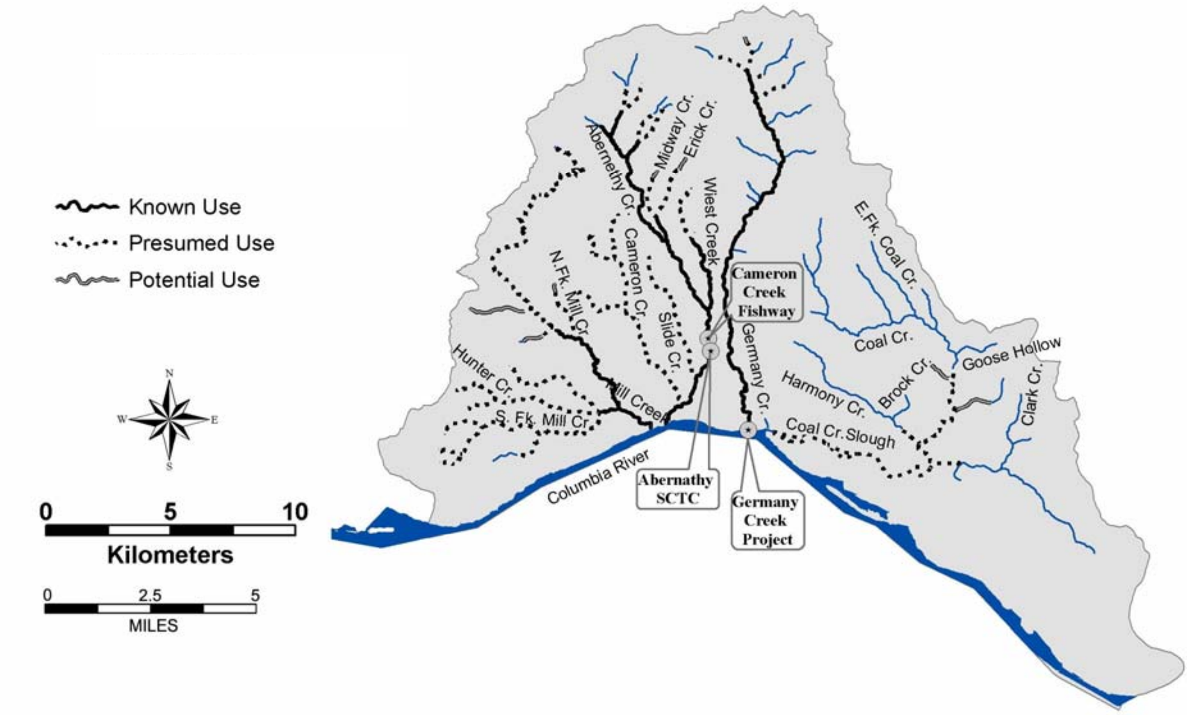
Harvest

- 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
- Lower Columbia River tule fall Chinook are an important contributor to Washington ocean sport and troll fisheries and to the lower Columbia estuary sport fishery
- Columbia River commercial harvest occurs primarily in September, but tule Chinook flesh quality is low once the fish move from salt water; price is low compared to higher quality bright Chinook stocks
- CWT data analysis of the 1976 brood year suggests that the majority of the lower Columbia River Hatchery fall Chinook stock harvest occurred in Southern British Columbia (40%), Columbia River (18.0%), and Washington ocean (17%) fisheries
- Annual harvest is dependent on management response to annual abundance in PSC (U.S./Canada), PFMC (U.S. ocean), and Columbia River Compact forums
- Harvest is constrained by Coweeman fall Chinook total ESA exploitation rate of 49%

3.2.2 *Coho—Mill/Abernathy/Germany*

ESA: Candidate 1995	SASSI: Unknown 2002

The historical combined adult population in Mill, Abernathy, and Germany creeks is estimated from 10,000-30,000 fish. The historical population is late stock which spawns from late November-March. Current returns are unknown but assumed be low. Natural spawning is presumed to occur in most areas accessible to coho in Mill, Abernathy, and Germany creeks, and also in nearby Coal Creek. Juvenile rearing occurs upstream and downstream of spawning areas. Juveniles rear for a full year in these creeks before migrating as yearlings in the spring.



Distribution

- Managers refer to late stock coho as Type N due to their ocean distribution generally north of the Columbia River
- Natural spawning is thought to occur in most areas accessible to coho in Mill, Abernathy (including Cameron Creek), Germany, and Coal Creeks

Life History

- Production is late stock coho and adults enter these tributaries from late September through February
- Peak spawning occurs in December and January
- Adults return as 2-year old jacks (age 1.1) or 3-year old adults (age 1.2)
- Fry emerge in spring, spend one year in fresh water, and emigrate as age-1 smolts in the following spring

Diversity

- Late stock coho (or Type N) were historically present in the Mill, Abernathy, and Germany Creek basins with spawning occurring from late November into March
- There was also late coho produced historically in nearby Coal Creek

- Early stock hatchery coho have been planted in these tributaries in some years, but not in recent years
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar
- Stocks in Mill, Germany, and Abernathy Creeks are designated based on distinct spawning distribution

Abundance

- During USFWS escapement surveys in 1936 and 1937, coho designated as ‘observed’ in Germany Creek and ‘reported’ in Mill Creek
- WDFW (1951) estimated an annual escapement of 800 late coho spawners to Mill, Abernathy, Germany, and Coal Creeks combined
- Recent year stream surveys have been conducted in September and early October to count fall Chinook and have shown minor numbers of coho

Productivity & Persistence

- Natural coho production is presumed to be very low
- A 1995 electrofishing survey in Mill Creek revealed low coho juvenile presence
- Ten seining trips were made in Abernathy Creek in 1995 and captured only 29 coho juveniles

Hatchery

- There are no production hatcheries located within these creeks, although out-of-basin plants have occurred in some past years

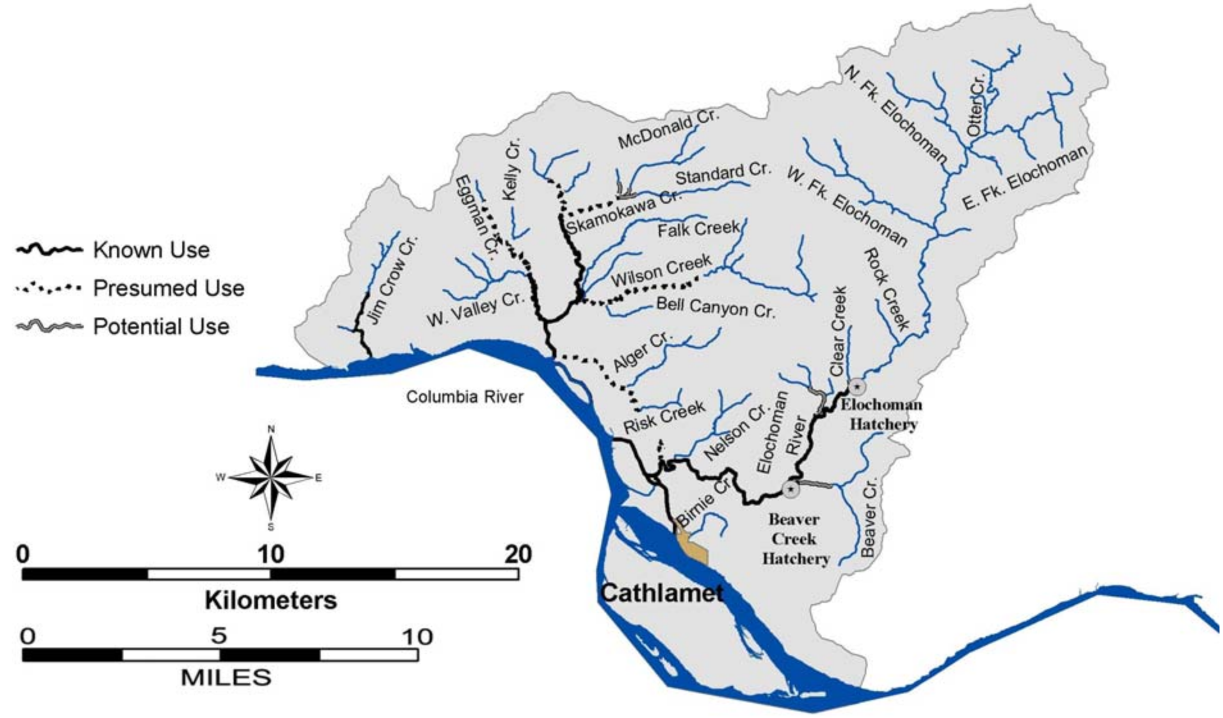
Harvest

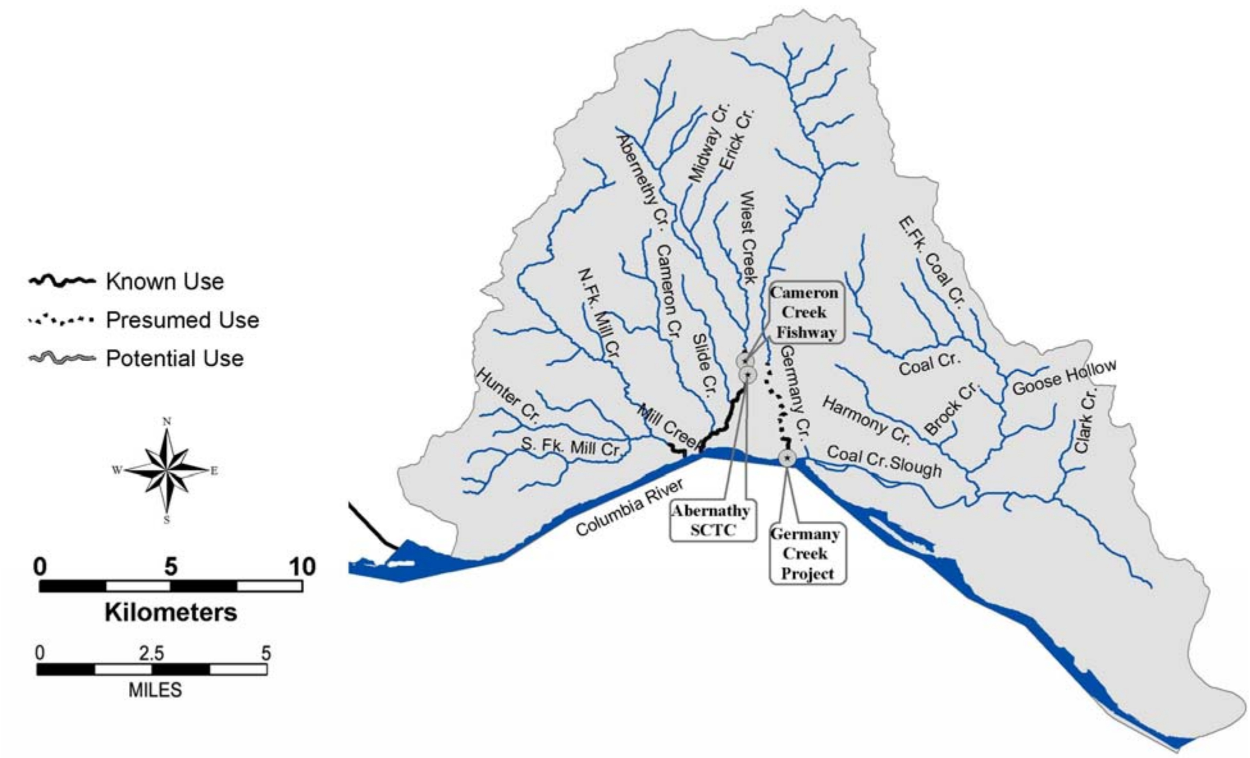
- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial coho fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas 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
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon state listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho 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
- 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
- These streams are not open to sport fishing for coho

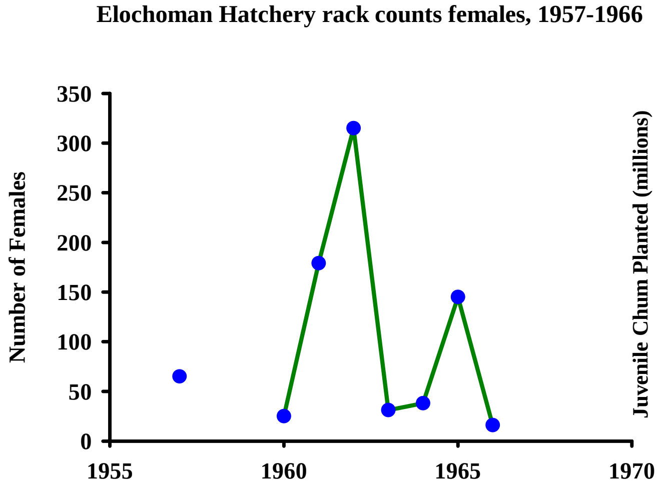
3.2.3 *Chum— Mill/Abernathy/Germany*

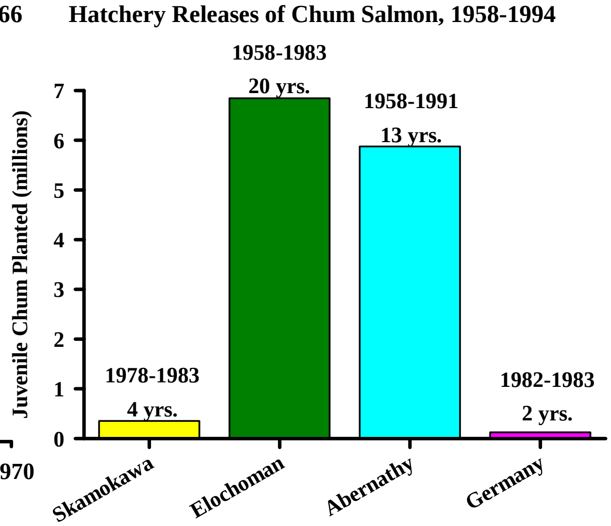
ESA: Threatened 1999	**SASSI: NA**

The historical combined adult population in Mill, Abernathy, and Germany creeks is estimated from 6,500-40,000 fish. Current natural spawning returns are 50-100. Spawning occurs in the lower reaches of Mill, Abernathy, and Germany creeks, with recent year spawning primarily concentrated in Abernathy and Germany creeks. Hatchery releases were discontinued in Germany Creek in 1983 and in Abernathy Creek in 1991. Juveniles emerge in the early spring and migrate to the Columbia with little rearing time in these creeks.









Distribution

- Spawning occurs in the lower 0.4 miles of Abernathy Creek and in the lower parts (above tidewater) of Skamakowa Creek, Mill Creek and Germany Creek

Life History

- Adults enter Mill, Abernathy, and Germany Creeks from mid-October through November; peak spawner abundance occurs in late November
- Dominant age classes of adults are 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts with little freshwater rearing time

Diversity

- Periodic supplementation programs have used Hood Canal and Willipa Bay stocks

Abundance

- In 1936, escapement surveys documented 92 chum in Abernathy Creek and chum were “observed” in Germany Creek and “reported” in Mill Creek
- WDF 1951 report estimated escapement to Abernathy/Mill/Germany Creeks area was 2,700 chum
- An estimated 100 chum spawned naturally in Abernathy Creek in 1990

Productivity & Persistence

- Natural chum production is expected to be low, although it is expected that some chum production continues in these streams
- A 1995 WDF seining operation in Abernathy Creek observed 7 chum juveniles

Hatchery

- Chum fry releases of various stocks occurred from 1958-1991 in Abernathy Creek and from 1982-1983 in Germany Creek.
- Germany Creek releases averaged 62,500 chum over 2 years, and Abernathy releases averaged 450,000 chum over 13 years

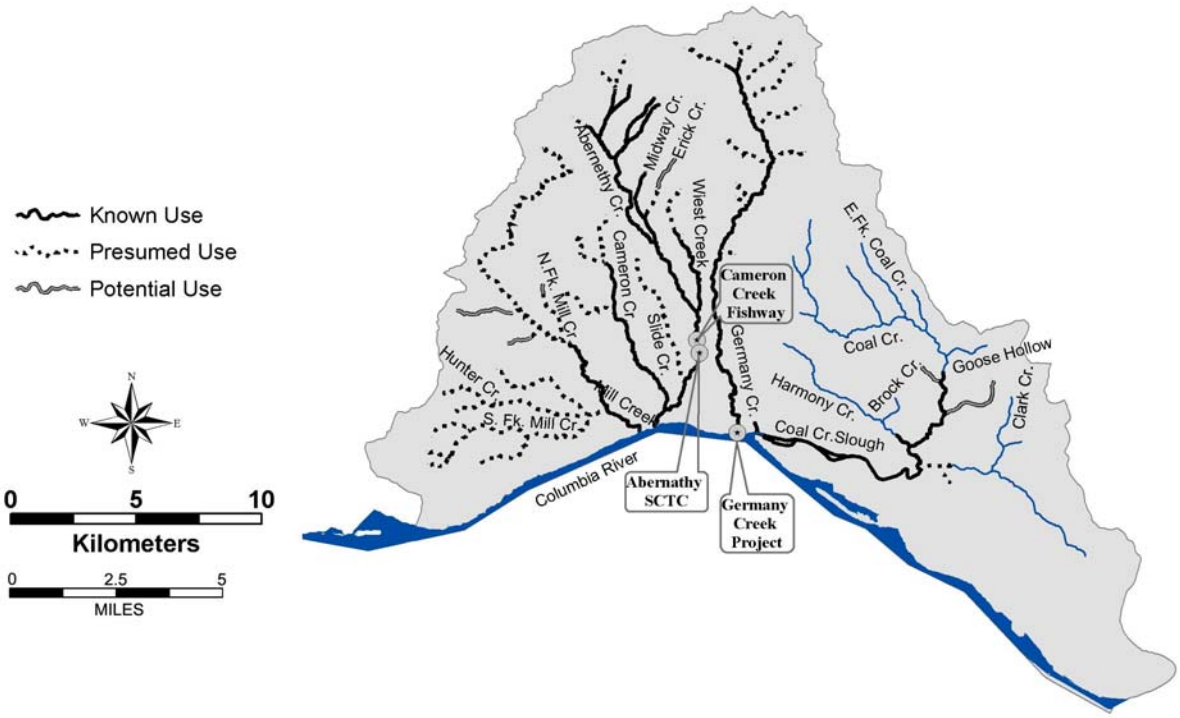
Harvest

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

3.2.4 *Winter Steelhead—Mill/Abernathy/Germany*

ESA: Threatened 1998	**SASSI: Mill—Unknown 2002; Abernathy and Germany—Depressed 2002**

The historical combined adult population in Mill, Abernathy, and Germany creeks is estimated at 2,000 fish. Current natural spawning returns to Abernathy and Germany creeks range from 50-500. Spawning in Mill Creek occurs in the mainstem, North Fork and unnamed tributaries. Spawning in Abernathy Creek occurs in the mainstem, Slide Creek, and Cameron Creek. Spawning in Germany Creek occurs in the mainstem, Loper Creek, and John Creek. Spawning time is March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the creeks

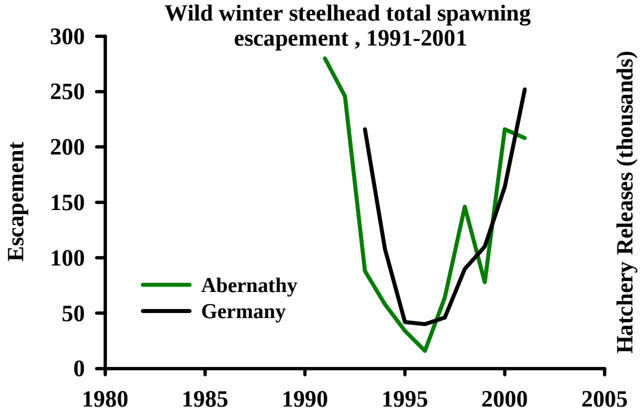


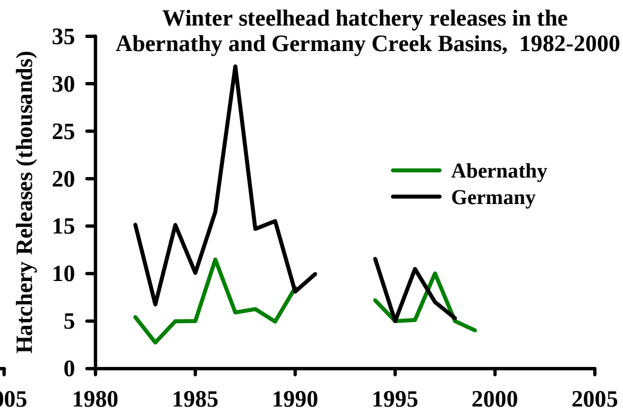
Distribution

- In Mill Creek, winter steelhead spawn in the mainstem, North Fork Mill Creek, and unnamed tributaries
- In Abernathy Creek, spawning occurs in the mainstem, Slide Creek, and Cameron Creek
- In Germany Creek, winter steelhead spawn in the mainstem, Loper Creek, and John Creek

Life History

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





Diversity

- Mill, Abernathy, and Germany winter steelhead stocks designated based on distinct spawning distribution
- Concern with wild stock interbreeding with hatchery brood stock from the Elochoman River, Chambers Creek, and the Cowlitz River
- Genetic analyses have not been performed on any of these stocks

Abundance

- In 1936, 1 steelhead was documented in Mill Creek and steelhead were observed in Abernathy and Germany Creeks during escapement surveys
- Total escapement counts from 1991-2001 for Abernathy Creek ranged from 16 to 280 (average 130); redd counts from 1991-1999 ranged from 3.1 to 12.7 redds/mile
- Total escapement counts from 1993-2001 for Germany Creek ranged from 40 to 252 (average 119); redd counts from 1993-1999 ranged from 2.4 to 13.4 redds/mile
- Escapement goals have been set at 306 fish in Abernathy Creek and 202 fish in Germany Creek

