Volume II, Chapter 5
Elochoman Subbasin

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5.0 Elochoman Subbasin

For the purposes of this analysis, the Elochoman subbasin includes the Elochoman, Skamokawa, Mill, Abernathy, Germany, and other smaller tributaries in the vicinity.

5.1 Subbasin Description

5.1.1 Topography & Geology

Streams in the Elochoman Subbasin originate in the Willapa Hills in southwest Lewis County and northeast Cowlitz County, and flow generally south to the Columbia. The subbasin area is approximately 315 mi^2. From west to east, the stream systems include Jim Crow Creek, the Skamokawa River, Brooks Slough, the Elochoman River, Birnie Creek, Mill Creek, Abernathy Creek, Germany Creek, Fall Creek, Coal Creek, Clark Creek, and the Longview Ditch network. The highest elevation lies at the head of the Elochoman basin at 2,673 feet and the lowest is near sea level on the Columbia. The surface geology is a combination of volcanic and sedimentary materials. Less than 20% of the soils are classified as highly erodible.

5.1.2 Climate

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

5.1.3 Land Use/Land Cover

Forestry is the predominant land use in the Elochoman subbasin. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Nearly 0% of the forest cover is in late-seral stages, however, as the forest matures, watershed conditions are recovering. Agriculture and residential land use is located along lower alluvial stream segments of the Skamokawa, Elochoman, Mill, Abernathy, and Germany Creeks. Skamokawa and Cathlamet are the two largest population centers. Projected population change from 2000 to 2020 for unincorporated areas in WRIA 25 is 37% (LCFRB 2001). The subbasin 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. A breakdown of land ownership and land cover in the Elochoman basin is presented in Figure 5-1 and Figure 5-2. Figure 5-3 displays the pattern of landownership for the Elochoman basin and Figure 5-4 displays the pattern of land cover / land-use.

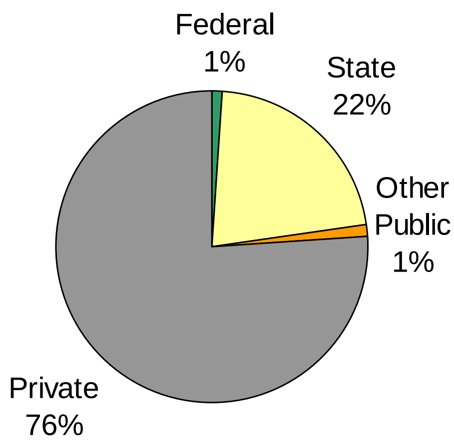


Figure 5-1. Elochoman River subbasin land ownership (includes Skamokawa, Elochoman, Mill, Abernathy, and Germany Creeks)

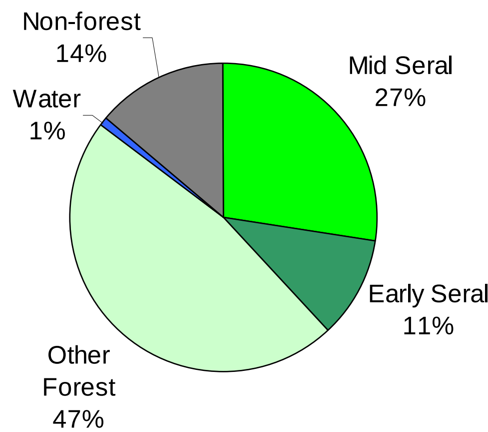


Figure 5-2. Elochoman River subbasin land cover. (includes Skamokawa, Elochoman, Mill, Abernathy, and Germany Creeks)

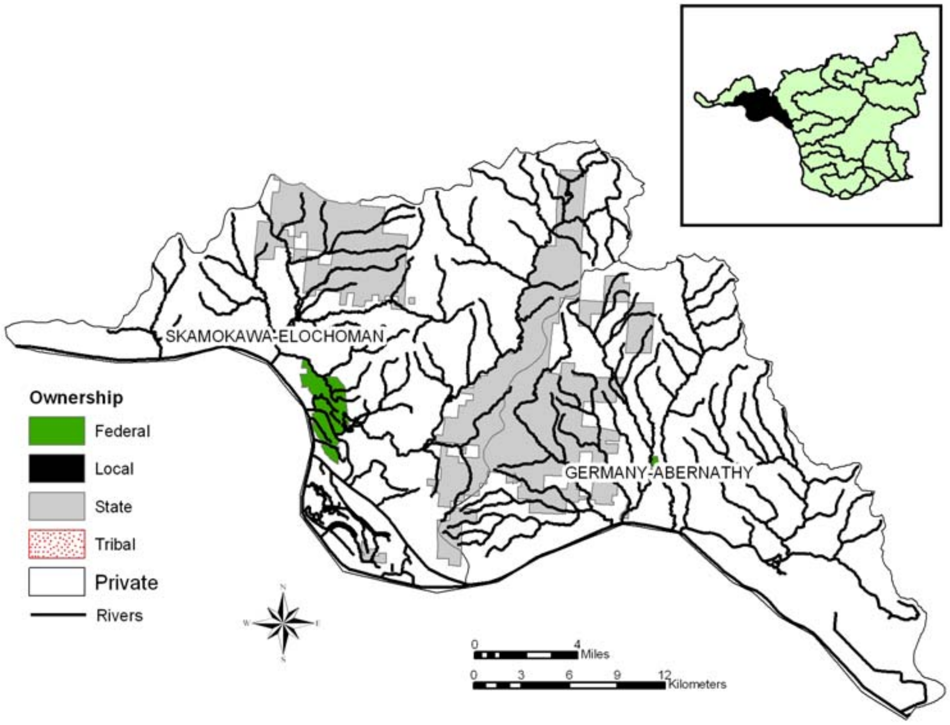


Figure 5-3. Landownership within Elochoman basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

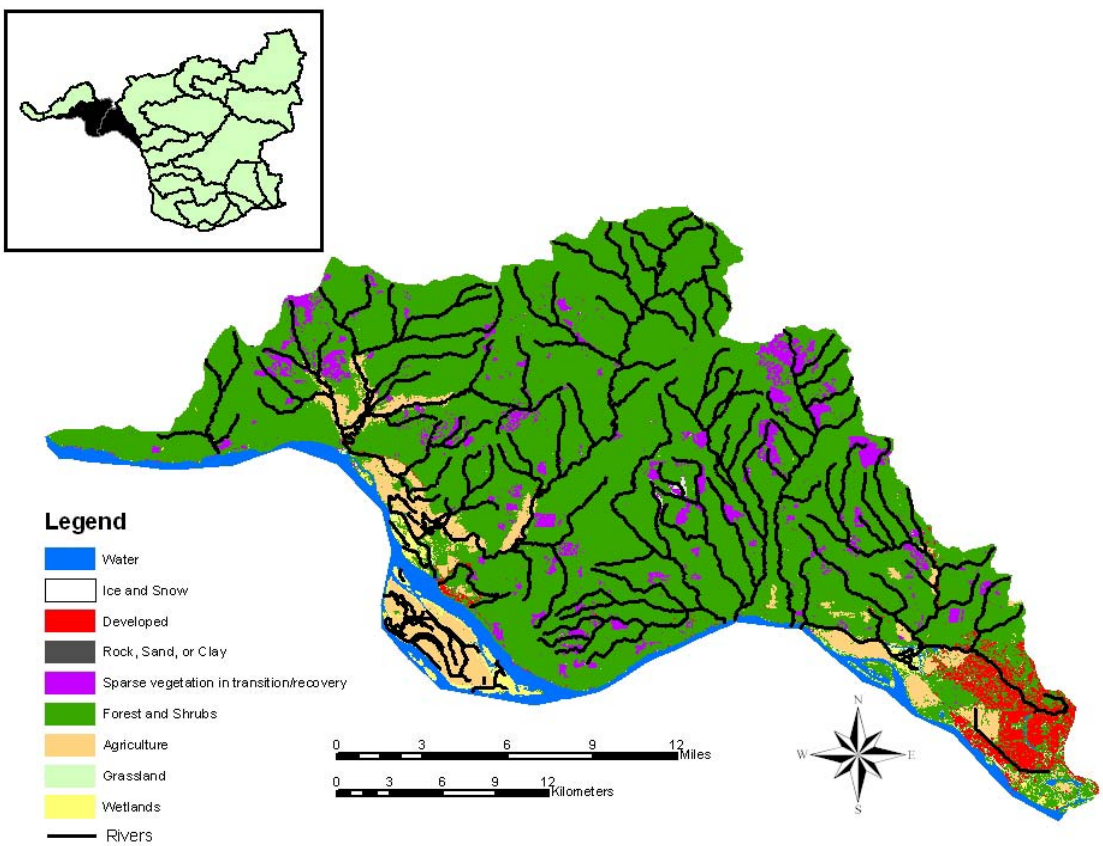
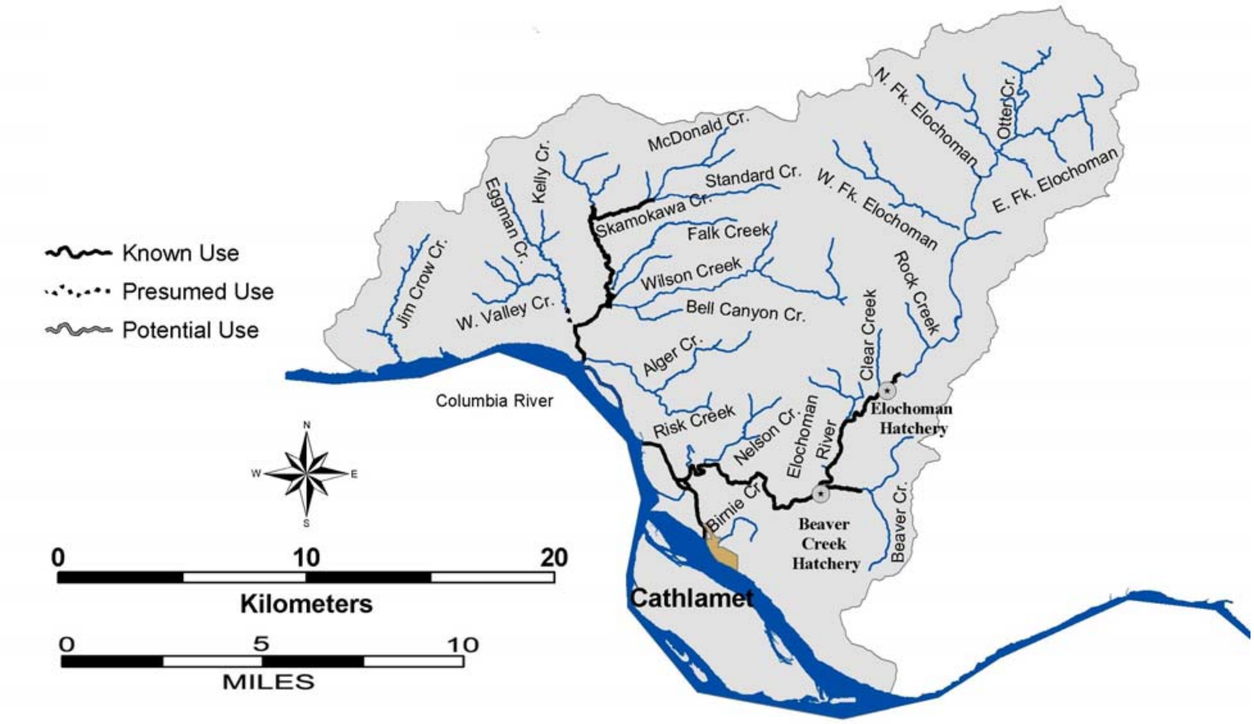


Figure 5-4. Land cover within the Elochoman basin. Data was obtained from the USGS National Land Cover Dataset (NLCD).

5.2 Focal Fish Species

5.2.1 Fall Chinook—Elochoman Subbasin (Elochoman/Skamokawa)

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

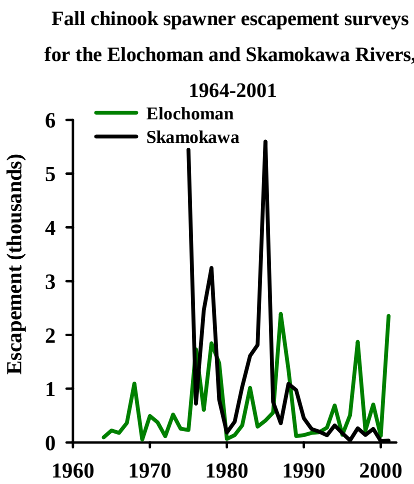


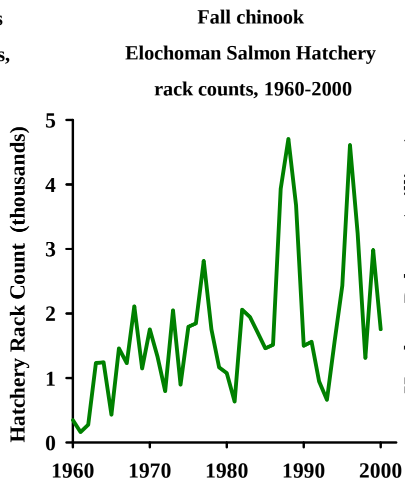
Distribution

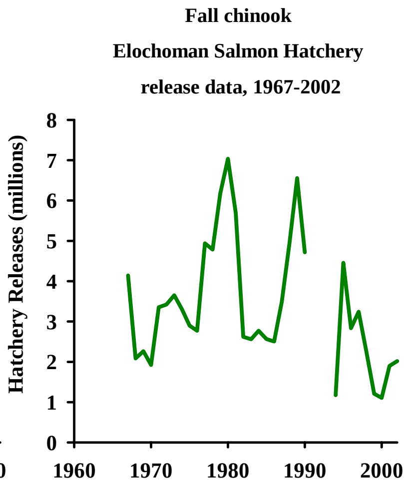
- Spawning occurs in the lower mainstem Elochoman between RM 4 and 9 (downstream of the Elochoman Hatchery)
- Spawning occurs in the mainstem Skamokawa from Wilson Creek upstream to Standard and McDonald Creeks (4.5 miles)

Life History

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







Diversity

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

Abundance

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

Productivity & Persistence

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

Hatchery

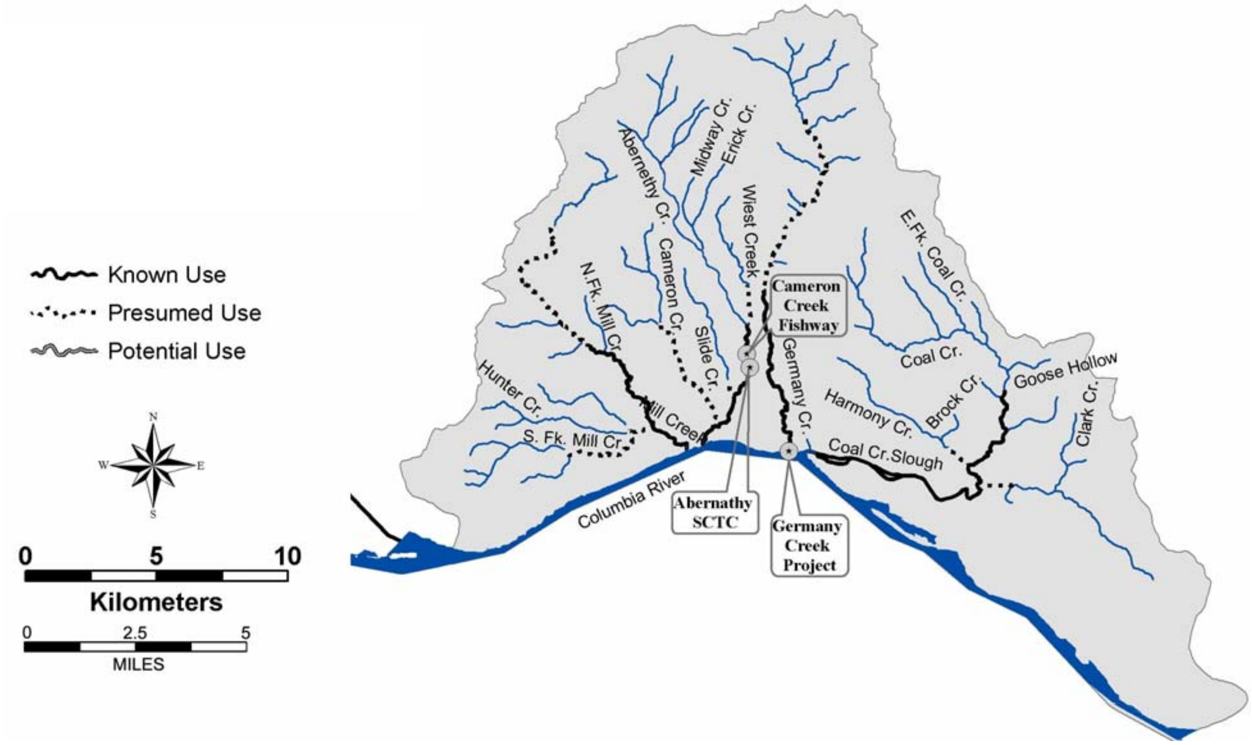
- Elochoman Hatchery located about RM 9; hatchery completed 1953
- Hatchery releases of fall chinook in the basin began in 1950; release data is displayed for the years 1967-2002
- The current program releases 2 million fall chinook juveniles annually into the Elochoman River; there are no hatchery fish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

Harvest

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

5.2.2 Fall Chinook—Elochoman Subbasin (Mill/Abernathy/Germany)

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



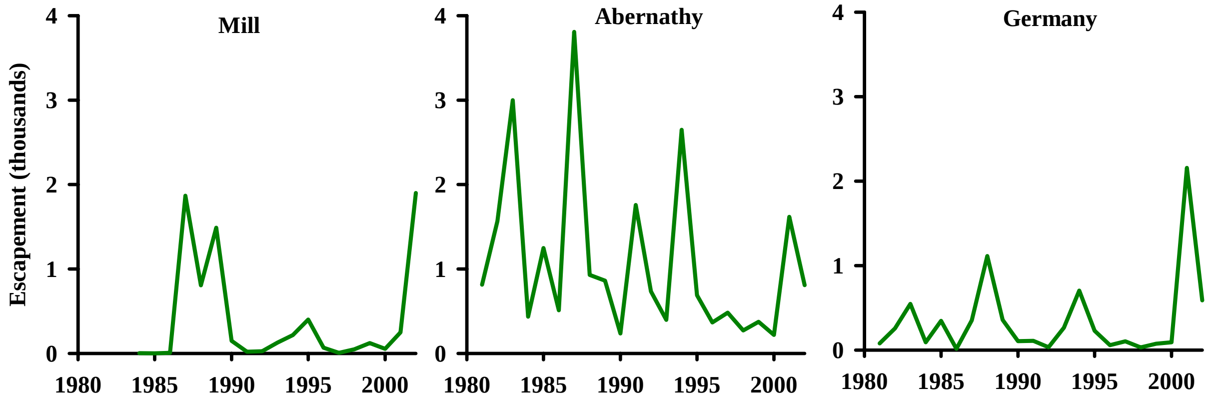
Distribution

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

Life History

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

Fall chinook spawner Escapement for Mill, Abernathy, and Germany creeks, 1981-2002



Diversity

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

Abundance

- Fall chinook may not be native to Mill, Abernathy, or Germany Creeks; hatchery production Fall chinook may not be native to Mill, Abernathy, or Germany Creeks; hatchery production and straying has contributed heavily to returns
- Mill Creek spawning escapements from 1986-2002 ranged from 2 to 1,900 (average 409)
- Abernathy Creek spawning escapement from 1981-2002 ranged from 200 to 3,807 (average 1,081)
- Germany Creek spawning escapement from 1981-2002 ranged from 15 to 2,158 (average 340)
- WDFW captured 910 fall chinook juveniles in ten seining trips to Abernathy Creek in 1995

