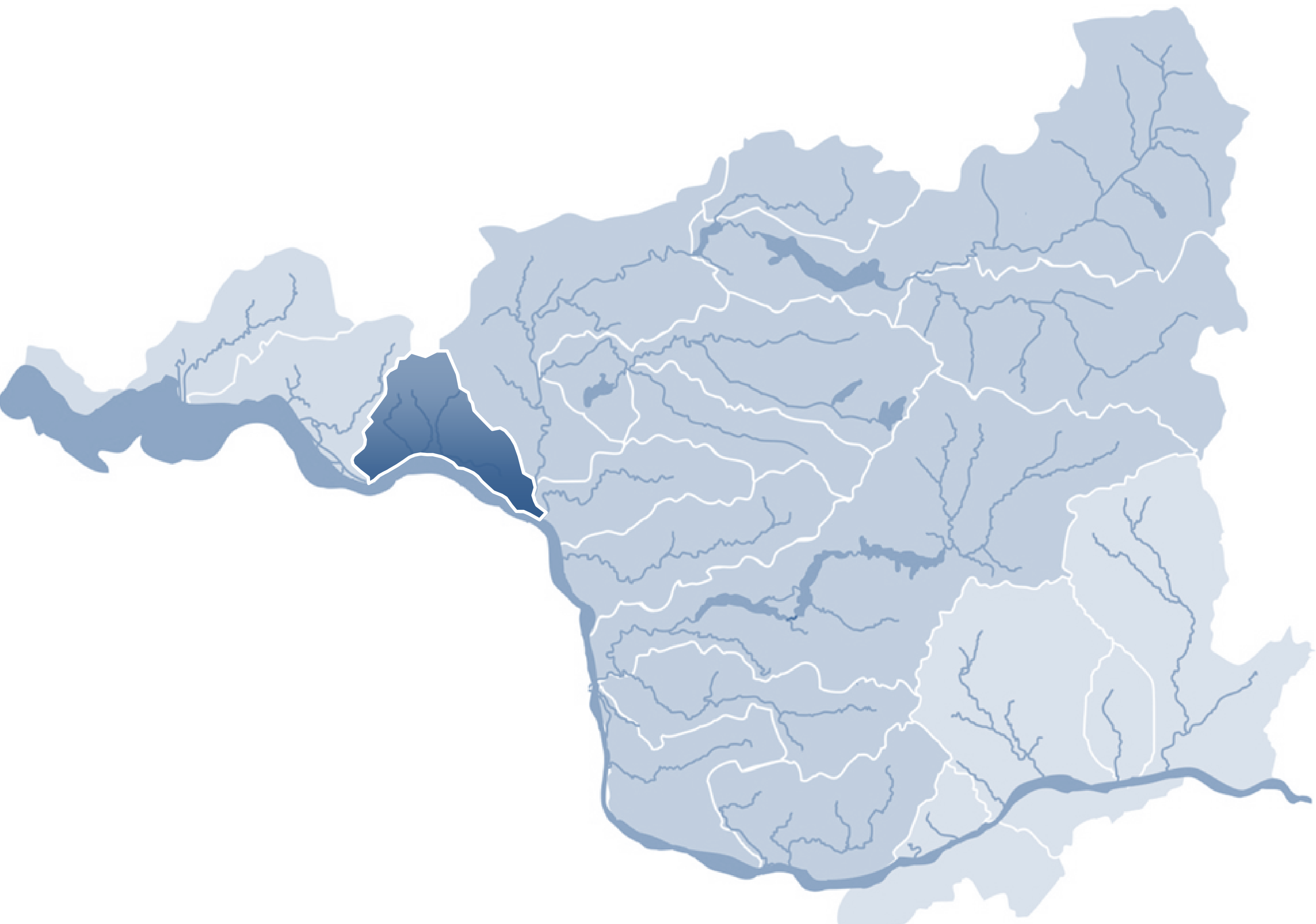
E. MILL, ABERNATHY AND GERMANY SUBBASIN



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E.1. Executive Summary

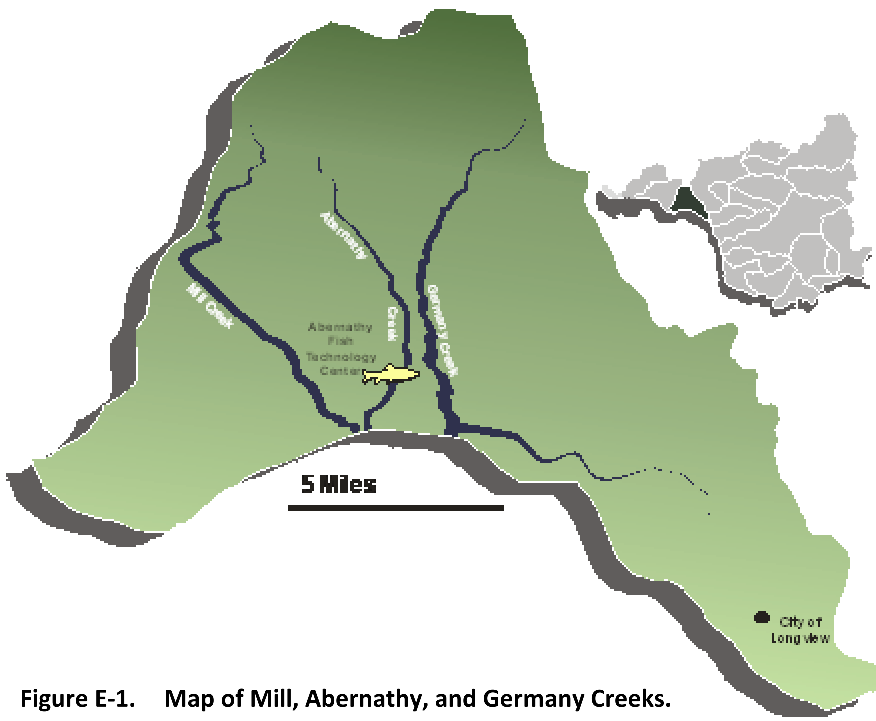


Figure E-1. Map of Mill, Abernathy, and Germany Creeks.

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, coho and chum have been listed as Threatened under the Endangered Species Act. The decline has occurred over decades and the reasons are many. Freshwater and estuary habitat quality has been reduced by agricultural and forestry practices. Key habitats have been isolated or eliminated by 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.

E.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 Chinook 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 its 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.

E.2. 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, and coho salmon listed as Threatened under the federal Endangered Species Act (ESA). The plan also serves as the Subbasin Plan for the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program to address effects of construction and operation of the Federal Columbia River Power System.

Development of this plan was led and coordinated by the Washington Lower Columbia 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.

E.3. Assessment

E.3.1. Subbasin Description

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 Chinook 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.

Climate

The watershed has a typical northwest maritime climate. Summers are dry and cool and winters are mild, wet, and cloudy. Most precipitation fall Chinooks between October and March, with mean annual precipitation ranging from 45-118 inches with an average mean of 70-85 inches. Snowfall Chinook 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).

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 E-2 and Figure E-3.

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.

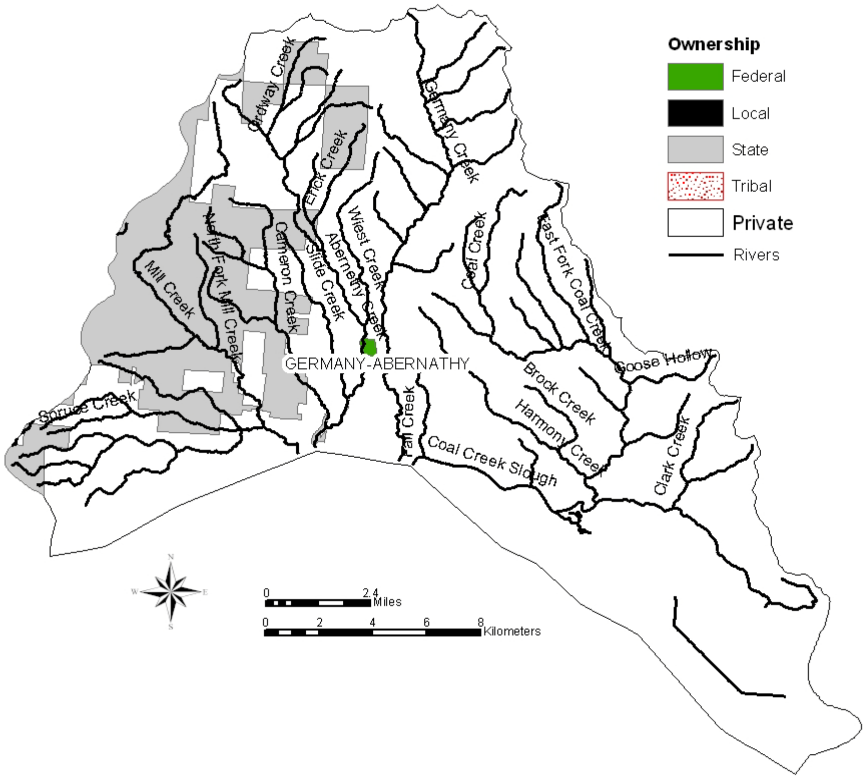


Figure E-2. Landownership within the Mill/Abernathy/Germany Watershed. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

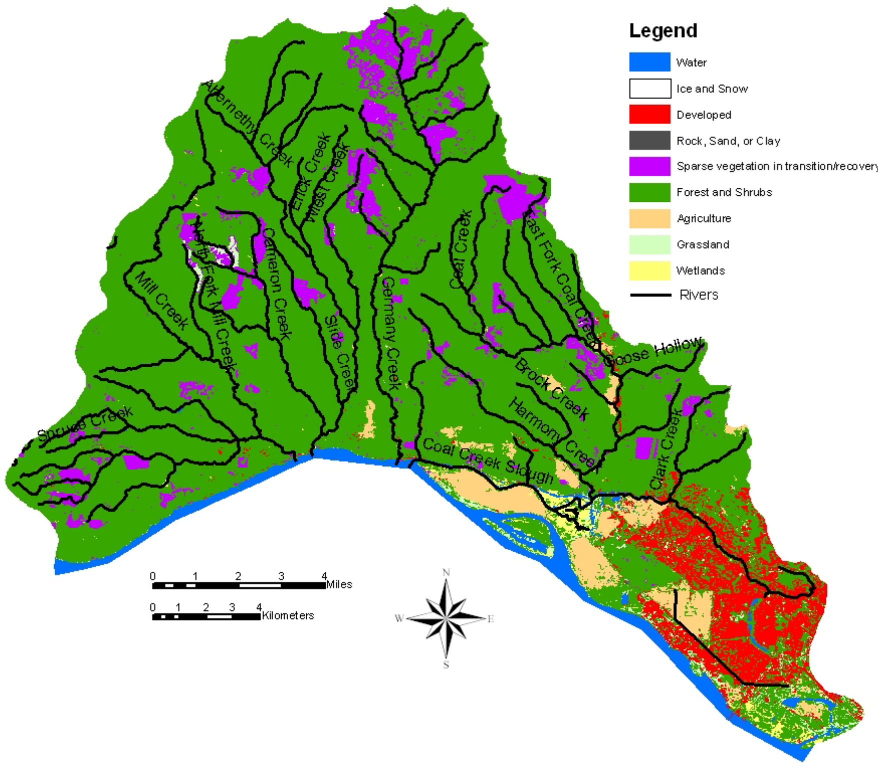


Figure E-3. Land cover within the Mill/Abernathy/Germany Watershed. Data was obtained from the USGS National Land Cover Dataset (NLCD).

E.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 E-1). Extinction risks are significant for all focal species – the current health or viability ranges from very low for coho, chum, and fall Chinook , to medium for winter steelhead. Returns of coho and winter steelhead include both natural and hatchery produced fish.

Table E-1. Status and goals for salmon and steelhead populations in the MAG creeks

		Recovery	Viability		Improve-	Abundance		
Species	Population	Priority[1]	Status[2]	Goal[3]	ment[4]	Historical[5]	Current[6]	Goal[7]
Fall Chinook (Tule)	M.A.G.	Primary	VL	H	80%	2,500	50	600
Chum	M.A.G.	Primary	VL	H	>500%	7,000	<100	Na[9]
Winter Steelhead	M.A.G.	Primary	M	H	0%[8]	900	600	600
Coho	M.A.G.	Contributing	VL	M	>500%	2,800	<50	1,800

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

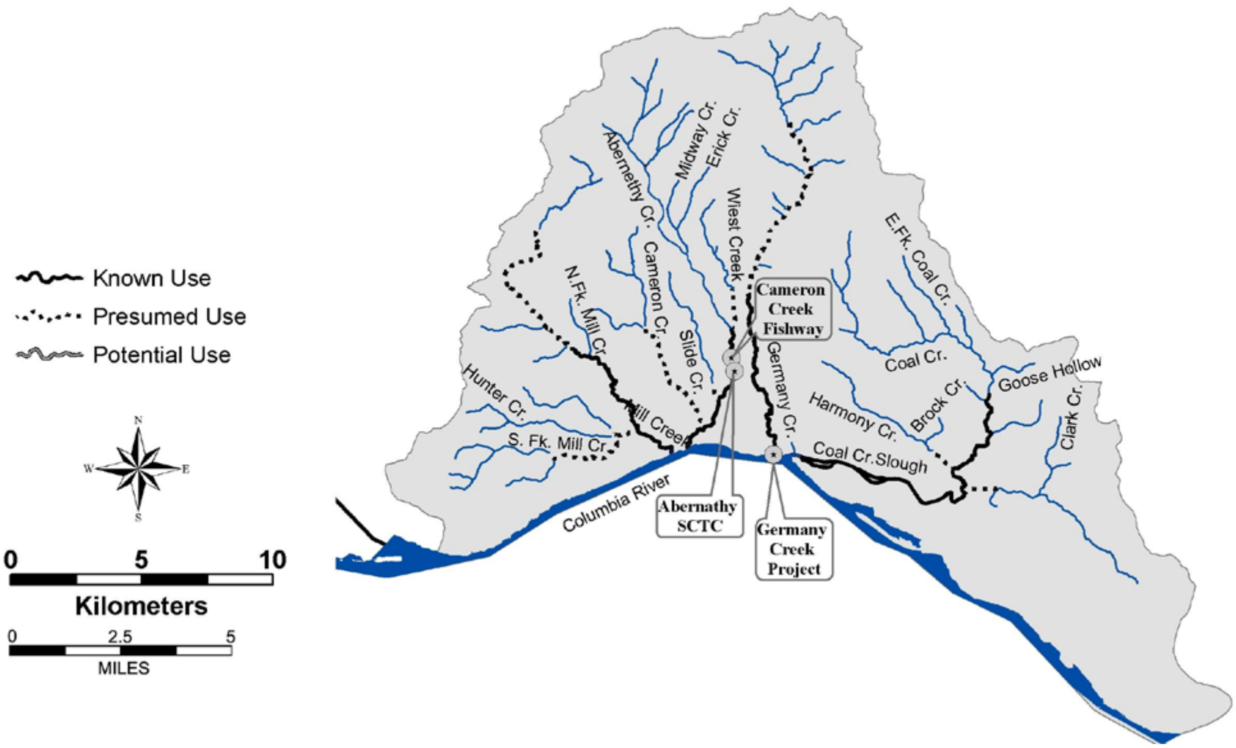
Other species of interest in the Mill/Abernathy/Germany Watershed include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

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).