Productivity & Persistence

- Natural production in the basin is thought to be low

Hatchery

- There are no hatcheries located on any of these creeks; hatchery fish from the Beaver Creek Hatchery (Elochoman River) have been planted in the basin; hatchery brood stock has been from the Elochoman River, Chambers Creek, and the Cowlitz River
- Hatchery winter steelhead have rarely been planted in Mill Creek; hatchery winter steelhead have been planted in Abernathy and Germany Creeks since 1961; release data are displayed from 1982-2000
- Hatchery fish contribute little to natural winter steelhead production in Mill, Abernathy, or Germany Creek basins
- Native are stock still present in Germany Creek; native stock spawn later than non-native fish

Harvest

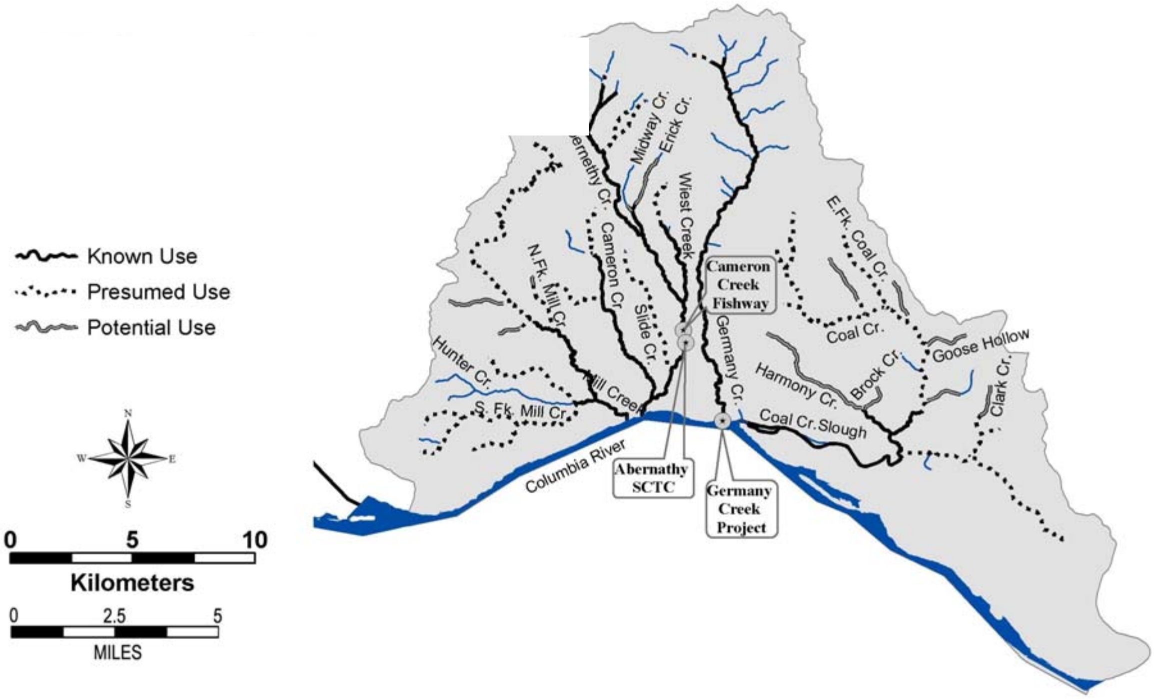
- No directed commercial or tribal fisheries target Mill, Abernathy, or Germany Creek winter steelhead; incidental mortality currently occurs during the lower Columbia River spring Chinook tangle net fisheries

- Treaty Indian harvest does not occur in Mill, Abernathy, or Germany Creek basins
- Winter steelhead sport harvest (hatchery and wild) in Mill, Abernathy, or Germany Creeks from 1977-1986 averaged 18, 85, and 196, respectively; since 1990, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild winter steelhead in the mainstem Columbia and in Elochoman basin

3.2.5 *Cutthroat Trout—Mill/Abernathy/Germany*

ESA: Not Listed	SASSI: Depressed

Anadromous and resident forms of cutthroat trout are present in Mill, Abernathy, and Germany creeks. Anadromous cutthroat counts at Abernathy trap have been very low at fewer than 15 fish since 1991. Anadromous cutthroat enter these creeks from August-April and spawn from January to April. Most juveniles rear 2-3 years before migrating from their natal stream.



Distribution

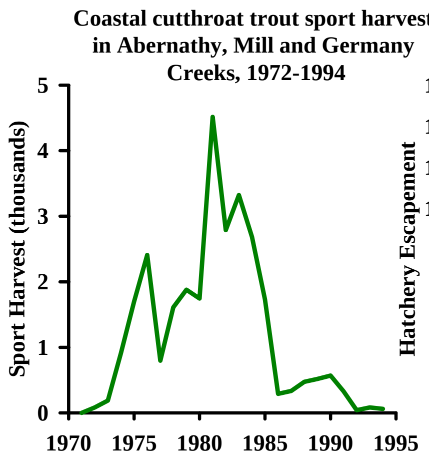
- Anadromous forms have access to the majority of the creek basins except for areas above falls on tributaries to Abernathy Creek
- Resident forms are documented throughout the system

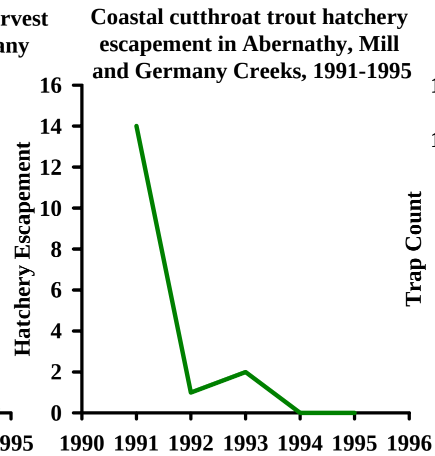
Life History

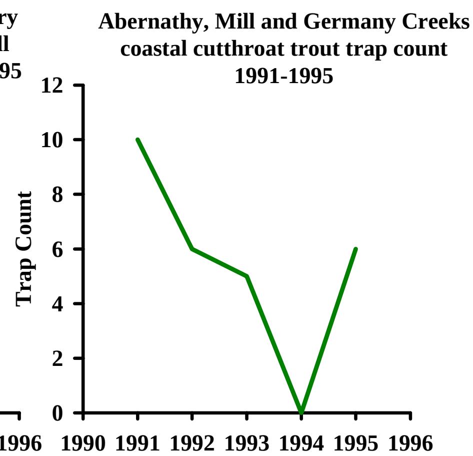
- Anadromous, fluvial and resident forms are present
- Anadromous river entry and spawn timing are unknown but are believed to be similar to Elochoman cutthroat trout
- Anadromous river entry is assumed to be from August through mid-April
- Anadromous spawning is assumed to be from January through mid-April
- Fluvial and resident spawn timing is not documented but is assumed to be similar to anadromous timing

Diversity

- These creeks are defined as one stock complex based on geographic proximity—all enter the Columbia River between RM 53 and RM 56
- No genetic sampling or analysis has been conducted
- Genetic relationship to other stocks and stock complexes is unknown
- As additional biological and genetic data become available it is possible that these creeks may be classified as separate stock complexes







Abundance

- Chronically low counts at Abernathy fish trap—between zero and 15 fish since 1991
- Wild anadromous escapement has been between zero and ten fish since 1991
- Long-term decline in Columbia River sport catch from RM 48 to RM 66, particularly since 1986

Hatchery

- USFWS operates a research hatchery facility on Abernathy Creek
- WDFW released cutthroat into Mill, Germany and Abernathy Creeks in the 1970s and early 1980s to provide catchable fish for the opening day resident trout fishery in late May
- After 1981 WDFW focused on anadromous cutthroat, releasing between 5500 and 6000 smolts into Mill, Germany, and Abernathy Creeks annually
- The anadromous cutthroat hatchery release program is now discontinued

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 Abernathy, Mill, and Germany Creeks
- Wild cutthroat (unmarked fish) must be released in the mainstem Columbia and in Abernathy, Mill, and Germany Creeks

3.2.6 *Other Species*

Pacific lamprey – – Information on lamprey abundance is limited and does not exist for Mill, Abernathy, and Germany populations. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have also declined in these creeks. 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 these creeks. Juveniles rear in freshwater up to seven years before migrating to the ocean.

3.3 Subbasin Habitat Conditions

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

Peak flows are associated with fall and winter rains and low flows typically occur in late summer. There are currently no stream gages operating on any of the major streams in the watershed.

There has been a significant decrease in vegetative cover in the Mill/Abernathy/Germany Watershed, with potential impacts to runoff properties. Approximately 72% of the basin is either in early-seral stage forests, is cultivated land, or is developed land. Late-seral stage forests are virtually non-existent. High road densities are also a concern, with road densities greater than 5 miles/mi^2 throughout most of the basin. Forest and road conditions have potentially altered flow regimes. The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that 11 or 14 subwatersheds in the watershed are ‘impaired’ with regards to runoff conditions; the remainder are ‘moderately impaired’. These results are similar to those from a peak flow risk assessment conducted by Lewis County GIS (2000), which revealed ‘impaired’ conditions in 6 of 7 watersheds.

Low flow assessments were conducted on several streams in the watershed in 1997 and 1998 using the Toe-Width method (Caldwell et al. 1999). These assessments indicate that all of the basins may suffer from a lack of adequate flows for fish. Flows became less than suitable for summer rearing by July 1. On Mill Creek, Abernathy Creek, and Germany Creek fall flows in 1998 were considerably lower than optimum flows needed for salmonid spawning and rearing. Flows in Coal Creek became suitable for rearing by mid October but were below optimum for spawning through the first week in November (Caldwell et al. 1999).

3.3.2 *Passage Obstructions*

The Mill Creek basin only has 1 culvert that is known to restrict passage. However, low flow passage problems are believed to be related to channel incision from past splash damming. There are several culverts and low flow issues on Abernathy Creek (see Wade 2002). Artificial fishways may create passage problems on Cameron Creek (Abernathy tributary) and need further assessment. There is approximately 3 miles of habitat above these structures. An electric weir at the Abernathy Fish Technology Center operates during the steelhead run, blocking passage to all but wild steelhead. Nine culverts and 1 puncheon restrict passage to over 6 miles of habitat in the Germany Creek basin. In the Coal Creek basin, a tidegate and culvert restrict passage from Coal Creek Slough into Clark Creek. A pump station on Coal Creek Slough also limits passage, as do several culverts throughout the watershed. Passage is completely blocked into and out of the Longview Ditches. The only exit is through pumping stations (Wade 2002).

3.3.3 *Water Quality*

Elevated water temperatures are a concern in Mill, Abernathy and Germany Creeks. The mainstems of Abernathy and Germany were listed on the state's 1998 303(d) list of impaired water bodies for exceedance of temperature standards (WDOE 1998). CCD Temperature monitoring in the summer of 2000 recorded exceedances of 18ºC on lower Mill Creek, on the South Fork Mill Creek, on the middle and lower mainstem of Abernathy Creek, on Wiest Creek (Abernathy tributary), at a few locations on mainstem Germany Creek, and on Coal Creek. Temperatures tend to be higher along reaches with agricultural uses and tend to be cooler in upper reaches. Stream temperatures generally cool down as water levels increase in the fall, however, high temperatures may be a problem for early-return salmon entering the system in the late summer (Wade 2002).

The WDOE identified a concern of aluminum toxicity in the biological communities in Mill Creek and Cameron Creek (Abernathy tributary), possibly related to bauxite deposits. In addition to elevated temperatures, Coal Creek has turbidity, landfill leachate, and sewage effluent concerns. The Longview Ditches have a glut of water quality concerns and are therefore listed on the state's 303(d) list. Specific concerns include elevated dissolved oxygen, fecal coliform, lead, and turbidity (WDOE 1998). Many water quality investigations have been conducted in the ditches and a TMDL study has been initiated. Lake Sacajawea, within the city of Longview, has concerns with several toxic substances including PCBs. Storm sewers and ditches contribute large amounts of sediment and nutrients to Lake Sacajawea, creating abundant algal growth. Restoration actions since the 1980s have improved conditions (Wade 2002).

In most of the basins, current escapement levels are considerably lower than historical levels. The lack of fish carcasses may create a nutrient deficit in the system. Carcass supplementation has occurred in a few places (Wade 2002).

3.3.4 *Key Habitat Availability*

Only two side channels were observed during WCD surveys of Lower Mill Creek. In Abernathy Creek, side channels are virtually non-existent from the mouth to Slide Creek Bridge. Channel confinement limits side channel formation above tidal influence. In Germany Creek, debris jams that were creating a multi-thread channel in the lower 3000 feet were removed by residents, thereby returning the stream to a single-thread channel. In the agricultural section (RM 1.9 to RM 5.7) streambed aggradation is creating mid-channel bars and lateral bank erosion, potentially increasing habitat diversity, but also creating concerns to local landowners (Schuett-Hames 2000). Upper reaches have limited side channels due to natural channel and valley confinement.

Mill Creek has poor pool habitat (almost 90% of reaches, WCD surveys), with bedrock substrate limiting pool development. Abernathy has over 90% of surveyed reaches with inadequate pool habitat. The highest pool quantities are in the upper basin and are attributed to greater LWD numbers. Germany has over 98% of reaches lacking pools. In the agricultural portion (RM 1.9 to RM 5.7), excessive bedload may be filling pools. In 1990, it was noted that pools were being filled by excessive bedload in the upper reaches (Wade 2002). These channels may be recovering as sediment pulses move downstream (Schuett-Hames 2000). The Coal Creek basin is generally lacking in pool habitats. Channels are scoured to bedrock in many places. The tributary Boulder Creek has been reported as having excellent habitat by the Columbia River Flyfishers.

3.3.5 *Substrate & Sediment*

WCD stream surveys revealed excessive substrate fines in approximately 10% of surveyed reaches of Mill Creek. High fines were mainly found in the tidally-influenced area. The lower river up to RM 1.5 is predominantly bedrock. Abernathy Creek exhibits a similar pattern, with high fines in the tidal area and scoured bedrock channels in the reaches just upstream. Basin-wide, Abernathy has over 55% of surveyed reaches falling into the poor category for substrate fines. In particular, high fines are a concern in low gradient channels in the upper basin. Germany Creek has over 11% of surveyed reaches in the poor category. Excessive bedload, consisting primarily of gravels and cobbles, is found in the agricultural reaches between RM 1.9 and RM 5.7. Portions of this section also suffer from high fines, mostly in low gradient reaches adjacent to agricultural land that also exhibit degraded riparian conditions (CCD surveys). Excessive fines in the upper watershed are believed to originate from recent mass wasting events. The Coal Creek basin has mostly confined channels that are scoured to bedrock, with few substrate fines (Wade 2002).

High road densities and naturally unstable soils create a risk of elevated sediment supply from hillslopes. The Mill, Abernathy, and Germany basins all have road densities greater than 4 mi/mi^2.

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results suggest that nearly all (25 of 30) of the subwatersheds in the Mill/Abernathy/Germany and Elochoman/Skamokawa watersheds are “moderately impaired” with respect to landscape conditions that influence sediment supply. Three Mill/Abernathy/Germany subwatersheds are rated as “impaired” and three are rated as “functional”. The greatest impairments are located close to Longview. High road densities and naturally unstable soils are the primary drivers of the sediment supply impairment.

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*

Approximately 90% of Mill Creek lacks adequate quantities of instream LWD. Wood is almost non-existent in the lower 1.5 miles and above this to RM 4 it is concentrated in debris jams. Single logs functioning in the channel are rare. Quantities increase slightly in the upper basin. Abernathy Creek has approximately 79% of surveyed reaches suffering from a lack of LWD. The lower reaches especially have very little LWD, with low recruitment potential. Quantities increase in the upper basin. Germany also has many reaches lacking instream wood (over 78%). Most wood is located in debris jams, some of which have been removed due to concerns by local residents. Upper basin reaches have slightly better conditions. LWD is virtually non-existent in the Coal Creek basin (Wade 2002).

3.3.7 *Channel Stability*

Half of the reaches surveyed by the WCD in Mill Creek rated as “fair” or “poor” (80%-90% not actively eroding and <80% not actively eroding, respectively) for bank erosion. A particularly severe area of bank erosion is located at RM 0.6 on the outside bend of the channel. On Abernathy Creek, there are erosion concerns at the boat ramp and camping area. Bank erosion has also been identified between RM 1.5 and 3.4 where agriculture and residential uses have impacted riparian vegetation. In the tidally influenced portion of Germany Creek, debris jams have caused channel shifts and local residents have worked to remove these jams to decrease erosion. The channel between RM 1.5 and RM 6 has experienced streambed aggradation, causing bank erosion and lateral channel migration. This condition has also created landowner concerns (Wade 2002).

3.3.8 *Riparian Function*

The lower 3 miles of Mill Creek suffer from narrow buffer widths due to a stream adjacent road and residential development. The upper basin was harvested extensively in the mid 20th century and is now maturing. According to Cowlitz Conservation District (CCD) surveys, over half of the reaches in the Abernathy basin have poor riparian conditions. The lower portion up to RM 1.5 has narrow buffers due to a roadway, residential development, and recreational use. River mile 1.5 to 3.4 is dominated by agricultural land with a predominance of deciduous species and narrow buffers. Above this to RM 10 is impacted by a stream-adjacent road and suffers from a narrow buffer of mixed hardwoods and conifers. None of the reaches surveyed by the CCD in the Germany basin rated as "good" and over half rated "poor". A roadway limits buffer widths on the lower river and agricultural practices limit buffer widths and favor deciduous species between RM 1.9 and 5.7. The upper watershed was heavily harvested in the 1980s, which left narrow buffers. A stream-adjacent road in the upper basin also limits the development of a mature riparian forest. Roads and land use practices impact riparian areas in lower Coal Creek. The upper basin suffers from impacts related to historical agricultural practices (Wade 2002).

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*

Mill Creek Road restricts Mill Creek to an incised channel in the lower reaches. Splash damming has caused channel incision in lower Mill Creek, which has also impacted several tributaries. Conditions in the upper basin are believed to be better though data is lacking. Abernathy Creek has good connectivity in the tidally influenced area. Roads confine portions of lower Abernathy Creek and lower portions of tributaries. Lower reaches are highly incised due to agricultural practices and past splash damming. Floodplain connectivity improves above Erick Creek. Germany Creek has slight confinement from roads and slight entrenchment from agricultural practices, but has good floodplain connectivity overall. CCD surveys indicate that Coal Creek is highly entrenched throughout the entire basin. In many places residential development limits floodplain connectivity. Clark Creek is confined by Clark Creek Road along most of its length though the upper reaches have good floodplain connectivity. The Longview Ditches are maintained to ensure there is no connection with the floodplain (Wade 2002).

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 Mill, Abernathy, and Germany fall Chinook, coho, chum, and winter steerlhead.. 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 for chum, fall Chinook, winter steelhead and coho in the Mill, Germany and Abernathy basins. Model results indicate that adult productivity in Abernathy Creek has declined to approximately 20-30% of historical levels for all four species (Table 2), with the decline greatest for chum (to 22% of historical levels) and least for fall Chinook (to 31% of historical levels). Similarly, adult abundance shows severe declines for all species, with current numbers at 10% of historical levels for chum, at 27% of historical levels for fall Chinook, at 18% of historical levels for coho, and at 41% of historical levels for winter steelhead (Figure 4). Diversity (as measured by the diversity index) appears to have remained steady for fall Chinook, winter steelhead, and chum, but has declined by 33% for coho (Figure 4).

In Germany Creek, modeled adult productivity also shows severe declines, with current productivity at approximately 20-30% of historical levels for all species (Table 2). Adult abundance appears to have experienced similar declines. Currently, chum abundance is estimated at only one tenth of historical levels, while coho and fall Chinook are at 23% and 29% of historical levels, respectively (Figure 5). Winter steelhead abundance has declined to 52% of historical levels (Figure 5). In Germany Creek, the diversity of all species, except coho, has been maintained (Table 2). Model results indicate that coho diversity has declined to 69% of its historical level.

Mill Creek, the furthest downstream of the three Lower Columbia River tributaries, appears to have also experienced declines in productivity in all four species (Table 4). Model results indicate a decrease in productivity of 73% for fall Chinook, 81% for chum, and 76% for both coho and winter steelhead. Declines in adult abundance from historical levels have been greatest for chum (93%) and coho (82%), followed by fall Chinook (73%) and winter steelhead (54%) (Figure 6). Diversity appears to have remained unchanged in Abernathy Creek for both fall Chinook and winter steelhead. However, model results indicate a decrease in diversity for chum and coho to 57% and 62% of historical levels, respectively (Table 4).

Modeled historical-to-current changes in smolt productivity in Abernathy Creek have declined for all four species, with current levels of productivity at 30-60% of historical levels (Table 2). Similarly, smolt abundance levels in Abernathy Creek appear to have decreased by 50-83% from historical levels, with losses most significant for chum, and least for fall Chinook and winter steelhead (Table 2).

Losses in smolt productivity in Germany Creek are similar to those in Mill Creek. Current productivity levels range from one-third of historical levels for steelhead to slightly more than half of historical levels for chum (Table 3). Germany Creek has also experienced sharp declines in smolt abundance levels for all species (Table 3). Chum smolt abundance is currently estimated at only 16% of historical levels, while coho, fall Chinook and winter steelhead are estimated at 42%, 45% and 60% of historical levels, respectively.

As with the other two basins, smolt productivity in Mill Creek has declined for all four species, with estimated losses greatest for winter steelhead and coho (Table 4). Smolt abundance levels have also declined for all species (Table 4). Current chum and coho smolt abundances are only 13-18% of historical levels, respectively. Fall Chinook and winter steelhead abundances are approximately half of historical levels.

Model results indicate that restoration of PFC conditions in each of the three basins would produce substantial benefits (Table 2-Table 4). Adult returns for chum would benefit the most with runs increasing to 3-5 times current levels. Fall Chinook, winter steelhead and coho returns would increase by about 50%. Smolt abundance levels would benefit at similar rates to adults, increasing to 50-80% of historical levels. Significant improvements would also be seen in smolt and adult productivity.