Productivity & Persistence

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

Hatchery

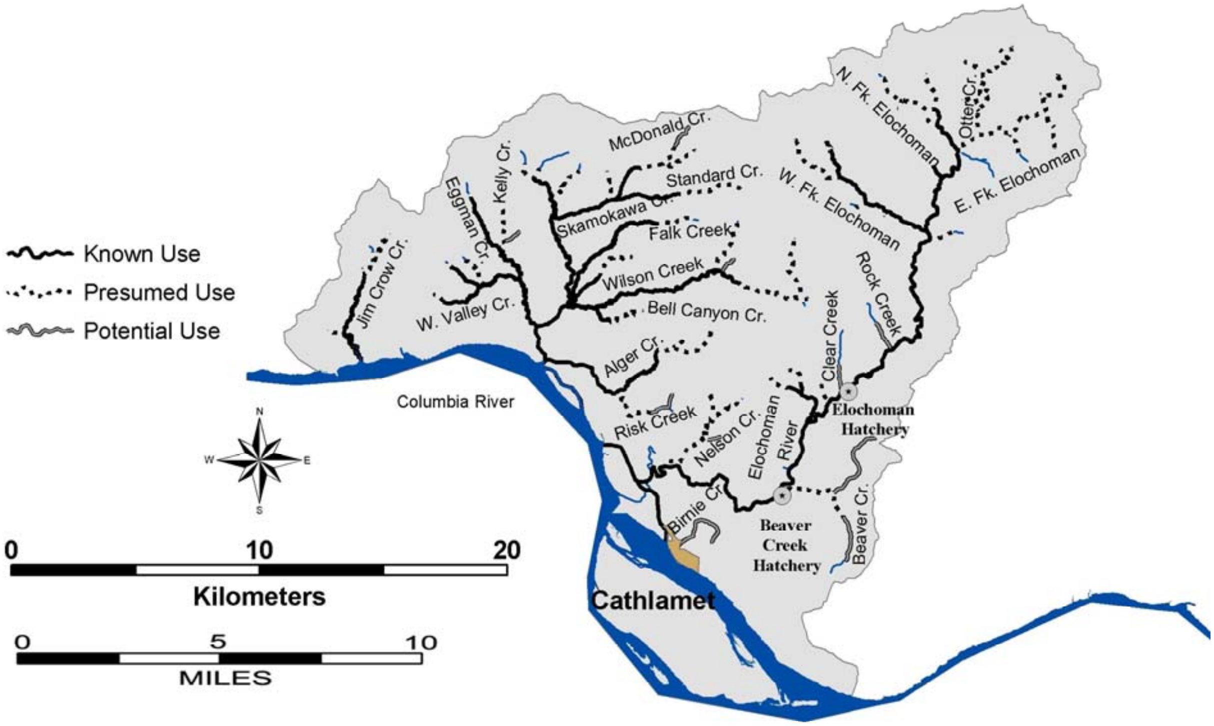
- The Abernathy Creek NFH released about 1 million fall chinook per year over a 21 year period (1974-1994); another 15,278,638 fall chinook were released in Abernathy Creek from 1960-1977 from other hatchery programs; broodstock largely derived from Spring Creek NFH chinook
- The Abernathy Creek NFH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

Harvest

- Fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial gill net and sport fisheries
- Lower Columbia River tule fall chinook are an important contributor to Washington ocean sport and troll fisheries and to the lower Columbia estuary sport fishery
- Columbia River commercial harvest occurs primarily in September, but tule chinook flesh quality is low once the fish move from salt water; price is low compared to higher quality bright chinook stocks
- CWT data analysis of the 1976 brood year suggests that the majority of the lower Columbia River Hatchery fall chinook stock harvest occurred in Southern British Columbia (40%), Columbia River (18.0%), and Wahington 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%

5.2.3 Coho—Elochoman Subbasin (Elochoman/Skamokawa)

ESA: Candidate 1995	SASSI: Unknown 2002

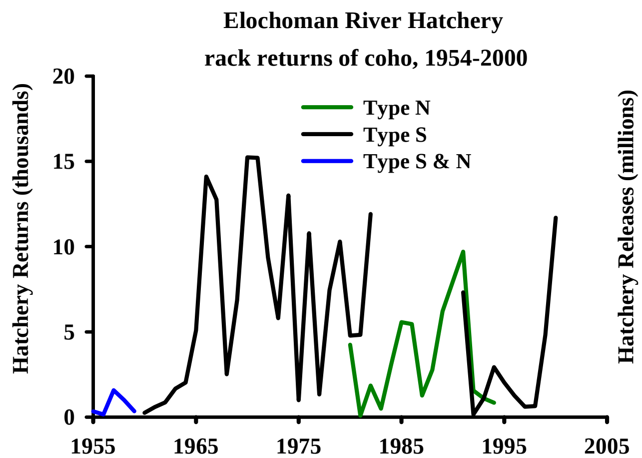


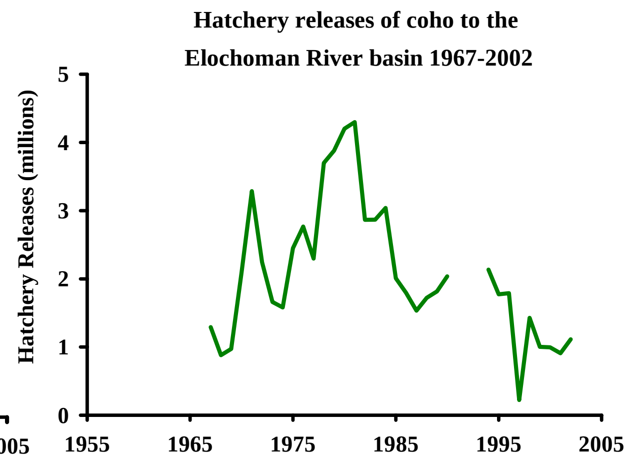
Distribution

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

Life History

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





Diversity

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

Abundance

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

Productivity & Persistence

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

Hatchery

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

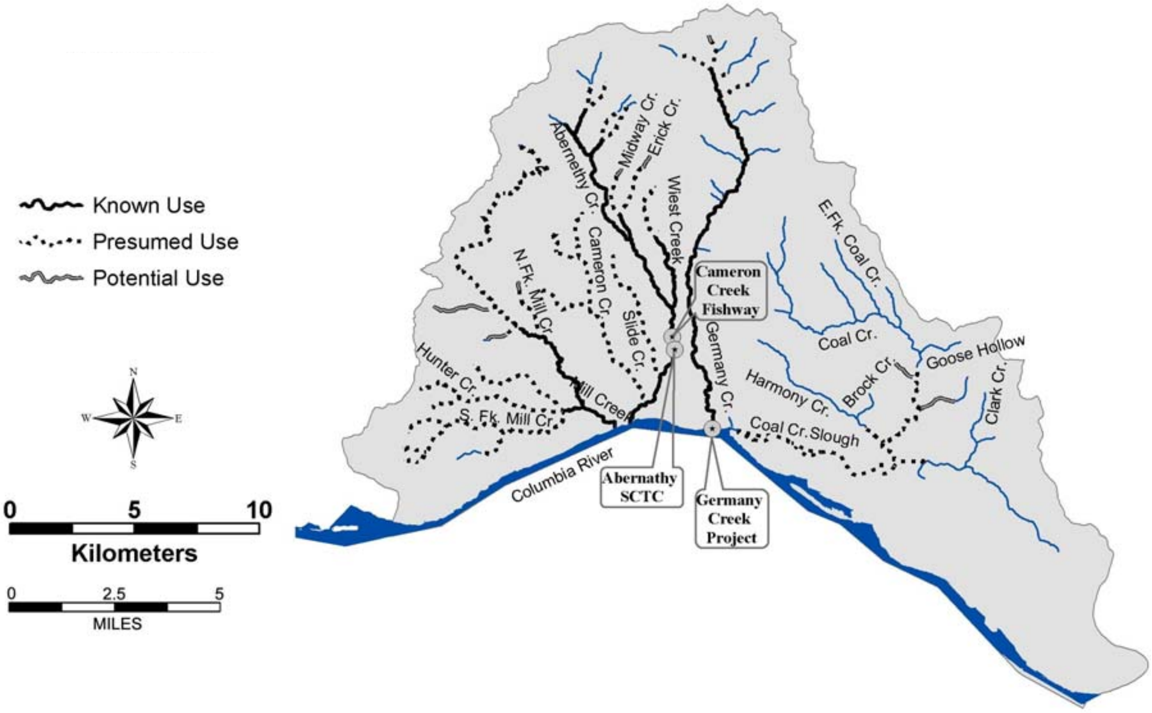
Harvest

- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial coho fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas coho

- Since 1999, returning Columbia River hatchery coho have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon state listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery Coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho in September is constrained by fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early coho, but late coho harvest can also be substantial
- An average of 1,183 coho (1981-1988) were harvested annually in the Elochoman River sport fishery
- CWT data analysis of 1995-97 early coho released from Elochoman Hatchery indicates 49% were captured in a fishery and 51% were accounted for in escapement
- CWT data analysis of 1995-97 brood late coho released from Elochoman Hatchery indicates 61% were captured in a fishery and 39% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 brood Elochoman early coho were distributed between Columbia River (53%), Washington ocean (40%), and Oregon ocean (7%) sampling areas
- Fishery CWT recoveries of 1995-97 brood Elochoman late coho were distributed between Columbia River (59%), Washington ocean (29%), and Oregon ocean (11%) sampling areas

5.2.4 Coho—Elochoman Subbasin (Mill/Abernathy/Germany)

ESA: Candidate 1995	SASSI: Unknown 2002



Distribution

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

Life History

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

Diversity

- Late stock coho (or Type N) were historically present in the Mill, Abernathy, and Germany Creek basins with spawning occurring from late November into March
- There was also late coho produced historically in nearby Coal Creek
- Early stock hatchery coho have been planted in these tributaries in some years, but not in recent years
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar
- Stocks in Mill, Germany, and Abernathy Creeks are designated based on distinct spawning distribution

Abundance

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

Productivity & Persistence

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

Hatchery

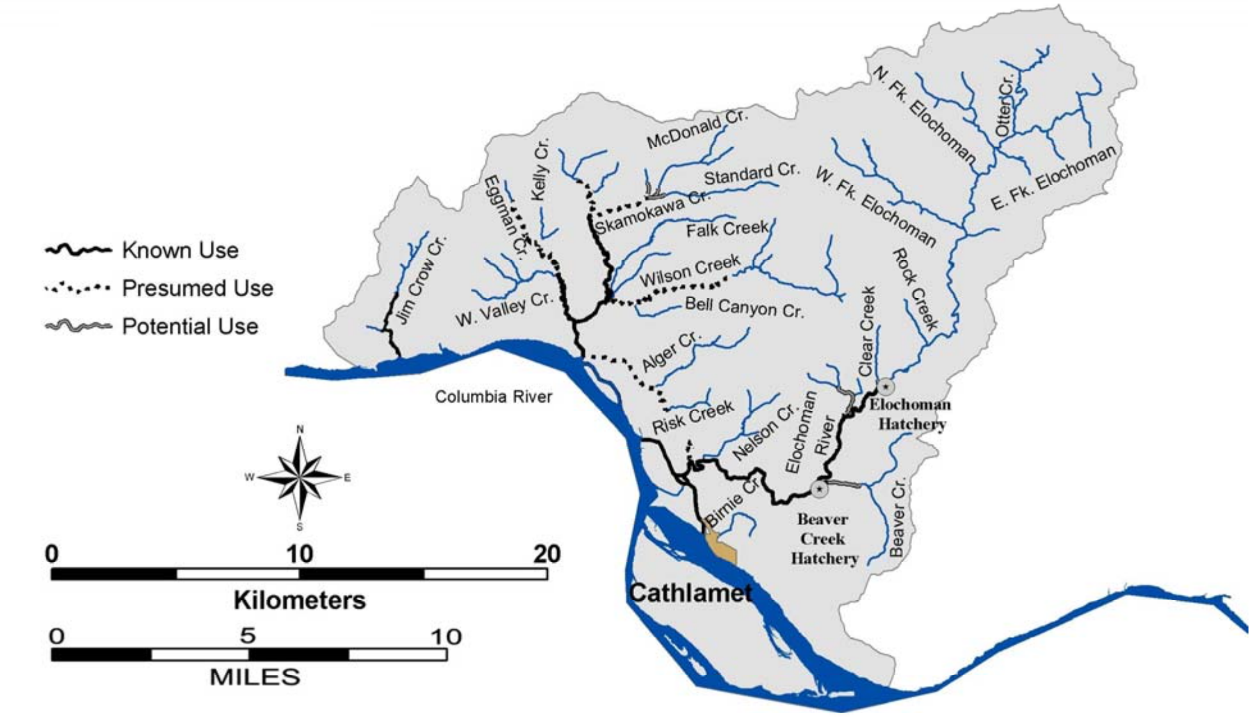
- There are no production hatcheries located within these creeks, although out-of-basin plants have occurred in some past years

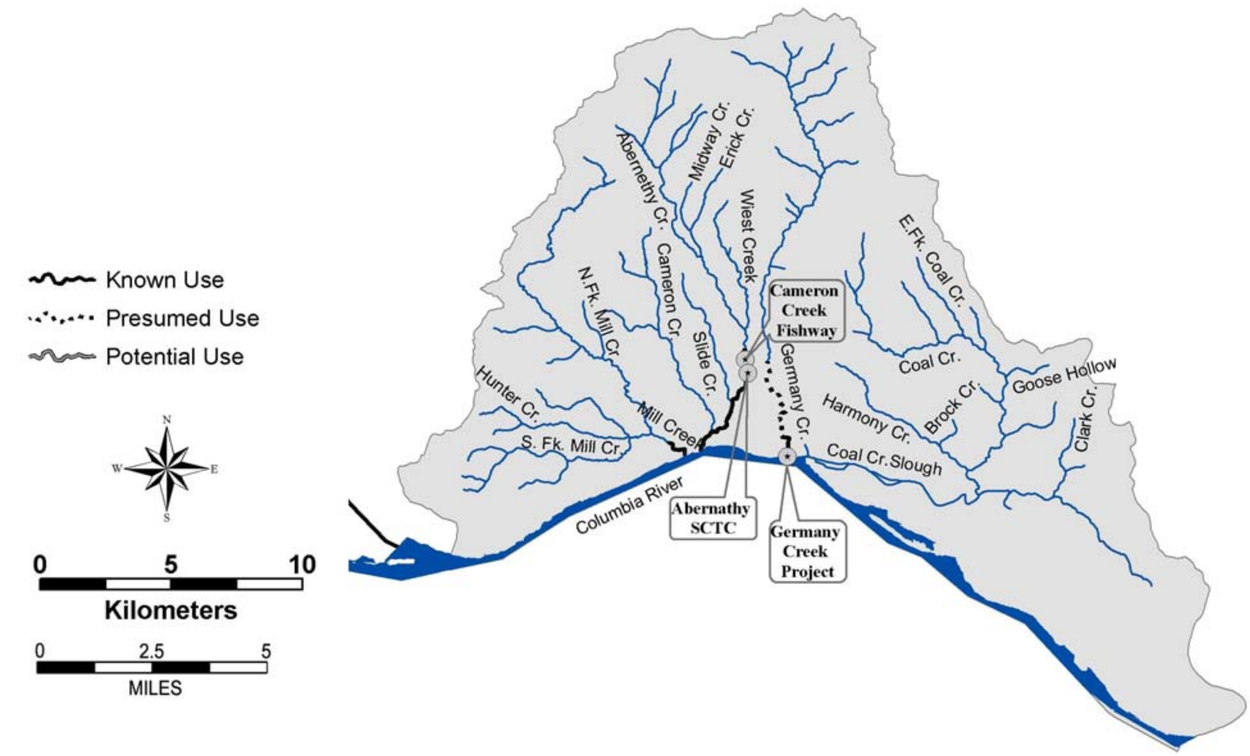
Harvest

- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial coho fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas coho
- Since 1999, returning Columbia River hatchery coho have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon state listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho in September is constrained by fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early coho, but late coho harvest can also be substantial
- These streams are not open to sport fishing for coho

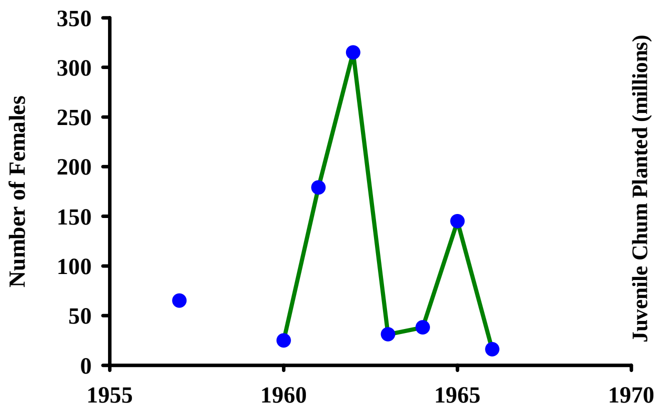
5.2.5 Chum—Elochoman Subbasin

ESA: Threatened 1999	SASSI: NA

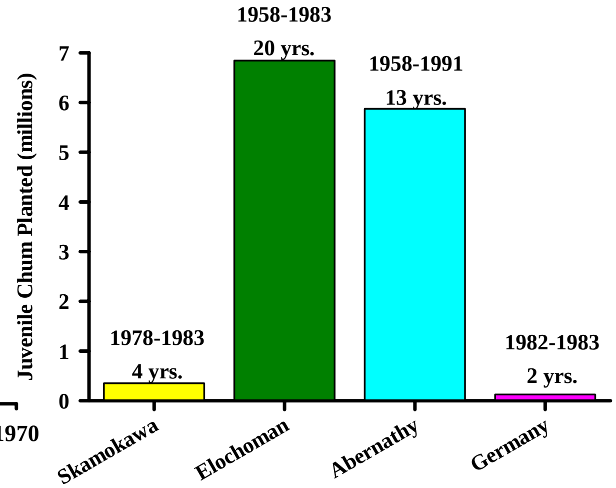




Elochoman Hatchery rack counts females, 1957-1966



Hatchery Releases of Chum Salmon, 1958-1994



Distribution

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

Life History

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

Diversity

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

Abundance

- In 1936, escapement surveys documented 158 chum in Elochoman River, 92 in Abernathy Creek, and chum were “observed” in Germany Creek and “reported” in Skamokawa River and Mill Creek
- WDF 1951 report estimated escapement of approximately 1,000 chum to the Elochoman River and 3,000 chum to the Skamokawa River; 1973 survey reported “small” run
- WDF 1951 report estimated escapement to Abernathy/Mill/Germany Creeks area was 2,700 chum
- An estimated 100 chum spawned naturally in Abernathy Creek in 1990