Fall Chinook — Mill/Abernathy/Germany Subbasin

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.



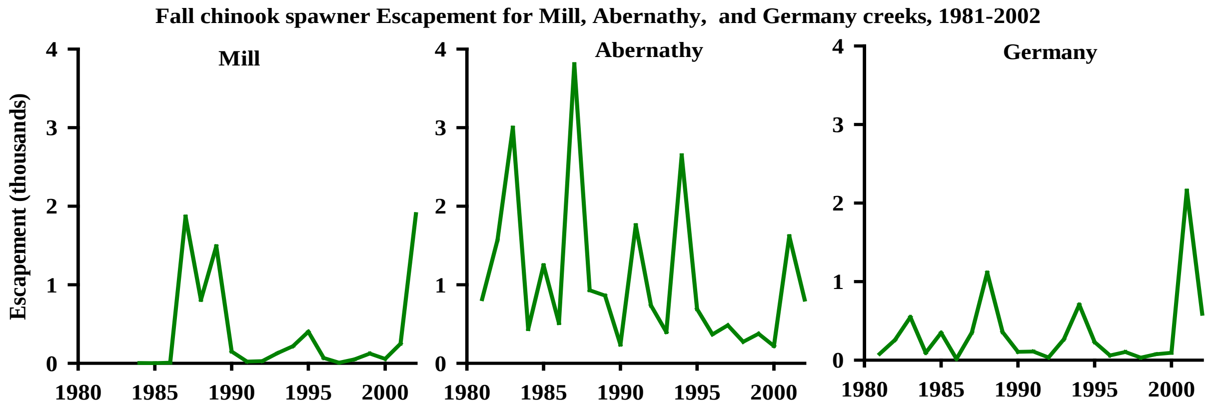
Distribution

- 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 Chinook 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 than lower Columbia fall Chinook



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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 from 1995, 1997, and 1998 were significantly different from other lower Columbia River 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

- Baseline risk assessment determined a high to very high risk of extinction for fall Chinook in the M-A-G subbasin
- 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

- The Abernathy Creek NFH fall Chinook program was discontinued in 1995 because of federal funding cuts

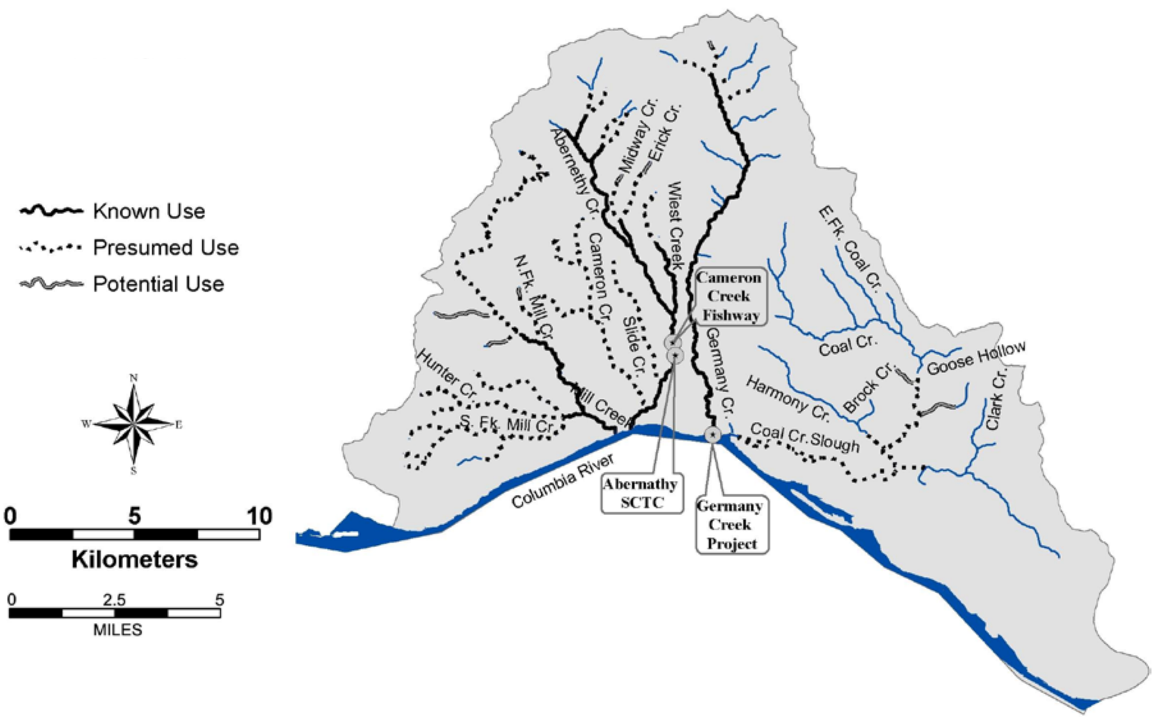
Harvest

- 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 flesh quality is low once the fish move from salt water; price is low compared to higher quality bright 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%

Coho—Mill/Abernathy/Germany Subbasin

ESA: Threatened 2005	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
- Baseline risk assessment determined a high to very high risk of extinction for coho in the M-A-G subbasin
- 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

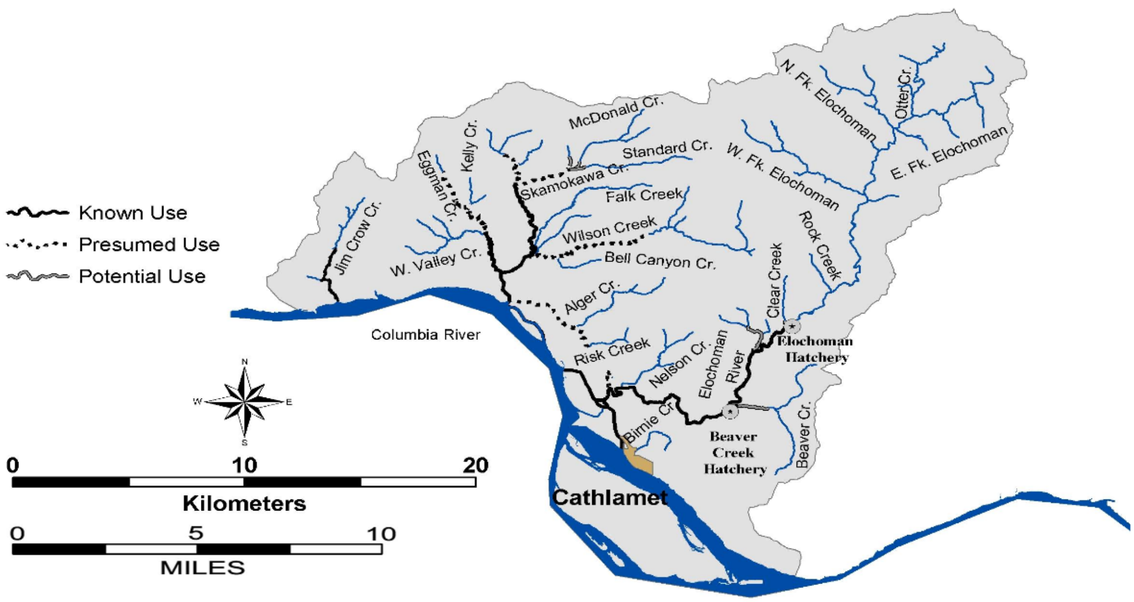
management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho

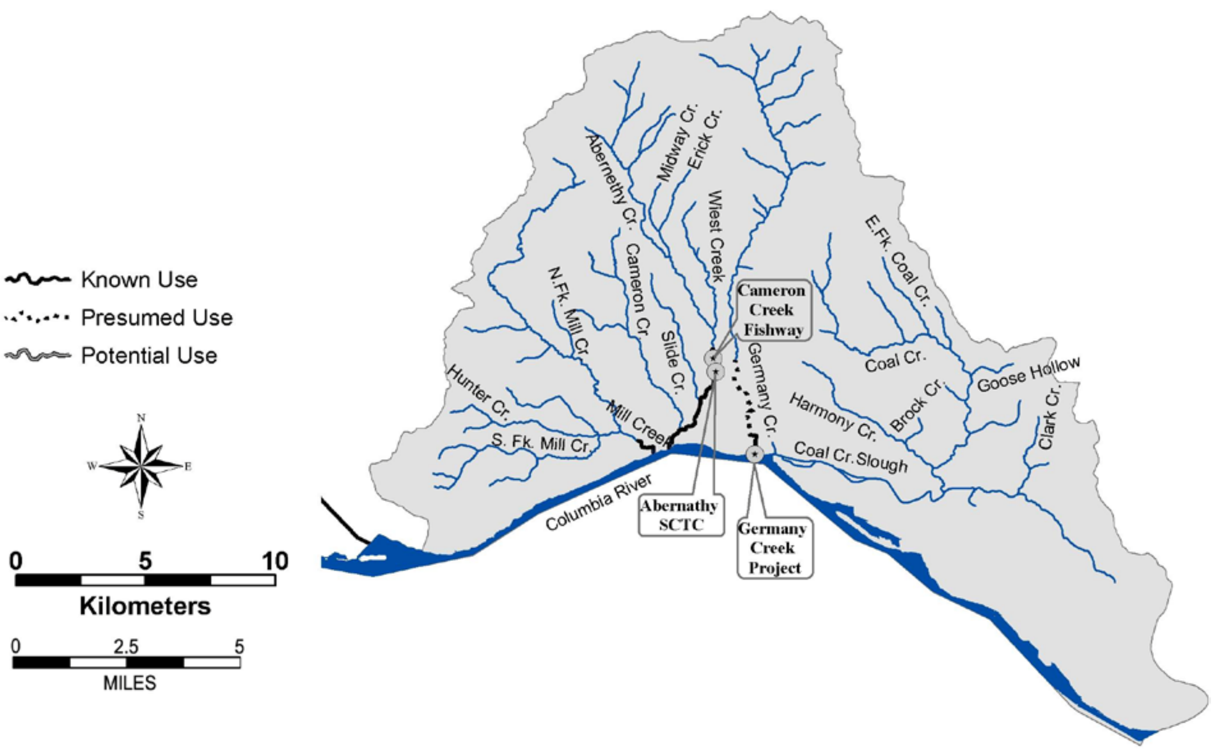
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early coho, but late coho harvest can also be substantial
- These streams are not open to sport fishing for coho

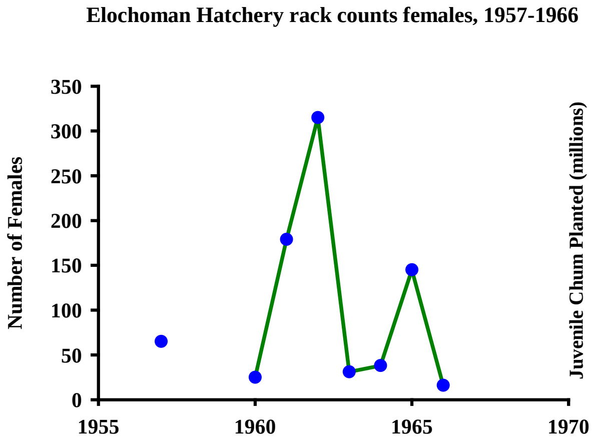
Chum— Mill/Abernathy/Germany Subbasin

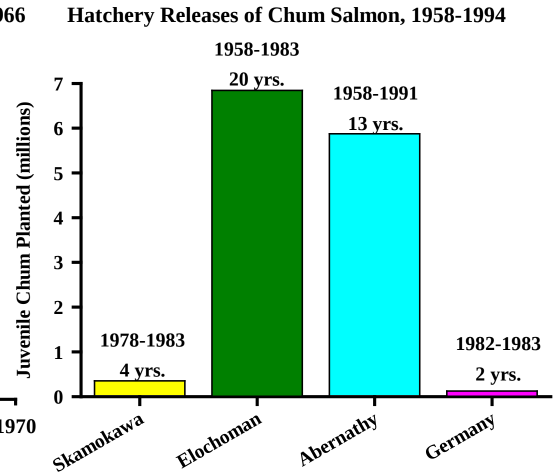
ESA: Threatened 1999	SASSI: NA

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 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
- Baseline risk assessment determined a high to very high risk of extinction for chum in the M-A-G subbasin
- 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

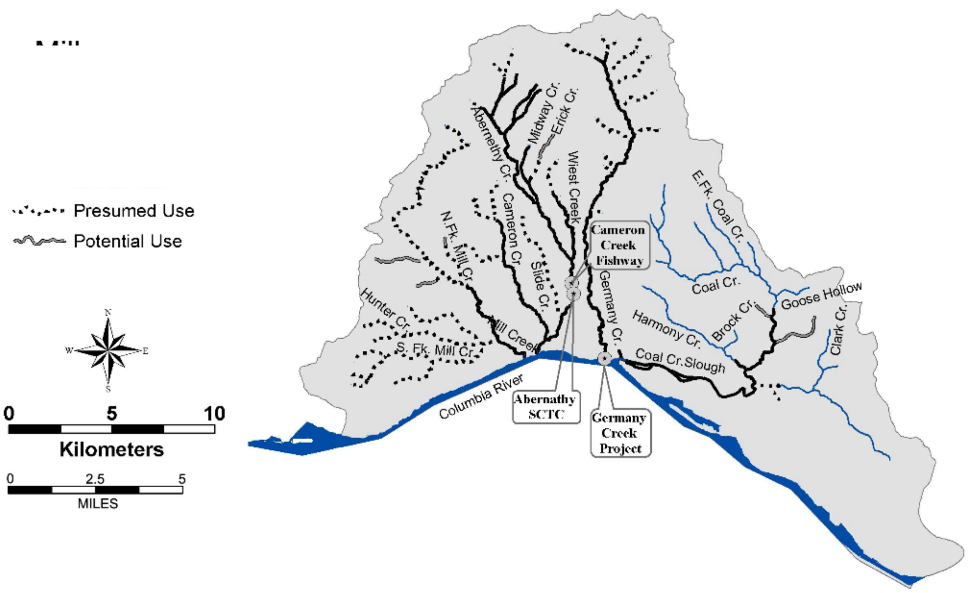
- Currently very limited chum harvest occurs in the ocean and Columbia River and is incidental to fisheries directed at other species
- Columbia River commercial fishery historically harvested chum salmon in large numbers (80,000 to 650,000 in years prior to 1943); from 1965-1992 landings averaged less than 2,000 chum, and since 1993 less than 100 chum

- In the 1990s November commercial fisheries were curtailed and retention of chum was prohibited in Columbia River sport fisheries
- The ESA limits incidental harvest of Columbia River chum to less than 5% of the annual return