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

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	T[1]
Fall Chinook	455	709	1,646	3.6	6.1	11.5	1.00	1.00	1.00	101,917	168,583	217,323	557	897	1,125
Chum	182	619	1,878	2.1	5.9	9.3	1.00	1.00	1.00	114,902	374,578	668,348	760	1,054	1,218
Coho	800	1,279	4,302	4.7	8.1	20.0	0.62	0.78	0.92	13,575	28,734	40,595	92	183	286
Winter Steelhead	395	541	962	4.9	9.3	19.9	1.00	1.00	1.00	5,254	8,474	10,558	49	118	161

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

Table 3. Germany Creek— 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	524	736	1,798	3.3	6.4	11.8	1.00	1.00	1.00	120,843	194,235	271,309	497	944	1,175
Chum	300	886	3,094	1.9	5.6	8.7	0.99	1.00	1.00	169,971	528,781	1,038,737	675	1,016	1,175
Coho	518	850	2,264	4.9	8.9	20.1	0.62	0.70	0.90	11,040	19,941	26,386	111	210	298
Winter Steelhead	347	420	665	5.8	9.2	18.5	1.00	0.97	0.97	5,846	7,689	9,805	73	140	219

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

Table 4. Mill Creek— 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	386	627	1,411	3.4	6.4	12.4	1.00	1.00	1.00	82,397	141,161	185,456	522	924	1,177
Chum	121	624	1,615	1.7	5.4	8.6	0.57	1.00	1.00	69,066	319,162	531,083	656	972	1,138
Coho	727	881	4,055	4.6	6.9	19.2	0.55	0.77	0.89	4,287	14,942	23,639	71	146	259
Winter Steelhead	155	230	339	4.4	9.5	18.9	0.98	1.00	1.00	2,623	4,048	5,006	75	163	271

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

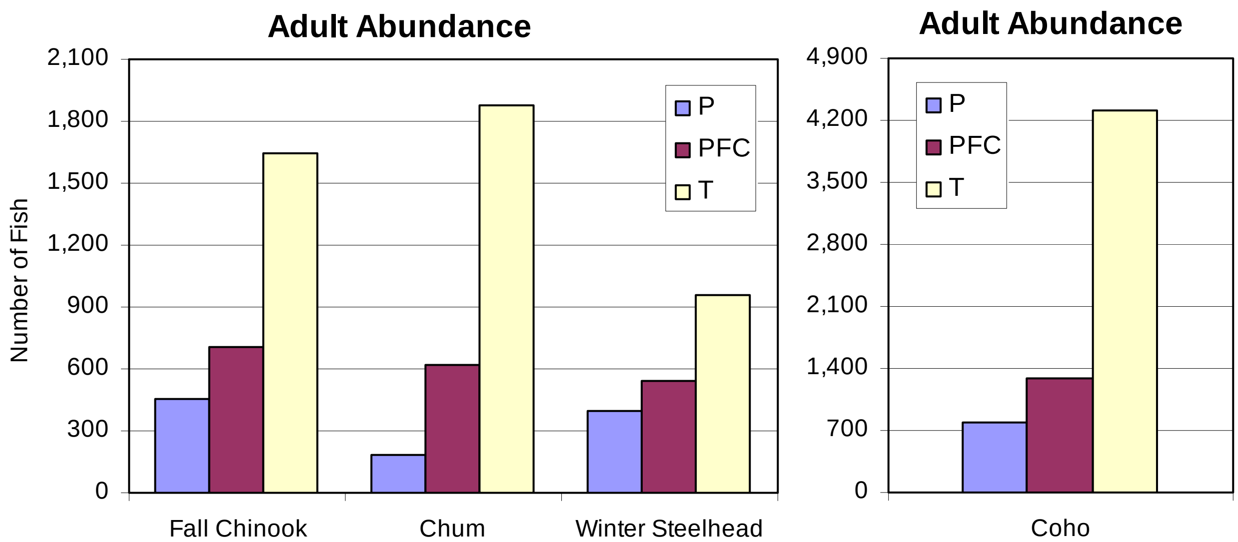


Figure 4. Adult abundance of Abernathy Creek fall Chinook, chum, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

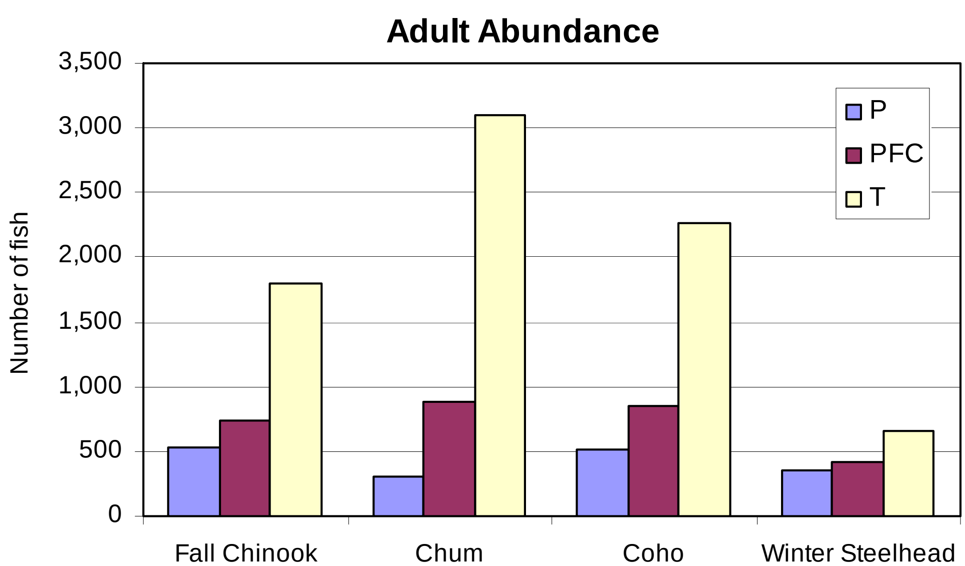


Figure 5. Adult abundance of Germany Creek fall Chinook, chum, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

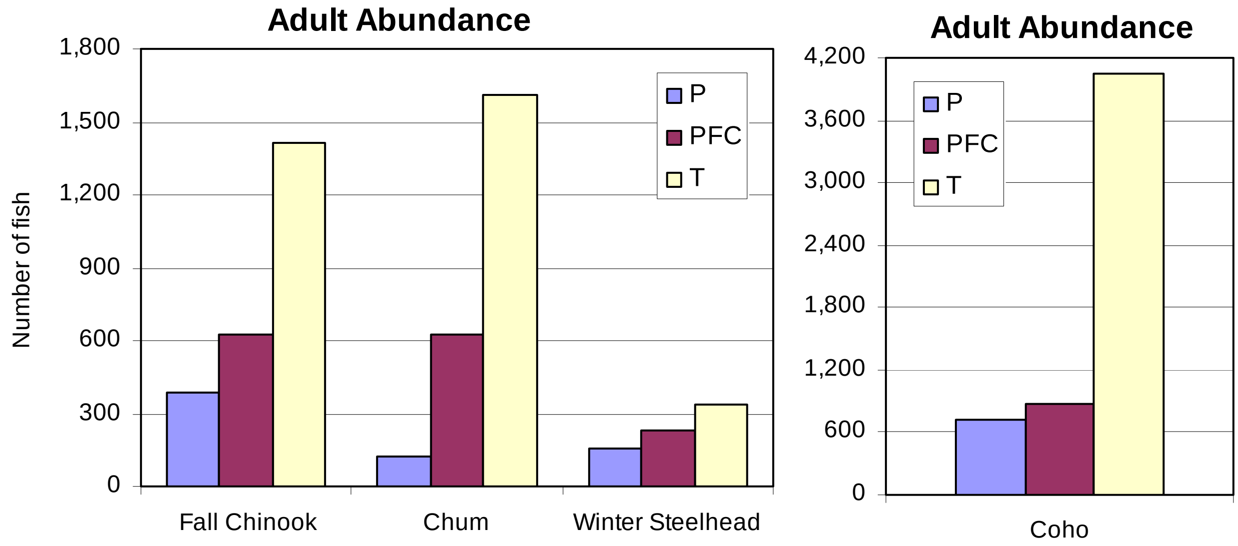


Figure 6. Adult abundance of Mill Creek fall Chinook, chum, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

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 basin. Refer to Figure 7 for a map of high priority stream reaches within Mill, Abernathy and Germany Creeks.

Winter steelhead production in Mill Creek is primarily in Spruce Creek, North Fork Mill Creek, and South Fork Mill Creek. Fall Chinook and chum are found in the lowest reaches of the mainstem Mill Creek. Coho distribution in the basin is not well understood, but it is assumed that they use all areas accessible.

Reach Mill 2, with a combined preservation and restoration emphasis, is the lone high priority reach for fall Chinook (Figure 8). The single high priority reach for chum is the lowest reach of South Fork Mill Creek, SF Mill 1 (Figure 9). SF Mill 1 also shows a combined preservation and restoration emphasis.

High priority reaches for coho include lower, middle and upper sections of Mill Creek (Mill 2, 4, 5 and 8), lower South Fork Mill Creek (SF Mill 1), lower North Fork Mill Creek (NF Mill 2), and the lower sections of Spruce Creek (Spruce 1 and Spruce 2) (Figure 10). The majority of these high priority reaches have a mixed preservation and restoration emphasis, with the reach Spruce 1 showing the greatest expected change in population performance (Figure 10).

For winter steelhead in Mill Creek, high priority reaches include Mill Creek below North Fork Mill Creek (Mill 2 and Mill 4), portions of South and North Fork Mill Creek (SF Mill 1, NF Mill 2), and the long middle reach of Spruce Creek, downstream of Hunter Creek (Spruce 1 and Spruce 2) (Figure 11). These high priority reaches have a mixed preservation and restoration emphasis, with the greatest change in population performance expected in the reach Spruce 1 (Figure 11).

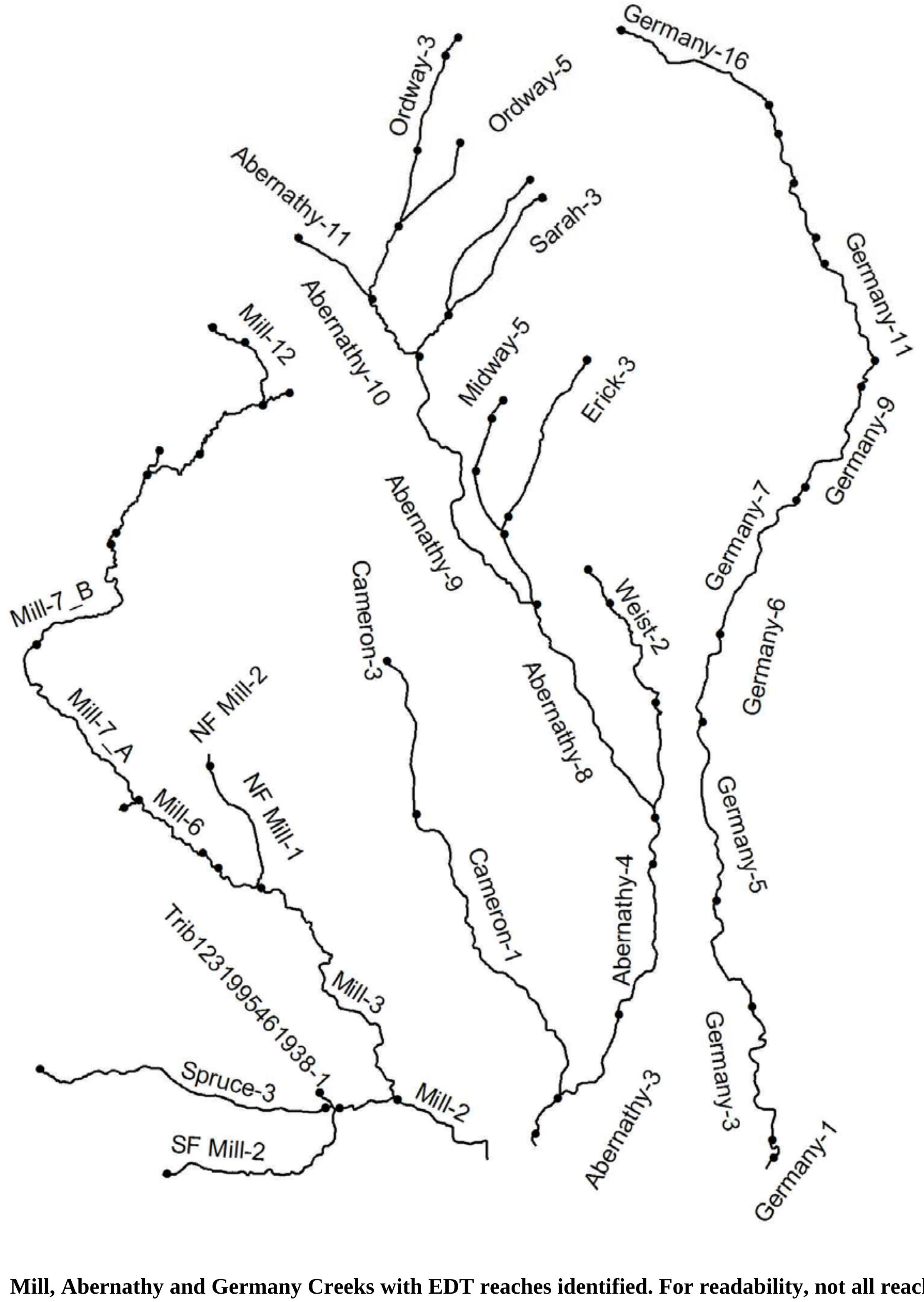


Figure 7. Mill, Abernathy and Germany Creeks with EDT reaches identified. For readability, not all reaches are labeled.

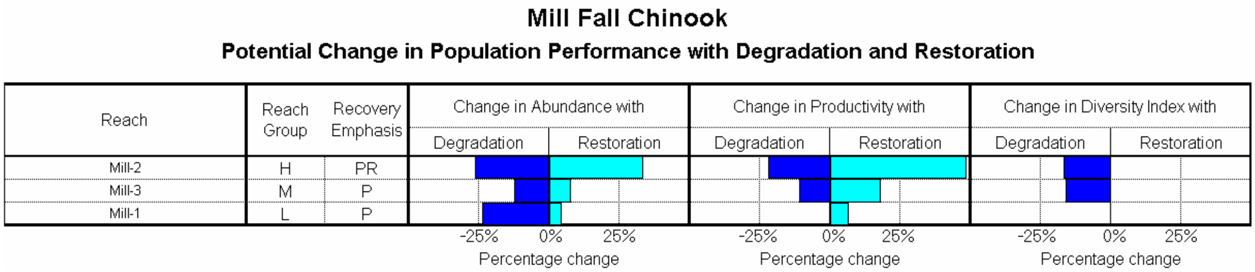


Figure 8. Mill Creek fall chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For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

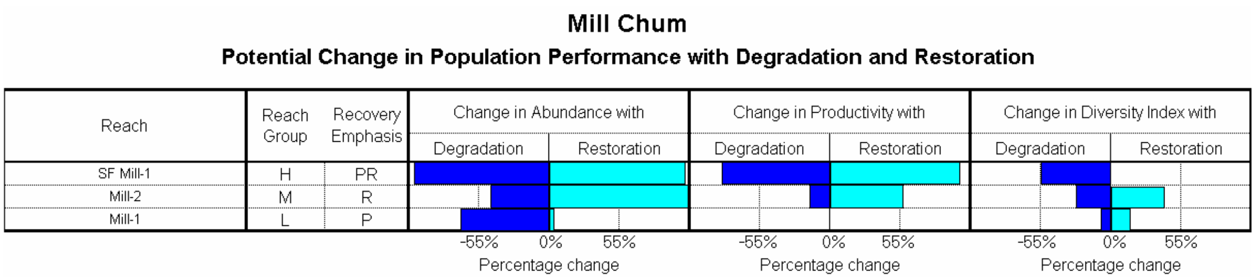


Figure 9.Mill Creek chum ladder diagram.

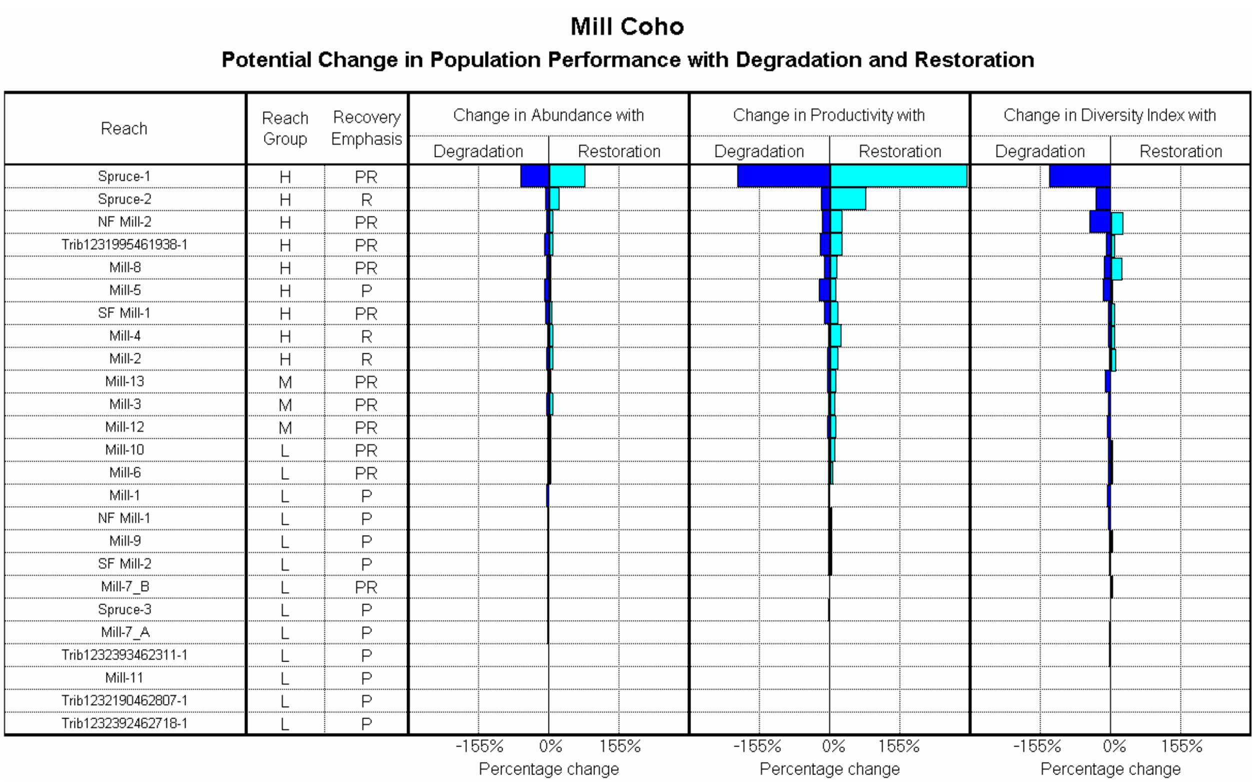


Figure 10. Mill Creek coho ladder diagram.

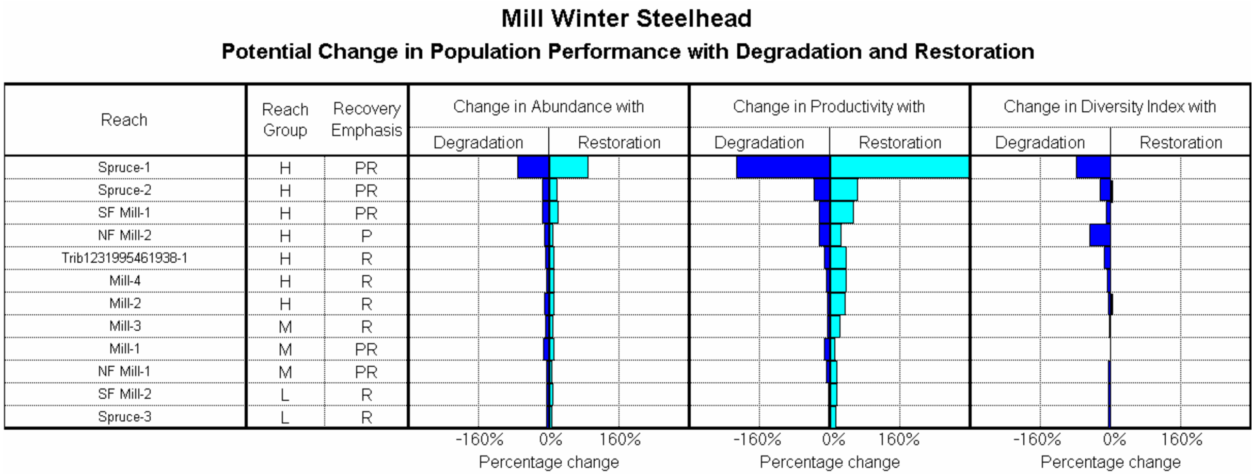


Figure 11. Mill Creek winter steelhead ladder diagram.

Winter steelhead spawn in the mainstem Germany Creek up to the headwaters, as well as in Loper Creek and John Creek. Fall Chinook and chum are found in the lowest reaches of the mainstem Germany Creek. Coho distribution in the basin is not well understood, but it is assumed that they use all areas accessible. Refer to Figure 7 for a map of stream reaches within Mill, Abernathy and Germany Creeks.

The high potential reaches for both fall Chinook and chum exist in lower Germany Creek. The two high priority reaches for fall Chinook are Germany 2 and Germany 3, each with a combined preservation and restoration emphasis (Figure 12). For chum, the single high priority reach is Germany 2, again with a combined preservation and restoration emphasis (Figure 13).

Two of the four high priority reaches identified for coho are in lower Germany Creek (Germany 2 and Germany 3) (Figure 14). The other two reaches are located in the middle (Germany 8) and upper (unnamed tributary) sections of the Creek. All high priority reaches for coho had a combined preservation and restoration emphasis.