Productivity & Persistence

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

Hatchery

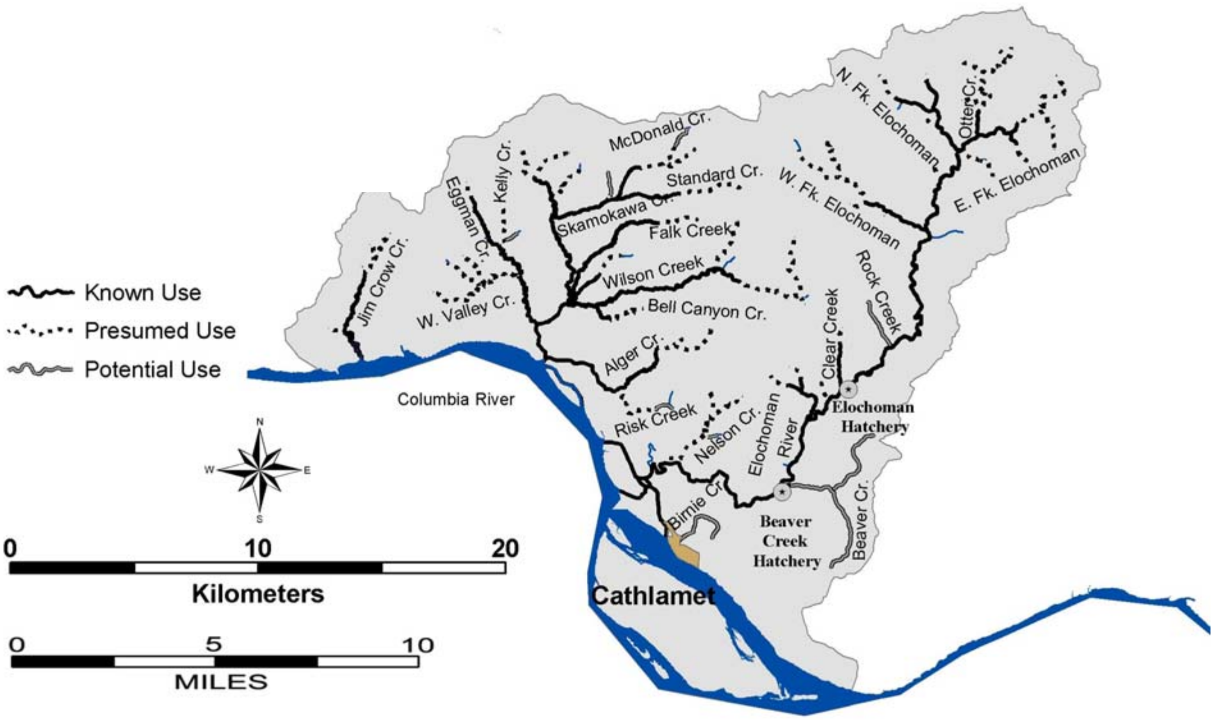
- Chum fry releases of various stocks occurred from 1958-1983 in the Elochoman River, 1958-1991 in Abernathy Creek, 1978-1983 in Skamokawa Creek, and 1982-1983 in Germany Creek
- Elochoman releases average 340,000 over 20 years, Skamokawa releases averaged 88,000 over four years, Germany Creek releases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

Harvest

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

5.2.6 Winter Steelhead—Elochoman Subbasin (Elochoman/Skamokawa)

ESA: Not Warranted	SASSI: Depressed 2002

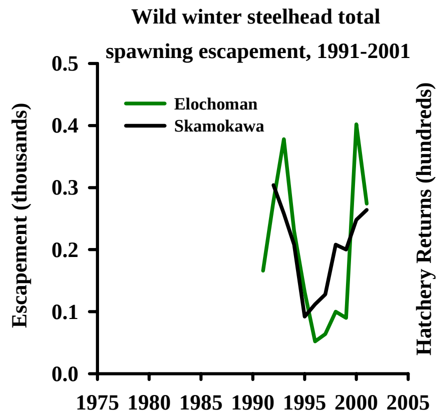


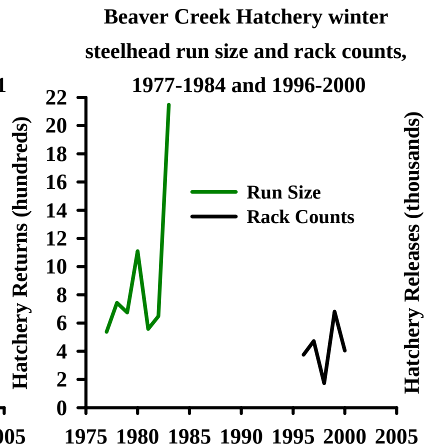
Distribution

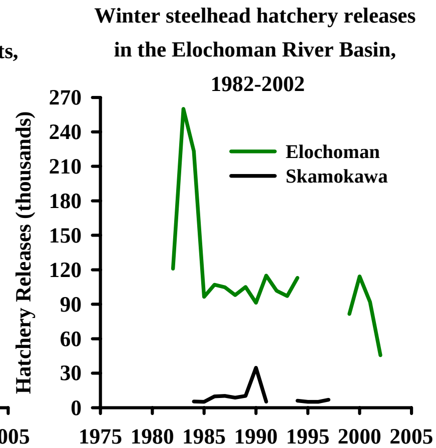
- Winter steelhead are distributed throughout the mainstem Elochoman and in the lower reaches of Beaver, Duck, Clear, Rock, and Otter Creeks and the East, North, and West Fork Elochoman
- In the Skamokawa, steelhead are distributed throughout the mainstem Skamokawa, Wilson Left Fork, Quartz, and McDonald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

Life History

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







Diversity

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

Abundance

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

Productivity & Persistence

- Natural production in the basin is thought to be low

Hatchery

- The Elochoman Hatchery, located on the mainstem, does not produce winter steelhead
- The Beaver Creek Hatchery, located several hundred yards upstream on Beaver Creek (RM 4), produced winter steelhead until closed in 1999; average annual production was 400,000 to 500,000 smolts
- Hatchery winter steelhead have been planted in the Elochoman River basin since 1955; broodstock from the Elochoman and Cowlitz Rivers and Chambers Creek have been used; release data are displayed from 1983-2001
- Currently, about 50,000 winter smolts are released from Beaver Creek annually

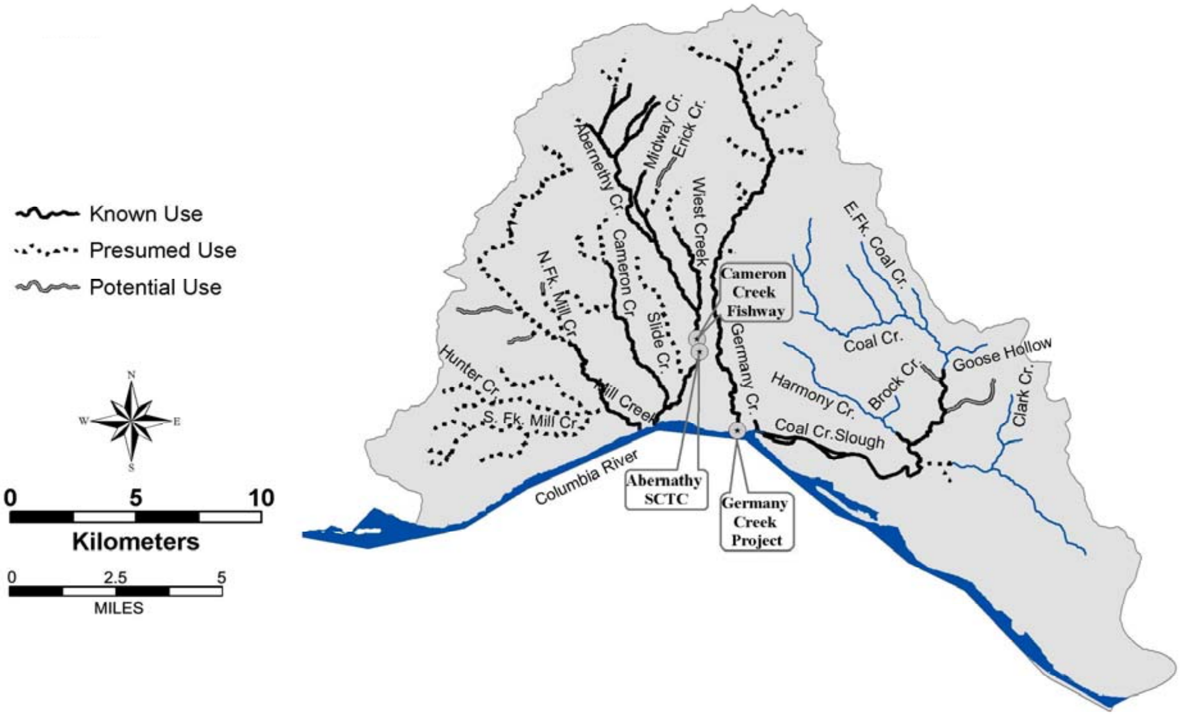
- Although hatchery winter steelhead constitute the majority of the run, hatchery fish contribute little to natural winter steelhead production in the Elochoman and Skamokawa River basins

Harvest

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

5.2.7 Winter Steelhead—Elochoman Subbasin (Mill/Abernathy/Germany)

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



Distribution

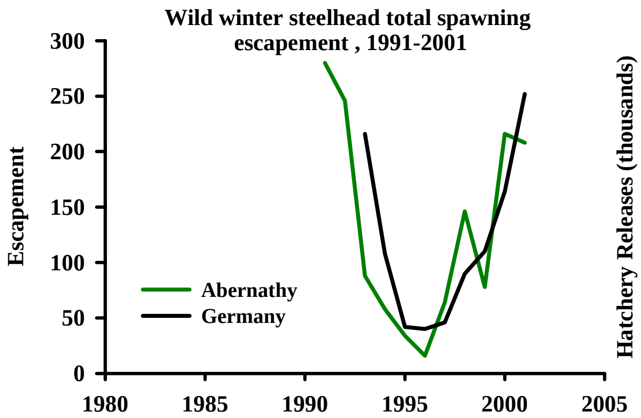
- In Mill Creek, winter steelhead spawn in the mainstem, North Fork Mill Creek, and unnamed tributaries
- In Abernathy Creek, spawning occurs in the mainstem, Slide Creek, and Cameron Creek
- In Germany Creek, winter steelhead spawn in the mainstem, Loper Creek, and John Creek

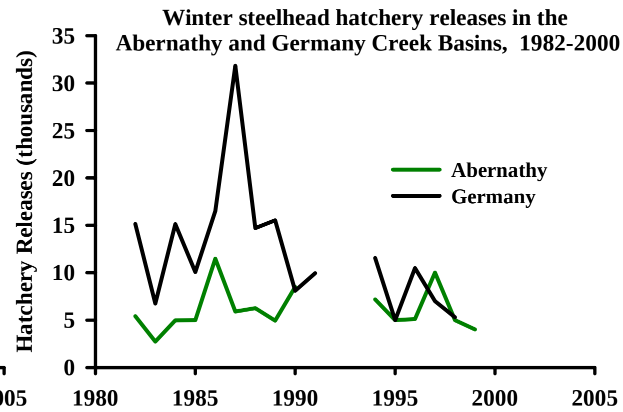
Life History

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

Diversity

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





Abundance

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

Productivity & Persistence

- Natural production in the basin is thought to be low

Hatchery

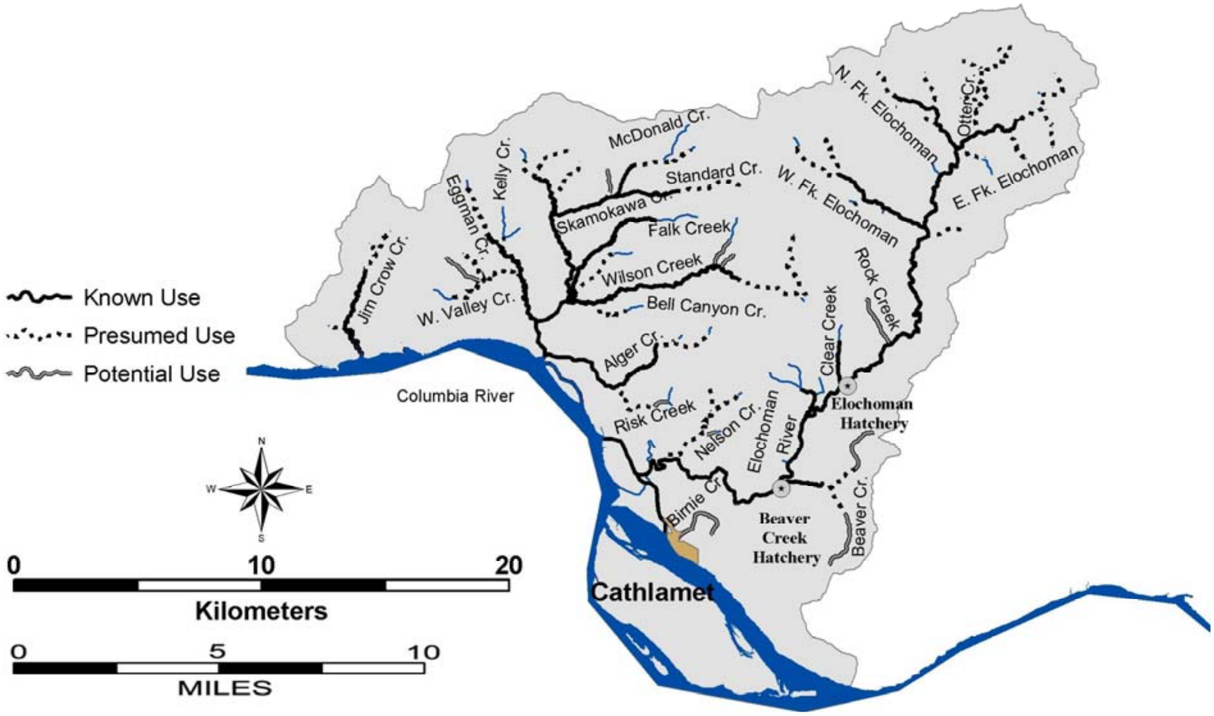
- There are no hatcheries located on any of these creeks; hatchery fish from the Beaver Creek Hatchery (Elochoman River) have been planted in the basin; hatchery brood stock has been from the Elochoman River, Chambers Creek, and the Cowlitz River
- Hatchery winter steelhead have rarely been planted in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

Harvest

- No directed commercial or tribal fisheries target Mill, Abernathy, or Germany Creek winter steelhead; incidental mortality currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Treaty Indian harvest does not occur in Mill, Abernathy, or Germany Creek basins
- Winter steelhead sport harvest (hatchery and wild) in Mill, Abernathy, or Germany Creeks from 1977-1986 averaged 18, 85, and 196, respectively; since 1990, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild winter steelhead in the mainstem Columbia and in Elochoman basin

5.2.8 Cutthroat Trout—Elochoman Subbasin (Elochoman/Skamokawa)

ESA: Not Listed	SASSI: Depressed



Distribution

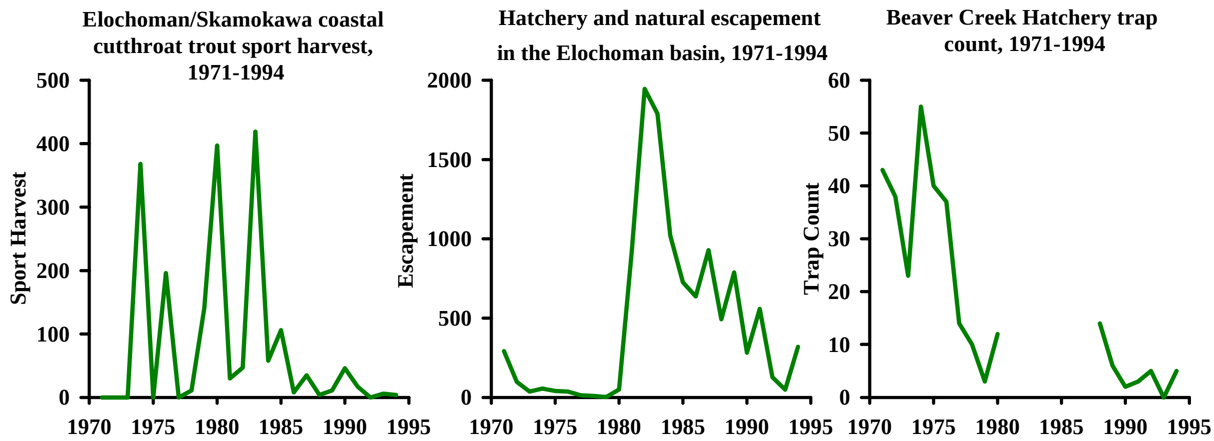
- Anadromous forms have access to most of the Elochoman except at Beaver Creek, where a weir blocks passage; at Duck Creek, where a falls blocks entry; and upper tributary reaches where gradients may limit access during high flows
- Anadromous cutthroat have access to all Skamokowa tributaries
- Resident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

Life History

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

Diversity

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



Abundance

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

Hatchery

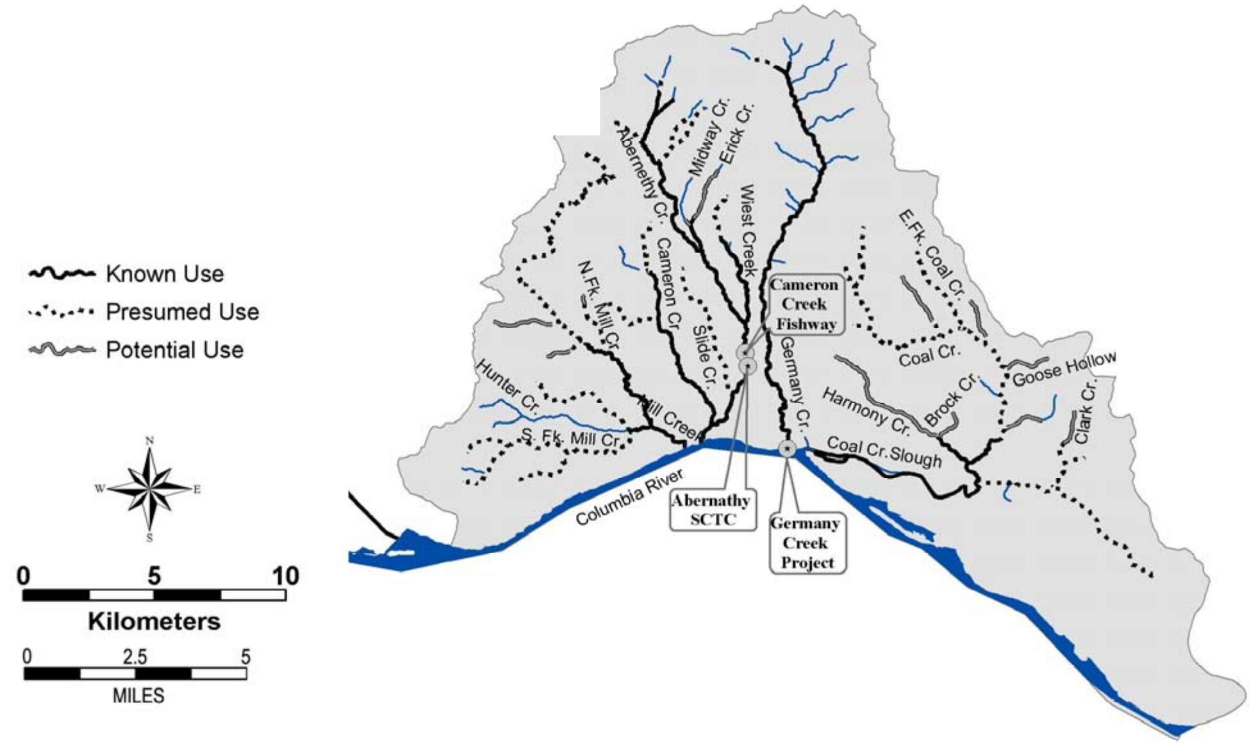
- Beaver Creek Hatchery (RM 6) released steelhead and anadromous cutthroat until its closure in 1999
- From 1989-1993 an average of 34,620 sea-run cutthroat smolts were released annually
- Elochoman Hatchery (RM 9) produces coho and fall chinook

Harvest

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

5.2.9 Cutthroat Trout—Elochoman Subbasin (Mill/Abernathy/Germany/Coal Creek)

ESA: Not Listed	SASSI: Depressed



Distribution

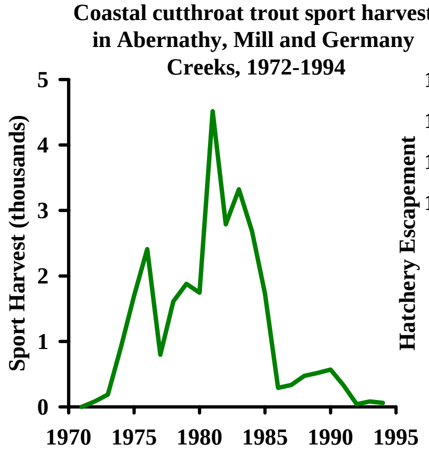
- Anadromous forms have access to the majority of the creek basins except for areas above falls on tributaries to Abernathy Creek
- Resident forms are documented throughout the system

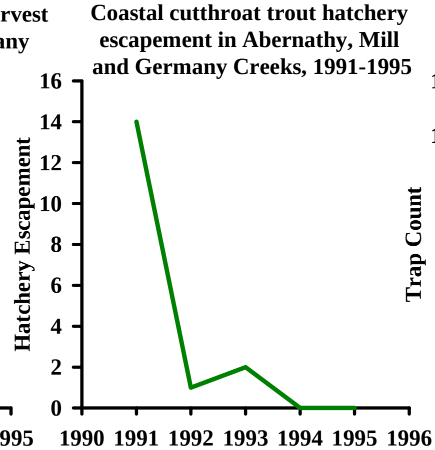
Life History

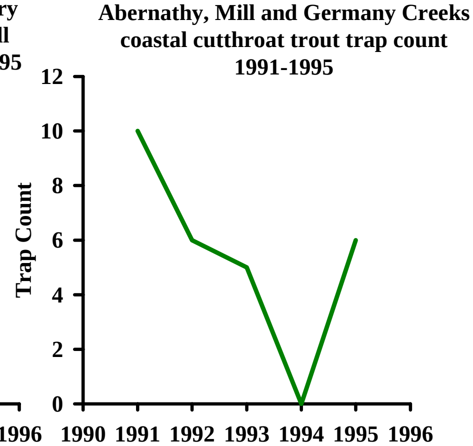
- Anadromous, fluvial and resident forms are present
- Anadromous river entry and spawn timing are unknown but are believed to be similar to Elochoman cutthroat trout
- Anadromous river entry is assumed to be from August through mid-April
- Anadromous spawning is assumed to be from January through mid-April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

Diversity

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







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

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

Harvest
- Not harvested in ocean commercial or recreational fisheries
- Angler harvest for adipose fin clipped hatchery fish occurs in mainstem Columbia summer fisheries downstream of the Abernathy, Mill, and Germany Creeks
- Wild cutthroat (unmarked fish) must be released in the mainstem Columbia and in Abernathy, Mill, and Germany Creeks

5.3 Potentially Manageable Impacts

In Volume I of this Technical Foundation, we evaluated factors currently limiting Washington lower Columbia River salmon and steelhead populations based on a simple index of potentially manageable impacts. The index incorporated human-caused increases in fish mortality, changes in habitat capacity, and other natural factors of interest (e.g. predation) that might be managed to affect salmon productivity and numbers. The index was intended to inventory key factors and place them in perspective relative to each other, thereby providing general guidance for technical and policy level recovery decisions. In popular parlance, the factors for salmon declines have come to be known as the 4-H's: hydropower, habitat, harvest, and hatcheries. The index of potentially manageable mortality factors has been presented here to prioritize impacts within each subbasin.