Winter Steelhead—Mill/Abernathy/Germany Subbasin

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

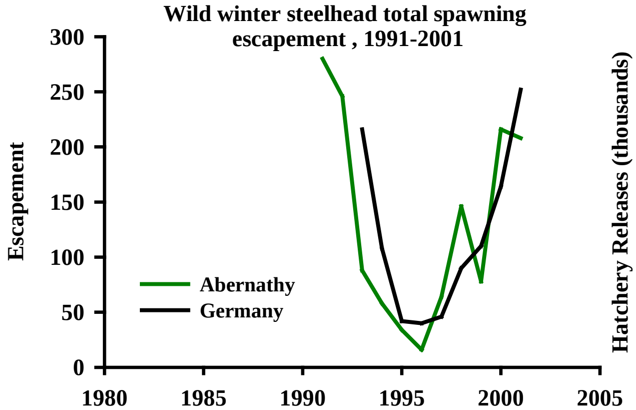
- In Mill Creek, winter steelhead spawn in the mainstem, NF Mill Creek, and unnamed tributaries
- In Abernathy Creek, spawning occurs in the mainstem, Slide Creek, and Cameron Creek
- In Germany Creek, winter steelhead spawn in the mainstem, Loper Creek, and John Creek

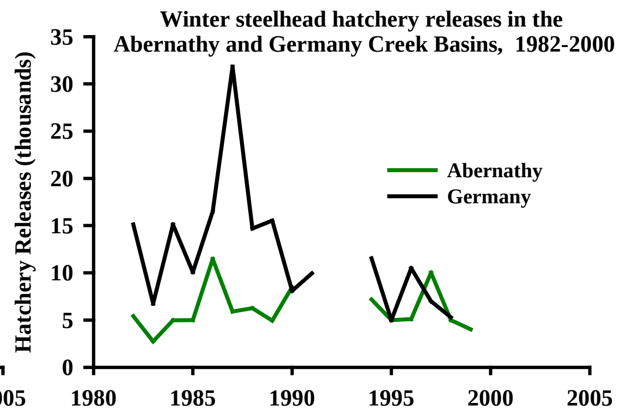
Life History

- Adult migration timing for M-A-G 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
- Baseline risk assessment determined a moderate risk of extinction for winter steelhead in the M-A-G subbasin

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

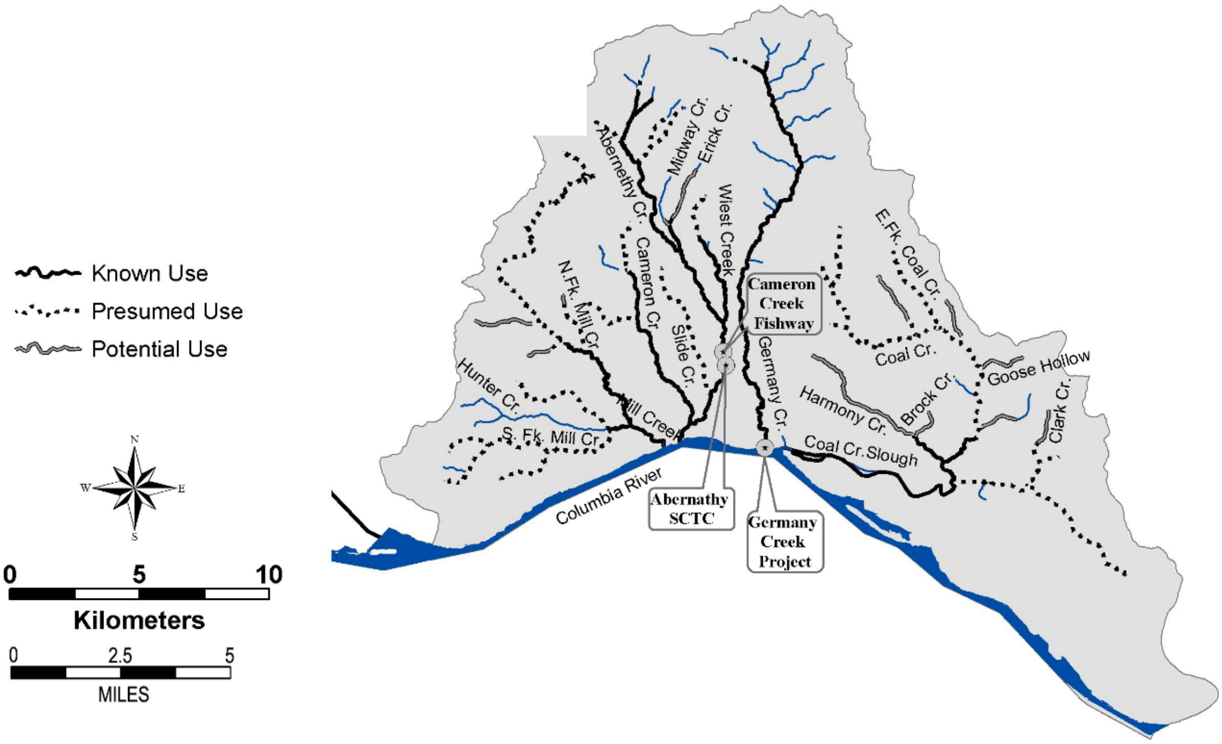
Harvest

- 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

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 fall Chinooks on tributaries to Abernathy Creek
- Resident forms are documented throughout the system

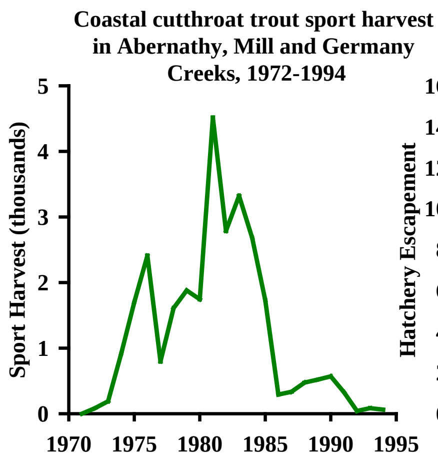
Life History

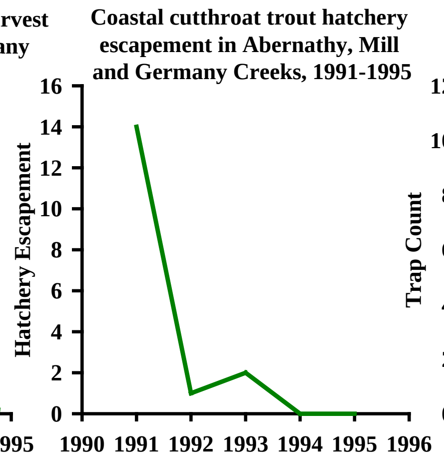
- Anadromous, fluvial and resident forms are present
- Anadromous river entry and spawn timing are unknown but are believed to be similar to Elochoman cutthroat trout
- Anadromous river entry is assumed to be from August through mid-April
- Anadromous spawning is assumed to be from January through mid-April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

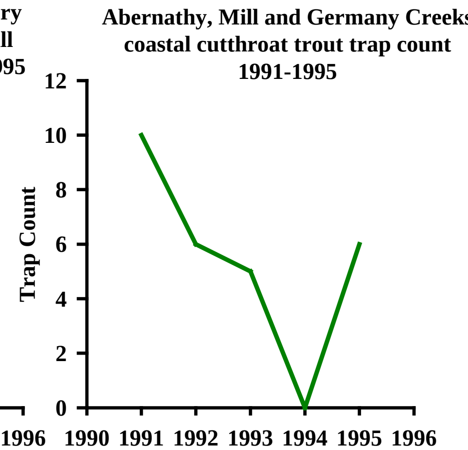
Diversity

- 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

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 Fall Chinooks 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.

E.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.

Watershed Hydrology

Peak flows are associated with fall Chinook 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 Chinook 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).

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).

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 Chinook, however, high temperatures may be a problem for early-return salmon entering the system in the late summer (Wade 2002).

Ecology 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).

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.

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. 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.

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).

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).

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 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.

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).

E.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 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 developing and implementing specific recovery actions.

Population Analysis

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

Habitat-based assessments were completed for 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 23-51% of historical levels for all four species (Table E-3), with the greatest decline for chum (to 23% of historical levels) and least for fall Chinook (to 51% of historical levels). Similarly, adult abundance shows severe declines for all species, with current numbers at 10% of historical levels for chum, at 45% of historical levels for fall Chinook, at 50% of historical levels for coho, and at 60% of historical levels for winter steelhead (Figure E-4). Diversity (as measured by the diversity index) appears to have remained steady for winter steelhead and chum, but has declined significantly for fall Chinook and coho (Figure E-4).

In Germany Creek, modeled adult productivity also shows severe declines, with current productivity at approximately 22-51% of historical levels for all species (Table E-4). 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 43% and 65% of historical levels, respectively (Figure E-6). Winter steelhead abundance has declined to 62% of historical levels (Figure E-6). In Germany Creek, the diversity of all species, except coho, has been maintained (Table E-4). Model results indicate that coho diversity has declined to 52% 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 E-2). Model results indicate a decrease in productivity of 46% for fall Chinook, 80% for chum, 60% for coho, and 63% for winter steelhead. Declines in adult abundance from historical levels have been greatest for chum (93%), followed by coho (47%) fall Chinook (36%) and winter steelhead (29%) (Figure E-4). 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 72% of historical levels, respectively (Table E-2).

Modeled historical-to-current changes in smolt productivity in Abernathy Creek have declined for all four species, with current levels of productivity at 29-62% of historical levels (Table E-3). Similarly, smolt abundance levels in Abernathy Creek appear to have decreased by 17-58% from historical levels, with losses most significant for chum, and least for fall Chinook and winter steelhead (Table E-3).

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 E-4). Germany Creek has also experienced sharp declines in smolt abundance levels for all species (Table E-4). Chum smolt abundance is currently estimated at only 17% of historical levels, while coho, fall Chinook and winter steelhead are estimated at 36%, 62% 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 fall Chinook and chum (Table E-2). Smolt abundance levels have also declined for all species (Table E-2). Current smolt abundances are 13-62% of historical levels, with chum suffering the greatest losses.

Table E-2. Mill Creek— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

	Adult Abundance		Adult Productivity		Diversity Index		Smolt Abundance		Smolt Productivity	
Species	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**
Fall Chinook	482	759	4.50	8.30	0.82	0.82	127,658	208,235	767	1,312
Chum	121	1,615	1.70	8.60	0.57	1.00	69,066	531,083	656	1,138
Coho	441	833	4.40	10.90	0.50	0.69	4,534	15,223	94	236
Winter Steelhead	134	190	6.40	17.30	0.99	1.00	1,877	3,040	130	351

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

Table E-3. Abernathy Creek- Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient) and historical (T or template)[1] habitat conditions.

	Adult Abundance		Adult Productivity		Diversity Index		Smolt Abundance		Smolt Productivity	
Species	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	***T***
Fall Chinook	391	872	4.30	8.40	0.50	0.88	112,948	223,491	773	1,266
Chum	182	1,878	2.10	9.30	1.00	1.00	114,902	668,348	760	1,218
Coho	553	1,099	4.60	10.40	0.46	0.83	7,269	22,158	100	225
Winter Steelhead	238	395	4.90	16.90	0.99	1.00	3,976	6,914	93	323

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

Table E-4. Germany Creek— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

	Adult Abundance		Adult Productivity		Diversity Index		Smolt Abundance		Smolt Productivity	
Species	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**
Fall Chinook	545	843	4.30	8.50	0.85	0.85	124,717	200,846	724	1,303
Chum	300	3,094	1.90	8.70	0.99	1.00	169,971	1,038,737	675	1,175
Coho	375	866	4.30	11.50	0.47	0.91	6,662	18,428	96	252
Winter Steelhead	182	295	4.40	16.10	0.97	0.10	3,003	5,028	83	309

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

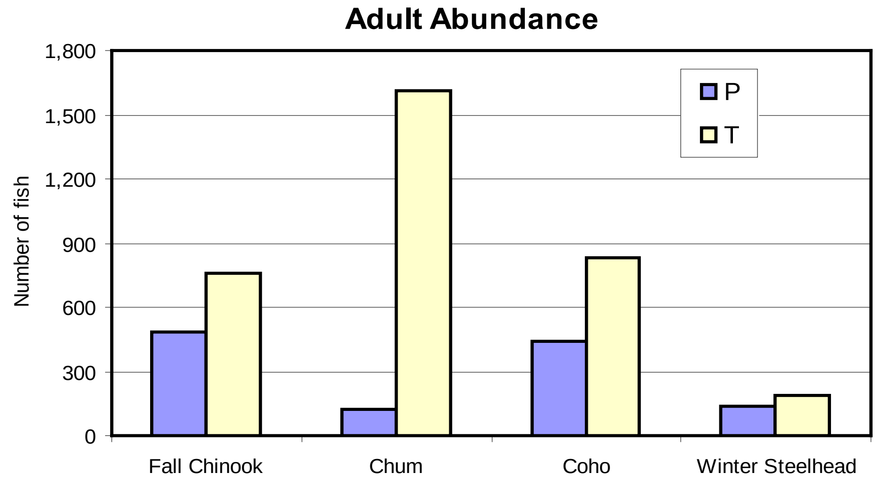


Figure E-4. Adult abundance of Mill Creek fall Chinook , chum, coho and winter steelhead based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

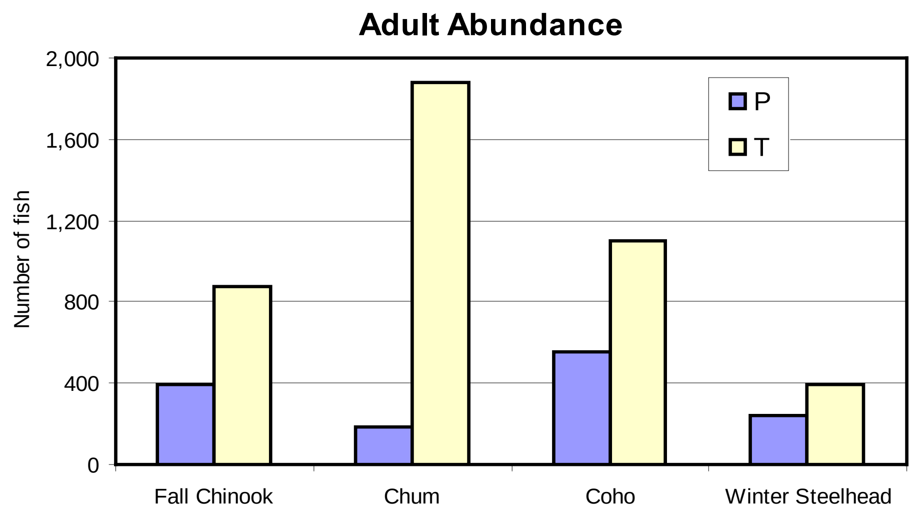


Figure E-5. Adult abundance of Abernathy Creek fall Chinook , chum, coho and winter steelhead based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

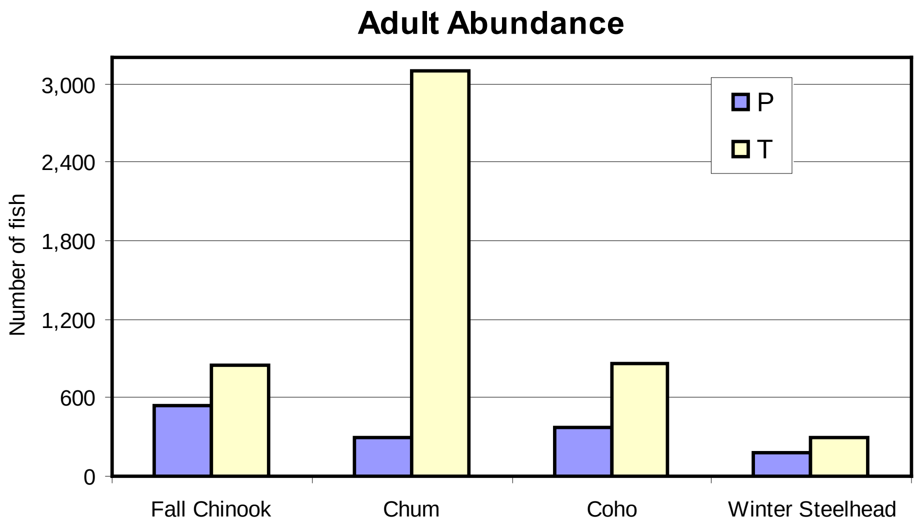


Figure E-6. Adult abundance of Germany Creek fall Chinook , chum, coho and winter steelhead based on EDT analysis of current (P or patient) and historical (T or template) habitat conditions.