For winter steelhead in Germany Creek, high priority reaches exist primarily in the middle and upper sections of Germany Creek (Germany 6, 8, 10, and 12-15) and in one unnamed tributary in upper Germany Creek (Figure 15). These high priority reaches, with the exception of Germany 8, have mixed preservation and restoration emphasis.

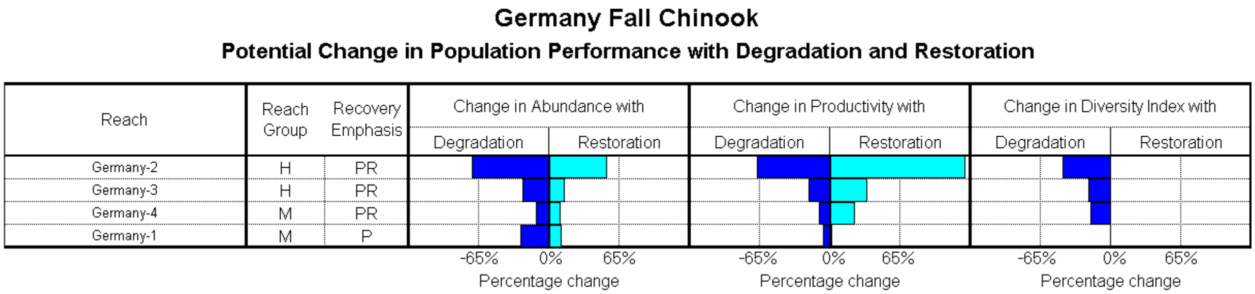


Figure 12. Germany Creek fall chinook ladder diagram

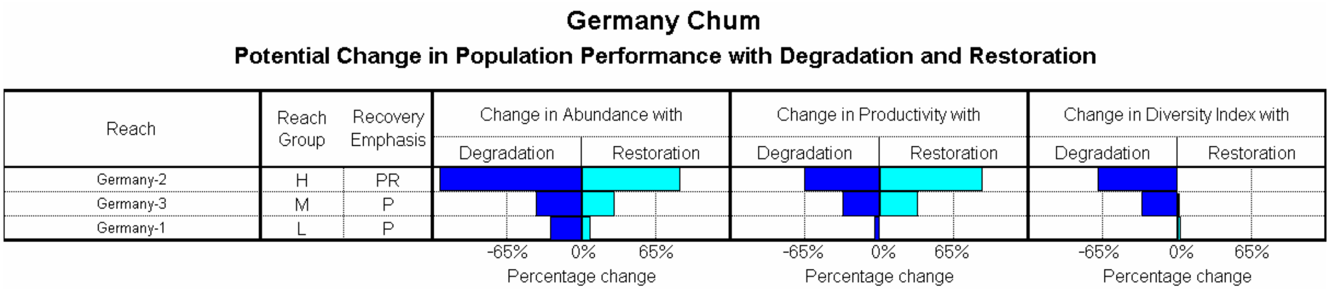


Figure 13. Germany Creek chum ladder diagram

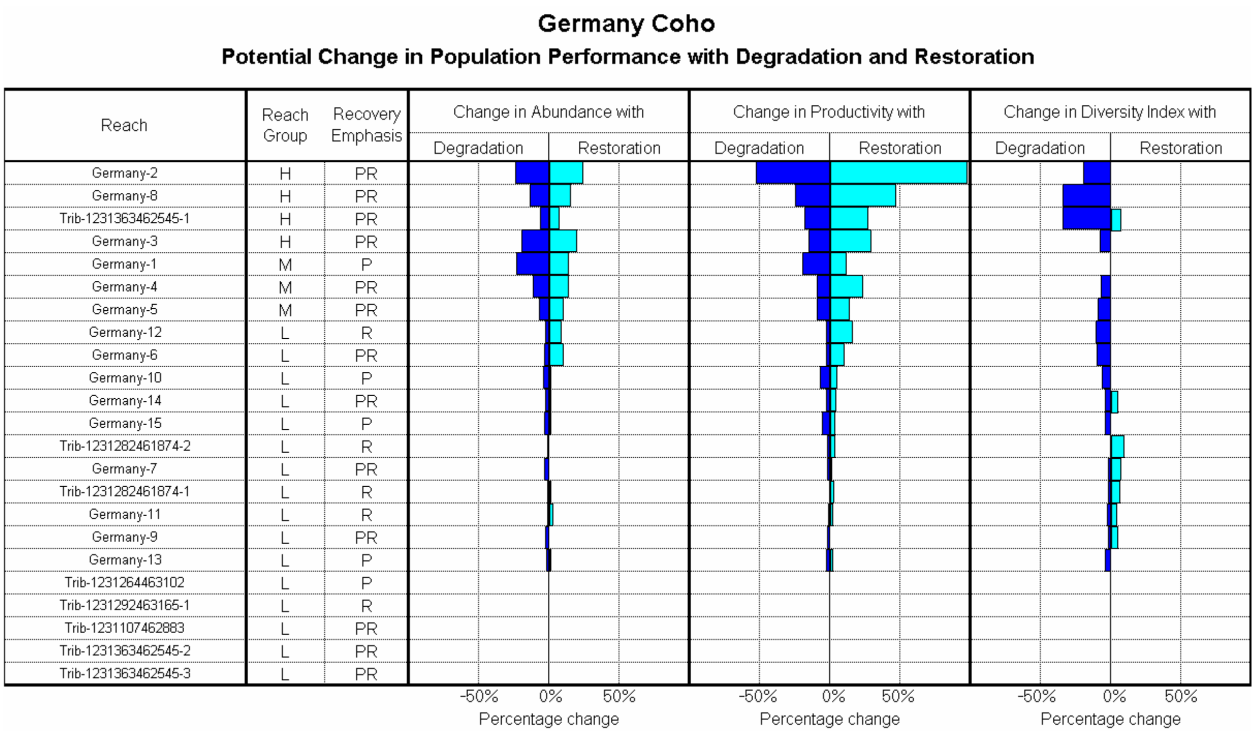


Figure 14. Germany Creek coho ladder diagram.

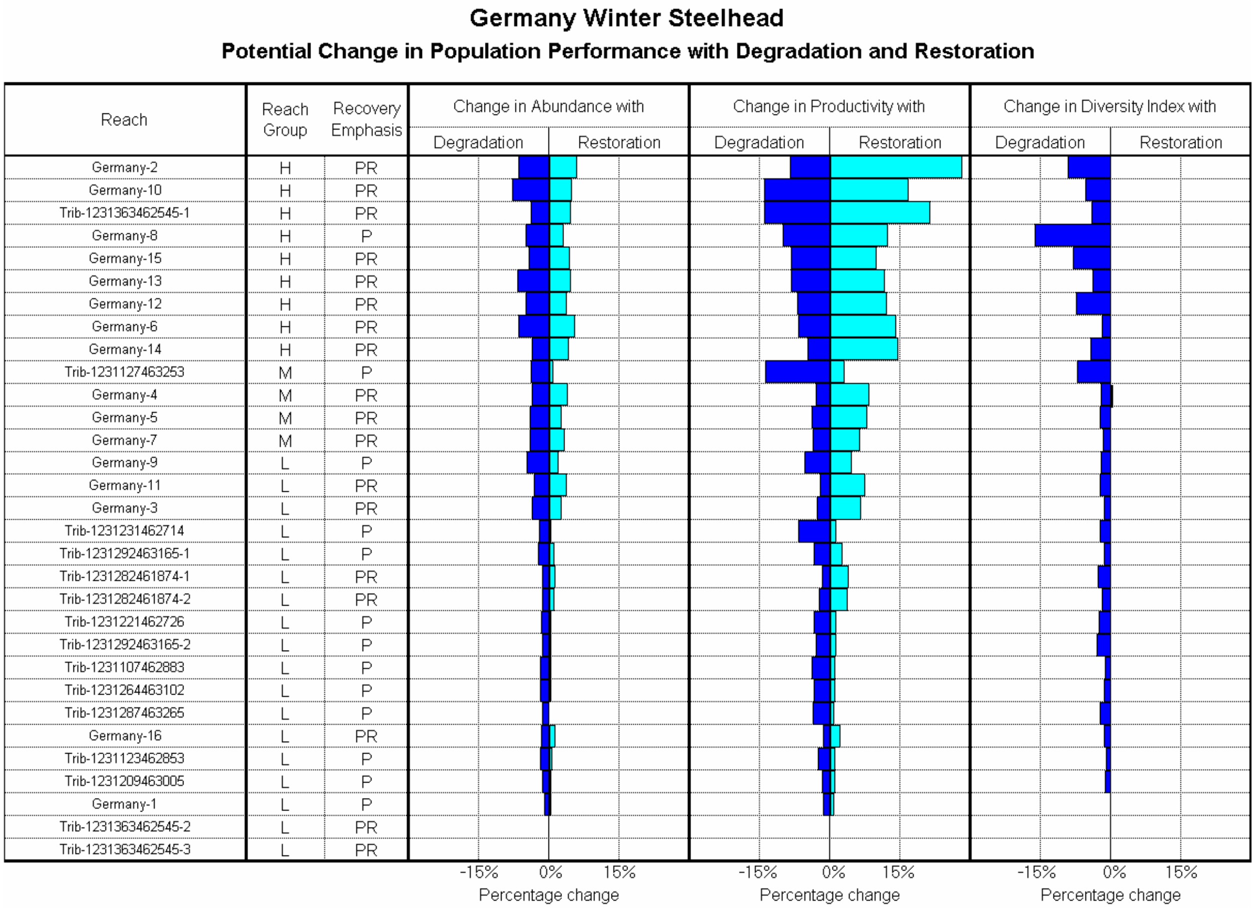


Figure 15. Germany Creek winter steelhead ladder diagram

In Abernathy Creek, winter steelhead are found throughout the entire mainstem, Slide Creek and Cameron Creek, while fall Chinook and chum are both found in the lower reaches of the mainstem. Coho distribution in the basin is not well understood, but it is assumed that they use all areas accessible. Refer to Figure 7 for a map of stream reaches within Mill, Abernathy and Germany Creeks.

For both fall Chinook and chum, the two high priority reaches, Abernathy 1 and Abernathy 2, are located below Weist Creek (Figure 16 and Figure 17). For fall Chinook, Abernathy 1 has a combined preservation and restoration emphasis, and Abernathy 2 has a preservation emphasis (Figure 16). For chum, Abernathy 1 has a restoration emphasis and Abernathy 2 has a combined preservation and restoration emphasis (Figure 17).

High priority reaches for Coho in Abernathy Creek occur in select mainstem sections in lower and middle Abernathy Creek (Abernathy 2, 5, and 7) (Figure 18). Abernathy 2 and 7 both have a combined preservation and restoration emphasis while Abernathy 5 has only a restoration emphasis.

High priority reaches for winter steelhead within Abernathy Creek include sections in lower and middle Abernathy Creek (Abernathy 1-2, 4-5, and 7-8), and smaller tributaries entering the middle and upper creek (Erik 2 and Midway 5) (Figure 19). These reaches are an even mix of those with a restoration emphasis and those with a combined preservation and restoration emphasis (Figure 19).

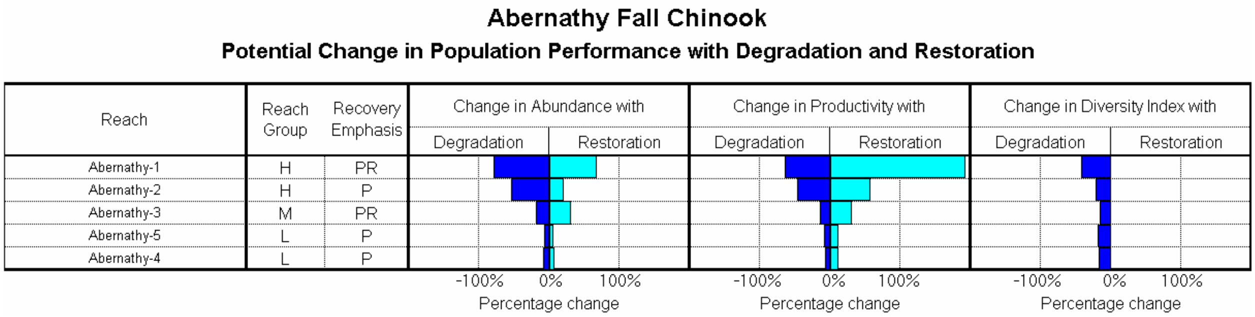


Figure 16. Abernathy Creek fall Chinook ladder diagram.

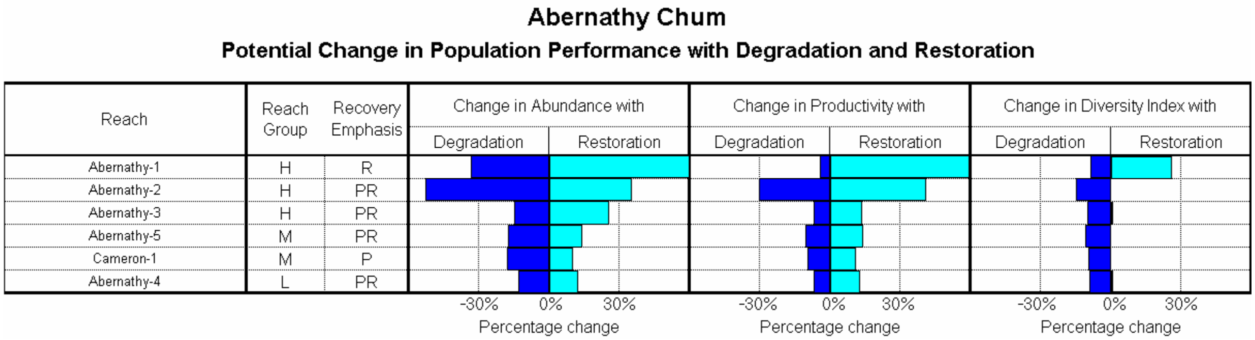


Figure 17. Abernathy Creek chum ladder diagram.

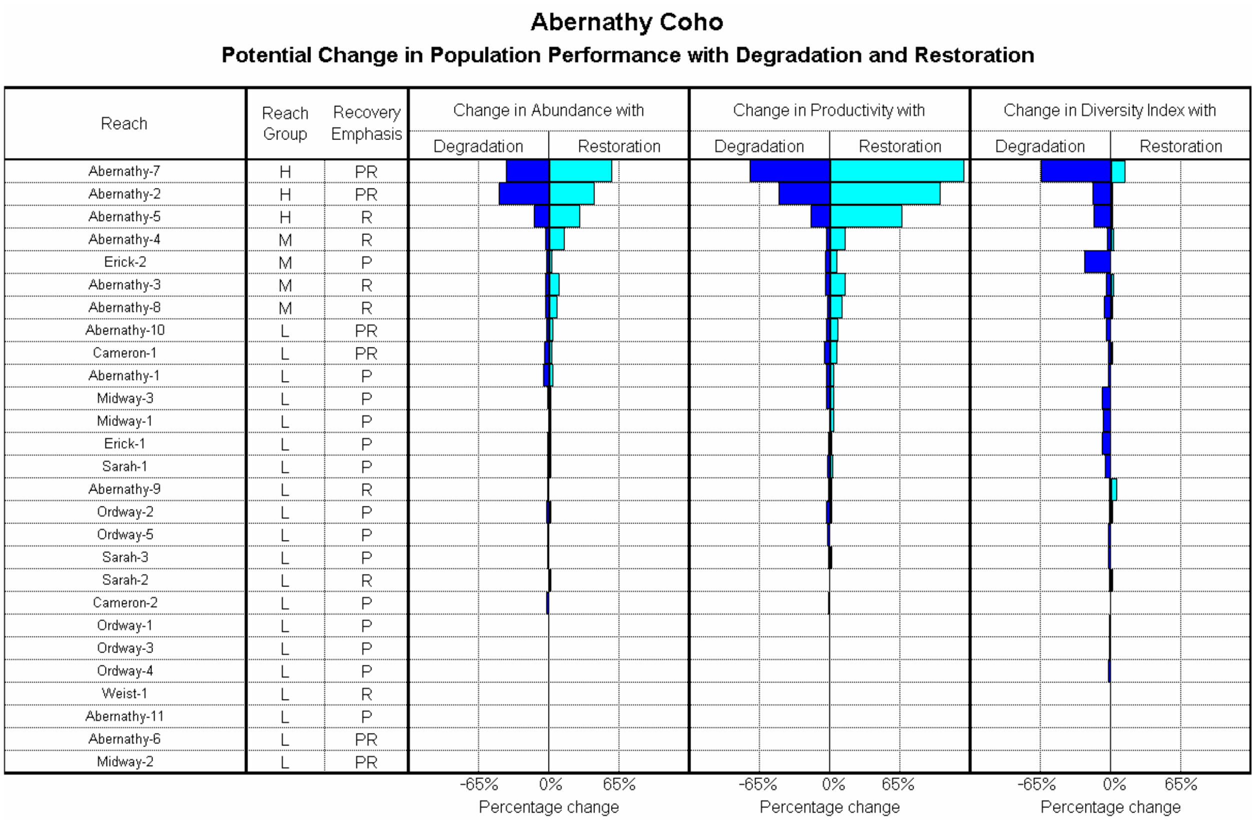


Figure 18. Abernathy Creek coho ladder diagram.

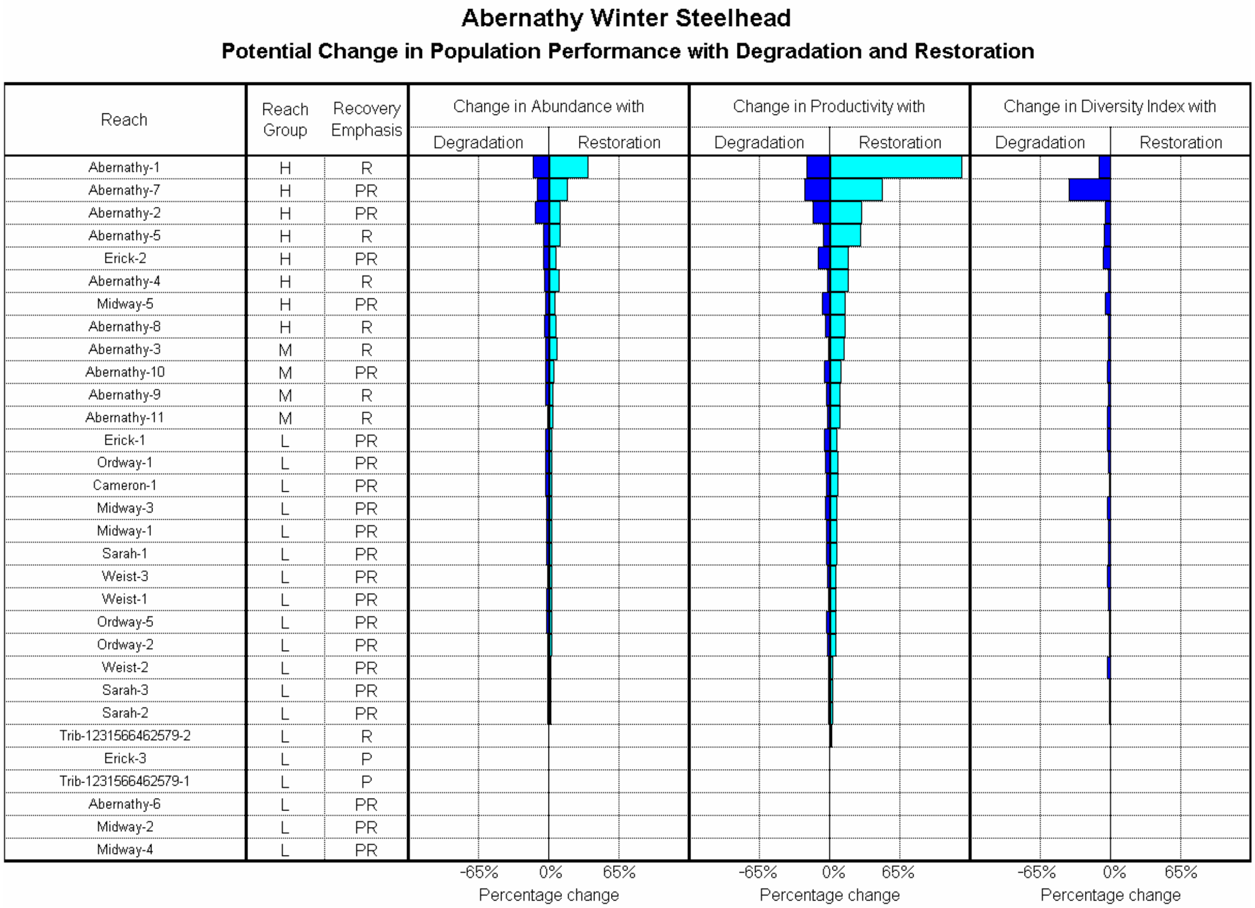


Figure 19. Abernathy Creek winter steelhead ladder diagram.

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 5.

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

Mill

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
Mill Fall Chinook				
most critical	Egg incubation	channel stability, sediment	harassment	
second	Fry colonization	flow, habitat diversity	channel stability, food, key habitat	
third	Spawning	habitat diversity	harassment, sediment	
Mill Chum				
most critical	Egg incubation	channel stability, sediment	harassment	
second	Prespawning holding	habitat diversity	harassment, key habitat	flow
third	Spawning	habitat diversity	harassment	
Mill Coho				
most critical	Egg incubation	channel stability, sediment		
second	0-age summer rearing	habitat diversity	flow, food, channel stability	temperature, key habitat
third	0-age winter rearing	flow, habitat diversity	channel stability	food, key habitat
Mill Winter Steelhead				
most critical	Egg incubation	channel stability, sediment	temperature	
second	Fry colonization	flow, habitat diversity	channel stability, food	
third	0-age summer rearing	flow, habitat diversity	channel stability, food	

Germany

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
Germany Fall Chinook				
most critical	Egg incubation	sediment	channel stability	
second	Fry colonization	food, habitat diversity, key habitat	channel stability, flow	
third	Prespawning holding	temperature	flow, habitat diversity, sediment	
Germany Chum				
most critical	Egg incubation	sediment	channel stability	
second	Prespawning holding	habitat diversity	harassment	
third	Spawning	habitat diversity, harassment		
Germany Coho				
most critical	Egg incubation	sediment	channel stability	
second	0-age summer rearing	temperature	food, habitat diversity	flow
third	0-age winter rearing	flow, habitat diversity	channel stability, food	
Germany Winter Steelhead				
most critical	Egg incubation	sediment	temperature, channel stability	
second	0-age summer rearing	pathogens, temperature		
third	0,1-age winter rearing	habitat diversity, flow	food	

Abernathy

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

The consumer reports diagrams have also been summarized to show the relative importance of habitat factors by reach. The summary figures are referred to as habitat factor analysis diagrams and are displayed for each species below. The reaches are ordered according to their combined restoration and preservation rank. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to historical conditions.