Elochoman / Skamokawa

- Loss of tributary habitat quality and quantity is an important impact for all species, particularly for chum but less so for fall chinook. Loss of estuary habitat quality and quantity is also important, accounting for relative impacts of about 20% for chum and fall chinook, 15% for winter steelhead, and 10% for coho.
- Harvest accounts for the largest relative impact on fall chinook, but is a minor factor for other species.
- Hatchery impacts are substantial for coho and fall chinook and moderately important to coho, but of lesser importance for winter steelhead and chum.
- Predation impacts are moderate for winter steelhead and chum, but are relatively low for coho and fall chinook.
- Hydrosystem access and passage impacts appear to be relatively minor for all species.

Mill/Abernathy/Germany Subbasin

- Loss of tributary habitat quality and quantity is an important impact for all species, particularly for chum but less so for fall chinook. Loss of estuary habitat quality and quantity is also important, accounting for relative impacts of about 20% for chum, fall chinook and winter steelhead, and 10% for coho.
- Harvest accounts for the largest relative impact on fall chinook and is moderately important to coho, but is a relatively minor factor for other species.
- Hatchery impacts are substantial for coho and fall chinook, but of lesser importance for winter steelhead and chum.
- Predation impacts are moderate for winter steelhead and chum, but are relatively low for coho and fall chinook.
- Hydrosystem access and passage impacts appear to be relatively minor for all species.

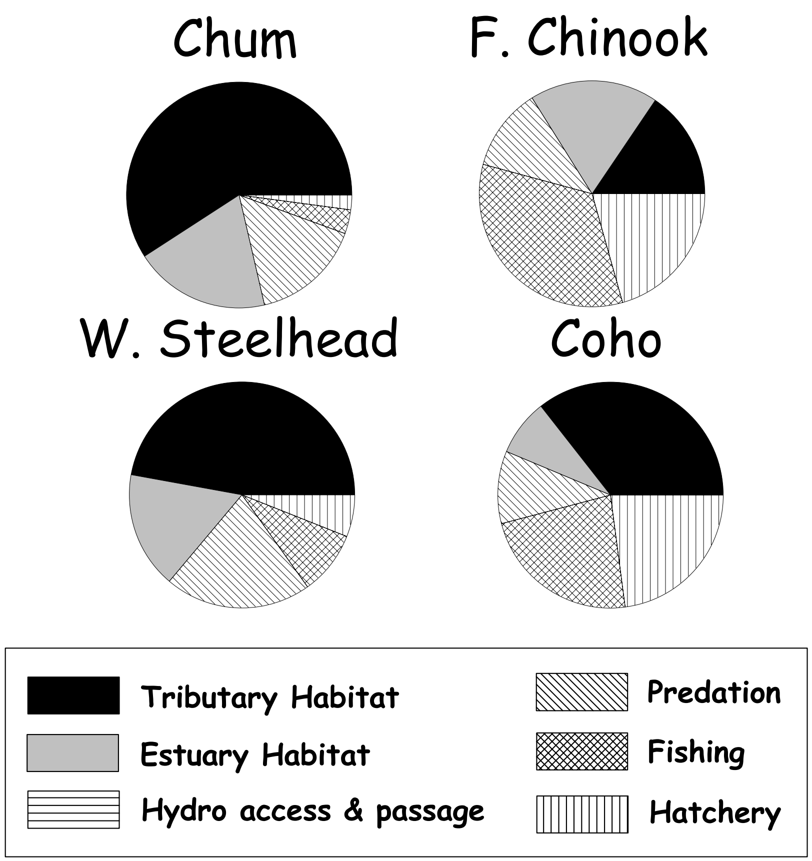


Figure 5-5. Relative index of potentially manageable mortality factors for each species in the Elochoman subbasin.

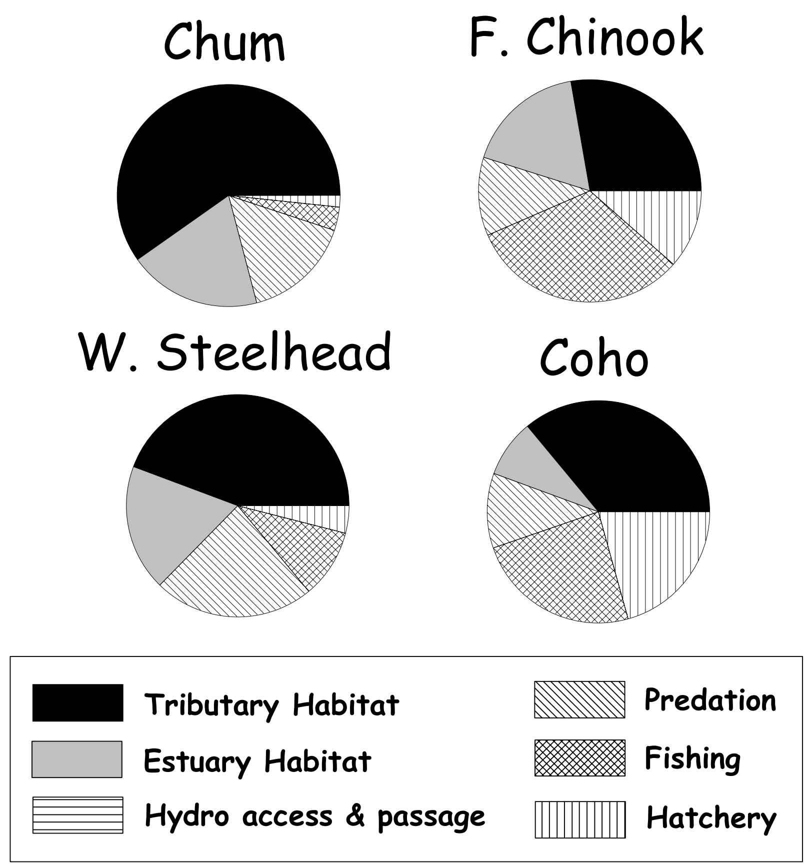


Figure 5-6. Relative index of potentially manageable mortality factors for each species in the Mill, Abernathy and Germany subbasin.

5.4 Hatchery Programs

5.4.1 Elochoman

Two hatcheries exist on the Elochoman River; the Beaver Creek Hatchery is located about RM 4 and the Elochoman Hatchery (completed in 1953) is located about RM 9.[1] The Beaver Creek Hatchery historically produced early-run winter steelhead, but was closed in 1999. The Elochoman Hatchery historically produced fall chinook, early-run coho, and late-run coho; current release goals are 2 million fall chinook, 418,000 early-run coho, and 512,000 late-run coho (Figure 5-7). The Elochoman Hatchery started an early run winter steelhead program in 2000 with an annual release goal of 60,000 smolts (Figure 5-7). The Elochoman Hatchery has also started a local broodstock late-run winter steelhead program with the goal of producing 30,000 smolts. The local broodstock production is expected to expand and may replace the current early-run steelhead program. The success of this program may be dependent on the repair of the weir at the hatchery. Additionally, there are 30,000 summer steelhead (Lewis River stock) planned for release from the hatchery.

The early-run coho hatchery program includes a collaboration of the Grays River Hatchery, Elochoman Hatchery and Steamboat Slough Net Pens. Coho are captured at the Grays Hatchery, where eggs are incubated; eyed eggs are transferred to the Elochoman Hatchery for final incubation and early rearing. The pre-smolt fish are transferred to Steamboat Slough Net Pens for final rearing and acclimation. Annual release goal for the net pen operation is 200,000 early-run coho smolts (Figure 5-7). Results of the fishery on returning coho have been very poor thus far.

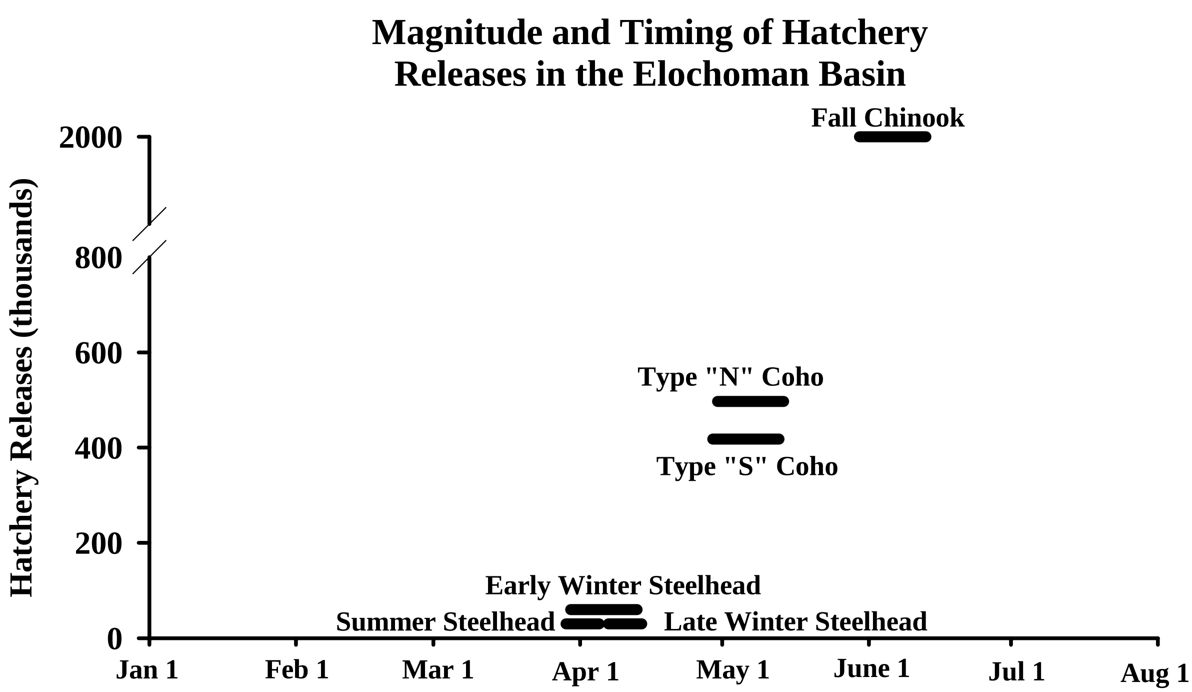


Figure 5-7. Magnitude and timing of hatchery releases in the Elochoman River basin by species, based on 2003 brood production goals.

[1] Alternatively known as the Elokomin Hatchery.

Genetics—Broodstock for the fall chinook hatchery program comes from fish trapped near tidewater in the lower Elochoman River. Historical releases of fall chinook have included significant transfers from outside the Elochoman basin, although more then 99 percent of the releases have come from broodstock within the Lower Columbia ESU. The largest donor stocks have been Spring Creek Hatchery and Kalama Hatchery chinook. Allozyme analyses indicate that Elochoman fall chinook are similar but distinct from other lower Columbia River fall chinook stocks, although bright fall chinook net pen releases from the Rogue River (Select Area Brights) have been observed straying into the Elochoman River and genetic introgression may have occurred. However, the numbers have been low, and they are uniquely marked to prevent inclusion into the hatchery broodstock.

Broodstock for the early and late run coho hatchery programs are from coho adults trapped at the Elochoman Hatchery (except for the Steamboat Slough program which originates from Grays Hatchery early coho). Historical releases included substantial transfers, primarily early coho from Toutle Hatchery and late coho from Cowlitz Hatchery.

Early-run winter steelhead released from the Beaver Creek Hatchery originated from Elochoman and Cowlitz river and Chambers Creek (a Puget Sound Hatchery) stocks; there is some potential for wild Elochoman winter stock interbreeding with the out-of-basin hatchery stocks, however it may be minimized by temporal differences between the early returning hatchery fish and later returning wild fish. Allele frequency analysis of Elochoman and Skamokawa winter steelhead in 1995 was unable to distinguish this stock from other lower Columbia steelhead stocks. A new winter steelhead program at the Elochoman Salmon Hatchery will take broodstock only from wild Elochoman River late-run winter steelhead, with a release goal of 30,000 winter steelhead. The early-run program also has continued with a release of 60,000 winter steelhead.

Chum salmon released in the basin were developed from Willapa Bay and Hood Canal stocks; chum have not been released in the basin since 1983 so any adults presently returning to the Elochoman basin are considered natural Elochoman chum or strays from other basins.

Interactions—A significant portion of past years' fall chinook spawners (estimated 82% in 1997) in the Elochoman River were first generation hatchery fish (Figure 5-8). With annual releases of 2 million fall chinook, there is potential for competition between hatchery-released and naturally produced juvenile fall chinook. However, most hatchery releases are smolts (not fry) that migrate shortly after release, which minimizes potential freshwater competition. In most years, hatchery-released juvenile fall chinook considerably outnumbered naturally produced juveniles. Northern pikeminnow, common merganser, and Caspian tern have been identified as important predators of juvenile salmonids in the Elochoman River. Large releases of hatchery smolts may attract additional predators causing increased predation on wild fish; wild fish may benefit, however, from the presence of large numbers of hatchery fish because wild fish usually have better predator avoidance capabilities.

Spawning of wild coho is presumed to be low so there may be little interaction between wild and hatchery fish (Figure 5-8). Also, most wild coho in the Elochoman River originated from late-run coho while the hatchery production is dominated by early-run coho and interaction is therefore minimized through the temporal segregation of the runs.

Hatchery winter steelhead fish contribute very little to natural production so interaction between hatchery and wild winter steelhead is expected to be minimal (Figure 5-8). The new winter steelhead program at the Elochoman Salmon Hatchery uses only wild Elochoman River winter steelhead, so the genetic effects of hatchery/wild fish interactions, with fish produced from this program, is expected to be minimal.

Recent Averages of Returns to Hatcheries and Estimates of Natural Spawners in the Elochoman and Grays Basins

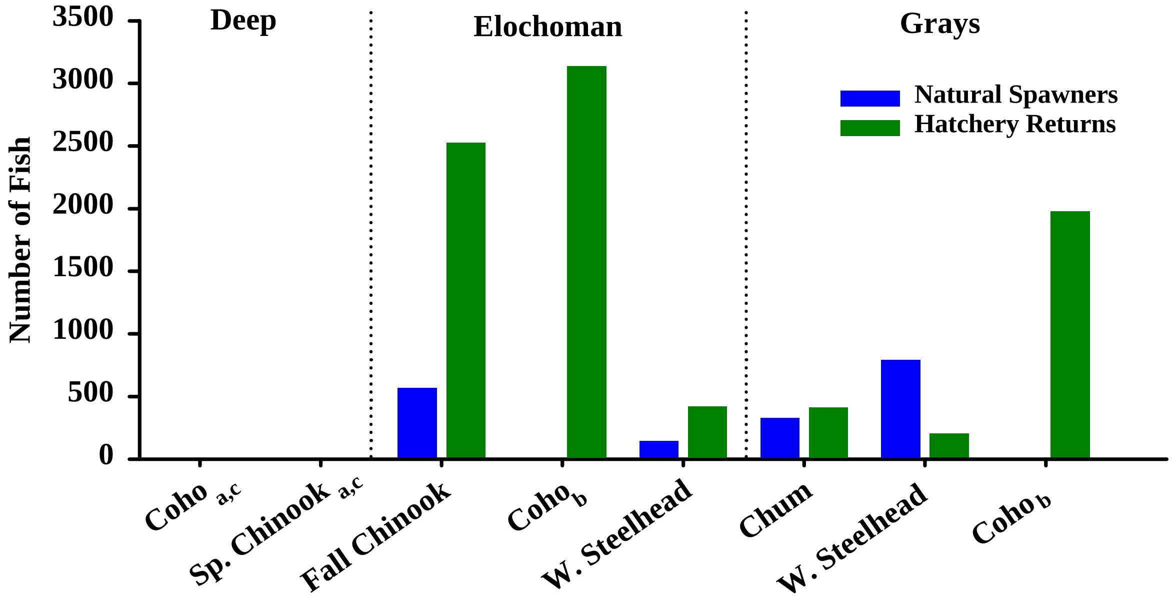


Figure 5-8. Recent average hatchery returns and estimates of natural spawning escapement in the Deep, Grays, and Elochoman River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present. Calculation of each average utilized a minimum of 5 years of data, except for Grays chum (1998–2000) and Grays winter steelhead (1998 and 2000).

Water Quality/Disease—Water for the Elochoman Hatchery is drawn directly from the Elochoman River; thus, the natal water source for wild fish and the hatchery water source are the same. Water quality parameters and effluent discharge are monitored under an NPDES permit. Fish health is monitored daily and the area fish health specialist inspects monthly. Diseases are treated under the fish health specialist's advice according to the Co-Managers Fish Health Manual.

The Steamboat Slough Net Pens are located in Steamboat Slough; early-run coho salmon pre-smolts from the Elochoman Hatchery are transferred to the net pens for final rearing, acclimation, and release.

Mixed Harvest—Fall chinook and coho are important target species in ocean and Columbia River commercial and recreational fisheries, as well as tributary recreational fisheries. Historically, the fishery exploitation rates of Elochoman River Hatchery fall chinook and coho and Beaver Creek Hatchery winter steelhead likely were similar to wild fish. In recent years, regulations for wild fish release have been in place for coho and steelhead fisheries. All hatchery coho and steelhead are now adipose fin-clipped to allow for selective harvest. Specific hatchery-selective commercial and recreational fisheries in the lower Columbia target hatchery coho, and selective tributary fisheries target steelhead. Therefore, the exploitation rates for recent commercial and recreational fisheries are higher for Elochoman River Hatchery coho and steelhead than wild fish. Hatchery and wild fall chinook harvest rates remain similar but are constrained by ESA harvest limitations.