Stream Reach Analysis

Habitat conditions and suitability for fish are better in some portions of a subbasin than in others. The reach analysis of the EDT model uses estimates of the difference in projected population performance between current/patient and historical/template habitat conditions to identify core and degraded fish production areas. Core production areas, where habitat degradation would have a large negative impact on the population, are assigned a high value for preservation. Likewise, currently degraded areas that provide significant potential for restoration are assigned a high value for restoration. Collectively, these values are used to prioritize the reaches within a given basin. Refer to Figure E-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 preservation emphasis, is the lone high priority reach for fall Chinook (Figure E-8). The single high priority reach for chum is the lowest reach of South Fork Mill Creek, SF Mill 1 (Figure E-9). SF Mill 1 also shows a combined preservation and restoration emphasis.

High priority reaches for coho include middle and upper sections of Mill Creek (Mill 1, 3, and 5), and the lower sections of Spruce Creek (Spruce 1 and 2) (Figure E-10). The majority of these high priority reaches have a mixed preservation and restoration emphasis, with reach Spruce 1 showing the greatest expected change in population performance because of a dramatic increase in the diversity index with restoration (Figure E-10).

For winter steelhead in Mill Creek, high priority reaches include Mill 1, 3 and 5 (Figure E-11). Mill 1 and 5 have a preservation emphasis and Mill 3 has a mixed emphasis.

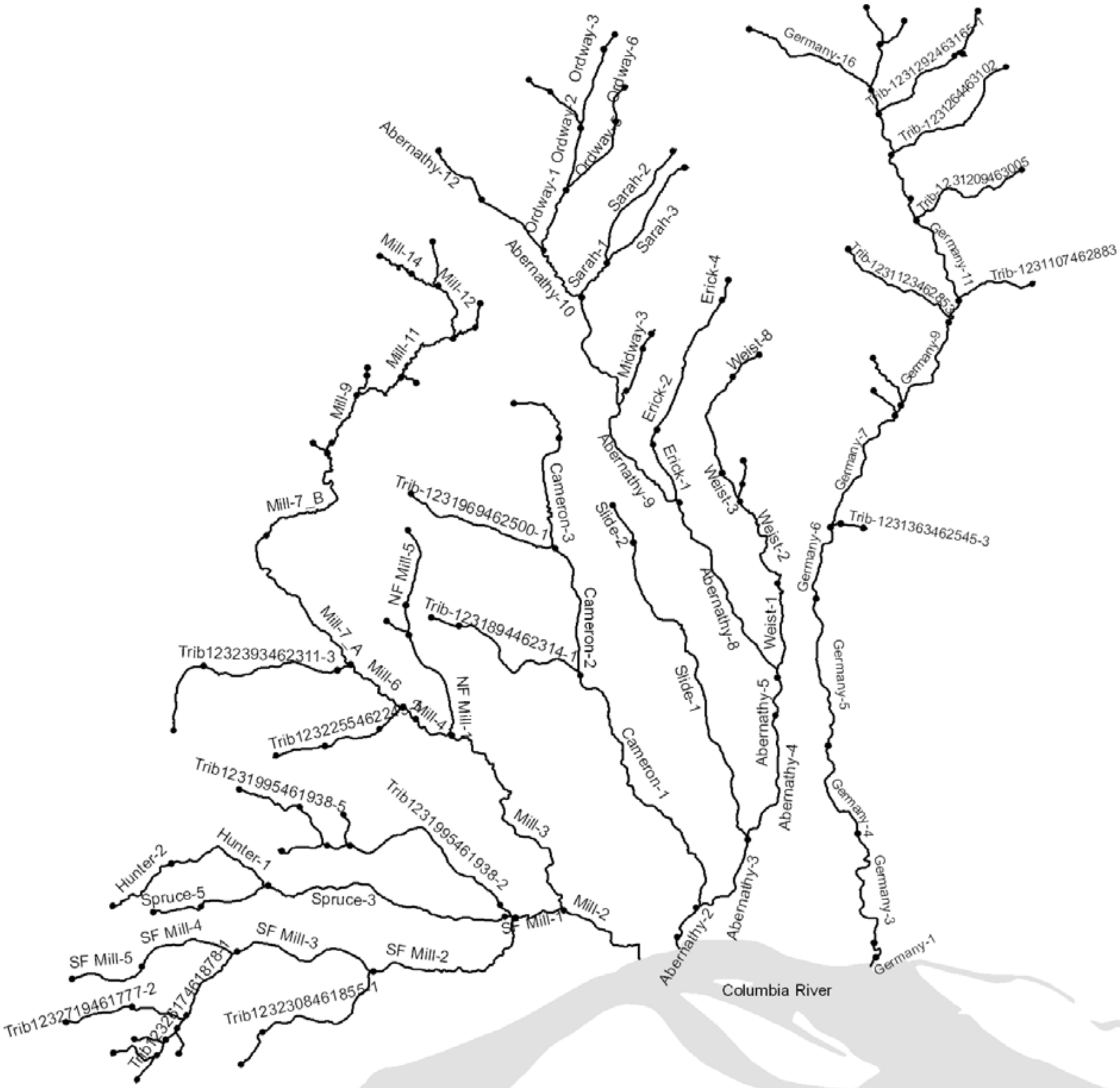


Figure E-7. Mill, Abernathy and Germany Creeks with EDT reaches identified. For readability, not all reaches are labeled.

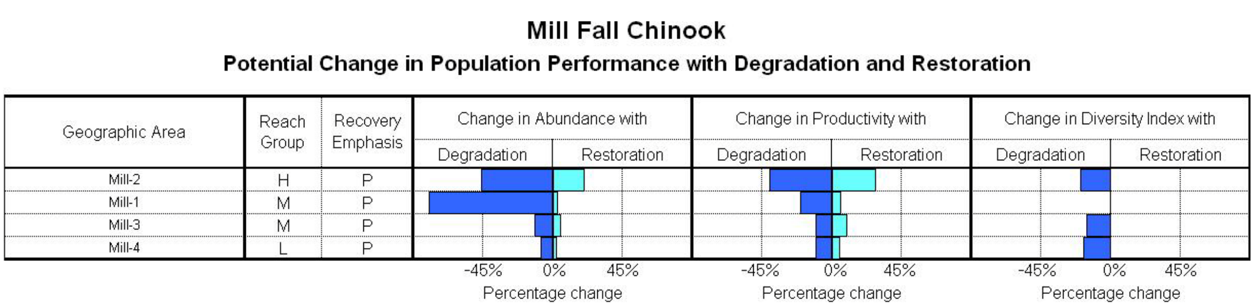


Figure E-8. Mill Creek fall Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For 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.

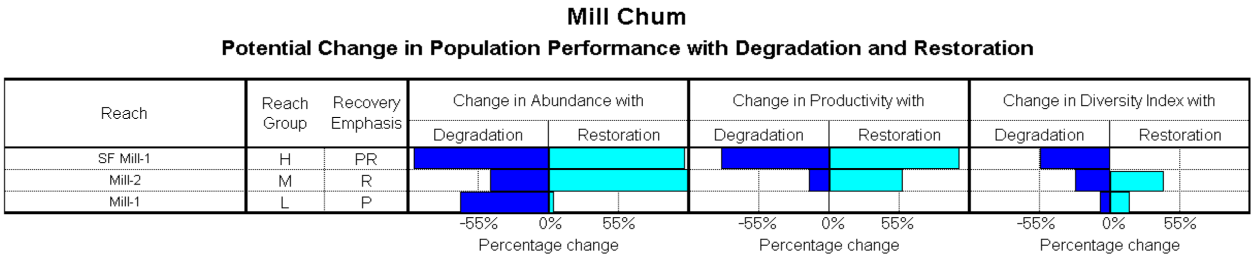


Figure E-9. Mill Creek chum ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach,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

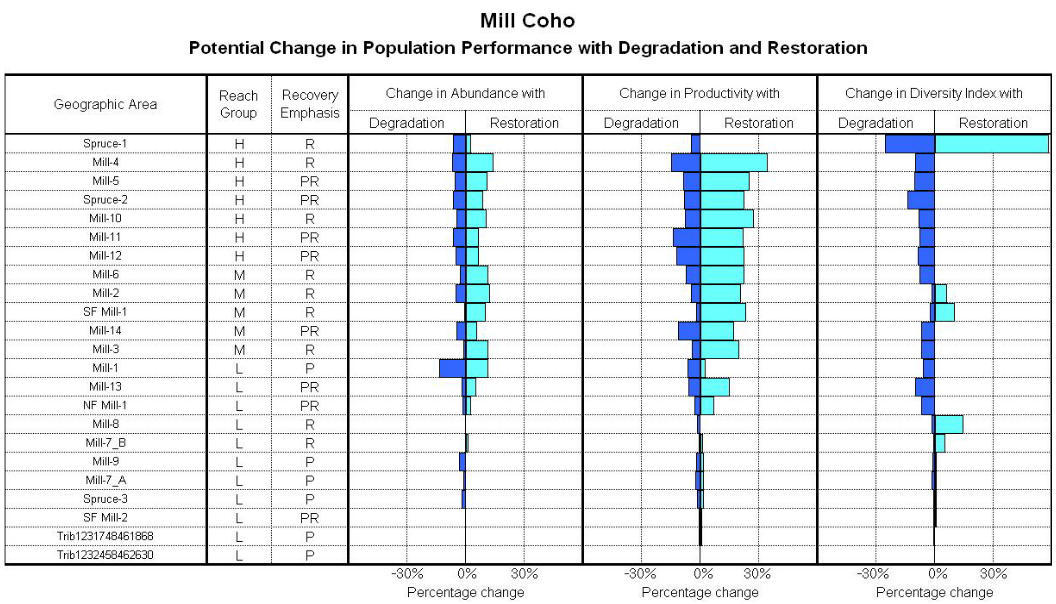


Figure E-10. Mill Creek coho ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.

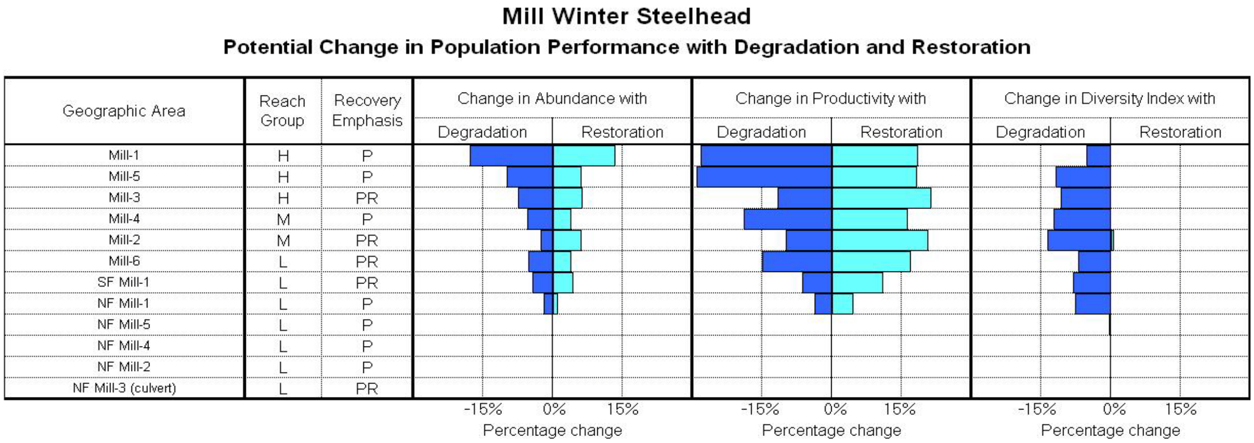


Figure E-11. **Mill Creek winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.**

Winter steelhead spawn in the mainstem Germany Creek up to the headwaters, as well as in several mainstem tributaries. 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 nearly all accessible areas. Refer to Figure E-7 for a map of stream reaches within Mill, Abernathy and Germany Creeks.

The high potential reach for both fall Chinook and chum is reach 2 in lower Germany Creek. Germany 2 has preservation emphasis for fall Chinook and a combined emphasis for chum (Figure E-12 and Figure E-14). The two high priority reaches identified for coho are in lower Germany Creek (Germany 3 and Germany 4) (Figure E-13). The high priority reaches for coho have restoration emphasis. For winter steelhead in Germany Creek, high priority reaches are in the lower and middle sections of Germany Creek (Germany 2, 5, 6, 8, and 10) (Figure E-15). These high priority reaches have either preservation or restoration emphasis.