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

In Mill Creek, the highest priority restoration areas fall Chinook and chum habitat in Mill Creek are just below Spruce Creek. Habitat diversity and sediment are the factors most contributing to degradation of this reach (Figure 20 and Figure 21). Reduced riparian function and low levels of large woody debris contribute to habitat diversity problems. Riparian function problems result from narrow buffer widths due to residential development and roads adjacent to the streams. Sediment problems result from land use practices and high road densities in the upper basin increasing sediment loads which aggregate in lower basin reaches.

Key coho restoration reaches are generally located in middle and lower Mill Creek, lower North and South Fork Mill Creek, and Spruce Creek. A loss of habitat diversity, sedimentation, and decreased key habitat quantity are the primary limiting conditions in these reaches (Figure 22). The loss of habitat diversity is expressed as a lack of side channel habitat resulting from residential development and roads along the streams.

The most important restoration reaches for winter steelhead in the Mill Creek Basin are in Spruce Creek and the lower sections of South Fork and North Fork Mill Creek. Habitat diversity, flow, sediment, and channel stability all have substantial negative impacts in these areas (Figure 23). . The causes of habitat and sediment impacts are similar to those described for fall Chinook and chum. Flow alterations are also due to upper basin land use practices. Impairments to channel stability are evident as debris flows and high width-to-depth ratios

Mill Fall Chinook

Reac hName	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
Mill-2	Moderate	High							Moderate	High	Low				Moderate	Moderate
Mill-3	Low	Moderate							Low	High	Low					Moderate
Mill-1	Low	Moderate		Low					Low		Low					Low Positive

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

Figure 20. Mill Creek fall chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See section Appendix E Chapter 6 for more information on habitat factor analysis diagrams.

Mill Chum

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
SF Mill-1	Low	High							Low	High						Moderate
Mill-2	Low	High							Low	High					Moderate	Moderate
Mill-1		Low														

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

Figure 21. Mill Creek chum habitat factor analysis diagram.

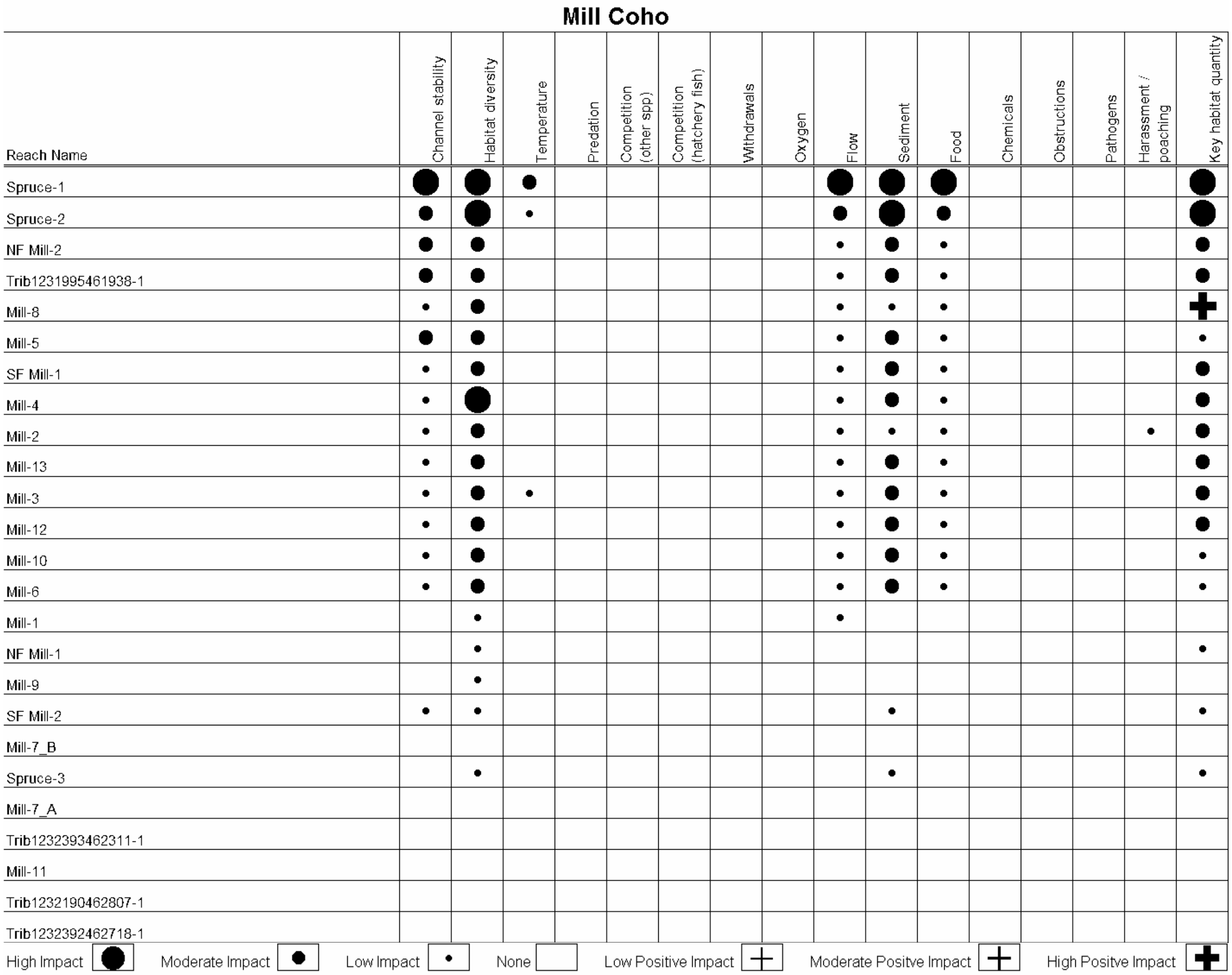


Figure 22. Mill Creek coho habitat factor analysis diagram.

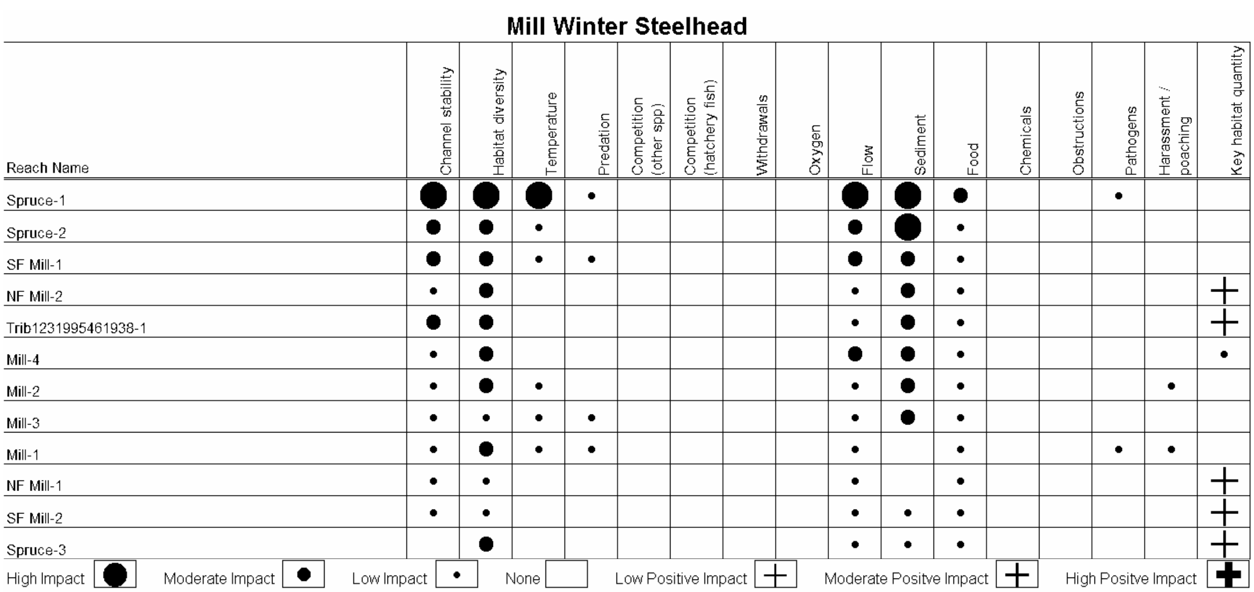


Figure 23. Mill Creek winter steelhead habitat factor analysis diagram.

In Germany Creek, important restoration reaches for fall Chinook and chum are in the lower Creek. These reaches have been most negatively influenced by increased sediment levels and low habitat diversity (Figure 24 and Figure 25). High fine sediment loads in the lower basin have resulted from deposition from contributions in upper reaches, and from riparian degradation in agricultural sections. Habitat diversity reductions are partially attributable to land use and stream management practices that have channelized and simplified the stream. Removal of LWD has also reduced habitat diversity in these critical reaches. A road along the stream contributed to numerous negative impacts in the key restoration reaches including lost habitat diversity, increased temperature, increased sediment, and lost key habitat.

The highest restoration potential for coho exists throughout the mainstem Germany Creek where reaches have been negatively impacted by increased sediment, decreased habitat diversity, and altered temperatures (Figure 26). The cause of these impacts is the same as those cited for fall Chinook and chum restoration reaches.

In Germany Creek, the highest priority restoration areas for winter steelhead are primarily in the middle and upper mainstem. Habitat diversity, sediment, and flow have the largest negative impacts in these reaches (Figure 27). The causes for habitat diversity and sediment impacts are the same as those cited for fall Chinook and chum restoration reaches. Flow issues are related to high road densities in the basin.

Germany Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Germany-2	Moderate	High	Moderate	Low					Moderate	High	Moderate				Moderate	Moderate
Germany-3	Low	Moderate	Low						Low	High	Low					Low Positive
Germany-4	Low	Moderate	Low						Low	High	Low					Low
Germany-1	Low	Moderate	Low	Low					Low	Low	Low					Low

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

Figure 24. Germany Creek fall chinook habitat factor analysis diagram.

Germany Chum

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
Germany-2	Low	High	Low						Low	High	Low				Moderate	Moderate
Germany-3	Low	Moderate							Low	High						Low Positive
Germany-1	Low	Low		Low					Low		Low					Low

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

Figure 25. Germany Creek chum habitat factor analysis diagram.

Germany Coho

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
Germany-2	M	H	H	L					M	H	M			L	L	L
Germany-8	M	H	L						M	H	M					M
Trib-1231363462545-1	M	M							L	M	L					M
Germany-3	M	H	H	L					M	H	M			L		M
Germany-1	M	H	M	M					M	L	M			L	L	L
Germany-4	M	H	M	L					M	H	M			L		M
Germany-5	L	M	M	L					M	H	M			L		M
Germany-12	L	H				L			M	H	L					M
Germany-6	L	H	M	L					L	H	M					M
Germany-10	L	L							L	M	L					
Germany-14	L	L								L						L
Germany-15	L	L								L						L
Trib-1231282461874-2																
Germany-7		L														
Trib-1231282461874-1	L	L							L	L						L
Germany-11	L	M							L	L						L
Germany-9		L								L						
Germany-13	L	L							L	L						L
Trib-1231264463102																
Trib-1231292463165-1																

High Impact (H) Moderate Impact (M) Low Impact (L) None Low Positive Impact Moderate Positve Impact High Positve Impact

Figure 26. Germany Creek coho habitat factor analysis diagram.

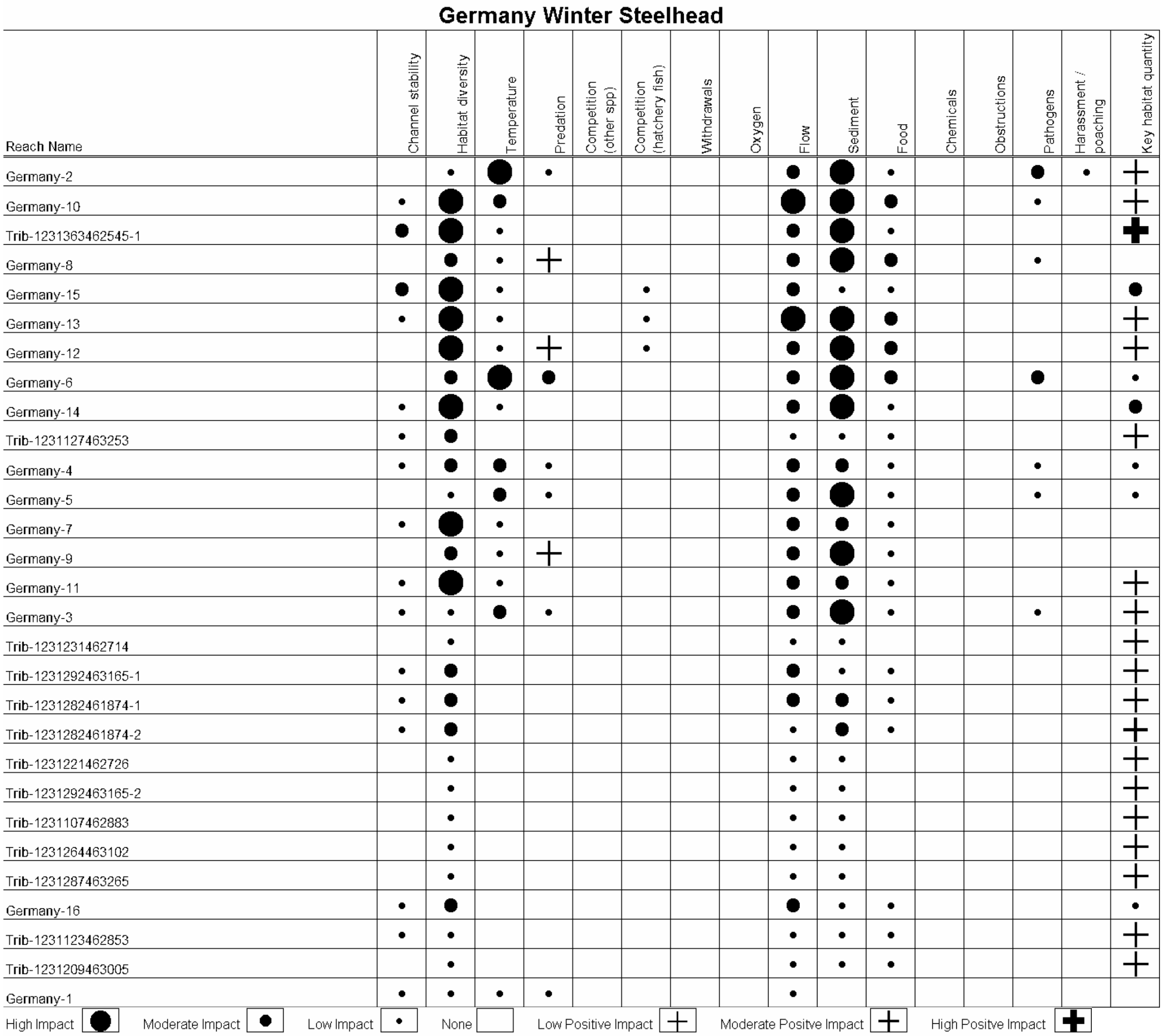


Figure 27. Germany Creek winter steelhead habitat factor analysis diagram.

In Abernathy Creek, important restoration reaches for fall Chinook and chum are below Weist Creek. These reaches have been most negatively influenced by increased sediment levels, lower habitat diversity, and loss of key habitat (Figure 28 and Figure 29). Sediment and flow issues are partially attributable to high road densities in the basin. Sediment issues are exacerbated by agricultural practices between RM 1.5 and 3.4. Habitat diversity is limited by the lack of side channels in the lower reaches, lack of LWD for pool formation, and confinement by roads in some sections. Much of the basin is covered by early-seral or non-forest vegetation. This may influence water temperature in the basin, and coupled with high road densities, may be leading to altered flow regimes.

The highest restoration potential for coho is in lower and middle Abernathy Creek, where reaches have been impacted by decreased habitat diversity, increased sediment, disrupted flow regimes, and decreased channel stability (Figure 30). Causes for these impacts are the same as those described for fall Chinook and chum restoration reaches.

Winter steelhead restoration reaches in Abernathy Creek are scattered throughout the lower and middle mainstem Abernathy Creek. Impacts to these reaches have resulted from degradation of the following habitat features: sediment, flow, habitat diversity, and temperature (Figure 31). Causes of impacts are the same as those described for fall Chinook and chum restoration reaches.

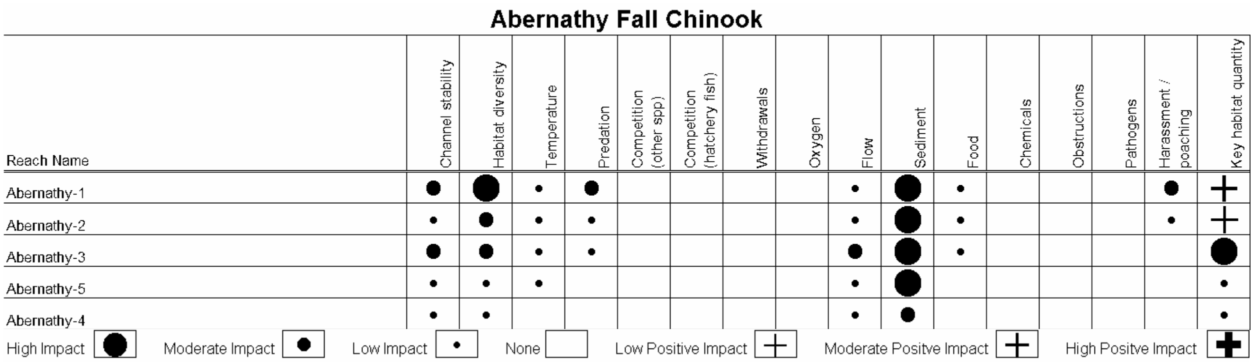


Figure 28. Abernathy Creek fall Chinook habitat factor analysis diagram.

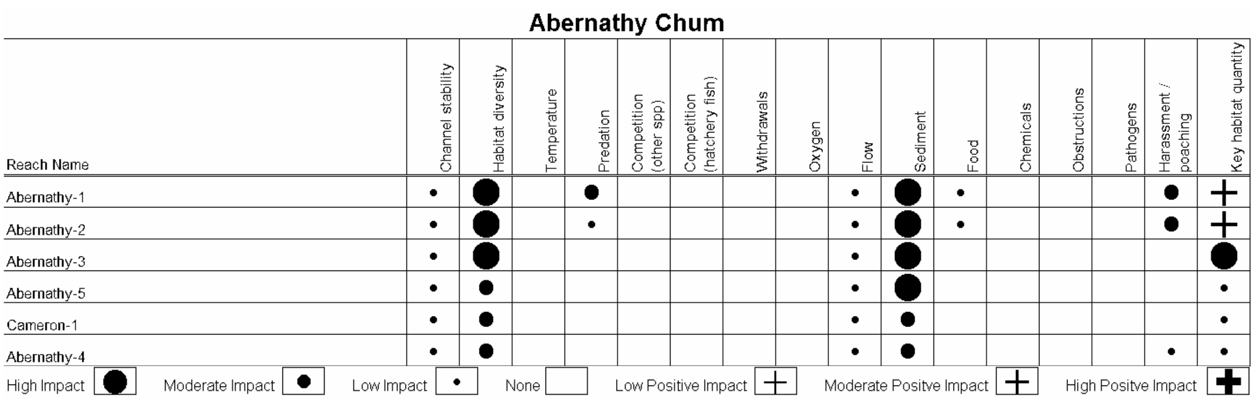


Figure 29. Abernathy Creek chum habitat factor analysis diagram.