The purpose of the coho salmon program in the Steamboat Slough Net Pen is isolated harvest; these fish are produced specifically for harvest opportunity. Chum salmon are not targeted in lower Columbia or tributary fisheries and are prohibited from retention in all Columbia River basin sport fisheries. Winter steelhead are targeted mostly in tributary recreational fisheries. Historically, fishery exploitation rates of Beaver Creek Hatchery winter steelhead were likely similar to wild fish. The current incidental (catch and release) mortality of wild winter steelhead was estimated to range from 0-6% in lower Columbia River tributary fisheries; harvest rates on targeted hatchery winter steelhead stocks have averaged near 50%. The primary purpose of the wild winter steelhead hatchery program is to mitigate for the loss of wild winter steelhead as a result of development in the Columbia River basin and its goal is the provision of fish for harvest. The wild winter steelhead hatchery program at the Elochoman Hatchery is relatively new; a harvest management plan is under development, pending consultation between WDFW and NOAA Fisheries.

Passage—A tidewater weir set up near the mouth of the Elochoman River collects fall chinook for broodstock; the weir retains fall chinook but allows coho and steelhead to continue upstream. The diversion weir at the Elochoman Hatchery suffered flood damage and needs repair. Currently fish are able to bypass the hatchery ladder and trap, making collection of broodstock difficult. The Elochoman Hatchery adult collection facility consists of a step and pool ladder system by which fish are diverted into an earthen holding pond where they remain until they are ripe and ready for broodstock collection. Fish are able to bypass the hatchery collection facility and continue upstream to the upper Elochoman River basin.

Supplementation—Hatchery fall chinook and coho account for most spawners in the Elochoman River. These programs are not intended to produce self-sustaining runs; the hatchery program goal for fall chinook and coho salmon is to mitigate for the loss of wild fish resulting from development in the Columbia River basin. The purpose of the new Elochoman Hatchery winter steelhead program is to work towards replacement of the previous steelhead program with indigenous stock and provide fish for harvest opportunities. Additionally, this program serves as a risk management tool, maintaining wild broodstock in case of a catastrophic event that negatively effects the natural population. Supplementation is currently not the goal of the new winter steelhead program.

5.4.2 Mill, Abernathy, Germany

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 have all been released in these basins; releases were produced out-of-basin. The Abernathy Fish Technology Center now operates at the former NFH facility; the major emphases of the Center's applied research programs are to assist in the repositioning of National Fish Hatcheries as tools in the conservation of natural populations, to examine the use of natural broodstocks by federal hatcheries to meet management objectives, and to promote and support propagation and management methods resulting in healthy Pacific salmon, steelhead/rainbow trout, cutthroat and bull trout, and white sturgeon populations.

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

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

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

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

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

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

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

5.5 Fish Habitat Conditions

5.5.1 Passage Obstructions

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

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).

5.5.2 Stream Flow

Peak flows are associated with fall and winter rains and low flows typically occur in late summer (Figure 5-9). Flow in the Elochoman averaged 375 cfs during the period of record (1941-1971), with a maximum of 8,530 cfs and a minimum of 9.8 cfs. The Elochoman is used as a domestic water supply for the City of Cathlamet. The intake is located at approximately RM 4. There are currently no stream gages operating on any of the major streams in the subbasin.

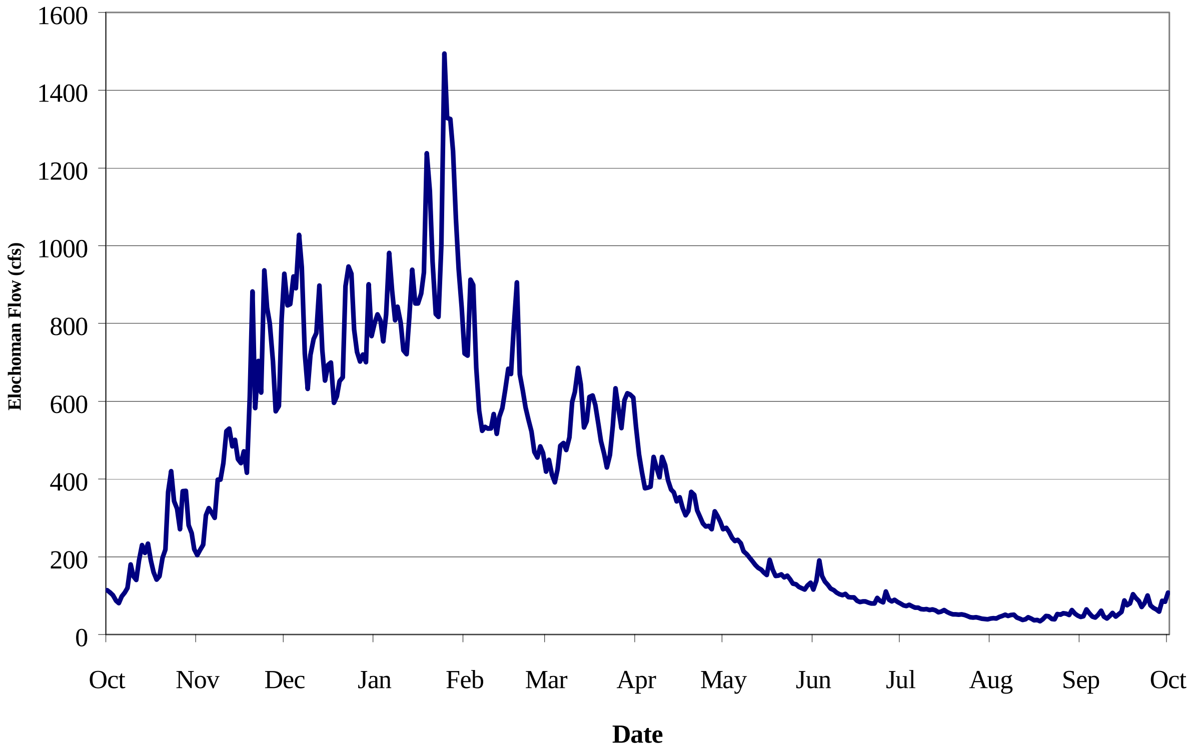


Figure 5-9. Elochoman River hydrograph (1962-1971). Elochoman River flows exhibit a fall through spring rainfall dominated regime, with flows less than 50 cfs common in late summer. USGS Stream Gage #14247500; Elochoman River near Cathlamet, Wash.

There has been a significant decrease in vegetative cover in the Elochoman subbasin, 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 23 of 31 subwatersheds in the subbasin are 'impaired' with regards to runoff conditions; the remainder are 'moderately impaired'. These results are similar to those from a peak flow risk assessment conducted by Lewis County GIS (2000), which revealed 'impaired' conditions in 6 of 7 watersheds. Only the North Elochoman Watershed Administrative Unit (WAU) had a rating of 'likely impaired'.

Low flow assessments were conducted on several streams in the subbasin 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. On Wilson Creek (Skamokawa tributary) flows were adequate for salmon and steelhead rearing in the fall but were inadequate for salmon spawning. On the Elochoman at the Steel Bridge, flows were below suitable for spawning on October 1 but were adequate by November 1. Flows became less than suitable for summer rearing by July 1. On Mill Creek, Abernathy Creek, and Germany Creek fall flows in 1998 were considerably lower than optimum flows needed for salmonid spawning and rearing. Flows in Coal Creek became suitable for rearing by mid October but were below optimum for spawning through the first week in November (Caldwell et al. 1999).

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

5.5.3 Water Quality

WCD temperature monitoring in the summer of 2000 recorded excursions beyond the state standard of 18ºC[2] in the Upper Skamokawa and Wilson Creek (Skamokawa tributary). Temperatures in lower Wilson Creek regularly exceeded the standard in August. An assessment of water quality by the Washington State Department of Ecology (WDOE) in response to a 1975 fish kill found elevated fecal coliform levels that were likely related to human and animal sources. Nevertheless, the fish kills were ultimately attributed to high fish numbers causing critically low dissolved oxygen levels. WCD monitoring of surface water and shallow groundwater in 1997 revealed elevated fecal coliform and nitrate levels. The source was believed to be septic systems and agricultural practices (Wade 2002).

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

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

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

[2] 18°C (64°F) is the state standard for Class A streams; 16°C (61°F) is the state standard for Class AA streams.

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).

5.5.4 Key Habitat

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

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

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.

5.5.5 Substrate & Sediment

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

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

High road densities and naturally unstable soils create a risk of elevated sediment supply from hillslopes. Road density in the Jim Crow basin is a high 5.14 mi/mi^2; however, Waterstrat (1994) reported that most of the roads are well-established and adequately designed, with few failures, thus limiting sediment delivery to streams. The Skamokawa basin has a road density greater than 4 mi/mi^2 and is composed of steep slopes with sedimentary rock that is prone to landslides. The basin has 2 watersheds with the highest mass failure rates in the county (Waterstrat 1994). These processes likely result in elevated volumes of sediment delivered to stream channels. In the Elochoman basin, forest practices have contributed to many mass failures, however, road erosion is probably responsible for most of the sediment delivery to streams (WDNR 1996). 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 Elochoman subbasin are “moderately impaired” with respect to landscape conditions that influence sediment supply. Three subwatersheds are rated as “impaired” and three are rated as “functional”. The greatest impairments are located close to Longview. High road densities and naturally unstable soils are the primary drivers of the sediment supply impairment.

Sediment production from private forest roads is expected to decline over the next 15 years as roads are updated to meet the new forest practices standards, which include ditchline disconnect from streams and culvert upgrades. The frequency of mass wasting events should also decline due to the new regulations, which require geotechnical review and mitigation measures to minimize the impact of forest practices activities on unstable slopes.

5.5.6 Woody Debris

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

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).

5.5.7 Channel Stability

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

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).

5.5.8 Riparian Function

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, 6 of the 31 subwatersheds in the Elochoman subbasin are rated as ‘impaired’ for riparian function, 24 are rated as ‘moderately impaired’, and only 1 is rated as ‘functional’. The greatest impairments are located in and around the Longview, WA metropolitan area. Results from the IWA are consistent with impaired conditions that were identified throughout the subbasin in surveys conducted by the WCD.

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

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

Riparian function is expected to improve over time on private forestlands. This is due to the requirements under the Washington State Forest Practices Rules (Washington Administrative Code Chapter 222). Riparian protection has increased dramatically today compared to past regulations and practices.

5.5.9 Floodplain Function

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

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).

5.6 Fish/Habitat Assessments

The previous descriptions of fish habitat conditions can help identify general problems but do not provide sufficient detail to determine the magnitude of change needed to affect recovery or to prioritize specific habitat restoration activities. A systematic link between habitat conditions and salmonid population performance is needed to identify the net effect of habitat changes, specific stream sections where problems occur, and specific habitat conditions that account for the problems in each stream reach. In order to help identify the links between fish and habitat conditions, the Ecosystem Diagnosis and Treatment (EDT) model was applied to Elochoman, Skamokawa, Mill, Abernathy, and Germany fall chinook, coho, chum, and winter stelhead. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Volume VI. Model results are discussed in separate sections for the Skamokawa-Elochoman basins and for the Mill-Abernathy-Germany basins.

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

5.6.1 Skamokawa-Elochoman

5.6.1.1 Population Analysis

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

Habitat-based assessments were completed for fall chinook, coho, chum, and winter steelhead in the Elochoman and Skamokawa basins. In the Elochoman, adult productivity for all four species has been reduced to 17-25% of historical levels (Table 5-1). Declines in adult abundance level have also been significant for all species (Figure 5-10), with the greatest decline seen for chum and coho. Current adult abundance of chum and coho is estimated at only 6% and 15% of historical levels, respectively. Abundance of both fall chinook and winter steelhead in the Elochoman has declined by approximately 60% (Figure 5-10). Diversity (as measured by the diversity index) has remained steady for fall chinook, but has declined by 20-50% for winter steelhead, coho and chum (Table 5-1).

Smolt productivity numbers in the Elochoman have declined by 46-76% for all four species (Table 5-1), though losses have not been as great as for adult productivity, suggesting that out of basin factors are contributing to losses in adult productivity. Declines in smolt abundance levels have been greatest for chum and coho (84% and 78% decrease respectively), but losses have also occurred for fall chinook and winter steelhead smolts (40% and 49% decrease respectively) (Table 5-1).

Adult productivity declines in the Skamokawa basin have also been severe, with current levels only one quarter of historical levels for chum, winter steelhead and coho (Table 5-2). Fall chinook adult productivity has declined by 50% (Table 5-2). Current adult chum and coho abundance is estimated at only 13-21% of historical levels, respectively (Figure 5-11). While not as severe as chum and coho, the decline in abundance of adult winter steelhead and fall chinook is such that current levels are estimated at 60% and 27% of historical levels (Figure 5-11). Diversity (as measured by the diversity index) of all species has been fairly well maintained, though chum, winter steelhead, and coho have experienced some loss (Table 5-2).

Reductions in smolt productivity and abundance in the Skamokawa have been similar to those in the Elochoman, though to a slightly lesser degree. Smolt productivity has declined by 36-66%, and abundance has decreased by 26-70% (Table 5-2). Productivity losses were greatest for coho, and abundance losses have been greatest for chum.

Model results indicate that restoration of PFC conditions in both of the basins would produce substantial benefits. Adult returns for chum would benefit the most, with runs increasing to 2-3 times current levels (Table 5-1 and Table 5-2). Similarly, fall chinook, winter steelhead, and coho returns would increase by 65-185%. Smolt abundance levels would benefit at similar rates, with chum smolts benefiting the most (Table 5-1 and Table 5-2).

Table 5-1. Elochoman River— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

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

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

Table 5-2. Skamokawa River— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	581	762	795	4.2	6.9	8.7	1.00	1.00	1.00	95,719	130,225	129,940	509	826	1,024
Chum	1,125	3,269	8,499	2.3	6.0	9.3	0.94	1.00	1.00	564,503	1,277,833	1,898,123	739	994	1,148
Coho	1,081	1,773	5,099	5.2	10.2	22.4	0.79	0.84	0.91	19,736	38,648	54,514	116	235	347
Winter Steelhead	206	268	515	5.2	10.1	20.1	0.91	1.00	1.00	2,513	3,414	4,115	76	135	174

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

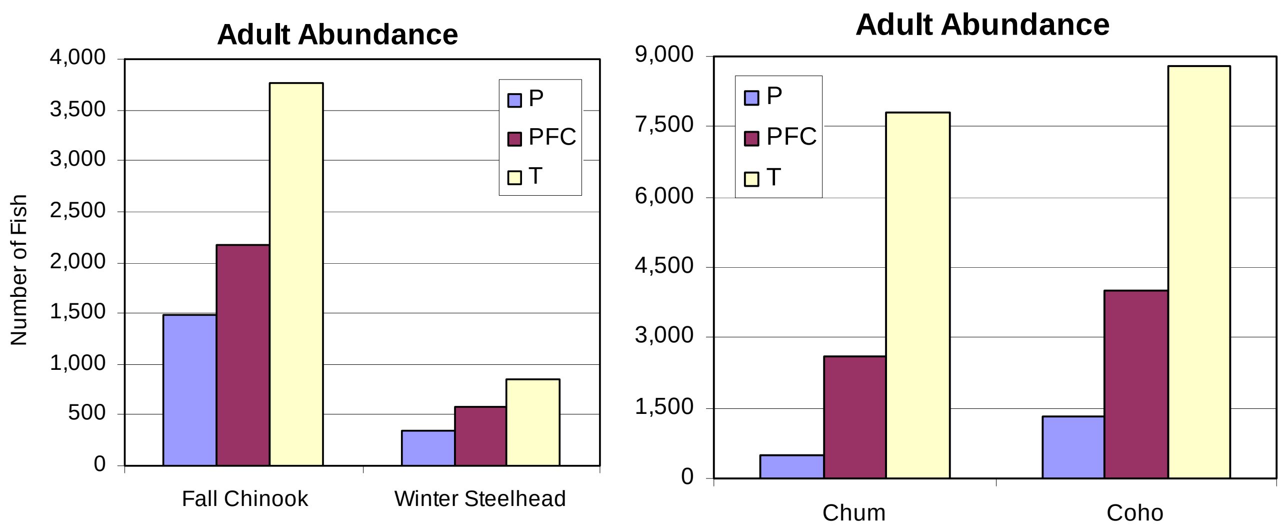


Figure 5-10. Adult abundance of Elochoman fall chinook, winter steelhead, chum and coho based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

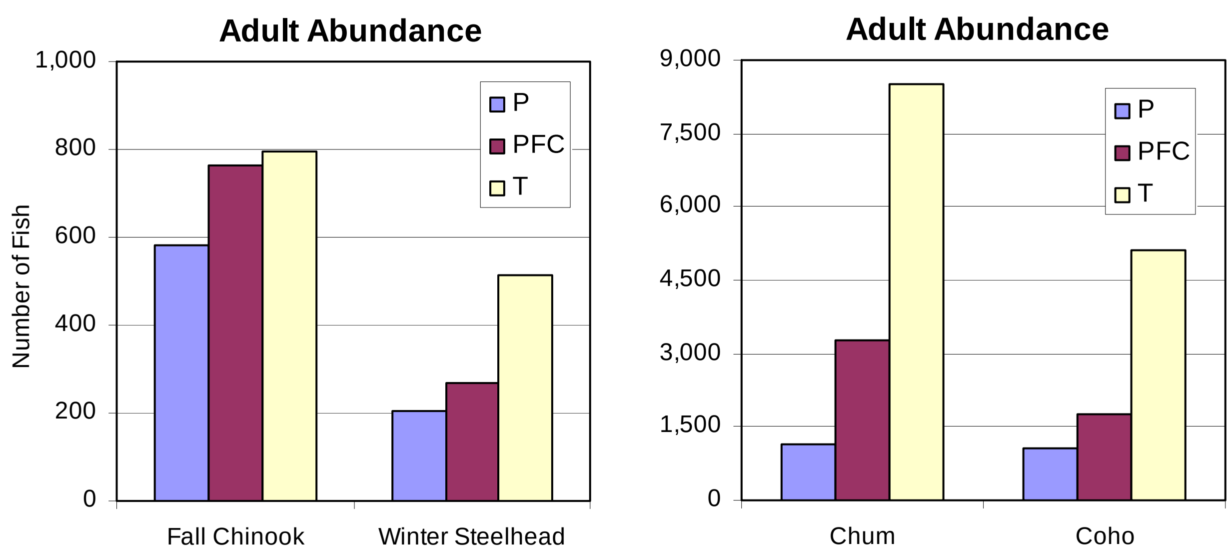


Figure 5-11. Adult abundance of Skamokawa fall chinook, chum, winter steelhead and coho based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

5.6.1.2 Restoration and Preservation Analysis

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

Winter steelhead are distributed throughout the Elochoman Basin including the mainstem and the tributaries of Beaver, Duck, Clear, Rock and Otter creeks and the East, North, and West Fork Elochoman. Fall chinook are found in the lower mainstem between river miles 4 and 9. Chum distribution is primarily in the lower mainstem above tidal influence. Coho are suspected to use most of the basin that is accessible, but primary spawning areas include the upper basin and the West Fork Elochoman. (See Figure 5-12 for a map of the EDT stream reaches).

High priority areas for winter steelhead in the Elochoman include middle and upper mainstem reaches (Elochoman 8, 10, 11 and 13) and the lowest reaches of the West Fork Elochoman (WF Elochoman 1 and 2) (Figure 5-13). Some smaller tributaries also rank as high priority for steelhead (Rock 1, Beaver 2, and Clear 1 and 3). Each of the mainstem reaches (with the exception of Eloch 13), and both WF Elochoman 1 and 2 have a restoration emphasis. Eloch 13, however, has a combined preservation and restoration emphasis. The majority of the mainstem tributaries have a preservation emphasis. The reach with the highest preservation emphasis for steelhead is Rock 1.

High priority reaches for fall chinook (Figure 5-14) and chum (Figure 5-15) are found primarily in select areas of the lower and mid Elochoman (Elochoman 4, 6, 7 and 10 for fall chinook and Eloch 3 and 4 for chum). All high priority reaches for fall chinook have a combined preservation and restoration emphasis. For chum, Eloch 3 has a combined preservation and restoration emphasis while Eloch 4 has a restoration only emphasis.