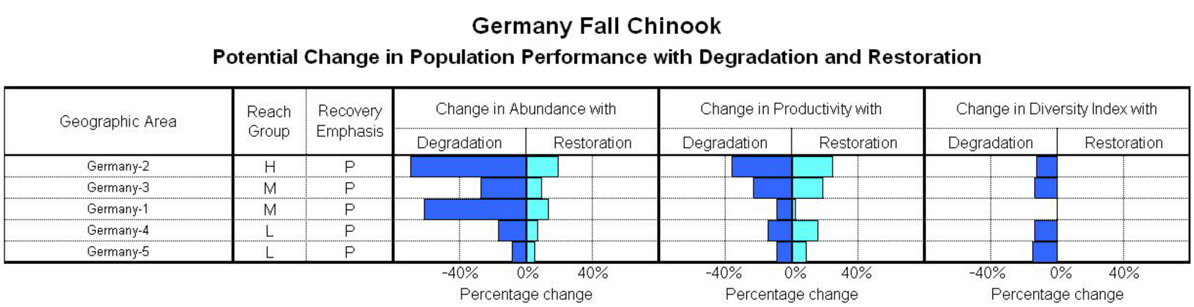


Figure E-12. **Germany Creek fall Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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.**

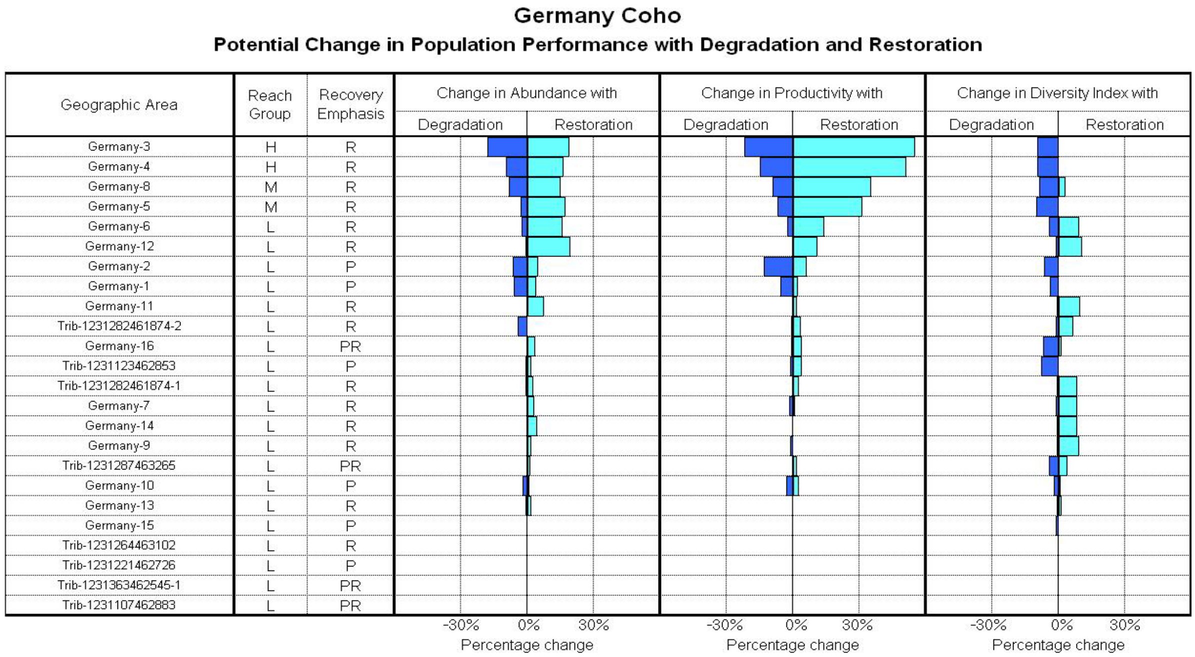


Figure E-13. **Germany Creek coho ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.**

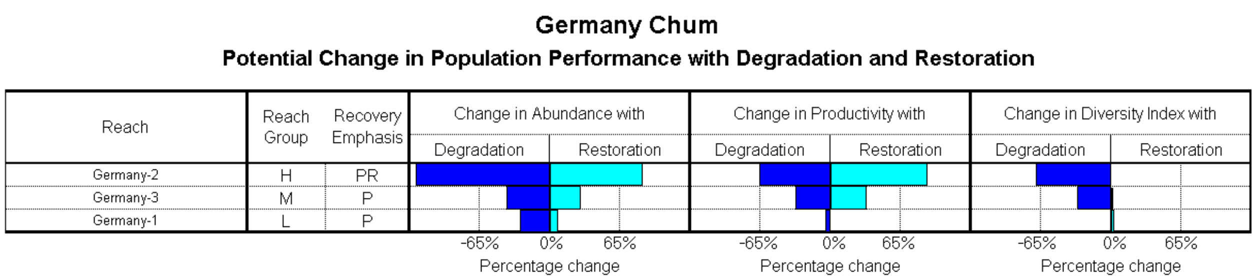


Figure E-14. **Germany Creek chum ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.**

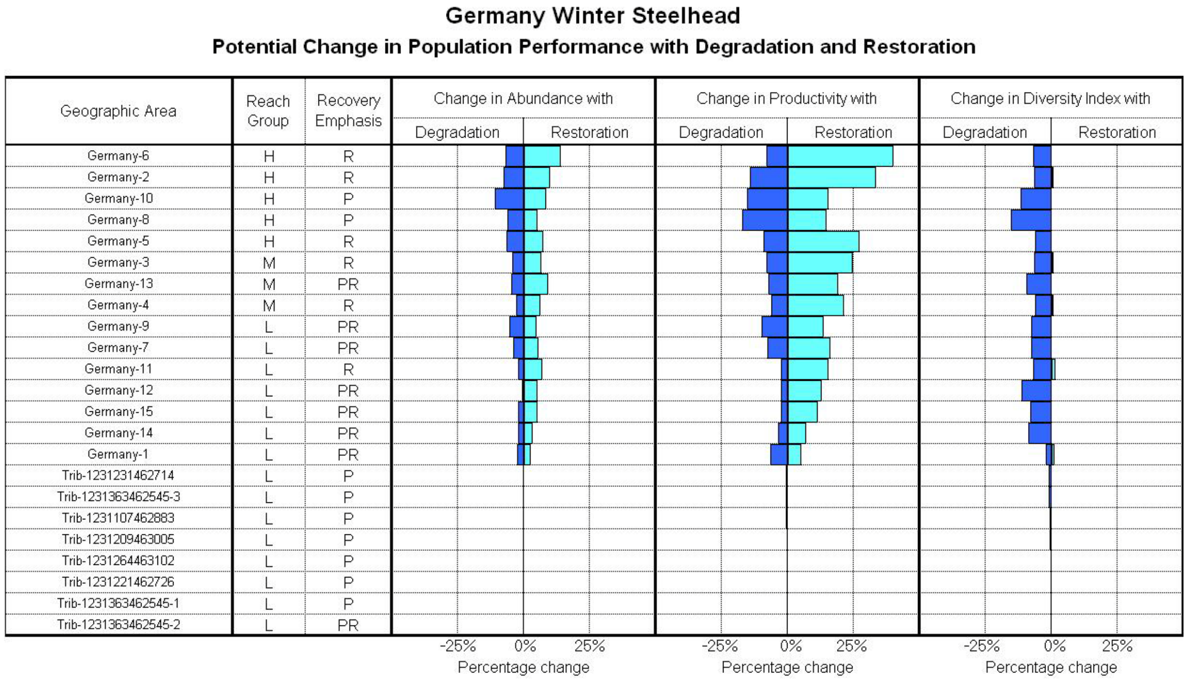


Figure E-15. **Germany Creek winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.**

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 nearly all accessible areas. Refer to Figure E-7 for a map of stream reaches within Mill, Abernathy and Germany Creeks. Abernathy 1, 2, and 3 are the most important for both fall Chinook and chum (Figure E-16 and Figure E-17). These reaches are located below Slide Creek. Preservation efforts would result in the greatest benefit for fall Chinook, whereas a combination of restoration and preservation approaches are best for chum. High priority reaches for coho in Abernathy Creek occur throughout mainstem reaches (Figure E-18). Recovery emphasis is either restoration or both restoration and preservation for these reaches. High priority reaches for winter steelhead also occur throughout the mainstem (Figure E-19). These reaches either have a restoration emphasis or a combined preservation and restoration emphasis.

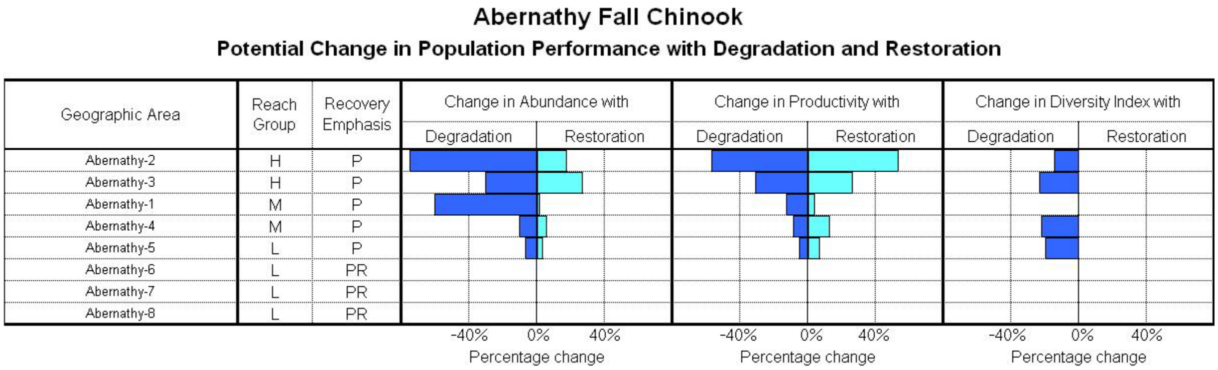


Figure E-16. Abernathy Creek fall Chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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.

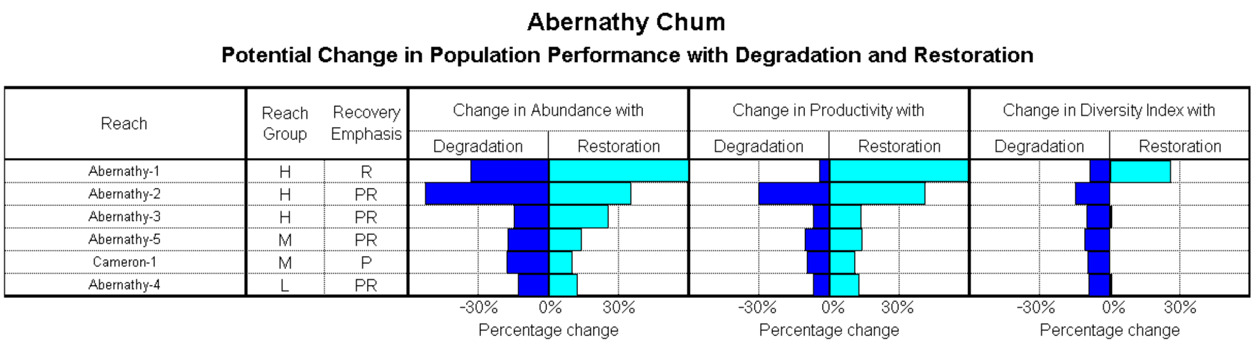


Figure E-17. Abernathy Creek chum ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.

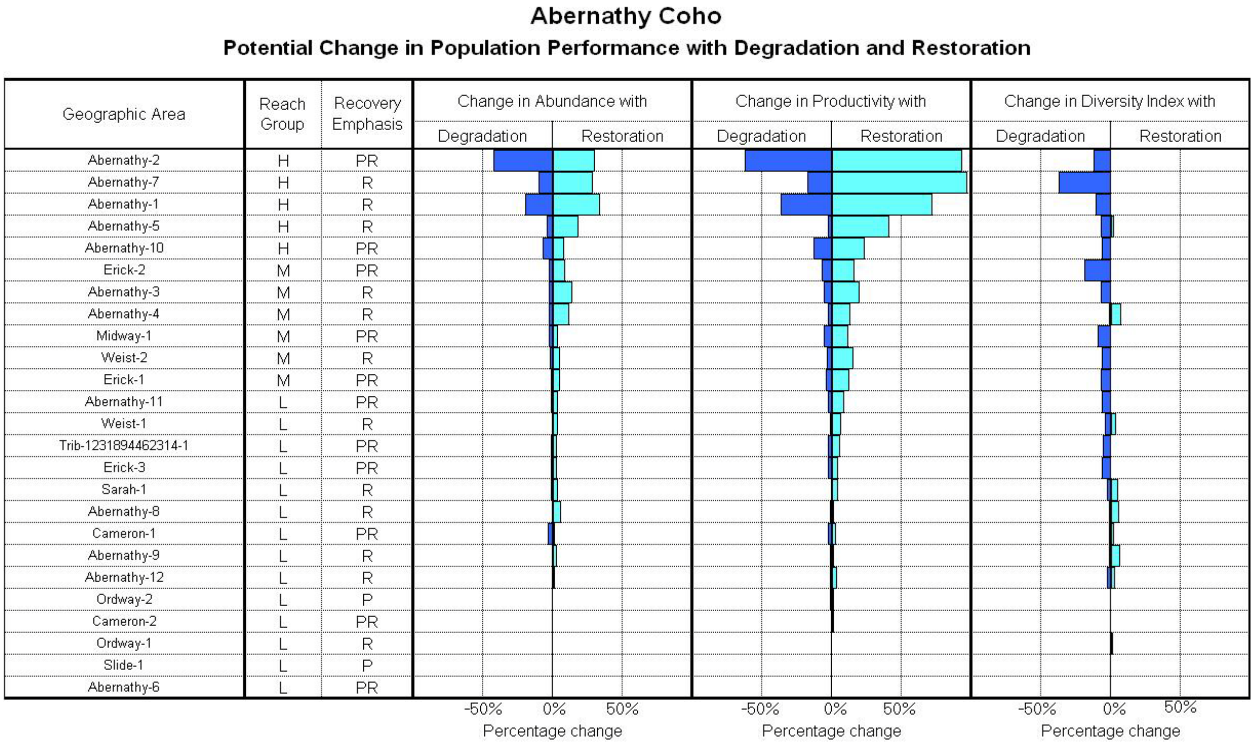


Figure E-18. Abernathy Creek coho ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.

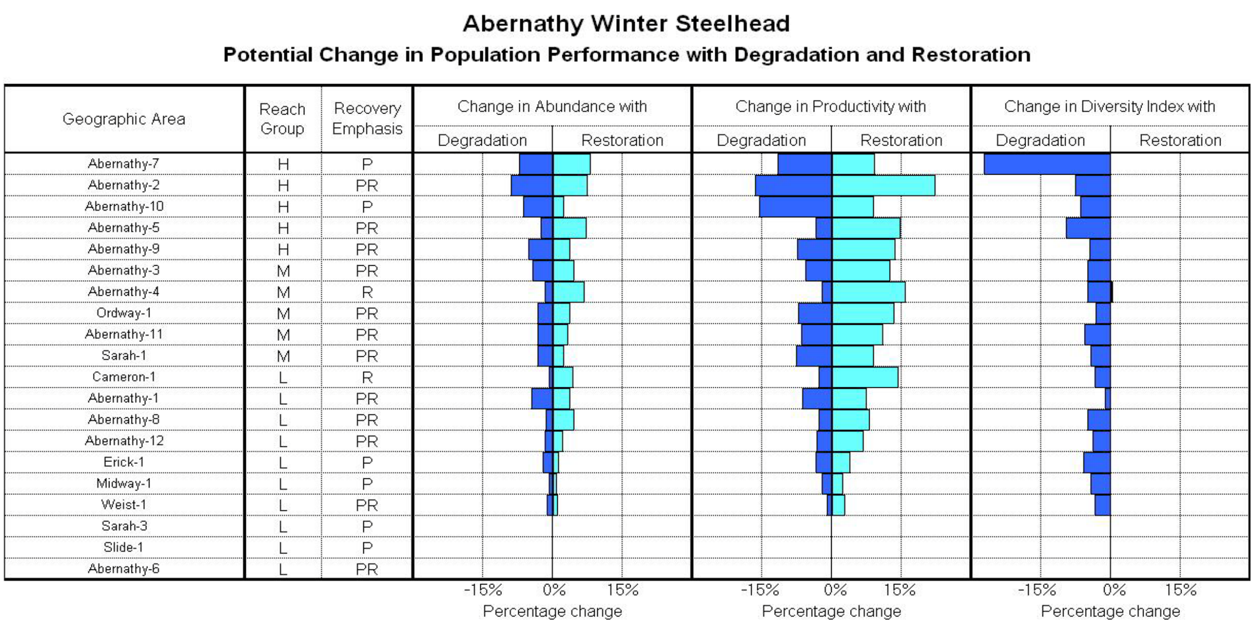


Figure E-19. Abernathy Creek winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.