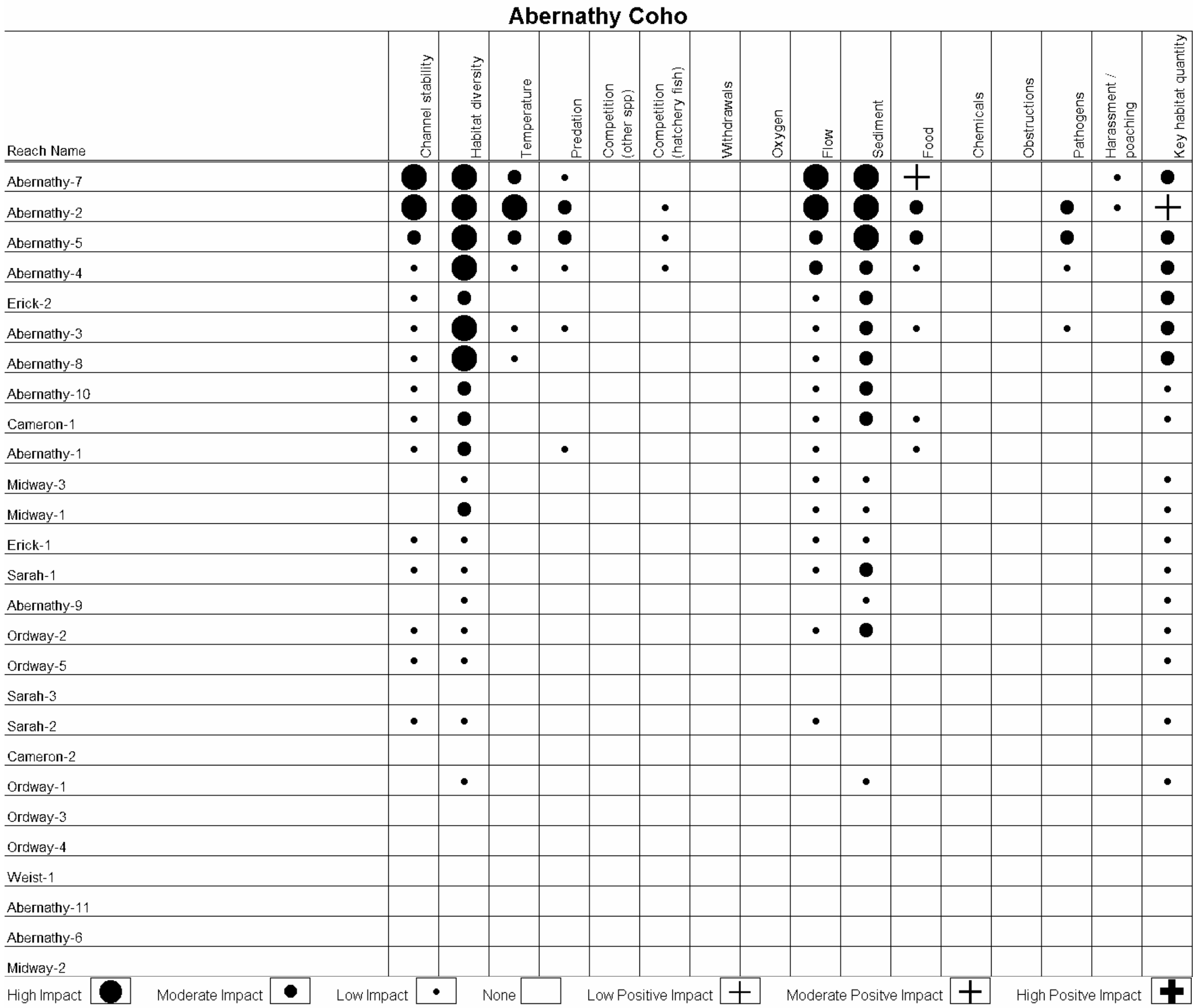


Figure 30. Abernathy Creek coho habitat factor analysis diagram.

Abernathy Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Abernathy-1	H	H	H	H		L			H	H	M			M	M	L
Abernathy-7	M	H	H	L					M	H	LP			L	L	
Abernathy-2	L	M	M	M		L			M	H	L			M	L	
Abernathy-5	L	H	M	M		L			M	M	L			M		L
Erick-2		M	L	L					M	H	L					M
Abernathy-4	L	M	M	L		L			M	M	L			M		L
Midway-5		M	L			L			M	H	L					M
Abernathy-8	L	M	L	L		L			M	M						L
Abernathy-3	L	H	M	L		L			M	M	L			L		L
Abernathy-10		M							M	M	LP					MP
Abernathy-9	L	M							M	M						
Abernathy-11	L	M							M	M						L
Erick-1		M	L						M	H	L					L
Ordway-1		M	L	L					M	H	L					MP
Cameron-1		M	L	L					L	H	L					LP
Midway-3		M							M	H						L
Midway-1		M							M	M						L
Sarah-1	LP	M	L						M	H	L					L
Weist-3	L	M	L						L	H						M
Weist-1	L	M	L						M	M						L
Ordway-5	MP	L	L						L	H						MP
Ordway-2	LP	M	L						M	H						MP
Weist-2	L	L							L	M						L
Sarah-3	L	L							L	M						L
Sarah-2	L	L							L	M						L
Trib-1231566462579-2		L							L							
Erick-3																
Trib-1231566462579-1																
Abernathy-6																
Midway-2																
Midway-4																

High Impact (H) | Moderate Impact (M) | Low Impact (L) | None (blank) | Low Positive Impact (LP) | Moderate Positve Impact (MP) | High Positve Impact (HP)

Figure 31. Abernathy Creek winter steelhead 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.

The Mill/Abernathy/Germany watershed is comprised of 14 IWA subwatersheds. IWA results for the Mill/Abernathy/Germany watershed are shown in Table 6. A reference map showing the location of each subwatershed in the basin is presented in Figure 32. Maps of the distribution of local and watershed level IWA results are displayed in Figure 33.

3.5.1 *Hydrology*

Current Conditions.— Of the fourteen subwatersheds in the basin, eleven are rated as hydrologically impaired at the local level, and three are rated as moderately impaired. Watershed level hydrology conditions are the same as those for local conditions. The only moderately impaired subwatersheds are located in headwater areas of the Abernathy Creek drainage (50401), and along Mill Creek (50502, 50503).

In the Mill Creek drainage, the mainstem subwatershed 50502 encompasses the most important reaches for anadromous fish. This subwatershed appears to be driven by local subwatershed problems, although some upstream conditions likely play a role as well. Road densities throughout the Mill Creek drainage are moderately high (4.1-4.7 mi/mi^2), but there is almost no rain-on-snow area, and mature vegetation cover is greater than 50% in the Mill Creek subwatersheds. Moderately impaired conditions in 50502 and 50503 likely buffer against the inputs from the impaired SF Mill subwatershed (50501).

In the Abernathy Creek drainage (50401-50403), the upper watershed (50401) is rated moderately impaired by IWA with respect to hydrologic process conditions, whereas the lower Abernathy (50402) and Cameron Creek (50403) subwatersheds are rated as moderately impaired. The Cameron and upper Abernathy watersheds are primarily under public ownership, the lower Abernathy subwatershed is mostly privately owned, and all are subject to active timber production. Rain-on-snow is not uncommon in subwatersheds 50401 and 50402. Immature forests cover most of these subwatersheds, with the average mature forest coverage at 28%. Road densities are moderately high, with an average of 5.1 mi/mi^2.

The hydrologic conditions in the Germany Creek subwatersheds (50301-50302) are impaired, which probably impacts the fish-bearing reaches in the lower Germany subwatershed

(50301). Impairment in subwatersheds 50301 and 50302 is driven by a lack of mature forest coverage (11% and 28%, respectively), moderately high road densities (6.0 mi/mi^2 and 6.2 mi/mi^2), and some impacts due to rain-on-snow events in the upper watershed (rain-on-snow zone covers 43%). Splash dams and culverts are reported to occur in the area as well. Most of the land is in private holdings, with large amounts in timber production.

Predicted Future Trends.— The land area in the Mill Creek subwatersheds is primarily publicly owned, although there is a substantial amount of private ownership (43%) in the lower subwatershed (50502). Forest cover on public land in these subwatersheds is predicted to generally mature and improve. Based on this information, hydrologic conditions are predicted to trend stable or improve gradually over the next 20 years in subwatershed 50502.

In the Abernathy Creek drainage, the high percentage of active timber lands, the high road densities, and the young forests suggest a stable (i.e., impaired, and moderately impaired) overall trend with respect to hydrologic conditions over the next 20 years.

Hydrologic conditions in the Germany Creek subwatersheds are predicted to trend stable (i.e., impaired, and moderately impaired) over the next 20 years due to ownership issues, high road densities, and young forests.

Table 6. IWA results for the Mill/Germany/Abernathy Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
50101	I	I	I	I	I	50104
50102	I	I	I	I	I	50104
50103	I	M	I	I	I	50201, 50202
50104	I	I	I	I	I	none
50201	I	M	M	I	M	50202
50202	I	M	M	I	M	none
50301	I	M	M	I	M	50302
50302	I	M	M	I	M	none
50401	M	M	M	M	M	none
50402	I	M	M	M	M	50401, 50403
50403	I	M	M	I	M	50401
50501	I	M	M	I	M	none
50502	M	F	M	M	M	50501, 50503
50503	M	M	F	M	M	none

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

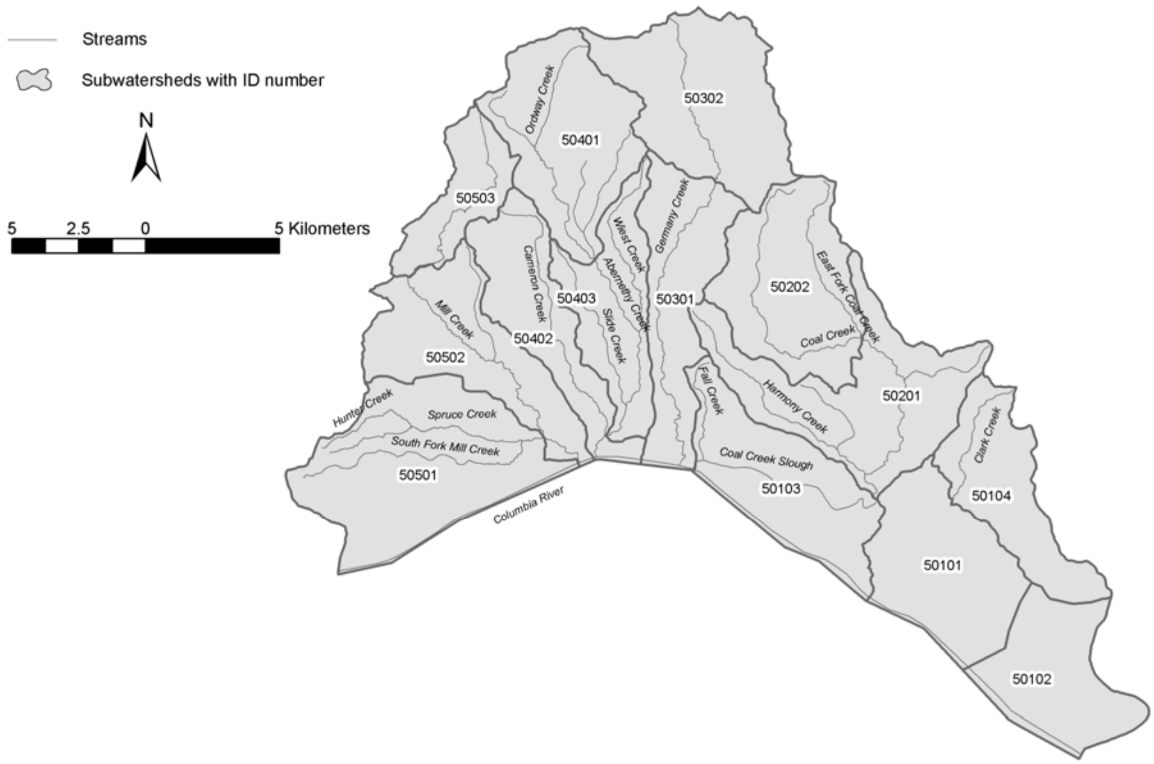


Figure 32. Map of the Mill, Abernathy, Germany watershed showing the location of the IWA subwatersheds.

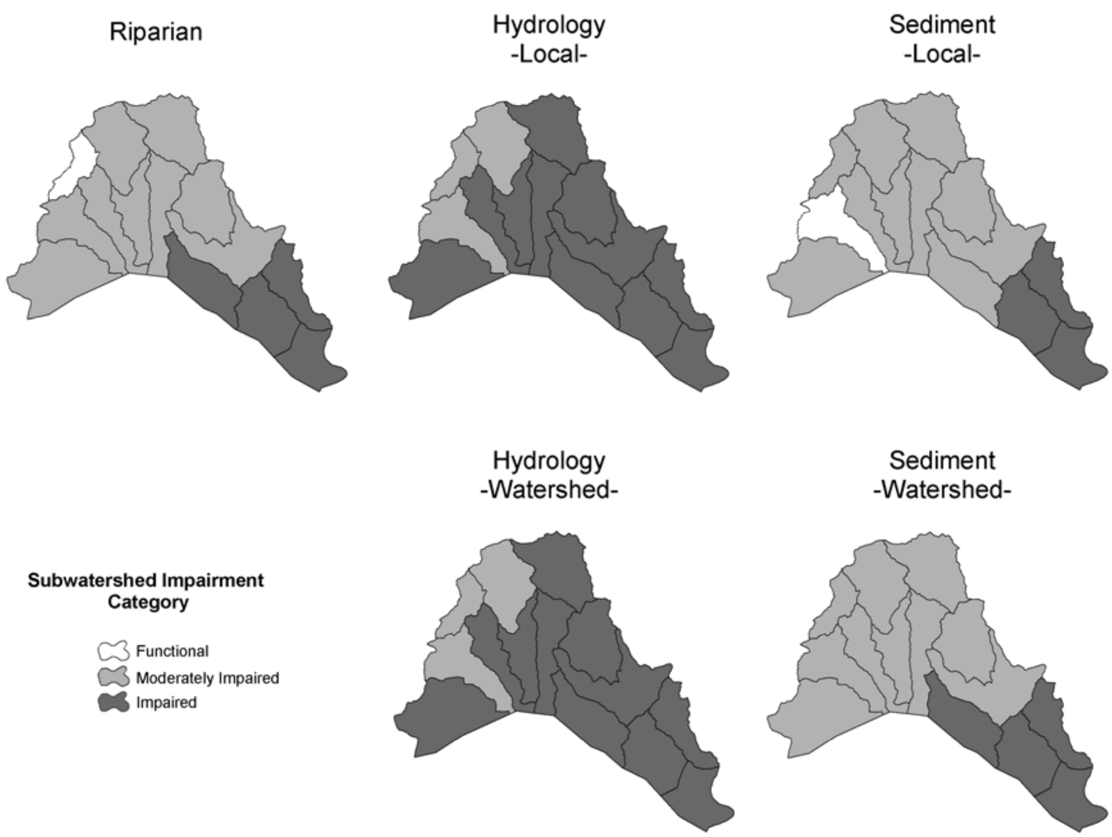


Figure 33. IWA subwatershed impairment ratings by category for the Mill, Abernathy, Germany watershed.

3.5.2 *Sediment Supply*

Current Conditions.— The majority of the subwatersheds in the Mill-Abernathy-Germany watershed are rated by IWA as moderately impaired. The exceptions include the impaired tideland areas in the lower Coal Creek drainage (50101-50104), and lower Mill Creek (50502), which is classified as functional for local conditions but moderately impaired at the watershed level. A comparison of Figure #-3 and Figure #-4 reveals that the impaired sediment conditions in the upper subwatersheds of Mill and Coal Creeks appear to contribute to the degradation of conditions within the lower subwatersheds.

Based on geology type and slope classification, most of the subwatersheds, not including the southeastern Coal Creek drainage, possess low natural erodability ratings. The erodability ratings in these subwatersheds are less than 12 on a scale of 0-126. This suggests that these subwatersheds would not be large sources of sediment impacts under undisturbed conditions. However, road densities, streamside roads, and stream crossings in these subwatersheds are relatively high, leading to erosion concerns.

Within the Mill Creek drainage, the locally functional sediment condition rating in subwatershed 50502 becomes moderately impaired at the watershed level. Moderately impaired conditions in the upper Mill Creek subwatershed (50503) and South Fork Mill Creek subwatershed (50501) are mostly driven by high road densities, and a lack of mature vegetation cover in subwatershed 50501.

Sediment conditions throughout the Abernathy Creek drainage (50401-50403) are rated as moderately impaired. These conditions are probably caused by moderate to high road densities (4.8–5.8 mi/mi^2) and stream crossing densities (2.1-5 crossings/stream mile) throughout the basin, and low mature vegetation coverage (averaging 30%) in the two lower subwatersheds (50402, 50403).

Both subwatersheds in the Germany Creek drainage are rated moderately impaired with respect to sediment supply. As with the other subwatersheds within the Germany-Abernathy watershed, high road densities (average is 6.1 mi/mi^2) in sensitive areas are primary contributing factors. In addition, poor mature forest cover (average is 20%) and high stream crossing densities (average is 5.9 crossings/stream mile) are factors that have the potential to increase sediment supply.

Predicted Future Trends.— Because most of the land in the Mill Creek subwatersheds is publicly owned, the outlook for stable or improving conditions above SF Mill Creek is good. A large percentage of private ownership and relatively low mature forest cover in the SF Mill Creek subwatershed (50501) indicates that sediment conditions in Mill Creek below SF Mill Creek may remain stable. The overall outlook for the lower Mill Creek subwatershed is stable.

With the amount of timber production and private land ownership within the Abernathy Creek drainage, sediment conditions are expected to remain stable. In the Germany Creek subwatersheds, most of the land is in private timber holdings and conditions are expected to remain stable or slowly decline.

3.5.3 *Riparian Condition*

Current Conditions.— The riparian conditions are similar to the sediment ratings, with 1 functional, 9 moderately impaired, and 4 impaired. Moderately impaired IWA riparian conditions exist throughout the watershed, with the exception of upper Mill Creek, which possesses a functional rating, and the subwatersheds southwest of Coal Creek (50101-50104), which are rated as impaired. These southwestern subwatersheds are largely degraded due to development around Longview, Washington.

Predicted Future Trends.— Based on the assumption that the trend for hydrologic recovery will also benefit riparian conditions, the predicted trend is for conditions in the western third of the watershed to remain relatively unchanged and to continue to degrade in the subwatersheds around Longview. The exception is the lower Mill Creek subwatershed (50502), which, due to its public ownership and relatively low streamside road impacts could improve gradually 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.

The Abernathy Creek NFH is the only hatchery in these basins. It primarily produced fall Chinook, but the program was discontinued in 1995 because of federal funding cuts. Coho and chum salmon and winter steelhead transfers have all been released in these basins in the past, but not currently; releases were produced out-of-basin. The Abernathy Fish Technology Center now operates at the former NFH facility; the major emphases of the Center's applied research programs are to assist in the repositioning of National Fish Hatcheries as tools in the conservation of natural populations, to examine the use of natural broodstocks by federal hatcheries to meet management objectives, and to promote and support propagation and management methods resulting in healthy Pacific salmon, steelhead/rainbow trout, cutthroat and bull trout, and white sturgeon populations.

Genetics—Most fall Chinook released in Abernathy Creek originated from Spring Creek Hatchery broodstock, which was derived largely from Big White Salmon River fall Chinook. Fall Chinook may not have been native to Abernathy, Mill, or Germany creeks. If they were not native, then the effects of hatchery operations on indigenous wild fall Chinook genetics would not be a major concern. Allele frequency analysis from multiple years in the late 1990s indicate that Abernathy Creek fall Chinook are significantly different from other lower Columbia River fall Chinook stocks, except for Kalama Hatchery fall Chinook. Historically, early-run coho were planted in these basins, although releases did not occur every year and no coho have been released in recent years. Natural coho in these tributaries were principally late stock origin. It is presumed that genetic mixing between hatchery and wild coho is likely minimal. Chum salmon released in these basins originated from Willapa Bay and Hood Canal stocks; chum have not been released in Abernathy Creek since 1991 or in Germany Creek since 1983, so any adults now returning to these basins are considered naturally spawning chum or strays from other basins. Winter steelhead released in Abernathy and Germany creeks were produced in the Beaver Creek Hatchery, which used broodstock from the Elochoman and Cowlitz rivers and Chambers Creek. It is presumed that temporal segregation between the early returning hatchery steelhead and later returning wild winter steelhead minimized genetic interaction between hatchery and wild fish. Currently, no winter steelhead hatchery fish are planted in these streams.

Interactions—Interactions between wild and hatchery chum and coho salmon are expected to be minimal because few wild fish are present in these basins and hatchery fish have not been released in recent years. Wild fall Chinook may not have been present historically in Abernathy, Mill, or Germany creeks. Winter steelhead have been released only rarely in Mill Creek; winter steelhead releases in Abernathy and Germany creeks did not occur every year and rarely exceeded 15,000 fish. Hatchery releases have now been discontinued. Hatchery fish contribute little to natural production in these basins and wild/hatchery fish interaction is expected to be minimal.

Water Quality/ Disease—Operational plans for the former Abernathy Creek NFH have not yet been obtained and the water source for the facility and disease treatments during the hatchery process are not yet known.

Mixed Harvest—There are no directed chum salmon fisheries on lower Columbia River chum stocks. Minor incidental chum harvest occurs in fisheries targeting fall Chinook and coho. Retaining wild chum salmon is prohibited in lower Columbia River and tributary sport fisheries.

Historically, fishery exploitation rates of hatchery fall Chinook, coho, and winter steelhead from these basins were likely similar to wild fish. Regulations for wild fish release have been in place in recent years for commercial and recreational fisheries for coho and steelhead. Specific hatchery-selective fisheries in the lower Columbia target hatchery coho and steelhead. Therefore, recent year exploitation rates for commercial and recreational fisheries are higher for hatchery coho and winter steelhead than for wild fish from these basins. Harvest rates for hatchery and wild fall Chinook remain similar and are constrained by ESA harvest limitations.

Passage—Operational plans for the former Abernathy Creek NFH have not yet been obtained, so specifics regarding the adult collection facility and passage concerns are not yet known.

Supplementation—Supplementation has not been the goal of the hatchery programs that released fish in these basins and few hatchery fish are released in Abernathy, Germany, or Mill creeks.

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 7 identifies hazards levels associated with risks involved with hatchery programs in the Mill/Abernathy/Germany creeks basin. Table 8 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 7. Preliminary BRAP for hatchery programs affecting populations in the Mill/Abernathy/Germany 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.
(shaded)	Hazard not relevant to population

Mill/Abernathy/ Germany Population	Hatchery Program		Risk Assessment of Hazards											
			Genetic			Ecological			Demographic		Facility			
	Name	Release (millions)	Effective Population Size	Domestication	Diversity	Predation	Competition	Disease	Survival Rate	Reproductive Success	Catastrophic Loss	Passage	Screening	Water Quality
	No WDFW Programs		—	—	—	—	—	—				—	—	—

Table 8. Preliminary strategies proposed to address risks identified in the BRAP for M-A-G Basin populations.