For coho in the Elochoman basin, high priority reaches include multiple areas in the lower and mid mainstem Elochoman (Elochoman 4-6, 10 and 13) (Figure 5-16). Some smaller tributaries also rank as high priority for coho (Rock 1, Clear 1 and 3, and Duck 1). All mainstem reaches show a restoration emphasis, while the smaller tributaries have either a preservation or a combined preservation and restoration emphasis.

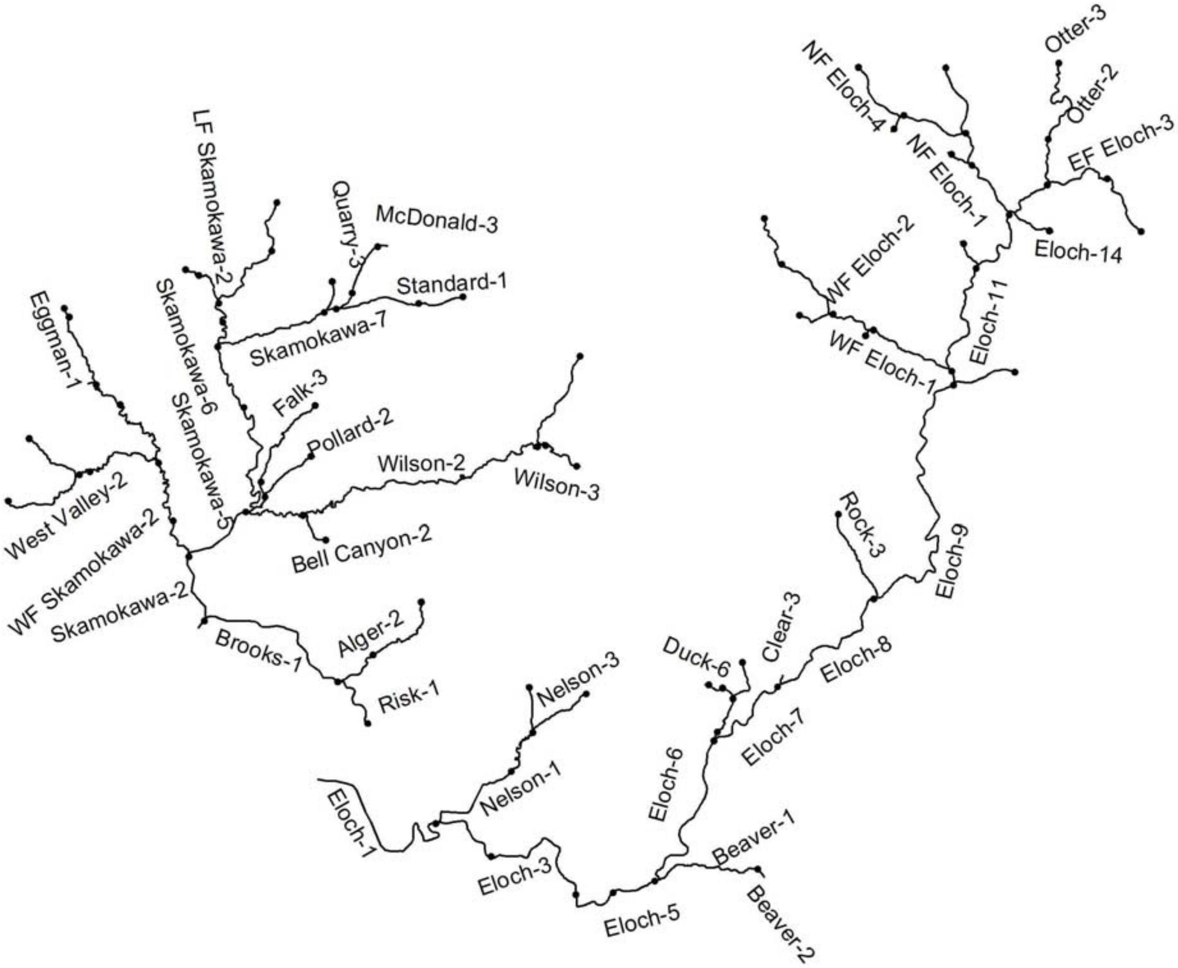


Figure 5-12. Elochoman and Skamokawa subbasin EDT reaches. Some reaches are not labeled for clarity.

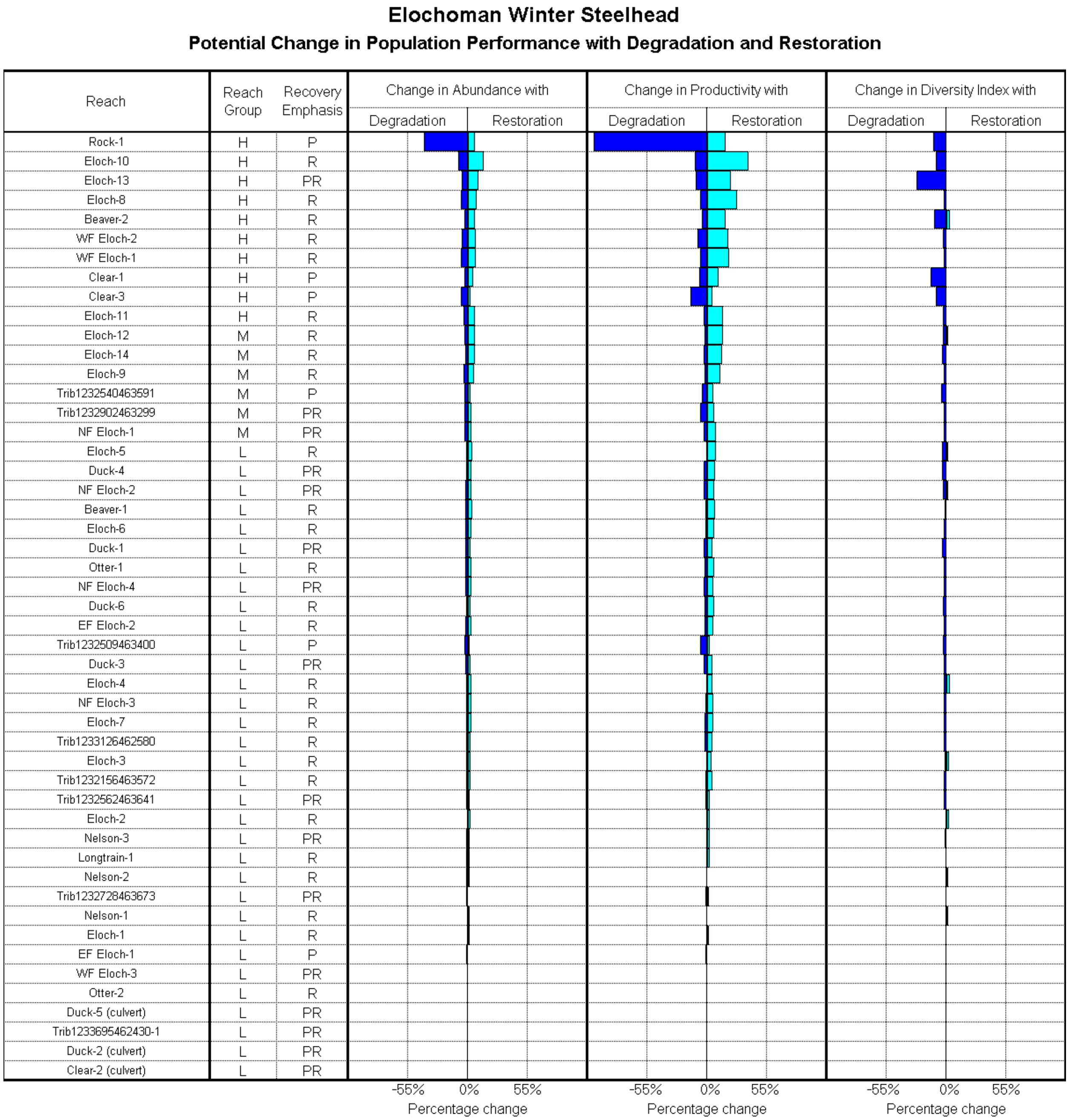


Figure 5-13. Elochoman basin winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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 Volume VI for more information on EDT ladder diagrams.

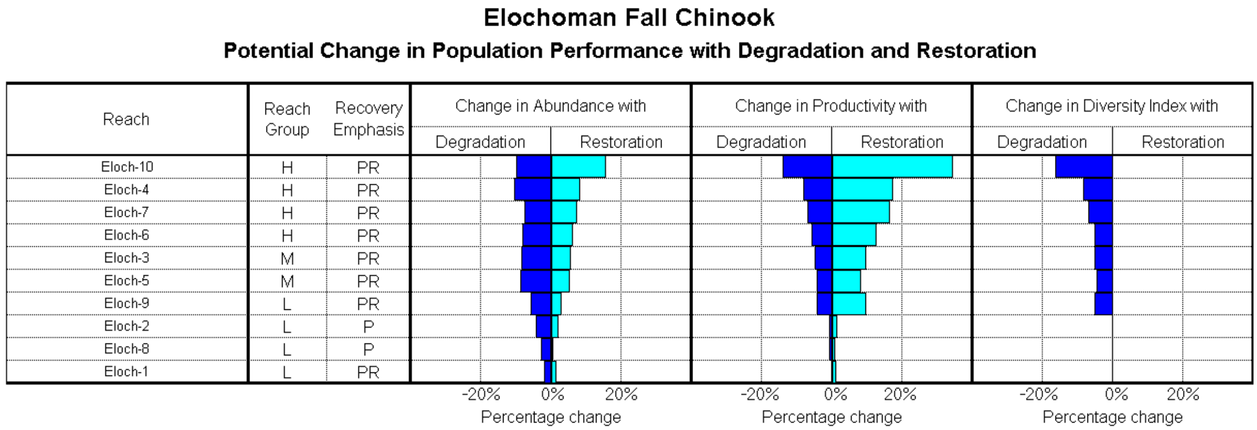


Figure 5-14. Elochoman fall chinook ladder diagram.

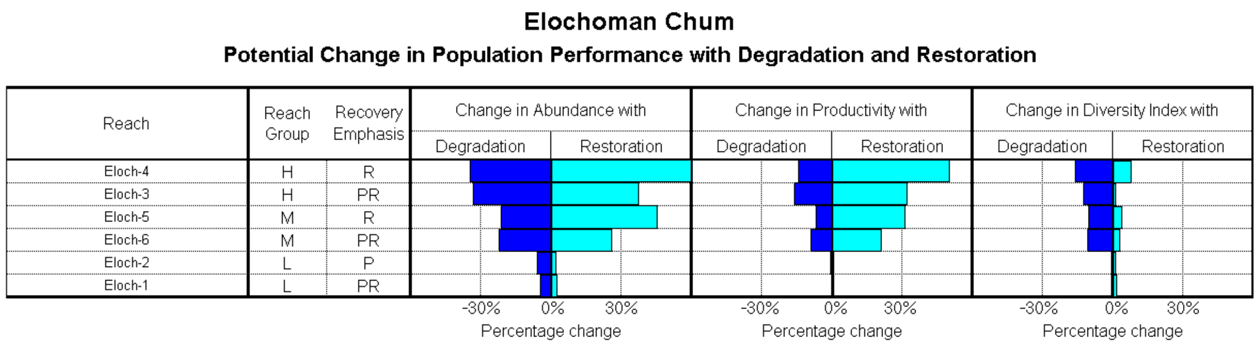


Figure 5-15. Elochoman chum ladder diagram.

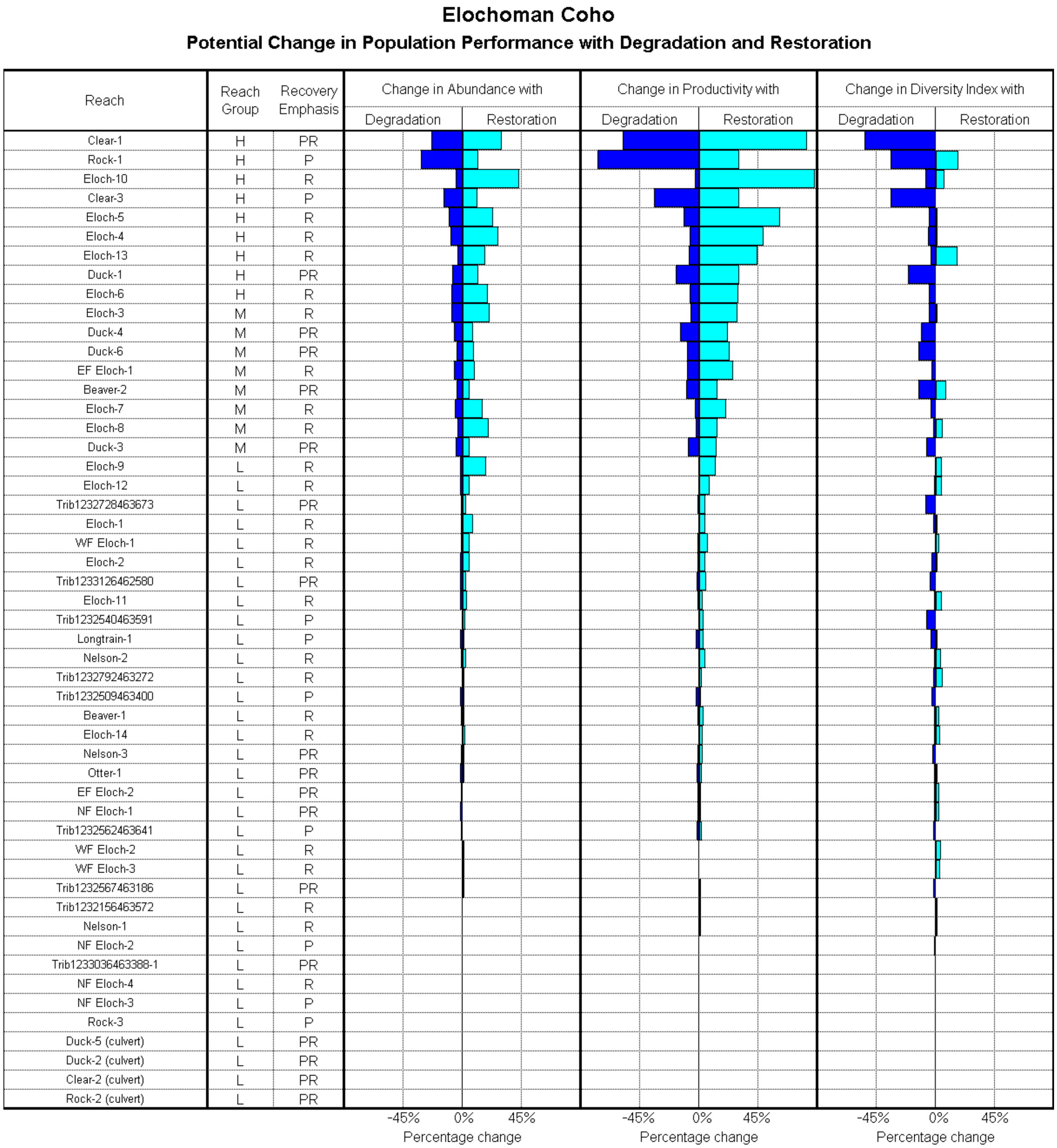


Figure 5-16. Elochoman coho ladder diagram.

In the Skamokawa, winter steelhead are found in the mainstem and in numerous tributaries. Fall chinook spawning is mainly between Wilson Creek and Standard and McDonald Creeks, a length of approximately 4.5 miles. Chum spawning in the Skamokawa is exclusively in the lowest reaches. Coho spawning in the Skamokawa is in the mainstem and in Wilson, Left Fork, Quartz, Standard, and McDonald Creeks. (See Figure 5-12 for a map of stream reaches with high value restoration and preservation reaches labeled).

High priority reaches for winter steelhead in the Skamokawa basin include the middle areas of the mainstem (Skamokawa 7 and 8), McDonald 1, and two middle reaches of Wilson Creek (Wilson 3 and 4) (Figure 5-17). All high priority reaches, except for Wilson 3, show a combined preservation and restoration emphasis. The reach with the highest restoration and preservation emphasis is Skamokawa 8.

For both fall chinook (Figure 5-18) and chum (Figure 5-19), the high priority reaches are generally located in the area between Falk Creek and Standard Creek (Skamokawa 5 and 8 for ChF, and Skamokawa 5 and 6 for chum). All high priority reaches for both species show a preservation emphasis, with Skamokawa 5 possibly having the greatest potential from preservation.

Coho in the Skamokawa have high priority reaches located primarily in the mid to upper areas of the basin (Skamokawa 5 and 6, LF Skamokawa 2, McDonald 3, Wilson 3, and West Valley 2) (Figure 5-20). Each of these reaches, except McDonald 3, show a combined preservation and restoration recovery emphasis. Reach Skamokawa 6 is estimated to have the greatest potential for preservation and restoration.

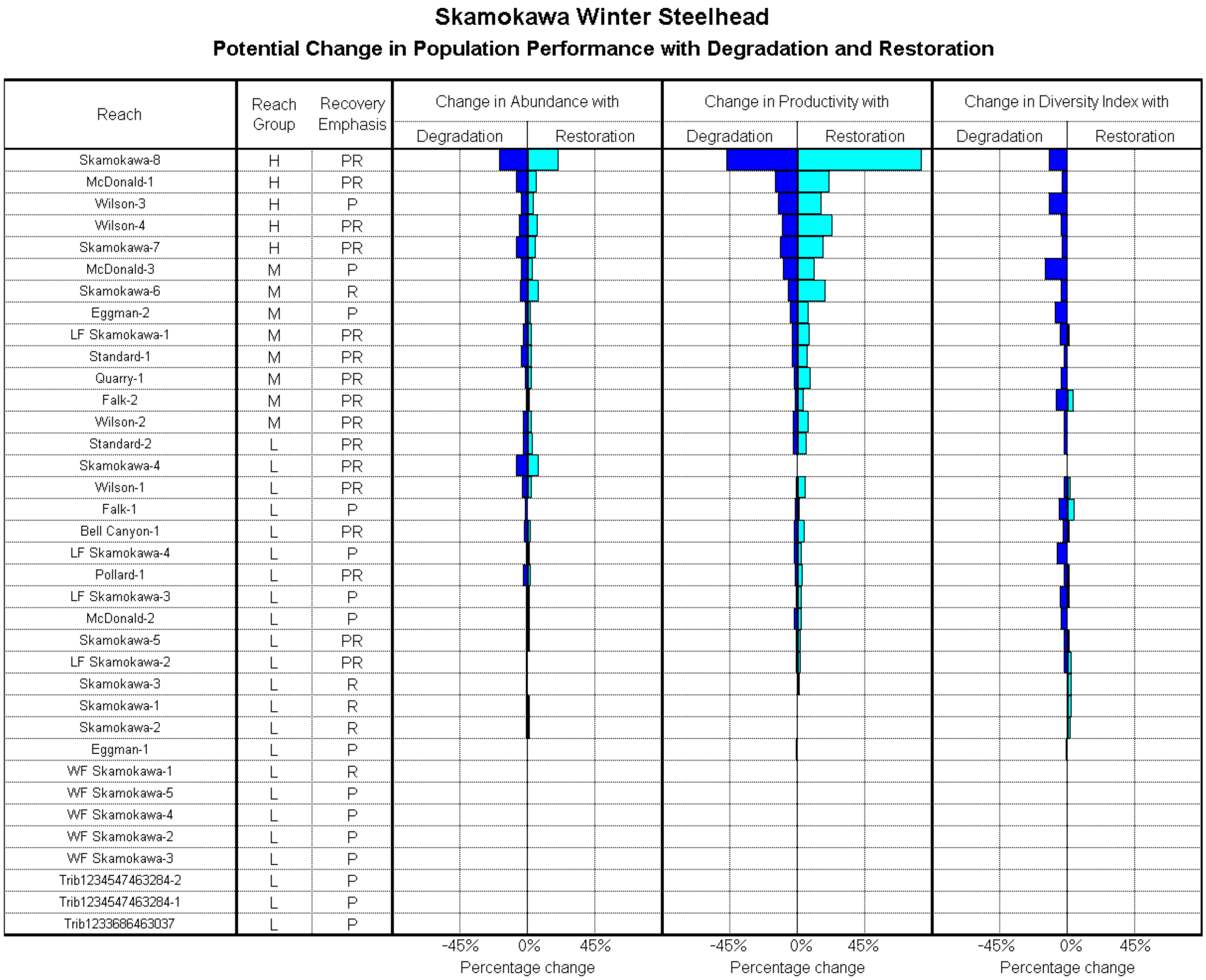


Figure 5-17. Skamokawa basin winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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 Volume VI for more information on EDT ladder diagrams.