Habitat Factor Analysis

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the habitat factor analysis compares current/patient and historical/template habitat conditions. For each reach, EDT generates what is referred to as a "consumer reports diagram", which identifies the degree to which individual habitat factors are acting to suppress population performance. The effect of each habitat factor is identified for each life stage that occurs in the reach and the relative importance of each life stage is indicated. For additional information and examples of this analysis, see Appendix E. Inclusion of the consumer report diagram for each reach is beyond the scope of this document. A summary of the most critical life stages and the habitat factors affecting them are displayed for each species in Table E-5.

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

Abernathy

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
Abernathy Fall Chinook				
most critical	Egg incubation	sediment	channel stability, temperature	
second	Spawning	temperature	habitat diversity	harassment, pathogens
third	Prespawning migrant	obstructions	temperature	flow, habitat diversity
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 winter rearing	habitat diversity, key habitat	flow	channel stability, food
third	0-age summer rearing	habitat diversity, key habitat	temperature	channel stability, food, flow, competition (hatchery)
Abernathy Winter Steelhead				
most critical	Egg incubation	sediment	temperature, channel stability	
second	0-age summer rearing	habitat diversity, temperature	pathogens, predation, flow, competition (hatchery)	
third	1-age summer rearing	habitat diversity, flow	channel stability, competition (hatchery), temperature, key habitat	

Germany

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

Mill

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

The consumer reports diagrams have also been summarized to show the relative importance of habitat factors by reach. The summary figures are referred to as habitat factor analysis diagrams and are displayed for each species below. The reaches are ordered according to their combined restoration and preservation rank. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance.

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 for fall Chinook and chum are in the lower mainstem and SF Mill. Habitat diversity, sediment, temperature, and key habitat are important factors contributing to degradation (Figure E-21 and Figure E-20). Reduced riparian function and low levels of large woody debris contribute to habitat diversity problems. Riparian function problems result from narrow buffer widths related to residential development and roads adjacent to streams. Sediment problems result from land use practices and high road densities in the upper basin increasing fine sediment loads in lower basin reaches.

Key coho restoration reaches are generally located in middle and lower Mill Creek and in Spruce Creek. A loss of habitat diversity, sedimentation, and decreased key habitat quantity are the primary limiting conditions in these reaches (Figure E-23). The loss of habitat diversity is partially related to a lack of side channel habitat from residential development and roads along the streams.

The most important restoration reaches for winter steelhead are in mainstem Mill Creek. Sediment and key habitat availability have the greatest negative impacts (Figure E-22). The causes of impairments 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.

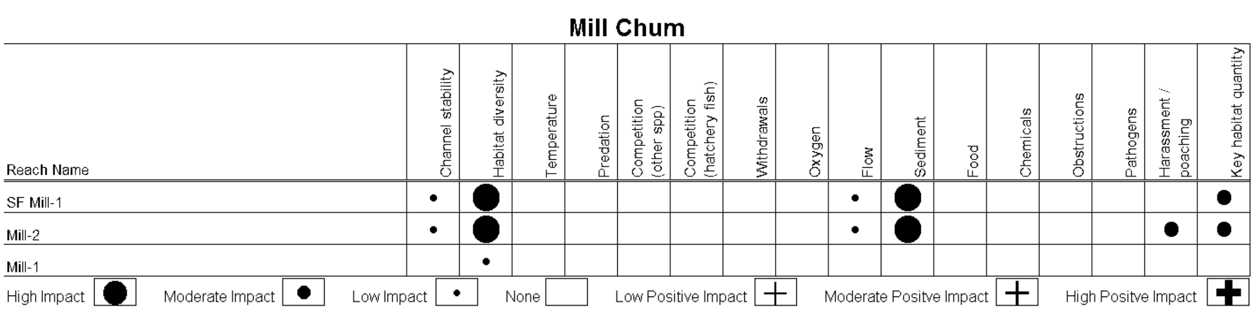


Figure E-20. Mill Creek subbasin chum habitat factor analysis diagram. This chum habitat factor analysis diagram differs from the others in that the dot size represents not only the relative within-reach impact of the habitat attributes, but also the relative contribution of each reach's impact on total population performance. The dots therefore decrease in size towards the bottom of the chart.

Mill Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Mill-2	•				•	•	●	•					●	●		●
Mill-1	•				•	•	●						•	•		•
Mill-3	•				•	•	●						●	●		●
Mill-4						•	•						●	•		●

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

Key to strategic priority (corresponding Benefit Category letter also shown)
A High; B Medium; C Low; D & E Indirect or General

Figure E-21. **Mill Creek subbasin fall Chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.**

Mill Winter Steelhead
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Mill-1					•	•	•					•		•		
Mill-5													●			●
Mill-3	•				•	•	•						●	•		●
Mill-4													●	•		●
Mill-2	•				•	•	•	•					●	•		●
Mill-6						•							●			●
SF Mill-1	•				•		•						●	•		●
NF Mill-1					•	•	•						●			●
NF Mill-5					•		•									
NF Mill-4																
NF Mill-2																
NF Mill-3 (culvert)																

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

Key to strategic priority (corresponding Benefit Category letter also shown)
A High; B Medium; C Low; D & E Indirect or General

Figure E-22. **Mill Creek winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.**

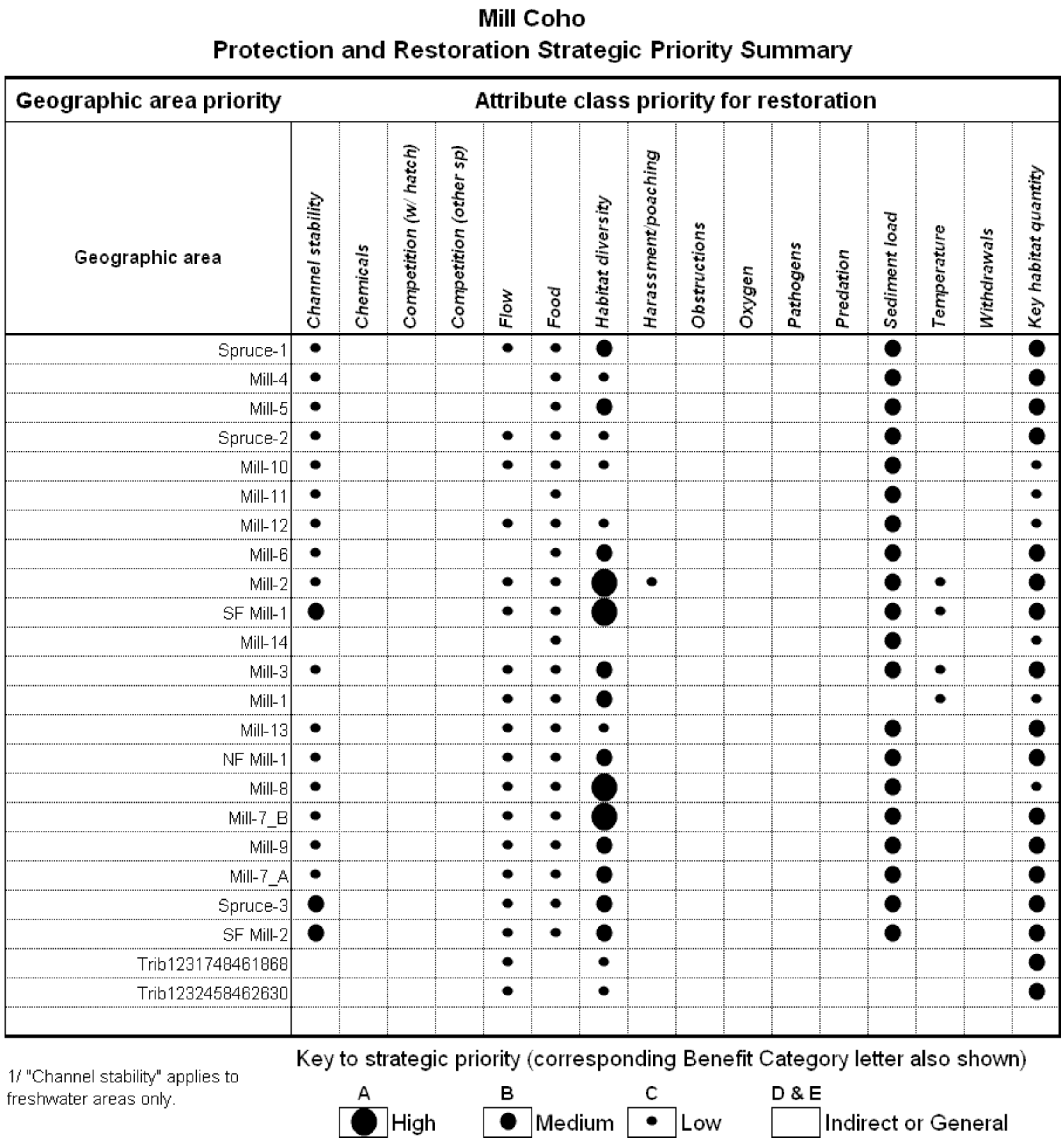


Figure E-23. Mill Creek coho habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

In Germany Creek, important restoration reaches for fall Chinook and chum are in the lower mainstem. These reaches have been most negatively influenced by increased fine sediment levels, reduced habitat diversity, and stream temperature increases (Figure E-24 and Figure E-25). High fine sediment loads originate from upper reaches and from riparian degradation in agricultural areas. Habitat diversity has been reduced through land use and stream management practices that have channelized and simplified stream channels. Removal of LWD has also reduced habitat diversity in these critical reaches.

Streamside roads contribute to numerous negative impacts, including lost habitat diversity, increased temperature, increased sediment, and lost habitat availability.

High restoration potential for coho is located throughout the mainstem, where reaches have been negatively impacted by decreased habitat diversity, channel instability, flow impacts, fine sediment, and loss of habitats (Figure E-26). The cause of these impacts is the same as those discussed for fall Chinook and chum restoration reaches.

The highest priority restoration areas for Germany Creek winter steelhead are located throughout the mainstem. Sediment, temperature, and key habitat have the greatest impacts (Figure E-27). The causes of impacts are the same as those discussed for fall Chinook and chum.

Germany Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Germany-2							Low						Medium	Medium		Low
Germany-3	Low				Low	Low	Low						Medium	Medium		Low
Germany-1					Low	Low	Low						Low	Low		Low
Germany-4	Low				Low	Low	Low						Medium	Medium		Low
Germany-5					Low	Low	Low						Medium	Medium		High

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

Key to strategic priority (corresponding Benefit Category letter also shown)
A High; B Medium; C Low; D & E Indirect or General

Figure E-24. Germany 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 impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

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						Positive Impact (+)
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 E-25. Germany Creek subbasin chum habitat factor analysis diagram. This chum habitat factor analysis diagram differs from the others in that the dot size represents not only the relative within-reach impact of the habitat attributes, but also the relative contribution of each reach's impact on total population performance. The dots therefore decrease in size towards the bottom of the chart.

Germany Coho
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Germany-1						C	C							C		B
Germany-2							C							C		B
Germany-15	B				B	C	A						B			B
Trib-1231282461874-1	B				B	C	A						B			B
Trib-1231282461874-2	C				B		A						B			B
Trib-1231287463265	C				C	C	B						B			B
Germany-16	C				C	C	B						B			C
Germany-3	C					C	C						B	C		C
Germany-4	C				C	C	C						B	C		C
Germany-5	C				C	C	C						B	C		B
Germany-6	B				C	C	A						B	C		B
Trib-1231363462545-1	C				B	C	B									B
Germany-7	C				C		A						B	C		C
Germany-8	C				C		C						B	C		C
Trib-1231221462726					C		C									B
Germany-9	C				C	C	A						B			C
Trib-1231123462853	C				C		B						B			B
Germany-10	C				C	C	C						B			C
Trib-1231107462883					C		C									B
Germany-11	B				B	C	A						B			B
Germany-12	B				C	C	A						B			B
Germany-13	C				C	C	B						B			B
Trib-1231264463102	C				B	C	B									B
Germany-14	B				C		A						B			B

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

Key to strategic priority (corresponding Benefit Category letter also shown)
A High; B Medium; C Low; D & E Indirect or General

Figure E-26. Germany Creek coho habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

Germany Winter Steelhead
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Germany-6	•				•	•	•						●	●		●
Germany-2											•		●	●		•
Germany-10					•		•						●	•		•
Germany-8	•				•		•						●	•		•
Germany-5	•				•						•		●	●		●
Germany-3	•						•				•		●	●		•
Germany-13	•				•		•						●			●
Germany-4	•				•		•				•		●	●		•
Germany-9													●	•		•
Germany-7					•		•						●	•		•
Germany-11	•				●		●						●			●
Germany-12	•				•		●						●			●
Germany-15	•				●		●						●			●
Germany-14	•				•		•						●			●
Germany-1					•		•				•	•		•		
Trib-1231231462714					•		•									
Trib-1231363462545-3					•		•									
Trib-1231107462883					•		•									
Trib-1231209463005					•		•									
Trib-1231264463102					•		•									
Trib-1231221462726					•		•									
Trib-1231363462545-1							•									
Trib-1231363462545-2																

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

Key to strategic priority (corresponding Benefit Category letter also shown)
A ● High B ● Medium C • Low D & E ☐ Indirect or General

Figure E-27. Germany Creek winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

In Abernathy Creek, important restoration reaches for fall Chinook and chum are below Slide Creek. These reaches have been most negatively influenced by sediment, temperature increases, loss of habitat diversity, and physical loss of key habitats (Figure E-28 and Figure E-31). 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 E-29). Key habitat has been lost in these areas as a result of adjacent land uses. Causes for these impacts are the same as those described above for fall Chinook and chum.

Winter steelhead restoration reaches in Abernathy Creek are scattered throughout the lower and middle mainstem Abernathy Creek. Impacts to these reaches have resulted from increases in fine sediment, impaired temperature regime, and loss of key habitats (Figure E-30). Causes of impacts are the same as those described for fall Chinook and chum restoration reaches.