Mill/Germany/ Abernathy Population	Hatchery Program		Risk Assessment of Hazards															
			Address Genetic Risks					Address Ecological Risks				Address Demographic Risks		Address Facility Risks			
	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abatemen
	No WDFW Programs																

Impact Assessment

The potential significance of negative hatchery impacts within the watershed 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 Mill/Germany/Abernathy Basin is quite low (2.5%) for chum. The fitness impact is similarly low for winter steelhead where hatchery and wild fish are segregated by differences in spawn timing (competition effects are not assessed). Fitness impact potential is substantially greater for the Chinook reintroduction program in the Chinook River (24%) and for coho (44%). However, the high incidence of fall Chinook and coho hatchery spawners suggests that the fitness of natural and hatchery fish is now probably quite similar and natural populations might decline substantially without continued hatchery subsidy under current habitat conditions. Interspecific impacts from predation appear to be negligible for all species.

Table 9. 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 Mill/Abernathy/Germany 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	0[h]	0.47	3	0.5	0.24	0	0
Chum	0[i]	0.25	1	0.9	0.025	0	0
Coho	0[j]	0.88	3	0.5	0.44	0	0
Winter steelhead	0[k]	0.06	4	0.3	0.040	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 and coho for fall chinook and coho. Includes steelhead for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.
[h] Abernathy hatchery stopped releasing fall chinook in 1995; hatchery returns were expected to significantly diminish starting with the 1999 return.
[i] There is currently no chum salmon hatchery program in Mill, Abernathy, or Germany Creek; hatchery chum salmon have not been released in Abernathy Creek since 1991 or Germany Creek since 1983.
[j] Hatchery coho salmon are no longer released in the basin; hatchery fish in these basins appear to be strays from other programs.
k There are no steelhead hatchery programs in Mill, Abernathy, or Germany Creek. Sporadic small releases of winter steelhead have been made from the former Beaver Creek Hatchery program

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, this can result in fewer spawners and can alter age, size, run timing, fecundity, and genetic characteristics. Fewer spawners result in fewer eggs for future generations and diminish marine-derived nutrients delivered via dying adults, now known to be significant to the growth and survival of juvenile salmon in aquatic ecosystems. The degree to which harvest-related limiting factors influence productivity varies by species and location.

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

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

Table 10. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60
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 in-basin (like Mill, Abernathy, and Germany creeks) sport fisheries are closed to the retention of Chinook to protect naturally spawning populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

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

Harvest of Mill/Abernathy/Germany coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish. Salmon fishing is closed in Mill, Abernathy, and Germany creeks.

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. Steelhead fishing is closed in Mill, Abernathy, and Germany creeks

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

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

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

3.6.4 *Hydropower Construction and Operation*

There are no hydro-electric dams in the Mill/Abernathy/Germany Basin. However, Mill/Abernathy/Germany 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 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 34 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for M-A-G 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.

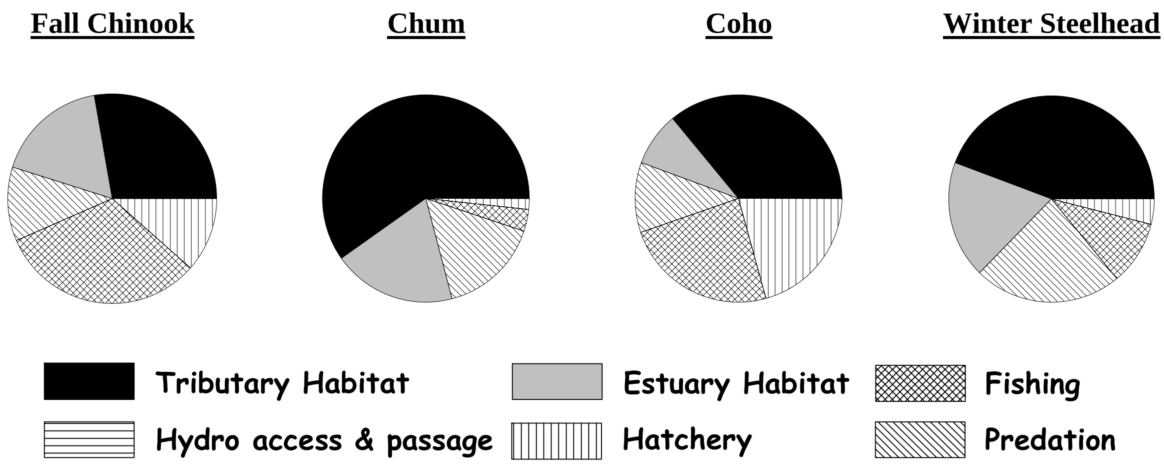


Figure 34. Relative contribution of potentially manageable impacts on Mill/Abernathy/Garmany salmonid populations.

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. Loss of tributary habitat quality and quantity accounts for the largest relative impact on all species. Loss of estuary habitat quality and quantity is also relatively important for all species, but less so for coho. Harvest has a sizeable effect on fall Chinook, but is relatively minor for chum and winter steelhead; harvest impact on coho is intermediate. Hatchery impacts are substantial for coho, moderate for fall Chinook, and relatively low for chum and winter steelhead. Predation impacts 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. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries. Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in its relative significance. Methods and data for these analyses are detailed in Appendix D.

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

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 *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.

4.1.5 *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 *Wahkiakum County*

Wahkiakum County is not planning under the State's Growth Management Act in its Comprehensive Planning process. Wahkiakum County manages natural resources primarily through its Critical Areas Ordinance.

4.3.2 *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.

4.3.3 *City of Longview*

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

4.3.4 *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 *Columbia River Estuary Study Taskforce*

The Columbia River Estuary Study Taskforce (CREST) is a council of local governments. CREST developed the Columbia River Estuary Regional Management Plan, which was adopted in local comprehensive plans and shoreline master programs. This plan contains an inventory of physical, biological and cultural characteristics of the estuary. Based on data needs identified during the development of the plan, Congress authorized and funded the Columbia River Estuary Data Development Program (CREDDP). This program provided a wealth of information that is still used by the local governments and by state and federal agencies in resource planning.

4.4.3 *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 M-A-G Basin.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Preservation	Abernathy Creek Restoration	Mill/Abernathy/Germany

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 Mill/Abernathy/Germany Watershed will play a key role in the regional recovery of salmon and steelhead. Natural populations of fall Chinook, winter steelhead, chum, and coho will be restored to high levels of viability by significant reductions in human impacts throughout the lifecycle. Salmonid recovery efforts will provide broad ecosystem benefits to a variety of subbasin fish and wildlife species. Recovery will be accomplished through a combination of improvements in subbasin, Columbia River mainstem, and estuary habitat conditions as well as careful management of hatcheries, fisheries, and ecological interactions among species.

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

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

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

Columbia basin hydropower effects on Mill/Abernathy/Germany salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. 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 full 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 Mill/Abernathy/Germany 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, 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 Mill/Abernathy/Germany Watershed are targeted to improve to a level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels.

Recovery goals call for restoring winter steelhead and chum to a high viability level, providing a 95% or better probability of population survival over 100 years. Fall Chinook and coho restoration goals of medium levels provide for a 75-94% probability of population 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 Mill/Abernathy/Germany Watershed although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the subbasin.

Table 11. Current viability status of Mill/Abernathy/Germany 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	No	Low	300-4,000	Medium[C]	250-2,000
Winter steelhead	Not Listed	Yes	Low+	50-500	High[P]	600
Chum	Threatened	No	Very Low	50-100	High[P]	1,100
Coho	Proposed	Yes	Low	unknown	Medium[C]	300

P = primary 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 role of the population in the recovery scenario. Productivity is defined as the inherent population replacement rate and is typically expressed by models as a median rate of population increase (PCC model) or a recruit per spawner rate (EDT model). Corresponding improvements in spawner numbers, juvenile outmigrants, population spatial structure, genetic and life history diversity, and habitat are implicit in productivity improvements.

Improvement targets were developed for each impact factor based on desired population productivity improvements and estimates of potentially manageable impacts (see Section 3.7). Impacts are estimates of the proportional reduction in population productivity associated with human-caused and other potentially manageable impacts from stream habitats, estuary/mainstem habitats, hydropower, harvest, hatcheries, and selected predators. Reduction targets were derived consistent with the strategy for equitable allocation of recovery responsibilities among all impact factors. Given the ultimate uncertainty in the effects of recovery actions and the need to implement an adaptive recovery program, this approximation should be adequate for developing order-of-magnitude estimates to which recovery actions can be scaled consistent with the current best available science and data. Objectives and targets will need to be confirmed or refined during plan implementation based on new information and refinements in methodology.

The following table (Table 12) 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 Mill/Abernathy/Germany fall Chinook must increase by 20% to reach population viability goals. This requires impact reductions equivalent to a 4% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts on fall Chinook must decrease from a 56% to a 54% impact in order to achieve the required 4% increase in tributary habitat potential from the current 44% of the historical potential to 46% of the historical potential.

Table 12. Productivity improvements consistent with biological objectives for the Mill/Abernathy/Germany Watershed.

	Net	Per	Baseline impacts					
Species	increase	factor	Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Fall Chinook	20%	4%	0.56	0.35	0.00	0.23	0.65	0.24
Chum	60%	7%	0.88	0.28	0.00	0.23	0.05	0.03
Winter Steelhead	20%	11%	0.44	0.18	0.00	0.23	0.10	0.04

5.4 Tributary Habitat

Habitat assessment results were synthesized in order to develop specific prioritized measures and actions that are believed to offer the greatest opportunity for species recovery in the watershed. 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 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 35 and each component is presented in detail in the sections that follow.

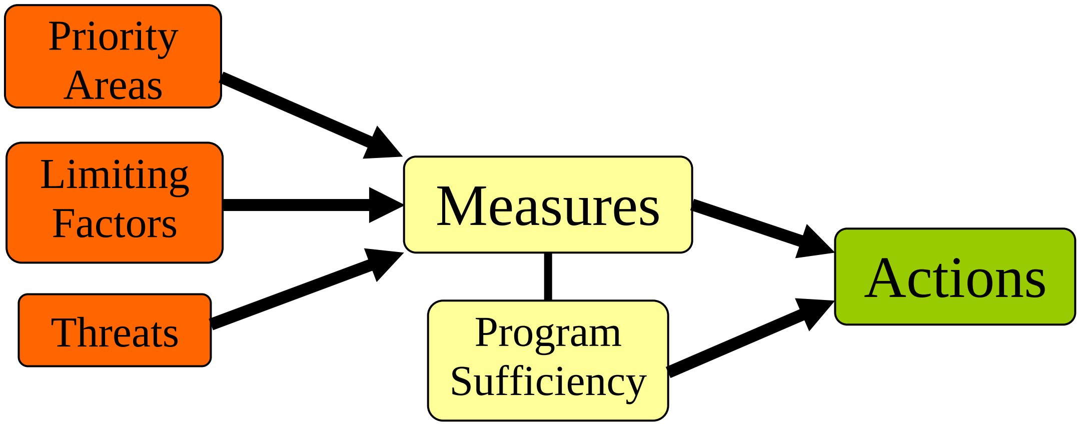


Figure 35. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Areas, Limiting Factors and Threats*

Priority habitat areas and factors in the watershed 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 M-A-G Watershed 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 M-A-G Watershed 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 13.

- Lower Mill Creek & tributaries (reaches Mill 1-5; SF Mill 1; Spruce 1-2; NF Mill 1-2) – The reaches with the most current and potential production in the Mill Creek basin are in the lower mainstem (below the SF confluence and just upstream of the NF confluence), in lower SF Mill Creek, and in NF Mill Creek. The Mill Creek basin is nearly entirely forest land, with scattered rural residential development along the lower mainstem and lower SF Mill Creek. The primary impacts are related to basin-wide forest practices and recovery measures should therefore focus primarily on forestry related impacts.
- Mainstem Abernathy Creek & tributaries (reaches Abernathy 1-11; Cameron 1; Erick 2; Midway 5) – The most productive reaches in Abernathy Creek are located in the lowest 3-4 miles of the mainstem and in the tributaries Erick and Midway creeks. These reaches suffer from basin-wide forest practices and from localized riparian and floodplain impacts related to agriculture and rural residential development. Successful restoration of habitat will involve riparian forest recovery, floodplain re-connection, and restoration of functional runoff and sediment supply processes from the entire basin.

- Mainstem Germany Creek (reaches Germany 1-8, 10, 12-15) – The lower and middle mainstem Germany reaches (Germany 1-8) are used by all salmonid populations. These reaches are impacted by basin-wide forest practices and by local agriculture and rural residential development. The upper Germany Creek reaches (Germany 10-15) are utilized most by winter steelhead. These reaches are impacted most by upper basin forest harvest and road conditions. Germany Creek reaches will require stream corridor (riparian areas and floodplains) restoration as well as basin-wide recovery of functional runoff and sediment supply processes.

Table 13. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the lower Mill Creek & tributaries (MI), mainstem Abernathy & tributaries (AB), and mainstem Germany & tributaries (GE). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors	MI	AB	GE
Habitat diversity			
Lack of stable instream woody debris	✓	✓	✓
Altered habitat unit composition	✓	✓	✓
Loss of off-channel and/or side-channel habitats	✓	✓	
Channel stability			
Bed and bank erosion	✓	✓	✓
Channel down-cutting (incision)	✓	✓	
Riparian function			
Reduced stream canopy cover	✓	✓	✓
Reduced bank/soil stability	✓	✓	✓
Exotic and/or noxious species	✓	✓	✓
Reduced wood recruitment	✓	✓	✓
Floodplain function			
Altered nutrient exchange processes	✓	✓	✓
Reduced flood flow dampening	✓	✓	✓
Restricted channel migration	✓	✓	✓
Disrupted hyporheic processes	✓	✓	✓
Stream flow			
Altered magnitude, duration, or rate of change	✓	✓	✓
Water quality			
Altered stream temperature regime	✓	✓	✓
Substrate and sediment			
Excessive fine sediment	✓	✓	✓
Embedded substrates	✓	✓	✓

Threats	MI	AB	GE
Agriculture / grazing			
Clearing of vegetation		✓	✓
Riparian grazing		✓	✓
Floodplain filling		✓	✓
Rural development			
Clearing of vegetation	✓	✓	✓
Floodplain filling	✓	✓	✓
Roads – riparian/floodplain impacts	✓	✓	✓
Forest practices			
Timber harvests –sediment supply impacts	✓	✓	✓
Timber harvests – impacts to runoff	✓	✓	✓
Riparian harvests	✓	✓	✓
Forest roads – impacts to sediment supply	✓	✓	✓
Forest roads – impacts to runoff	✓	✓	✓
Forest roads – riparian/floodplain impacts	✓	✓	✓
Splash-dam logging (historical)	✓	✓	
Channel manipulations			
Bank hardening	✓	✓	✓
Channel straightening	✓	✓	✓
Artificial confinement	✓	✓	✓

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 watershed, reach rankings for all of the modeled populations were combined, using population designations as a weighting factor. Population designations for the M-A-G Watershed 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 14. Reach tier designations for this basin are included in Table 15. Reach tiers and subwatershed groups are displayed on a map in Figure 36. A summary of reach- and-subwatershed-scale limiting factors is included in Table 16.

Table 14. 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 15. Reach Tiers in the Mill/Abernathy/Germany Watershed.

Tier 1	Tier 2	Tier 3	Tier 4	
Abernathy-1	Abernathy-10	Germany-1	Abernathy-6	Sarah-3
Abernathy-2	Abernathy-11	Mill-12	Cameron-2	SF Mill-2
Abernathy-3	Abernathy-9	Mill-13	Erick-1	Spruce-3
Abernathy-4	Cameron-1		Erick-3	Trib-1231107462883
Abernathy-5	Germany-3		Germany-11	Trib-1231123462853
Abernathy-7	Germany-4		Germany-16	Trib-1231209463005
Abernathy-8	Germany-5		Germany-9	Trib-1231221462726
Erick-2	Germany-7		Midway-1	Trib-1231231462714
Germany-10	Mill-1		Midway-2	Trib-1231264463102
Germany-12	Mill-3		Midway-3	Trib-1231282461874-1
Germany-13	Mill-5		Midway-4	Trib-1231282461874-2
Germany-14	Mill-8		Mill-10	Trib-1231287463265
Germany-15	NF Mill-1		Mill-11	Trib-1231292463165-1
Germany-2	Trib-1231127463253		Mill-6	Trib-1231292463165-2
Germany-6			Mill-7_A	Trib-1231363462545-2
Germany-8			Mill-7_B	Trib-1231363462545-3
Midway-5			Mill-9	Trib-1231566462579-1
Mill-2			Ordway-1	Trib-1231566462579-2
Mill-4			Ordway-2	Trib1232190462807-1
NF Mill-2			Ordway-3	Trib1232392462718-1
SF Mill-1			Ordway-4	Trib1232393462311-1
Spruce-1			Ordway-5	Weist-1
Spruce-2			Sarah-1	Weist-2
Trib-1231363462545-1			Sarah-2	Weist-3
Trib1231995461938-1				

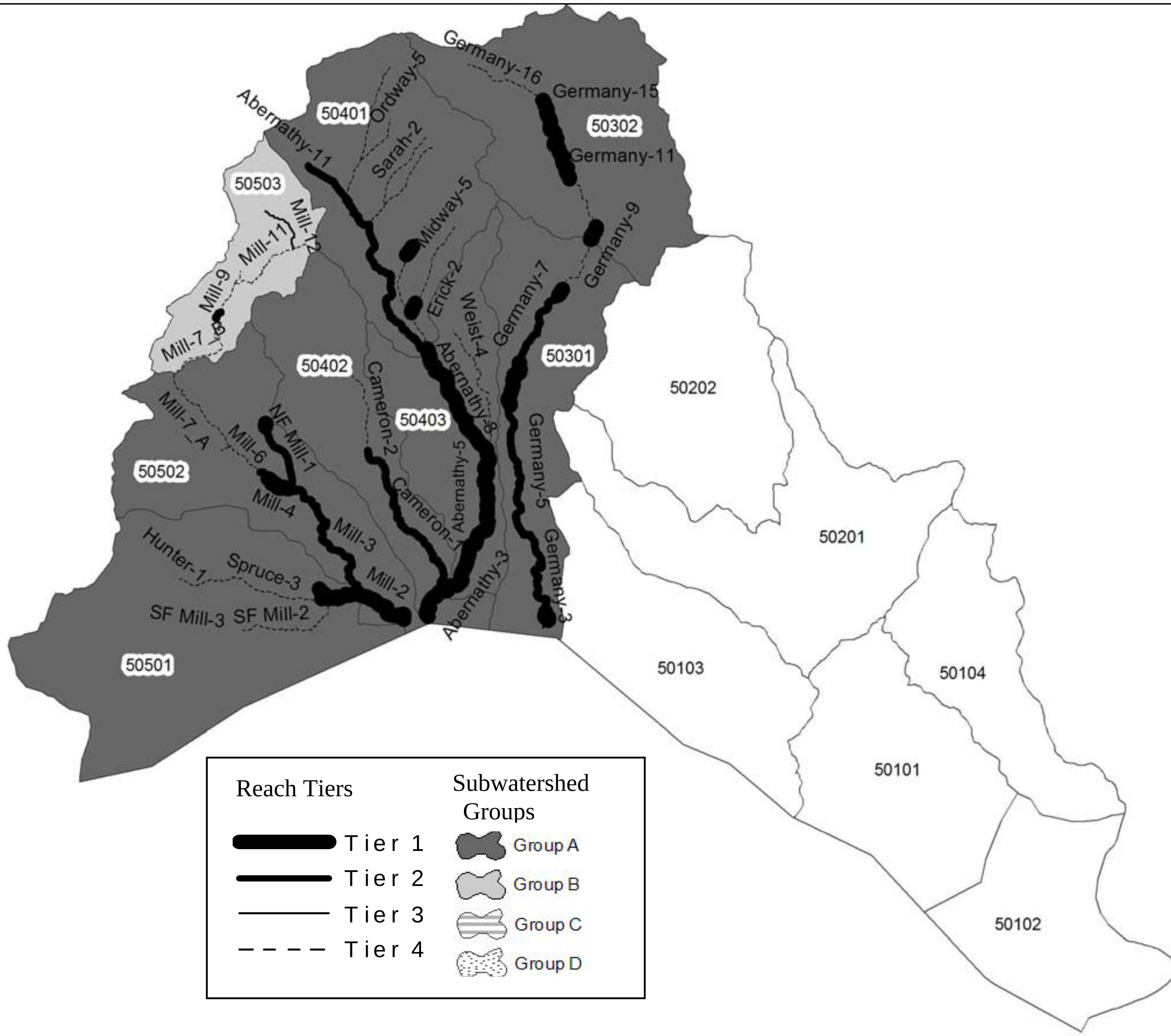


Figure 36. Reach tiers and subwatershed groups in the Mill/Abernathy/Germany Watershed. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. 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 16. 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.