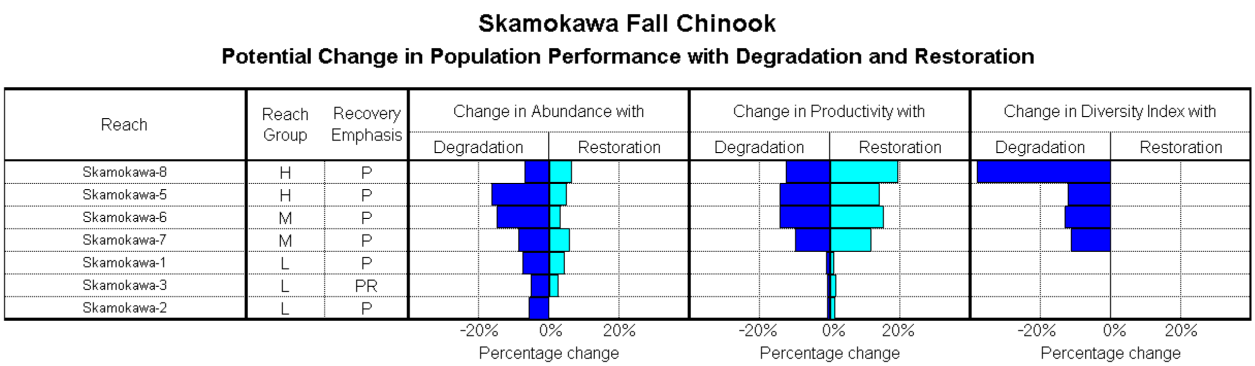


Figure 5-18. Skamokawa fall chinook ladder diagram.

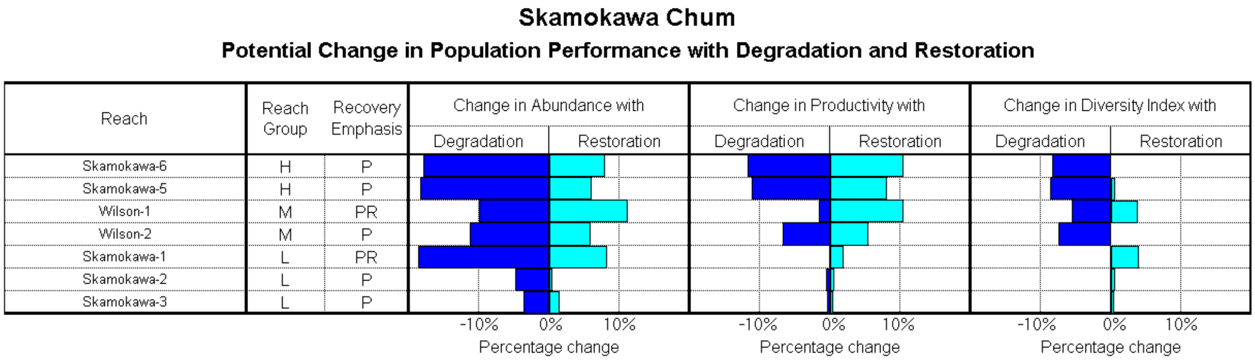


Figure 5-19. Skamokawa chum ladder diagram.

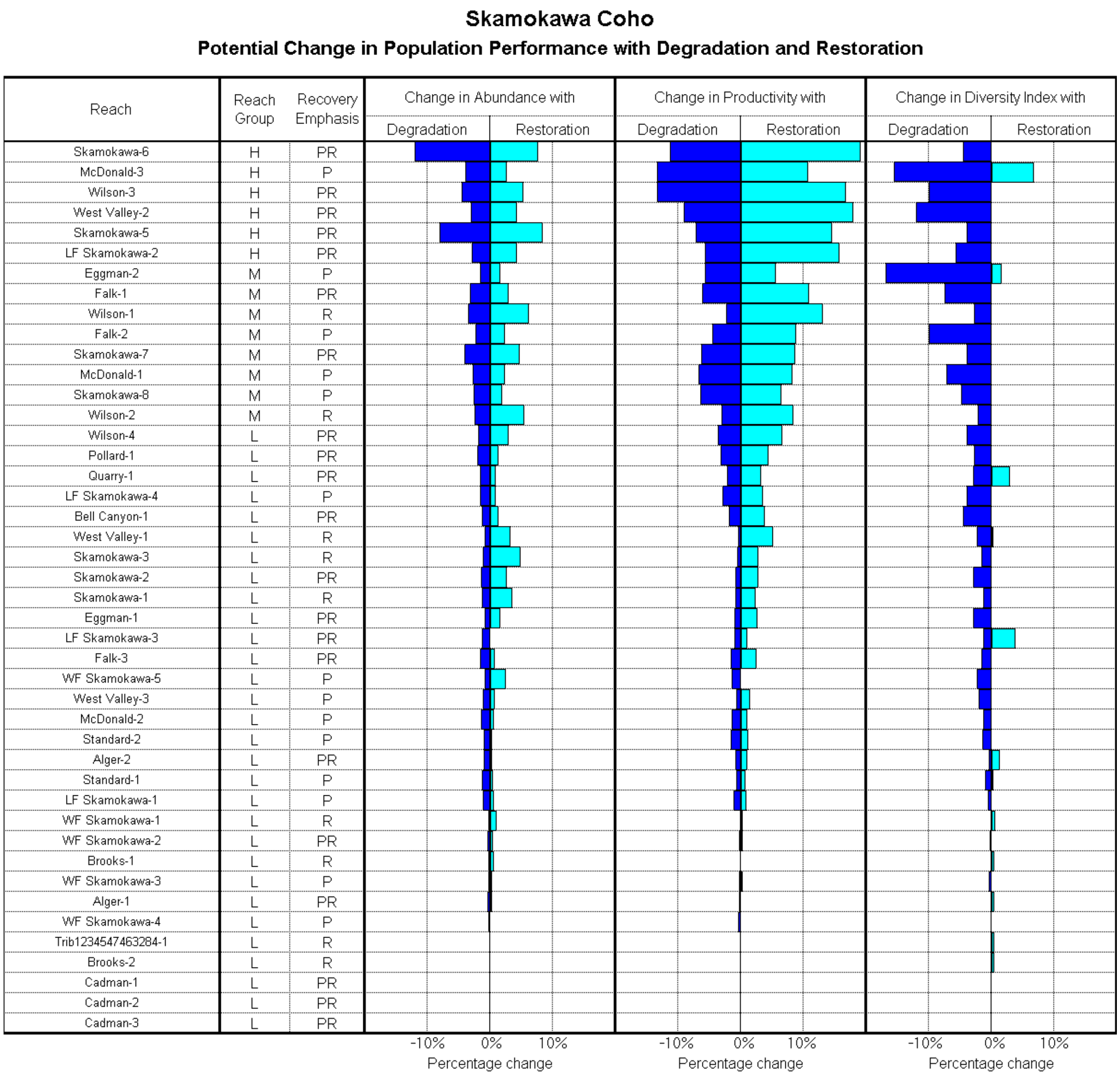


Figure 5-20. Skamokawa coho ladder diagram.

5.6.1.3 Habitat Factor Analysis

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

Key winter steelhead restoration reaches in the Elochoman River are located in both mainstem and tributaries areas between Clear Creek and the North Fork Elochoman. These reaches have degraded sediment, habitat diversity, flow regimes and channel stability (Figure 5-21). Flow impacts are related to upper basin vegetation and road conditions. Over half of the North Elochoman WAU is in early-seral, non-forest, or other cover types, while none of the basin is in the late-seral stage. Riparian vegetation conditions may also be leading to increased temperatures. Entrenchment in the mainstem has altered flow, reduced habitat diversity, and reduced channel stability. Habitat diversity has also been reduced by diking, roads, railroads, and agricultural practices. Lack of LWD has precluded the formation of pools. Road density in the basin is approximately 4 mi/mi^2, which likely contributes to increased fine sediments and altered flow regimes. WDNR (1996) cited road erosion as a primary culprit in delivery of fines to the Elochoman.

Fall chinook restoration reaches in the Elochoman are generally between Beaver Creek and the West Fork Elochoman. These reaches have been degraded by sedimentation, decreased habitat diversity, predation, and decreased channel stability (Figure 5-22). Predation concerns arise because of the presence of the Elochoman hatchery. Hatchery releases can trigger migration of wild fish in the “pied piper” effect while increasing the attraction of predators. The other impacts result from causes described in the winter steelhead discussion.

Important chum restoration reaches are in the lower mainstem below Duck Creek. These reaches have been impacted primarily by sediment, habitat diversity, predation, and harassment/poaching (Figure 5-23). Harvest concerns, related to harassment and poaching, are primarily due to the take of wild fish while fishing for returning hatchery fish. The other impacts result from causes described in the winter steelhead discussion.

Primary coho restoration reaches are scattered throughout the Elochoman, primarily below the West Fork Elochoman. The most important restoration reaches have been negatively affected by reduced habitat diversity, sediment, loss of key habitat, reduced channel stability, altered flow, and predation (Figure 5-24). All of these impacts are related to causes described for the other three species. These causes include land use practices and hatchery impacts.

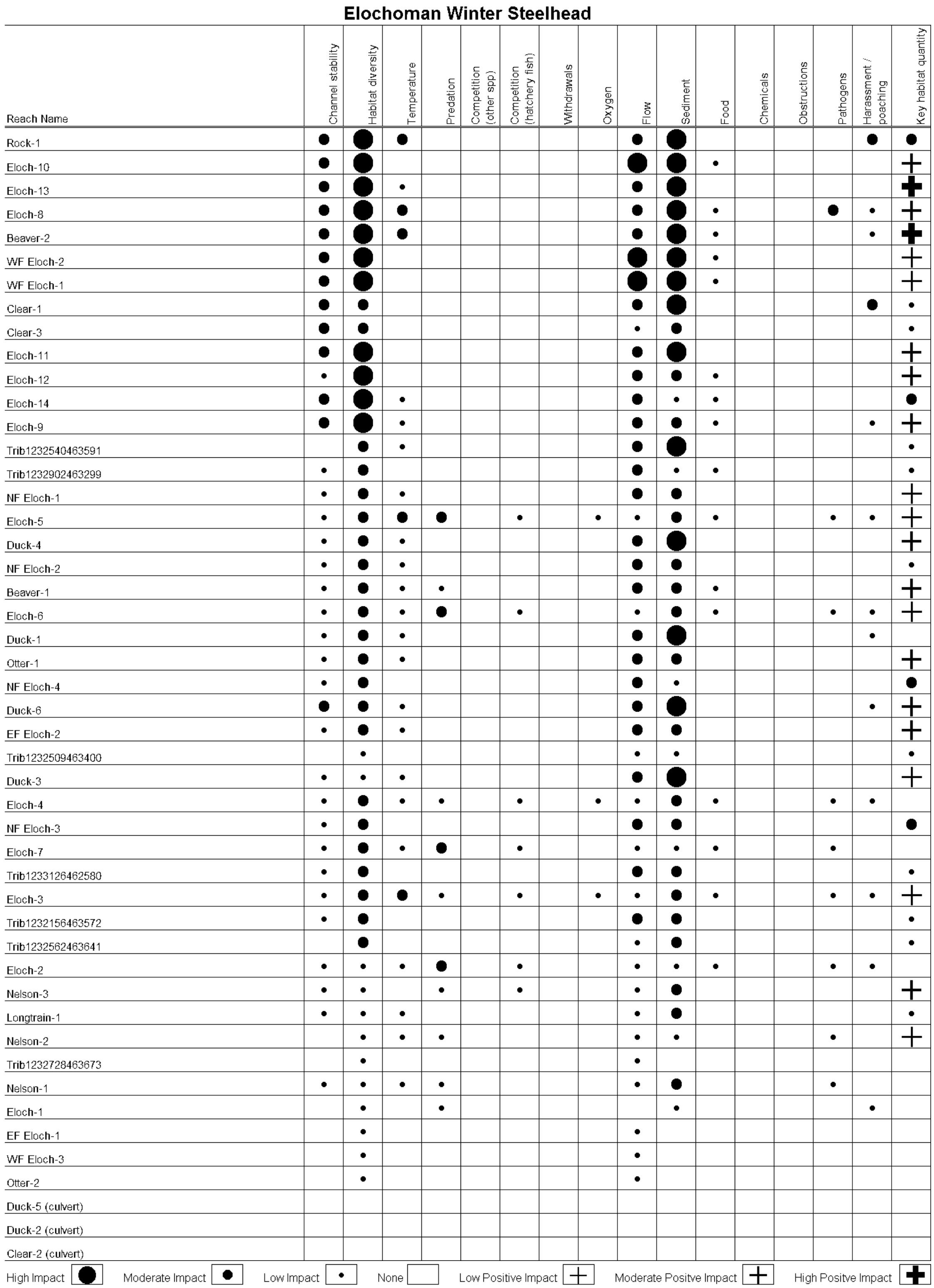


Figure 5-21. Elochoman basin winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Volume VI for more information on habitat factor analysis diagrams.

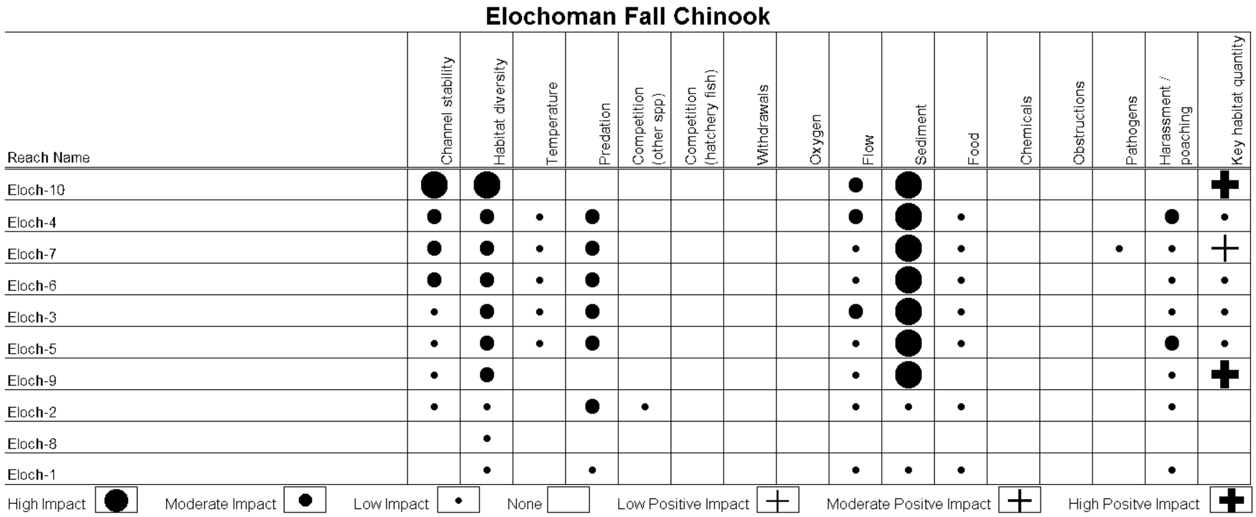


Figure 5-22. Elochoman fall chinook habitat factor analysis.

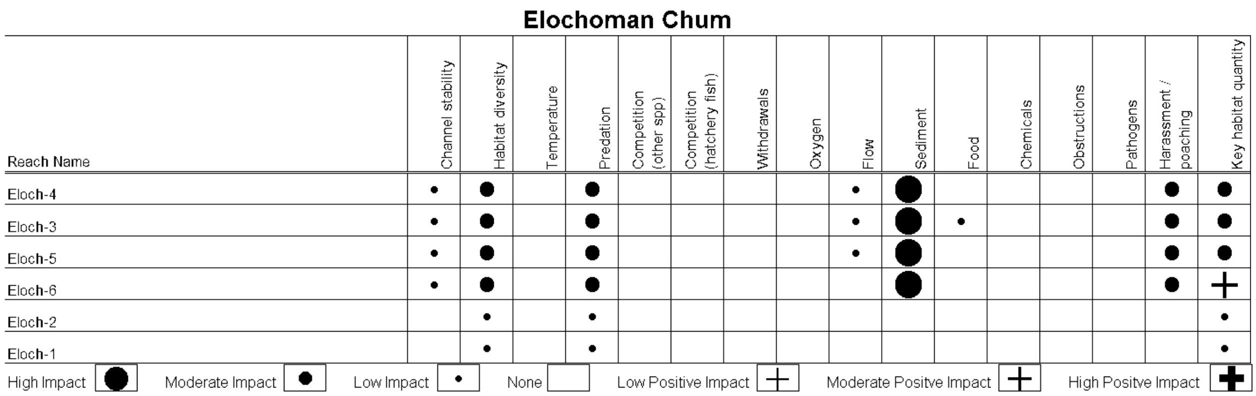


Figure 5-23. Elochoman chum habitat factor analysis.

Elochoman Coho

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Clear-1	⬤	⬤							●	⬤	•				•	⬤
Rock-1	●	⬤							●	●						⬤
Eloch-10	⬤	⬤							●	⬤	•					✚
Clear-3	●	⬤							●	●						⬤
Eloch-5	●	⬤	●	⬤		•		•	●	⬤	●			•	●	●
Eloch-4	●	⬤	●	●		•		•	●	⬤	●			•	•	●
Eloch-13	●	⬤							●	⬤						╋
Duck-1	●	⬤							●	⬤					•	●
Eloch-6	●	⬤	●	●		•			●	●	•			•	•	●
Eloch-3	●	⬤	●	●		•		•	●	⬤	●			•	•	●
Duck-4	•	●	•						●	⬤	•					╋
Duck-6	●	●							●	⬤					•	╋
EF Eloch-1	●	⬤	•						●	⬤	•					╋
Beaver-2	•	●							•	●						╋
Eloch-7	●	⬤	•	●		•			●	●	•			•	•	•
Eloch-8	●	⬤	•						●	●	•			•		╋
Duck-3	•	●							●	⬤						+
Eloch-9	●	⬤	•						●	●	•					✚
Eloch-12	•	●							•	•						+
Trib1232728463673	•	●							•	•						●
Eloch-1	•	●	•	●	•	•			•	•	•			•	•	•
WF Eloch-1	•	●							•	●						•
Eloch-2	•	•	•	●					•	•	•			•		•
Trib1233126462580	•	●							•	•						●
Eloch-11	•	●							•	•						+
Trib1232540463591	•	●							•	•						●
Longtrain-1	•	•							•	•						•
Nelson-2	•	•	•	●					•	●	•			•		•
Trib1232792463272	•	•														•
Trib1232509463400	•	•								•						•
Beaver-1		•							•	•						
Eloch-14	•	•							•	•	•					●
Nelson-3	•	•							•	•						+
Otter-1	•	•								•						+
EF Eloch-2																
NF Eloch-1																
Trib1232562463641		•								•						•
WF Eloch-2	•	•							•	•						•
WF Eloch-3		•								•						•
Trib1232567463186	•	•														•
Trib1232156463572		•								•						•
Nelson-1		•		•												•
NF Eloch-2																
Trib1233036463388-1																
NF Eloch-4																•
NF Eloch-3																
Rock-3																
Duck-5 (culvert)																
Duck-2 (culvert)																
Clear-2 (culvert)																
Rock-2 (culvert)																

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

Figure 5-24. Elochoman coho habitat factor analysis.