Abernathy Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Abernathy-2													Medium	Medium		Medium
Abernathy-3					Low		Low						Medium	Medium		Medium
Abernathy-1	Low				Low		Low						Low	Low		Low
Abernathy-4	Low				Low		Medium						Medium	Medium		Medium
Abernathy-5	Low				Low		Medium						Medium	Medium		Medium
Abernathy-6									High							
Abernathy-7	Low				Low		Medium						Medium	Medium		Medium
Abernathy-8	Low				Low		Medium						Medium	Medium		Low

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

Key to strategic priority (corresponding Benefit Category letter also shown): A High; B Medium; C Low; D & E Indirect or General

Figure E-28. Abernathy 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 impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

Abernathy Coho
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Abernathy-2	C												B	C		B
Abernathy-7	C				C		B						B	C		B
Abernathy-1	C				C		B					C		C		C
Abernathy-5	B				C		B				C		B	C		B
Abernathy-10	C						C						B			B
Erick-2	C				C		B						B			B
Abernathy-3	C				C		C						B	C		B
Abernathy-4	B				C	C	A				C		B	C		B
Midway-1							C						B			B
Weist-2	C				C		C						B			B
Erick-1	C				C		B						B			B
Abernathy-11	C				C		B						B			B
Weist-1	B				C		B						B			B
Trib-1231894462314-1	C				C	C	C						B			B
Erick-3	C						C						B			B
Sarah-1	C				C		A						B			B
Abernathy-8	B				C		A						B	C		C
Cameron-1	C				C	C	B						B	C		C
Abernathy-9	C				C		A						B			B
Abernathy-12	B				C		B						B			B
Ordway-2	C				C		B						B			B
Cameron-2	C				C	C	B						B			C
Ordway-1	C				C		B						B			B
Slide-1					C	C	C									B
Abernathy-6																

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

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

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

Figure E-29. Abernathy Creek coho habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

Abernathy Winter Steelhead
Protection and Restoration Strategic Priority Summary

Geographic area priority	Attribute class priority for restoration															
Geographic area	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Abernathy-7	•				•		•						●	•		●
Abernathy-2	•										•	•	●	●		●
Abernathy-10													●			●
Abernathy-5	•				•		●				•	•	●	•		●
Abernathy-9	•				•		•						●			●
Abernathy-3							•				•	•	●	●		●
Abernathy-4	•				•		•				•	•	●	●		●
Ordway-1	•				•		•						●			●
Abernathy-11	•				•		•						●			●
Sarah-1	•				•								●			●
Cameron-1	•				•	•	•						●	●		•
Abernathy-1					•		•				•	•		•		
Abernathy-8	•				•		•						●	•		•
Abernathy-12	•				•		•						●			●
Erick-1	•				•								●	•		●
Midway-1													●			●
Weist-1	•				•		•						●	•		●
Sarah-3					•		•									
Slide-1					•		•									
Abernathy-6																

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

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

A	B	C	D & E
⬤ High	● Medium	• Low	(blank) Indirect or General

Figure E-30. Abernathy Creek winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative impact of habitat attributes on reach-level performance. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches may not be included for display purposes.

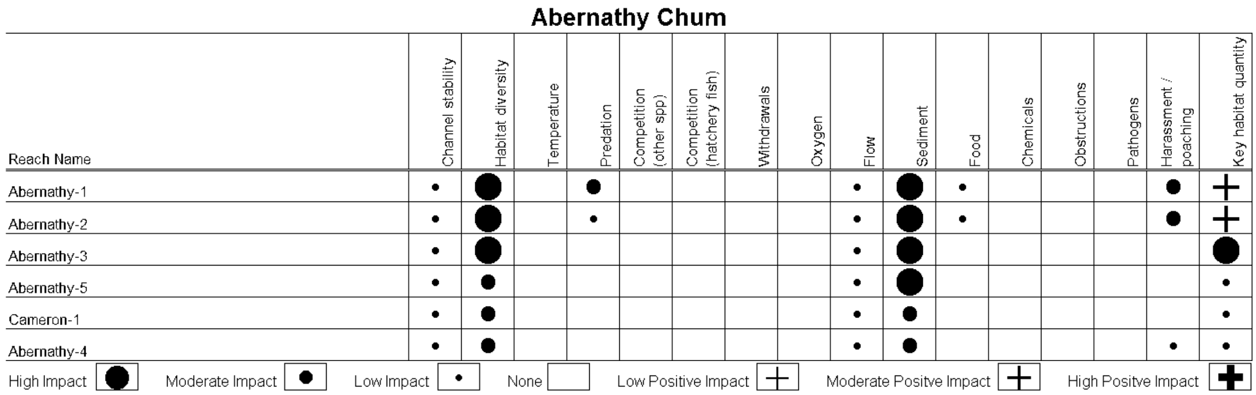


Figure E-31. Abernathy Creek subbasin chum habitat factor analysis diagram. This chum habitat factor analysis diagram differs from the others in that the dot size represents not only the relative within-reach impact of the habitat attributes, but also the relative contribution of each reach's impact on total population performance. The dots therefore decrease in size towards the bottom of the chart.

E.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 E-6. A reference map showing the location of each subwatershed in the basin is presented in Figure E-32. Maps of the distribution of local and watershed level IWA results are displayed in Figure E-33.

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 E-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

[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.

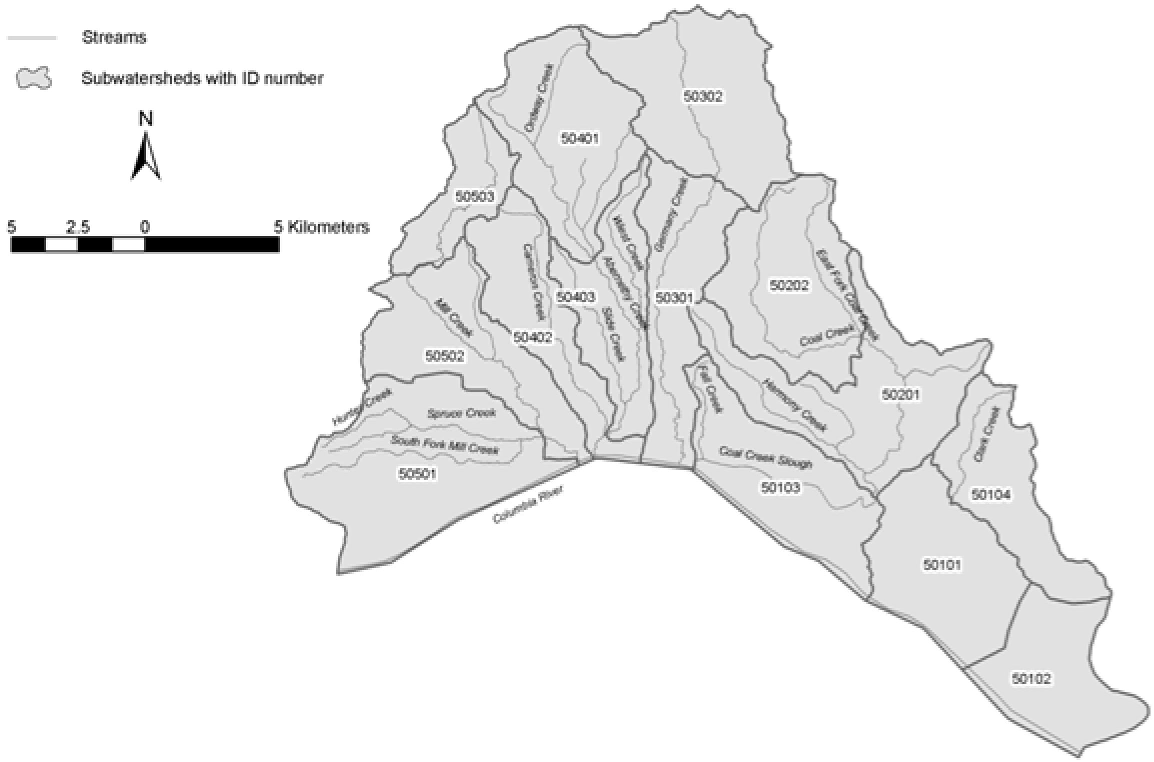


Figure E-32. Map of the Mill, Abernathy, Germany watershed showing the location of the IWA subwatersheds.

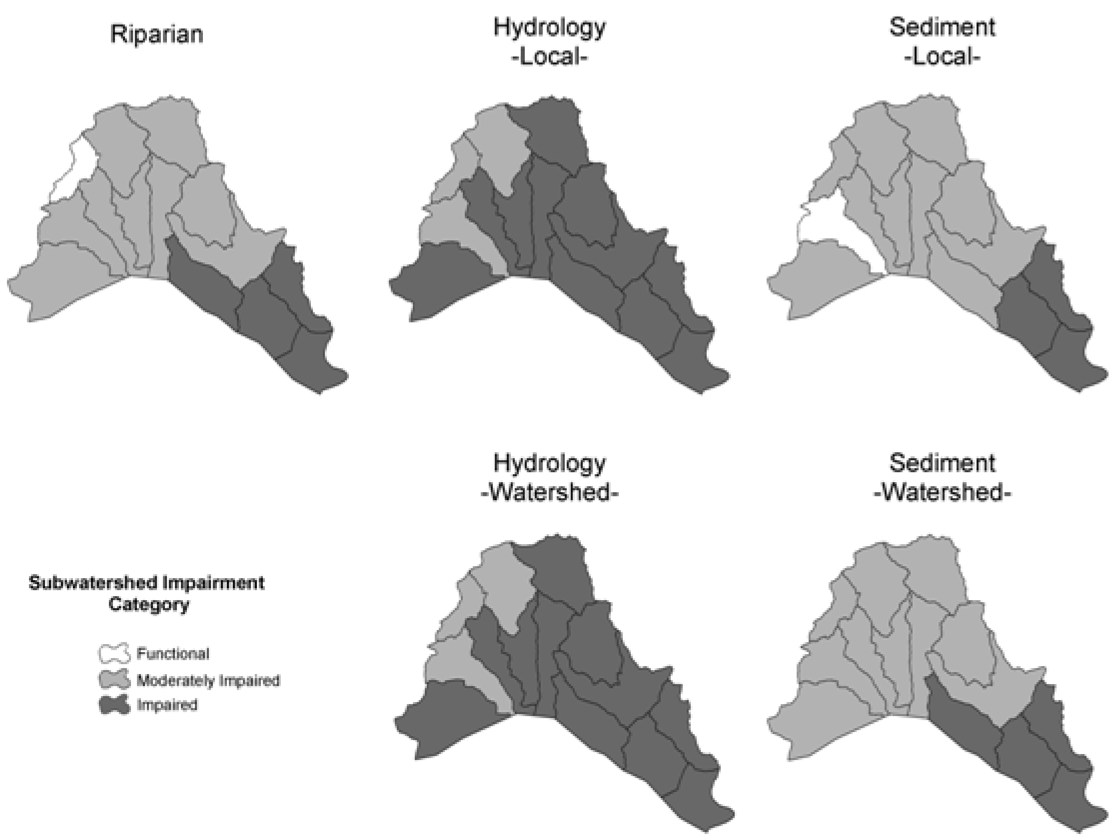


Figure E-33. IWA subwatershed impairment ratings by category for the Mill, Abernathy, Germany watershed.

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.

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.

E.4. Other Factors and Limitations

E.4.1. 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 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; 4) the federally mandated Artificial Production Review and Evaluation (APRE) process, and 5) the congressionally mandated, Hatchery Scientific Review Group (HSRG) review of all state, tribal and federal hatchery programs in Puget Sound and Coastal Washington, and in the Columbia River Basin. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program.

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

Table E-7 identifies hazards levels associated with risks involved with hatchery programs in the Grays River / Columbia Estuary Tributaries Basins. Table E-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 E-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.
(grey shading)	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 E-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 Abateme
	No WDFW Programs																

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

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

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

For Primary populations:

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

For Contributing populations:

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

For Stabilizing populations:

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

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

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

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

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

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

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

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

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

MAG Subbasin – Fall Chinook

The HSRG identified this as a candidate to develop a segregated harvest program of 1.0 million fish to replace tule production reduced elsewhere.

MAG Subbasin – Coho

The HSRG noted that this contributing population appears to be productive and abundant and meets the standards of a primary population. The HSRG recommends:

- Manage the population for natural production with actions focused on habitat protection
- Continue the removal of marked hatchery coho at the Abernathy weir

MAG Subbasin – Chum

The HSRG noted that there are no hatchery releases in these streams and recommends that managers monitor abundance of natural-origin chum.

MAG Subbasin – Winter Steelhead

The HSRG recommends monitoring contributions of hatchery strays in spawning escapement. There are no hatchery releases in Mill or Germany creeks, but 10,000 smolts are released in Abernathy as part of a research project scheduled to terminate in 2014.

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

Harvest

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

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

At the time of interim plan completion, fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table E-9). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced 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 E-9. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
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 stocks originating from Alaska, Canada, Washington, Oregon, and California. Columbia tule fall Chinook harvest is constrained by a Recovery Exploitation Rate (RER) developed by NMFS for management of Coweeman naturally-spawning fall Chinook . Some in-basin (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 Chinook 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 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.

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).

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 Volume I.

Ecological Interactions

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

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

Ocean Conditions

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

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

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

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

E.4.2. 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 E-34 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factors 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 the most significant factors for each species and where improvements might be expected to provide substantial benefits. Larger pie slices indicate greater significance and scope for improvement in an impact for a given species. These numbers also serve as a working hypothesis for factors limiting salmonid numbers and viability.

This assessment indicates that current salmonid status is the result of large impacts distributed among several factors. No single factor accounts for a majority of effects on all species. Thus, substantial improvements in salmonid numbers and viability will require significant improvements in several factors. Loss of tributary habitat quality and quantity accounts for the largest relative impact on all species. Loss of estuary habitat quantity and quality 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. No dams are operated in the subbasin and hydrosystem impacts are relatively minor and limited to habitat effects in the Columbia River mainstem and estuary.

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.

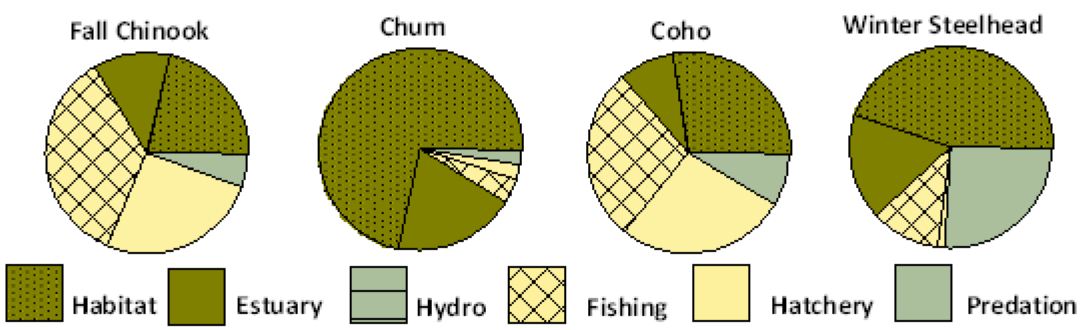


Figure E-34. Relative significance of potentially manageable factors for the MAG creeks fish populations.

E.5. Key Programs and Projects

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

E.5.1. Federal Programs

NMFS

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

U.S. Army Corps of Engineers

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

Environmental Protection Agency

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

Natural Resources Conservation Service

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

Northwest Power and Conservation Council

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

E.5.2. State Programs

Washington Department of Natural Resources

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

Washington Department of Fish & Wildlife

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

Washington Department of Ecology

The Department of Ecology (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 USACE Permits.