Mill

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local): Hydrology	Watershed processes (local): Sediment	Watershed processes (local): Riparian	Watershed processes (watershed): Hydrology	Watershed processes (watershed): Sediment
A	50501	Spruce-1 Spruce-2 Spruce-3 SF Mill-1 SF Mill-2 Trib1231995461938-1	StW	Spruce-1 Spruce-2 Trib1231995461938-1 SF Mill-1	spawning egg incubation fry colonization summer rearing winter rearing adult holding	channel stability habitat diversity temperature flow sediment	PR	I	M	M	I	M
			Chum	SF Mill-1	spawning egg incubation fry colonization adult holding	habitat diversity sediment	PR					
			Coho	Spruce-1 Spruce-2 Trib1231995461938-1 SF Mill-1	spawning egg incubation fry colonization summer rearing juvenile (age-0) migrant winter rearing adult holding	channel stability habitat diversity flow sediment food key habitat quantity	PR					
	50502	Mill-1 Mill-2 Mill-3 Mill-4 Mill-5 Mill-6 Mill-7 NF Mill-1 NF Mill-2 Trib1232393462311-1	StW	Mill-2 Mill-4 NF Mill-2	spawning egg incubation fry colonization summer rearing winter rearing adult holding	none	PR	M	F	M	M	M
			Chum	none								
			ChF	Mill-2	spawning egg incubation fry colonization adult holding	habitat diversity sediment	PR					
			Coho	Mill-2 Mill-4 Mill-5 NF Mill-2	spawning egg incubation fry colonization summer rearing juvenile (age-0) migrant winter rearing adult holding	habitat diversity	PR					
B	50503	Mill-7 Mill-8 Mill-9 Mill-10 Mill-11 Mill-12 Mill-13 Trib1232392462718-1 Trib1232190462807-1	Coho	Mill-8	egg incubation summer rearing winter rearing	none	PR	M	M	F	M	M

Abernathy

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local): Hydrology	Watershed processes (local): Sediment	Watershed processes (local): Riparian	Watershed processes (watershed): Hydrology	Watershed processes (watershed): Sediment
A	50403	Abernathy-3 Abernathy-4 Abernathy-5 Abernathy-6 Abernathy-7 Abernathy-8 Trib1231566462579-1 Trib1231566462579-2 Weist-1 Weist-2 Weist-3	StW	Abernathy-4 Abernathy-5 Abernathy-7 Abernathy-8	egg incubation fry colonization summer rearing winter rearing	habitat diversity temperature sediment	PR	I	M	M	I	M
			Chum	Abernathy-3	spawning egg incubation fry colonization adult holding	habitat diversity sediment key habitat quantity	PR					
			ChF	none								
			Coho	Abernathy-5 Abernathy-7	egg incubation summer rearing winter rearing	channel stability habitat diversity flow sediment	PR					
	50402	Abernathy-1 Abernathy-2 Cameron-1 Cameron-2	StW	Abernathy-1 Abernathy-2	egg incubation summer rearing	channel stability habitat diversity temperature predation flow sediment	PR	I	M	M	M	M
			Chum	Abernathy-1 Abernathy-2	spawning egg incubation adult holding	habitat diversity sediment	PR					
			ChF	Abernathy-1 Abernathy-2	spawning egg incubation fry colonization adult holding	habitat diversity sediment	PR					
			Coho	Abernathy-2	egg incubation summer rearing winter rearing	channel stability habitat diversity temperature flow sediment	PR					
	50401	Abernathy-9 Abernathy-10 Abernathy-11 Erick-1 Erick-2 Erick-3 Midway-1 Midway-2 Midway-3 Midway-4 Midway-5 Ordway-1 Ordway-2 Ordway-3 Ordway-4 Ordway-5 Sarah-1 Sarah-2 Sarah-3	StW	Erick-2 Midway-5	egg incubation fry colonization summer rearing winter rearing	sediment	PR	M	M	M	M	M
			Coho	none								

Germany

<table>
<tr><th rowspan="2">Sub-watershed Group</th><th rowspan="2">Sub-watershed</th><th rowspan="2">Reaches within subwatershed</th><th rowspan="2">Species Present</th><th rowspan="2">High priority reaches by species</th><th rowspan="2">Critical life stages by species</th><th rowspan="2">High impact habitat factors</th><th rowspan="2">Preservation or restoration emphasis</th><th colspan="3">Watershed processes (local)</th><th colspan="2">Watershed processes (watershed)</th></tr>
<tr><th>Hydrology</th><th>Sediment</th><th>Riparian</th><th>Hydrology</th><th>Sediment</th></tr>
<tr><td rowspan="6">A</td><td rowspan="2">50302</td><td rowspan="2">Germany-10
Germany-11
Germany-12
Germany-13
Germany-14
Germany-15
Germany-16
Trib-1231107462883
Trib-1231123462853
Trib-1231127463253
Trib-1231209463005
Trib-1231264463102
Trib-1231282461874-1
Trib-1231282461874-2
Trib-1231287463265
Trib-1231292463165-1
Trib-1231292463165-2</td><td>StW</td><td>Germany-10
Germany-12
Germany-13
Germany-14
Germany-15</td><td>egg incubation
summer rearing
winter rearing</td><td>habitat diversity
flow
sediment</td><td>PR</td><td rowspan="2">I</td><td rowspan="2">M</td><td rowspan="2">M</td><td rowspan="2">I</td><td rowspan="2">M</td></tr>
<tr><td>Coho</td><td>none</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">50301</td><td rowspan="4">Germany-1
Germany-2
Germany-3
Germany-4
Germany-5
Germany-6
Germany-7
Germany-8
Germany-9
Trib-1231221462726
Trib-1231231462714
Trib-1231363462545-1
Trib-1231363462545-2
Trib-1231363462545-3</td><td>StW</td><td>Germany-2
Germany-6
Germany-8
Trib-1231363462545-1</td><td>spawning
egg incubation
fry colonization
summer rearing</td><td>habitat diversity
temperature
sediment</td><td>PR</td><td rowspan="4">I</td><td rowspan="4">M</td><td rowspan="4">M</td><td rowspan="4">I</td><td rowspan="4">M</td></tr>
<tr><td>Chum</td><td>Germany-2</td><td>spawning
egg incubation
adult holding</td><td>habitat diversity
sediment</td><td>PR</td></tr>
<tr><td>ChF</td><td>Germany-2
Germany-3</td><td>egg incubation
fry colonization
adult holding</td><td>habitat diversity
sediment</td><td>PR</td></tr>
<tr><td>Coho</td><td>Germany-2
Germany-3
Germany-8
Trib-1231363462545-1</td><td>spawning
egg incubation
fry colonization
summer rearing
juvenile (age-0) migrant
winter rearing
adult holding</td><td>habitat diversity
temperature
sediment</td><td>PR</td></tr>
</table>

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the M-A-G subbasin and necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this watershed (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 M-A-G Watershed are presented in priority order in Table 17. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the watershed. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority Locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

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

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following priorities for approaches: 1) protect existing functional habitats and the processes that sustain them, 2) allow no further degradation of habitat or supporting processes, 3) re-connect isolated habitat, 4) restore watershed processes (ecosystem function), 5) restore habitat structure, and 6) create new habitat where it is not recoverable. These priorities have been adjusted for the specific circumstances occurring in the M-A-G Watershed. 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 watershed. These are presented in Table 18 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, but instead represent the suite of activities that are all necessary for recovery of listed species. The priority for implementation of these actions must consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table 17. Prioritized measures for the M-A-G Watershed.

#1 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	All Species	The lower mainstems of Mill, Abernathy, and Germany Creek have been altered by adjacent land uses including agriculture, rural residential development, and transportation corridors. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Tier 1 or 2 reaches with functional riparian conditions (IWA) (reach Mill 8)
2nd- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation (reaches: Mill1-3; SF Mill 1; Abernathy 1-8; Germany 2-6
3rd- Remaining Tier 1 and 2 reaches
4th- 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, State Forest Practices, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Wahkiakum County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural Lands 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, 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 subwatershed hydrology and sediment delivery. Land-use conversion is increasing throughout the basin and local government ordinances must ensure that new development occurs in a manner that protects key habitats. Conversion of land-use from forest or agriculture to residential use has the potential to increase impairment of aquatic habitat, particularly when residential development is paired with flood control measures. Local

governments can limit potentially harmful land-use conversions by thoughtfully directing growth through comprehensive planning and tax incentives, by providing consistent protection of critical areas across jurisdictions, and by preventing development in floodplains. In cases where existing programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary.

#2 – Protect hillslope processes

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

Priority Locations

1st- Functional subwatersheds contributing to Tier 1 or 2 reaches (functional for sediment *or* flow according to IWA – local rating)
Subwatersheds: 50502
2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 50501, 50503, 50402, 50403, 50401, 50301, 50302
3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 50202, 50201, 50103
4th- All remaining subwatersheds
Subwatersheds: 50101, 50104, 50102

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
Wahkiakum County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural Lands 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 (agriculture and rural residential), County Comprehensive Planning is the primary nexus for protection of hillslope processes. Counties can control impacts through zoning that protects open-space, through stormwater management ordinances, and through tax incentives to prevent agricultural and forest lands from becoming developed. There are few to no regulatory protections of hillslope processes that relate to agricultural practices; such deficiencies need to be addressed through local or state authorities. Protecting hillslope processes on agricultural lands would also benefit from the expansion of technical assistance and landowner incentive programs (NRCS, Conservation Districts).

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

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

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. Impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: 50501, 50502, 50402, 50503, 50403, 50401, 50301, 50302

2nd- Moderately impaired or impaired subwatersheds contributing to other reaches
Subwatersheds: 50202, 50201, 50103, 50104, 50101, 50102

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, State Forest Practices	✓	
WDFW	Habitat Program		✓
Cowlitz County	Stormwater Management		✓
Wahkiakum County	Stormwater Management		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural Lands Habitat Restoration Programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

Forest management programs including the new Forest Practices Rules (private timber lands) and the WDNR HCP (state timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements 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 agricultural lands occurs relatively infrequently and there are no programs that specifically require restoration in these areas. Restoring existing agricultural lands can involve retrofitting facilities with new materials, replacing existing systems, and adopting new management practices. 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 floodplain function and channel migration processes along the lower mainstems and major tributaries

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

Priority Locations

1st- Tier 1 reaches with hydro-modifications (obtained from EDT ratings)
Reaches: Mill 2; Abernathy 1, 2, 4, 5, & 8; Germany 2, 6, 12, 13, & 15
2nd- Tier 2 reaches with hydro-modifications
Reaches: Mill 1 & 3; Abernathy 7 & 9; Germany 4
3rd- Other reaches with hydro-modifications
Reaches: Mill 10; Weist 1-2; Ordway 1; Midway 1; Germany 1, 11, & 16; several small unnamed tributaries

Key Programs

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

Program Sufficiency and Gaps

There currently are no programs or policy in place that set forth strategies for restoring floodplain function and channel migration processes in the Mill/Abernathy/Germany Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners 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.

#5 - Restore riparian conditions throughout the basin

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

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, State Forest Practices	✓	
WDFW	Habitat Program		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural Lands Habitat Restoration Programs		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed 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 Wahkiakum and Cowlitz Counties Comprehensive Plans. Many degraded riparian zones in agricultural, rural residential, or transportation corridors will not passively restore with existing regulatory protections and will require active measures that are not called for in any existing policy. Riparian restoration in these areas may entail livestock exclusion, tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Exclude livestock from riparian areas B. Increase riparian shading C. Decrease channel width-to-depth ratios D. Reduce delivery of chemical contaminants to streams E. Address leaking septic systems	• Bacteria • Altered stream temperature regime • Chemical contaminants	• Timber harvest – riparian harvests • Riparian grazing • Leaking septic systems • Clearing of vegetation due to rural development and agriculture • Chemical contaminants from agricultural lands	• All species	There are known impairments to stream temperature throughout the basin, related primarily to degraded riparian canopy cover. Livestock grazing may be contributing to temperature as well as bacteria impairment in some areas. Bacteria is more of a human health concern than a fish health concern. The impact of leaking septic systems may also be a concern and should be further evaluated. The degree of impact of agricultural pollutants is unknown and needs further assessment. The Longview Ditches, in the southeastern portion of the basin near Longview suffer from a number of water quality impairments.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 Draft list)
Reaches: Abernathy 2-5 & 8 (temperature); Germany 3, 4, & 10 (temperature)
2nd- Other reaches with 303(d) listings
Reaches: Coal Creek (temperature); Longview Ditches (bacteria and dissolved oxygen)
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, State Forest Practices	✓	
WDFW	Habitat Program		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agriculture Lands Habitat Restoration Programs, Centennial Clean Water Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Wahkiakum County Health Department	Septic System Program		✓
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 are listed stream segments in the Abernathy, Germany, and Coal Creek Basins for stream temperature impairment (WDOE 2004) and several other streams are listed as a concern for stream temperature impairment (i.e. Mill Creek). The Longview Ditches suffer from a host of additional impairments. Water Quality Clean-up Plans (TMDLs) that address these impairments are required by the WDOE and it is anticipated that the TMDLs will adequately set forth strategies to address the primary water quality concerns in the basin. It will be important that the strategies specified in the TMDLs are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin, especially regarding agricultural pollutants.

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

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

Priority Locations

1st- Lower mainstems of Mill, Abernathy, and Germany Creeks and lower portions of major tributaries
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, although voluntary efforts have been initiated in some areas (i.e. lower Germany Creek). Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

#8 - Restore 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	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring channel stability and structure. Passive restoration is expected to slowly occur as a result of protections afforded to riparian areas and hillslope processes. Past projects have largely been opportunistic and have been completed due to the efforts of local NGOs 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.

#9 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve flows during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Mill/Abernathy/Germany Basin have been identified as part of Watershed Planning for WRIA 25 (LCFRB 2004). Strategies include water rights closures, setting of minimum flows, and drought management policies. This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

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

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 by December 2004. Instream flow management in the Mill/Abernathy/Germany Basin will be conducted using the recommendations of the WRIA 25/26 Planning Unit, which is coordinated by the LCFRB. Draft products of the WRIA 25/26 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the planning unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies. Ecology should implement the recommendations of the WRIA 25/26 Watershed Planning Unit relative to instream flow protections.

#10 – 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 5 miles of potentially accessible habitat are blocked by culverts or other barriers. The blocked habitat is believed to be marginal in the majority of cases and no individual barriers in themselves account for a significant portion of blocked miles. Passage restoration projects should focus only on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Tributaries to Mill Creek and Coal Creek
2nd- Other small tributaries with blockages

Key Programs

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

Program Sufficiency and Gaps

The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Past efforts have corrected major blockages 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.

Table 18. Habitat actions for the M-A-G Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
M-A-G 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, 5, 6 & 10	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
M-A-G 2. Expand standards in County Comprehensive Plans to afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Wahkiakum County, Cowlitz County	1 & 2	Medium: Private lands. Applies primarily to lands in the lower basin in agriculture, 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
M-A-G 3. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Wahkiakum County, Cowlitz County, WDOE	1	Medium: Private lands currently in agriculture or timber production in lowland areas.	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
M-A-G 4. Seize opportunities to conduct voluntary floodplain restoration on lands being phased out of agricultural production. Survey landowners, build partnerships, and provide financial incentives	New program or activity	NRCS/WCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 6, 7, &, 8	Medium: Middle mainstem Abernathy and Germany Creeks	High: Restoration of floodplain function, habitat diversity, and habitat availability	High
M-A-G 5. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of agriculture and timber lands to developed uses through zoning regulations and tax incentives	Expansion of existing program or activity	Wahkiakum County, Cowlitz County	1 & 2	Medium: Private lands. Applies primarily to lands in the lower basin in agriculture, 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
M-A-G 6. 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	Wahkiakum County, Cowlitz County	1, 3, 5, & 6	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
M-A-G 7. 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 Wahkiakum CD	7	Medium: Lower Mill, Abernathy, and Germany Creeks	High: Increased habitat availability for spawning and rearing	Medium
M-A-G 8. Implement the prescriptions of the WRIA 25/26 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 25/26 Planning Unit, Cowlitz County	9	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium

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

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
M-A-G 9. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	**Expansion of existing program or activity**	**LCFRB, BPA (NPCC), NGOs, WDFW, NRCS Wahkiakum CD**	**3, 4, 5, 6, 7, 8, & 10**	**High: Priority stream reaches and subwatersheds throughout the basin**	**Medium: Improved conditions related to water quality (temperature and bacteria), LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes**	**Medium**
M-A-G 10. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers.	**Expansion of existing program or activity**	**WDNR**	**1, 2, 3, 5, 6 & 10**	**Low: Small private timberland owners**	**High: Reduction in road-related fine sediment delivery; restoration and preservation of fish access to habitats**	**Medium**
M-A-G 11. 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: Mixed-use lands at risk of degradation**	**High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes**	**High**
M-A-G 12. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	**Expansion of existing program or activity**	**NRCS Wahkiakum CD, WDNR, WDFW, LCFEG**	**All measures**	**Medium: Private lands. Applies primarily to lands in the lower basin in agriculture, rural residential, and forestland uses**	**High: Increased landowner stewardship of habitat. Potential improvement in all factors**	**Medium**
M-A-G 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**	**Medium: State timber lands in the M-A-G Watershed (approximately 17% of the basin area)**	**Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands**	**Medium**
M-A-G 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 Wahkiakum CD**	**1 & 5**	**Medium: Greatest risk is in lower basin agriculture and residential use areas**	**Medium: restoration and protection of native plant communities necessary to support watershed and riparian function**	**Low**
M-A-G 15. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	**Expansion of existing program or activity**	**Wahkiakum County, Cowlitz County, Wahkiakum CD**	**6**	**Low: Private agricultural and rural residential lands in lower basin**	**Medium: Protection and restoration of water quality (bacteria)**	**Medium**
M-A-G 16. 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, Wahkiakum County, Cowlitz County, WSDOT, LCFEG**	**10**	**Low: As many of 5 miles of stream are blocked by artificial barriers**	**Low: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases**	**High**

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the Mill/Abernathy/Germany Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery actions in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. This may involve substantial changes in some hatchery programs from their historical focus on production for mitigation for fishing benefits. The recovery strategy includes a mixture of conservation programs and mitigation programs. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the Mill/Abernathy/Germany Basin are displayed by species in Table 19. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 19. Summary of natural production and fishery enhancement strategies to be implemented in the Mill/Abernathy/Germany Basin.

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

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

Conservation-based hatchery programs include strategies and 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 regugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural population on fitness and our ability to measure natural population productivity and will be key indicators of natural population status within the ESU. The Mill/Abernathy/Germany Basin would be a refuge area for natural fall Chinook and winter steelhead.

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 chum in the Mill/Abernathy/Germany Basin.

Hatchery/Natural Isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of spring and fall Chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This strategy would not be included in near-term measures for the Mill/Abernathy/Germany 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. There is not a Chinook harvest program in the Mill/Abernathy/Germany 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 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 winter steelhead and early coho in the Mill/Abernathy/Germany Basin.

Table 20. A summary of conservation and harvest strategies to be implemented through Abernathy Hatchery NFH programs.

		Stock
Natural Production Enhancement	Supplementation	Mill/Abernathy/Germany Chum√
	Hatch/Nat Conservation [1/]	
	Isolation	
	Broodstock development	Mill/Abernathy/Germany Chum√
Fishery Enhancement	In-basin releases (final rearing at Abernathy)	
	Out of Basin Releases (final rearing at Abernathy)	

1/ May include integrated and/or isolated strategy over time.
√ 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 Mill/Abernathy/Germany 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 Mill/Abernathy/Germany Basin (Table 21). 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 Mill/Abernathy/Germany 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 21. Hatchery program actions to be implemented in the Mill, Abernathy, and Germany Creek Watershed.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Develop a chum brood stock utilizing natural returns to Germany, Mill, and Abernathy creeks, or other genetically similar lower Columbia chum populations. • Establish a brood stock program at Abernathy NFH, Elochoman, or Cowlitz Hatchery dependent on logistics, stock similarities, and coordination between WDFW and USFWS.	** Hatchery programs utilized for chum supplementation	Elochoman Hatchery, Cowlitz Hatchery, or Abernathy NFH.	Mill Creek, Germany Creek, and Abernathy Creek chum.	Abundance, spatial distribution	• Risk of low number of natural spawners • Ecologically appropriate brood stock.	• Establish an appropriate brood stock to supplement and decrease risks to the Mill, Abernathy, and Germany Creek chum population. Chum abundance will increase with habitat improvements resulting in expanded distribution in the Coastal strata.
• Research, monitoring , and evaluation of performance of selected hatchery actions conducted at Abernathy NFH research hatchery facilities Scope of the USFWS research is prioritized to investigate lower Columbia salmon and steelhead recovery actions. • Abernathy NFH used for within watershed (Mill, Germany, Abernathy creeks) evaluation of chum enhancement program	** Monitoring and evaluation, adaptive management	Abernathy NFH	Potentially 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 • Abernathy NFH provides unique opportunity for research and evaluation of lower Columbia recovery actions and adjustments

** 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 Mill, Germany, and Abernathy creeks (Table 22). More complete details can be found in the WDFW Sport Fishing Rules Pamphlet.

Table 22. Summary of regulatory and protective fishery actions in Mill, Abernathy, and Germany creeks

Species	General Fishing Actions	Explanation	Other Protective Fishing Actions	Explanation
Fall Chinook	Closed to retention	Protects wild fall Chinook. No harchery fall Chinook produced for harvest in these creeks	No season for other salmon or steelhead	Prevents incidental handle of wild fall Chinook
chum	Closed to retention	Protects wild chum. No hatchery chum produced for harvest in these creeks	No season for other salmon or steelhead	Prevents incidental handle of wild fall chum
coho	Closed to retention	Protects wild coho. No hatchery coho produced for harvest in these creeks	No season for other salmon or steelhead	Prevents incidental handle of wild coho
Winter steelhead	Closed to retention	Protects wild winter steelhead. No hatchery steelhead produced for harvest in these creeks	Steelhead and trout fishing closed in the spring and minimum size restrictions in affect	Spring closure Protects adult wild steelhead during spawning and minimum size protects juvenile steelhead

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and 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 Mill/Abernathy/Germany Watershed populations are summarized in the following table:

Table 23. Regional harvest actions from Volume I, Chapter 7 with significant application to the Mill/Abernathy/Germany Watershed populations.

Action	Description	Responsible Parties	Programs	Comments
**F.A12	Monitor chum handle rate in winter steelhead sport fisheries.	WDFW	Columbia Compact	State agencies would include chum incidental handle assessments as part of their annual tributary sport fishery sampling plan. If winter steelhead fisheries continue in these basins.
*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 Mill/Abernathy/Germany Watershed, hence, no in-basin hydropower actions are identified. Mill/Abernathy/Germany 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

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

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 Mill/Abernathy/and Germany subbasin. This subbasin was selected as a long-term monitoring area for the Coast Strata.

Table 24. Summary of the biological monitoring plan for the Mill/Abernathy/Germany subbasin populations.

Mill/Abernathy/Germany: Lower Columbia Biological Monitoring Plan				
Monitoring Type	**Fall Chinook**	**Chum**	**Coho**	**Winter Steelhead**
Routine	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 25. Summary of the habitat monitoring plan for the Mill/Abernathy/Germany subbasin populations.

Mill/Abernathy/Germany : 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-Poor IFA-Moderate	WDOE-Poor USGS-Poor Temperature-Good
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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