Washington Department of Transportation

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

Washington Recreation and Conservation Office

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

Lower Columbia Fish Recovery Board

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

E.5.3. Local Government Programs

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.

Cowlitz County

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

City of Longview

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

Cowlitz / Wahkiakum Conservation District

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

E.5.4. Non-governmental Programs

Columbia Land Trust

The Columbia Land Trust is a private, non-profit organization founded in 1990 to work exclusively with willing landowners to find ways to conserve the scenic and natural values of the land and water.

Landowners donate the development rights or full ownership of their land to the Land Trust. CLT manages the land under a stewardship plan and, if necessary, will legally defend its conservation values.

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.

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.

E.5.5. Tribal Programs

Cowlitz Indian Tribe

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

E.5.6. NPCC Fish & Wildlife Program Projects

There are no NPCC Fish & Wildlife Program Projects in the M-A-G Basin.

E.5.7. Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Preservation	Abernathy Creek Restoration	Mill/Abernathy/Germany
Preservation/Restoration	Germany Creek	Mill/Abernathy/Germany
Preservation/Restoration	Abernathy Habitat Rest & Riparian Protection	Mill/Abernathy/Germany
Restoration	Germany Creek Nutrient Enhancement	Mill/Abernathy/Germany
Preservation/Restoration	Germany Creek Conservation and Restoration Phase II	Mill/Abernathy/Germany
Restoration	Germany Creek Nutrient Enhancement Community Outreach	Mill/Abernathy/Germany

E.6. Management Plan

E.6.1. Vision

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

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

The 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.

E.6.2. 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 NMFS. Criteria involve a hierarchy of ESU, Strata (i.e. ecosystem areas within the ESU – Coast, Cascade, Gorge), and Population standards. A recovery scenario describing population-scale biological objectives for all species in all three strata in the lower Columbia ESUs was developed through a collaborative process with stakeholders based on biological significance, expected progress as a result of existing programs, the absence of apparent impediments, and the existence of other management opportunities. Under the preferred alternative, individual populations will variously contribute to recovery according to habitat quality and the population's perceived capacity to rebuild. Criteria, objectives, and the regional recovery scenario are described in greater detail in Volume I.

Focal populations in the 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 fall Chinook , chum, and winter steelhead to a high viability level, providing a 95% or better probability of population survival over 100 years. 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 E-10. Status and goals for salmon and steelhead populations in the MAG creeks.

Species	Population	Recovery Priority[1]	Viability		Improve-ment[4]	Abundance		
			Status[2]	Obj[3]		Historical[5]	Current[6]	Target[7]
Fall Chinook	M.A.G.	Primary	VL	H	155%	2,500	50	900
Chum	M.A.G.	Primary	VL	H	>500%	7,000	<100	1,300
Winter Steelhead	M.A.G.	Primary	M	H	0%[8]	900	600	600
Coho	M.A.G.	Contributing	VL	M	>500%	2,800	<50	1,800

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

E.6.3. Integrated Strategy

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

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

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

Improvement targets were developed for each impact factor based on desired population productivity improvements and estimates of potentially manageable impacts (see Section 3.7). Impacts are estimates of the proportional reduction in population productivity associated with human-caused and other potentially manageable impacts from stream habitats, estuary/mainstem habitats, hydropower, harvest, hatcheries, and selected predators. Reduction targets were 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 E-11) identifies population and factor-specific improvements consistent with the biological objectives for this subbasin. Per factor increments are less than the population net because factor affects are compounded at different life stages and density dependence is largely limited to freshwater tributary habitat. For example, productivity of Mill/Abernathy/Germany fall Chinook must increase by 80% to reach population viability goals. This requires impact reductions equivalent to a 22% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts on fall Chinook must decrease from a 40% to a 31% impact in order to achieve the required 22% increase in tributary habitat potential from the current 60% of the historical potential to 69% of the historical potential.

Table E-11. 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	155%	28%	0.40	0.23	0.00	0.10	0.65	0.49
Chum	500%	50%	0.90	0.25	0.00	0.03	0.05	0.03
Coho	500%	50%	0.50	0.16	0.00	0.15	0.50	0.50
Winter Steelhead	0%	0%	0.40	0.15	0.00	0.23	0.10	0.01

E.6.4. Tributary Habitat

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

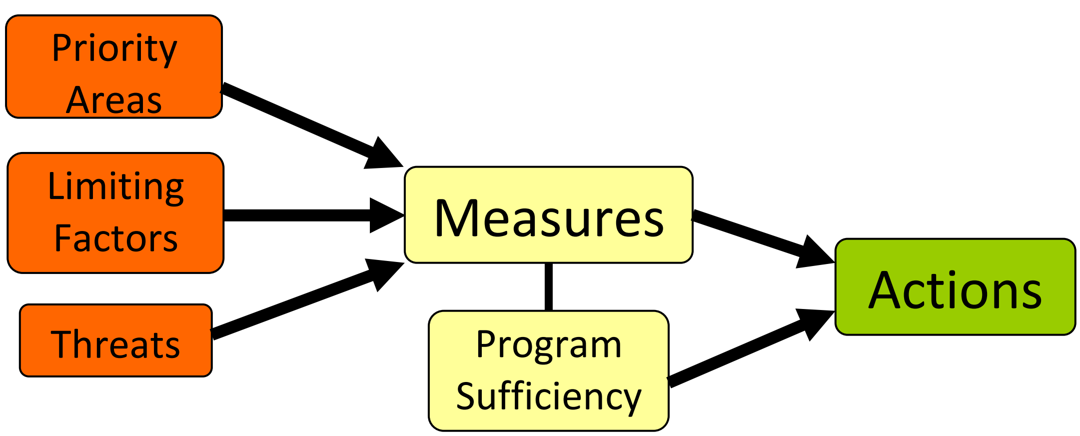


Figure E-35. Flow chart illustrating the development of subbasin measures and actions.

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 E-12.

- Lower Mill Creek & tributaries (reaches Mill 1-5; SF Mill 1; Spruce 1-2) – The reaches with the most current and potential production in the Mill Creek basin are in the lower and middle mainstem (above and below the SF confluence) and in lower SF 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; Ordway-1, Sarah-1) – The most productive reaches in Abernathy Creek are located in the lowest 3-4 miles of the mainstem and the upper reaches, 9-11. 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 1-13) – 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 E-12. 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 E-13. Reach tier designations for this basin are included in Table E-14. Reach tiers and subwatershed groups are displayed on a map in Figure E-36.

Table E-13. Rules for designating reach tier and subwatershed group priorities. See Biological Objectives section for information on population designations.

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

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

Tier 1	Tier 2	Tier 3	Tier 4	
Abernathy-2	Abernathy-4	Erick-1	Abernathy-8	Trib1232458462630
Abernathy-3	Cameron-1	Midway-1	Abernathy-12	NF Mill-3 (culvert)
Abernathy-5	Abernathy-11	Erick-2	Slide-1	Germany-11
Abernathy-1	Ordway-1	Weist-2	Weist-1	Germany-12
Abernathy-7	Sarah-1	Mill-6	Sarah-3	Germany-14
Abernathy-10	Mill-4	Mill-14	Abernathy-6	Germany-15
Abernathy-9	Mill-10		Cameron-2	Germany-7
Mill-1	Mill-11		Erick-3	Germany-9
Mill-2	Mill-12		Ordway-2	Trib-1231221462726
Mill-3	Spruce-1		Trib-1231894462314-1	Trib-1231264463102
Mill-5	Spruce-2		NF Mill-1	Trib-1231107462883
SF Mill-1	Germany-1		NF Mill-2	Trib-1231209463005
Germany-2	Germany-3		NF Mill-4	Trib-1231231462714
Germany-5	Germany-4		NF Mill-5	Trib-1231363462545-1
Germany-6	Germany-13		Mill-13	Trib-1231363462545-3
Germany-8			Mill-7_A	Germany-16
Germany-10			Mill-7_B	Trib-1231123462853
			Mill-8	Trib-1231282461874-1
			Mill-9	Trib-1231282461874-2
			SF Mill-2	Trib-1231287463265
			Spruce-3	Trib-1231363462545-2
			Trib1231748461868	

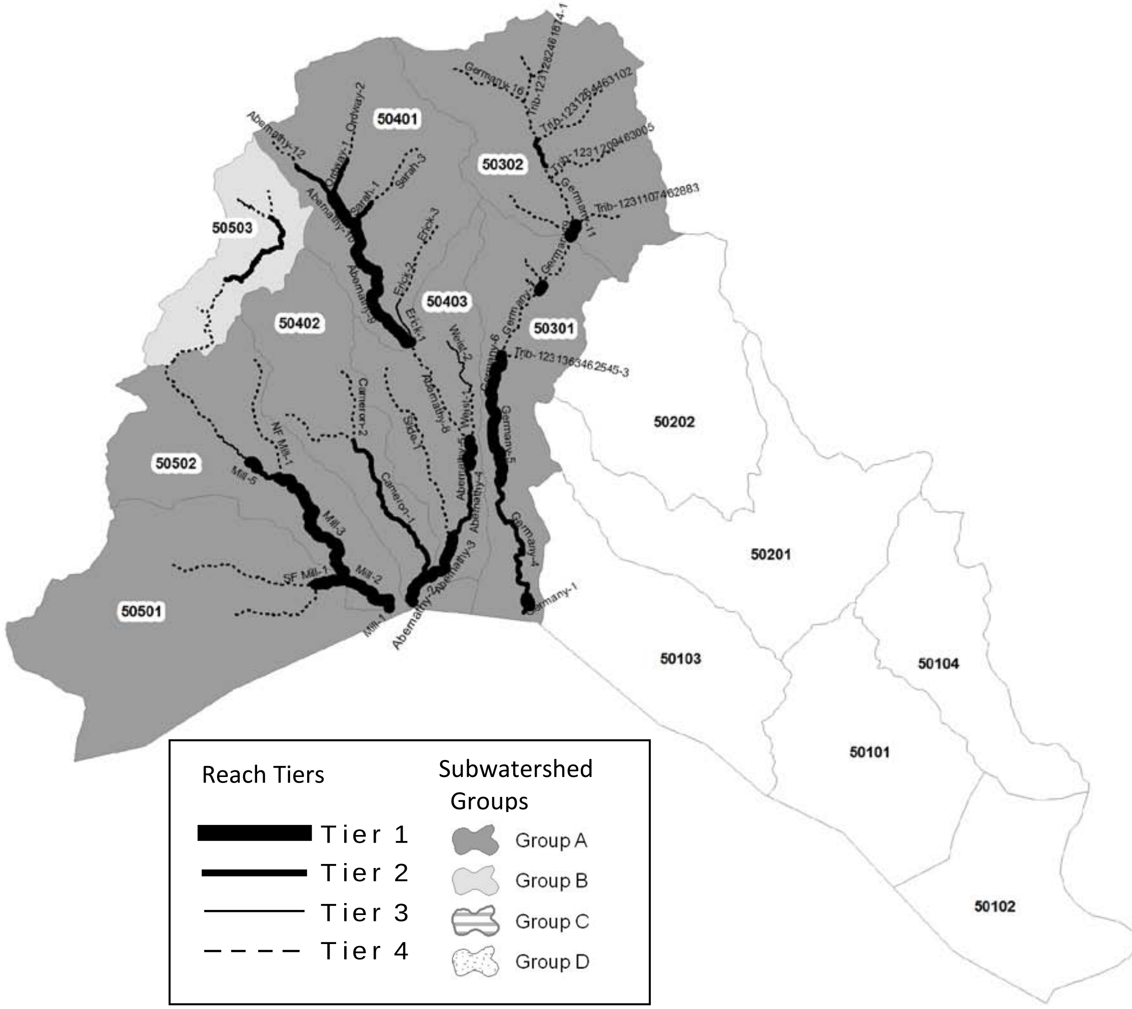


Figure E-36. Reach tiers and subwatershed groups in the Mill/Abernathy/Germany Watershed. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers.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

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 E-15. 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.

Habitat Actions

The prioritized measures and associated gaps are used to develop specific Actions for the watershed. These are presented in Table E-16 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 E-15. 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)
2nd- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation
3rd- Remaining Tier 1 and 2 reaches
4th- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NMFS	ESA Section 7 and Section 10	✓	
U.S. Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, 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)
2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
4th- All remaining subwatersheds

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)

2nd- Moderately impaired or impaired subwatersheds contributing to other reaches

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)
2nd- Tier 2 reaches with hydro-modifications
3rd- Other reaches with hydro-modifications

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
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
2nd- Other reaches with 303(d) listings
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, 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

Ecology's 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 Ecology 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 Ecology, in cooperation with the WDFW and other entities, manages water rights and instream flow protections. A collaborative process for setting and managing instream flows was launched in 1998 with the Watershed Planning Act (HB 2514), which called for the establishment of local watershed planning groups who's objective was to recommend instream flow guidelines to Ecology through a collaborative process. The current status of the planning effort is to adopt a watershed plan by December 2004. Instream flow management in the 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 E-16. 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, Ecology	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	Activity is	Ecology, WDFW,	9	High: Entire basin	Medium: Adequate instream flows to	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]
WRIA 25/26 Watershed Planning Unit regarding instream flows	currently in place	WRIA 25/26 Planning Unit, Cowlitz County			support life stages of salmonids and other aquatic biota.	
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

E.6.5. Hatcheries

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

Subbasin Hatchery Strategy

The desired future state of fish production within the 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 E-17. More detailed descriptions and discussion of the regional hatchery strategy can be found in Volume I.

Table E-17. Summary of potential 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	Supplementation				✓		
	Hatch/Nat Conservation [1]						
	Isolation						
	Refuge	✓				✓	
Fishery Enhancement	Hatchery Production						

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

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

Natural Refuge Watersheds: In this strategy, certain sub-basins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These refugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural population on fitness and our ability to measure natural population productivity and will be key indicators of natural population status within the ESU. 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 Chinook 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 Chinook 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 salmon in areas where harvest production occurs. There is not a 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 E-18. A summary of conservation and harvest strategies with potential implemention 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

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 E-19). 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 NMFS 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 Volume I.

Table E-19. Potential 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

E.6.6. Harvest

Fisheries are both an impact that reduces fish numbers and an objective of recovery. The long-term vision is to restore healthy, harvestable natural salmonid populations in many areas of the lower Columbia basin. The near-term strategy involves reducing fishery impacts on natural populations to ameliorate extinction risks until a combination of actions can restore natural population productivity to levels where 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. More complete details can be found in the WDFW Sport Fishing Rules Pamphlet.

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. Harvest actions with significant application to the MAG Watershed populations are summarized in Table E-21. No hydropower facilities exist in the MAG Watershed, hence, no in-basin hydropower actions are identified. MAG Creeks 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.

Table E-20. 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 hatchery 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 Chinook 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 Chinook closure Protects adult wild steelhead during spawning and minimum size protects juvenile steelhead

Table E-21. Regional harvest actions from Volume I with significant application to the MAG populations.

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

E.6.7. 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.

E.6.8. Ecological Interactions

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

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