Key restoration reaches for winter steelhead in the Skamokawa are in the mainstem just upstream and downstream of the LF Skamokawa, as well as in Wilson and McDonald Creeks. These reaches are degraded in numerous ways including sediment, flow, habitat diversity, temperature, food availability, and key habitat (Figure 5-25). None of the vegetative cover in the basin is in the late-seral stage, while 74% is in the early-seral, non-forest or other stage. This vegetation condition combined with a high road density has potentially altered the flow regime, increased sedimentation, and increased summer temperatures. Habitat diversity in the basin is not well quantified, but qualitative reports indicate that important restoration reaches are deficient of side channels. Sedimentation is exacerbated by steep slopes in the basin underlain with sedimentary rock prone to landslides (Ludwig 1992 as cited in Wade 2002). These important restoration reaches lack LWD because of historical land use practices and stream management. The loss of LWD has reduced habitat diversity and key habitat.

Fall chinook restoration reaches are in the mainstem Skamokawa between Falk Creek and Quarry Creek. These reaches have been impacted by decreased habitat diversity, sedimentation, decreased food availability, and loss of key habitat (Figure 5-26). These impacts are the result of the same causes as those described in the winter steelhead discussion.

There are two important chum restoration areas in the Skamokawa Basin. The first is in the mainstem Skamokawa, and the other is in lower Wilson Creek. Both sections are influenced primarily by the loss of habitat diversity and increased sediment (Figure 5-27). These impacts are the result of the same causes as those described in the winter steelhead discussion.

Primary coho restoration reaches are spread throughout the mainstem Skamokawa and in various smaller tributaries. These reaches have been negatively affected by numerous impacts, including sediment, reduced habitat diversity, loss of key habitat, reduced food, altered flow, and temperature regime impairment (Figure 5-28). These impacts are the result of the same causes as those described in the winter steelhead discussion. These causes are generally related to watershed management and land use practices.

Skamokawa Winter Steelhead

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

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

Figure 5-25. Skamokawa winter steelhead habitat factor analysis.

Skamokawa Fall Chinook

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

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

Figure 5-26. Skamokawa fall chinook habitat factor analysis.

Skamokawa Chum

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

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

Figure 5-27. Skamokawa chum habitat factor analysis.

Skamokawa Coho

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Skamokawa-6	M	H	H	L	L	L			M	H	H			L		H+
McDonald-3	M	H							L	H	L					H
Wilson-3	L	H	M	L					M	H	H					H
West Valley-2	M	H	L	L		L			M	H	M				L	H+
Skamokawa-5	M	H	H	L	L	L			M	H	H			L		M+
LF Skamokawa-2	M	H	L	L		L			M	H	M					H+
Eggman-2	M	M							L	H	L					M
Falk-1	M	M	L	L	L	L			M	H	M					M
Wilson-1	M	H	M	L	L	L			M	H	M					L
Falk-2	M	M	L	L	L	L			M	H	M				L	L
Skamokawa-7	L	H	M	L					M	H	M					H
McDonald-1	L	M	L	L					L	H	L					M
Skamokawa-8	M	M	L						L	H	L					M
Wilson-2	M	H	M	L		L			M	H	M					H
Wilson-4	L	H	L	L					M	H	M					H
Pollard-1	L	M	L			L			L	H	M					M
Quarry-1	L	M							L	M	L					M
LF Skamokawa-4	L	M							L	M	L					M
Bell Canyon-1	L	M							L	M	L					M
West Valley-1	M	M	M	L	L	L			M	M	M				L	M+
Skamokawa-3	L	M	M	M	L	L		L	M	M	M			L		H
Skamokawa-2		M	M	M	L	L			L	M	L			L		H+
Skamokawa-1	L	M	M	M	L	L			L	M	M			L	L	L
Eggman-1	L	M	L	L					M	M	M					M
LF Skamokawa-3																
Falk-3	L	L							L	M	L					M+
WF Skamokawa-5	L	M	L	L					M	L	M					H
West Valley-3	L	M							L	M	L					M
McDonald-2	L	L							L	M	L					L
Standard-2	L	L							L	M	L					L
Alger-2		L								L						L
Standard-1	L	L							L	M	L					L
LF Skamokawa-1	L	L							L		L					M+
WF Skamokawa-1		M	L	L					L	L	L					L
WF Skamokawa-2		L	L						L	L	L					M+
Brooks-1		L	L	L					L	L	L					L
WF Skamokawa-3		L							L		L					M+
Alger-1		L							L							L
WF Skamokawa-4		L														
Trib1234547463284-1																
Brooks-2																

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

Figure 5-28. Skamokawa coho habitat factor analysis.

5.6.2 Mill-Abernathy-Germany

5.6.2.1 Population Analysis

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

Habitat-based assessments were completed for chum, fall chinook, winter steelhead and coho in the Mill, Germany and Abernathy basins. Model results indicate that adult productivity in Abernathy Creek has declined to approximately 20-30% of historical levels for all four species (Table 5-3), with the decline greatest for chum (to 22% of historical levels) and least for fall chinook (to 31% of historical levels). Similarly, adult abundance shows severe declines for all species, with current numbers at 10% of historical levels for chum, at 27% of historical levels for fall chinook, at 18% of historical levels for coho, and at 41% of historical levels for winter steelhead (Figure 5-29). Diversity (as measured by the diversity index) appears to have remained steady for fall chinook, winter steelhead, and chum, but has declined by 33% for coho (Table 5-3).

In Germany Creek, modeled adult productivity also shows severe declines, with current productivity at approximately 20-30% of historical levels for all species (Table 5-4). 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 23% and 29% of historical levels, respectively (Figure 5-30). Winter steelhead abundance has declined to 52% of historical levels (Figure 5-30). In Germany Creek, the diversity of all species, except coho, has been maintained (Table 5-4). Model results indicate that coho diversity has declined to 69% of its historical level.

Mill Creek, the furthest downstream of the three Lower Columbia River tributaries, appears to have also experienced declines in productivity in all four species (Table 5-5). Model results indicate a decrease in productivity of 73% for fall chinook, 81% for chum, and 76% for both coho and winter steelhead. Declines in adult abundance from historical levels have been greatest for chum (93%) and coho (82%), followed by fall chinook (73%) and winter steelhead (54%) (Figure 5-31). Diversity appears to have remained unchanged in Abernathy Creek for both fall chinook and winter steelhead. However, model results indicate a decrease in diversity for chum and coho to 57% and 62% of historical levels, respectively (Table 5-5).

Modeled historical-to-current changes in smolt productivity in Abernathy Creek have declined for all four species, with current levels of productivity at 30-60% of historical levels (Table 5-3). Similarly, smolt abundance levels in Abernathy Creek appear to have decreased by 50-83% from historical levels, with losses most significant for chum, and least for fall chinook and winter steelhead (Table 5-3).

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 5-4). Germany Creek has also experienced sharp declines in smolt abundance levels for all species (Table 5-4). Chum smolt abundance is currently estimated at only 16% of historical levels, while coho, fall chinook and winter steelhead are estimated at 42%, 45% and 60% of historical levels, respectively.

As with the other two basins, smolt productivity in Mill Creek has declined for all four species, with estimated losses greatest for winter steelhead and coho (Table 5-5). Smolt abundance levels have also declined for all species (Table 5-5). Current chum and coho smolt abundances are only 13-18% of historical levels, respectively. Fall chinook and winter steelhead abundances are approximately half of historical levels.

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

Table 5-3. Abernathy Creek— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

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

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

Table 5-4. Germany Creek— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	524	736	1,798	3.3	6.4	11.8	1.00	1.00	1.00	120,843	194,235	271,309	497	944	1,175
Chum	300	886	3,094	1.9	5.6	8.7	0.99	1.00	1.00	169,971	528,781	1,038,737	675	1,016	1,175
Coho	518	850	2,264	4.9	8.9	20.1	0.62	0.70	0.90	11,040	19,941	26,386	111	210	298
Winter Steelhead	347	420	665	5.8	9.2	18.5	1.00	0.97	0.97	5,846	7,689	9,805	73	140	219

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

Table 5-5. Mill Creek— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	386	627	1,411	3.4	6.4	12.4	1.00	1.00	1.00	82,397	141,161	185,456	522	924	1,177
Chum	121	624	1,615	1.7	5.4	8.6	0.57	1.00	1.00	69,066	319,162	531,083	656	972	1,138
Coho	727	881	4,055	4.6	6.9	19.2	0.55	0.77	0.89	4,287	14,942	23,639	71	146	259
Winter Steelhead	155	230	339	4.4	9.5	18.9	0.98	1.00	1.00	2,623	4,048	5,006	75	163	271

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

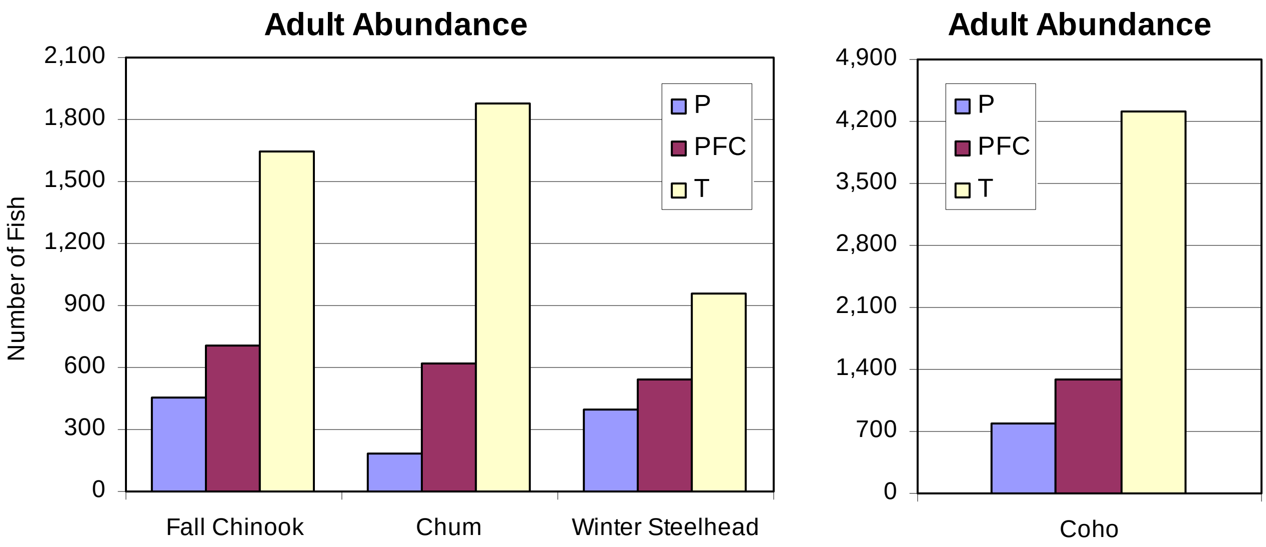


Figure 5-29. Adult abundance of Abernathy Creek fall chinook, chum, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

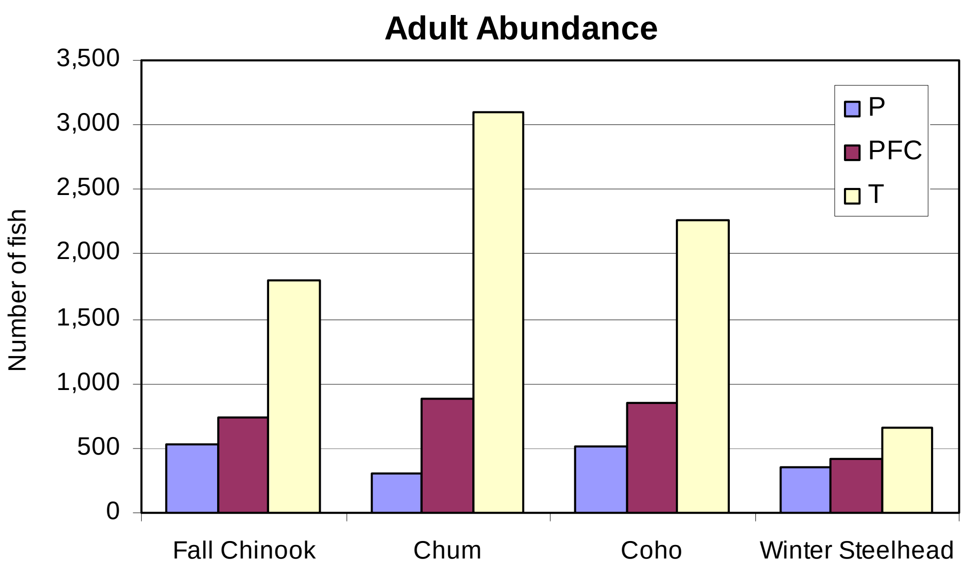


Figure 5-30. Adult abundance of Germany Creek fall chinook, chum, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

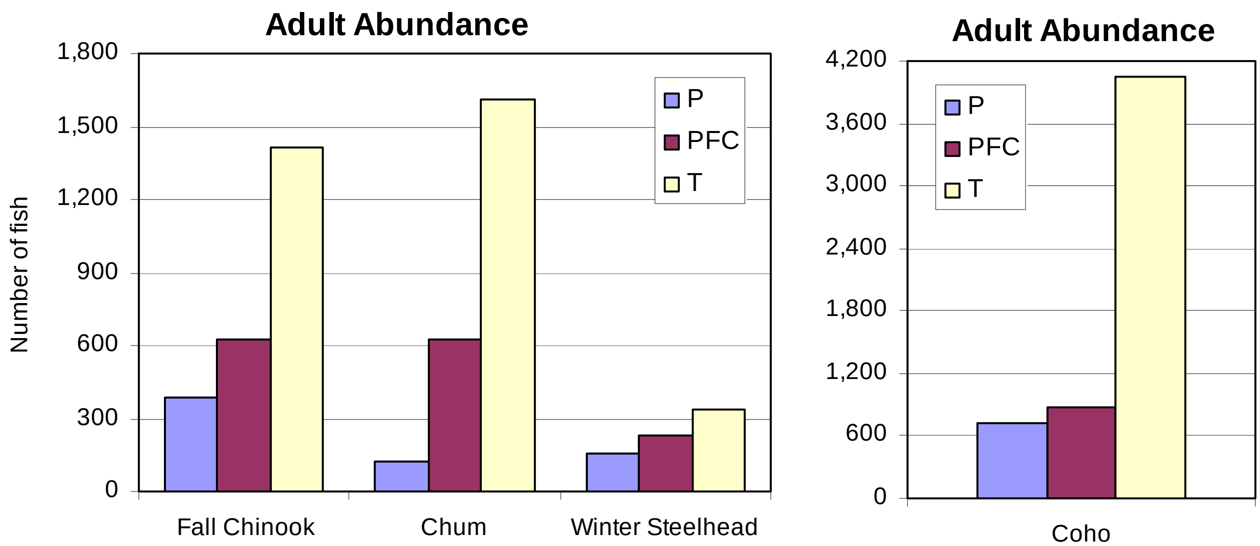


Figure 5-31. Adult abundance of Mill Creek fall chinook, chum, coho and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

5.6.2.2 Restoration and Preservation Analysis

Habitat conditions and suitability for fish are better in some portions of a subbasin than in others. The reach analysis of the EDT model uses estimates of the difference in projected population performance between current/patient and historical/template habitat conditions to identify core and degraded fish production areas. Core production areas, where habitat degradation would have a large negative impact on the population, are assigned a high value for preservation. Likewise, currently degraded areas that provide significant potential for restoration are assigned a high value for restoration. Collectively, these values are used to prioritize the reaches within a given subbasin. Refer to Figure 5-32 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.

For winter steelhead in Mill Creek, high priority reaches include Mill Creek below North Fork Mill Creek (Mill 2 and Mill 4), portions of South and North Fork Mill Creek (SF Mill 1, NF Mill 2), and the long middle reach of Spruce Creek, downstream of Hunter Creek (Spruce 1 and Spruce 2) (Figure 5-33). These high priority reaches have a mixed preservation and restoration emphasis, with the greatest change in population performance expected in the reach Spruce 1 (Figure 5-33).

A single, though different, high priority reach exists for both fall chinook and chum in Mill Creek. For fall chinook, reach Mill 2, with a combined preservation and restoration emphasis, is the lone high priority reach (Figure 5-34). The single high priority reach for chum is the lowest reach of South Fork Mill Creek, SF Mill 1 (Figure 5-35). SF Mill 1 also shows a combined preservation and restoration emphasis.

High priority reaches for coho include lower, middle and upper sections of Mill Creek (Mill 2, 4, 5 and 8), lower South Fork Mill Creek (SF Mill 1), lower North Fork Mill Creek (NF Mill 2), and the lower sections of Spruce Creek (Spruce 1 and Spruce 2) (Figure 5-36). The majority of these high priority reaches have a mixed preservation and restoration emphasis, with the reach Spruce 1 showing the greatest expected change in population performance (Figure 5-36).

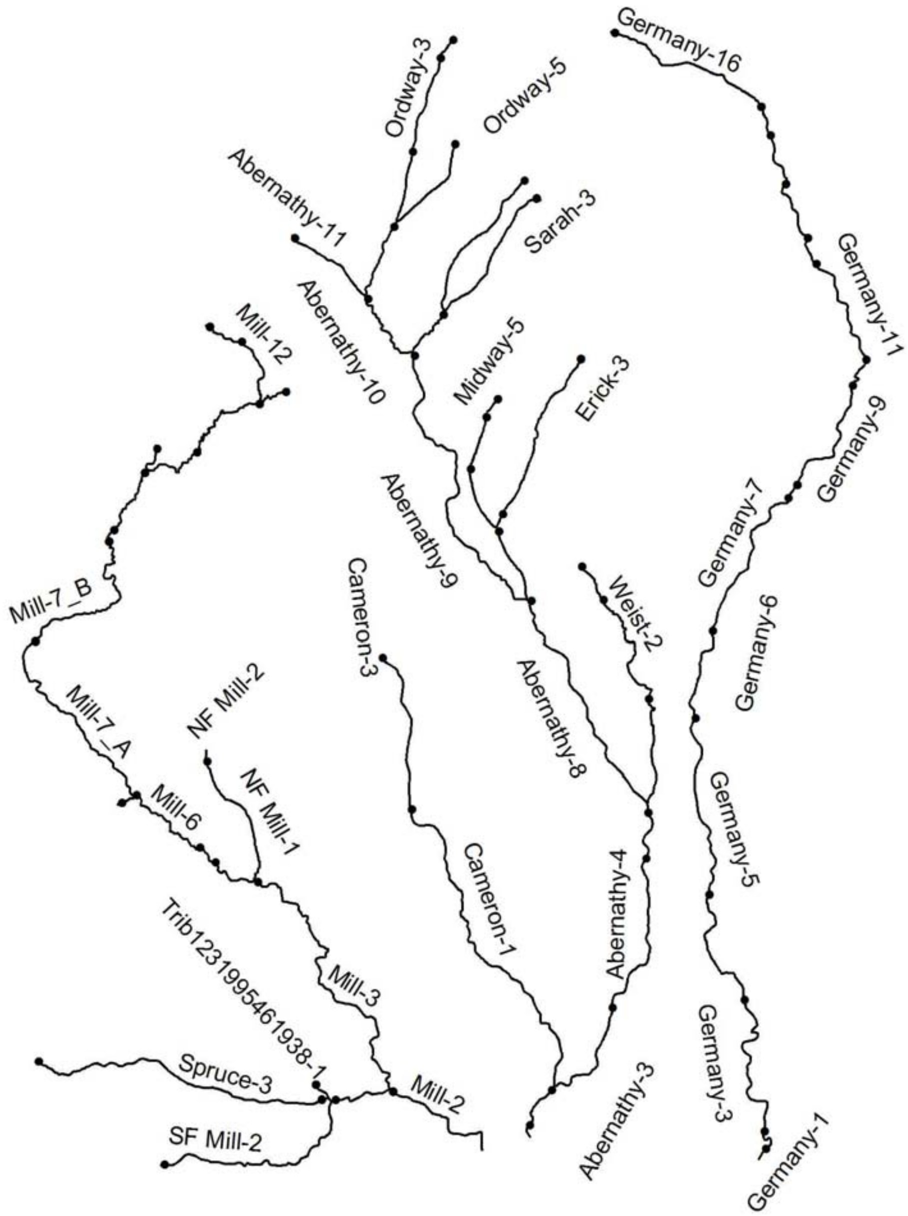


Figure 5-32. Location of EDT reaches in Mill, Germany and Abernathy Creeks. For readability, not all reaches are labeled.

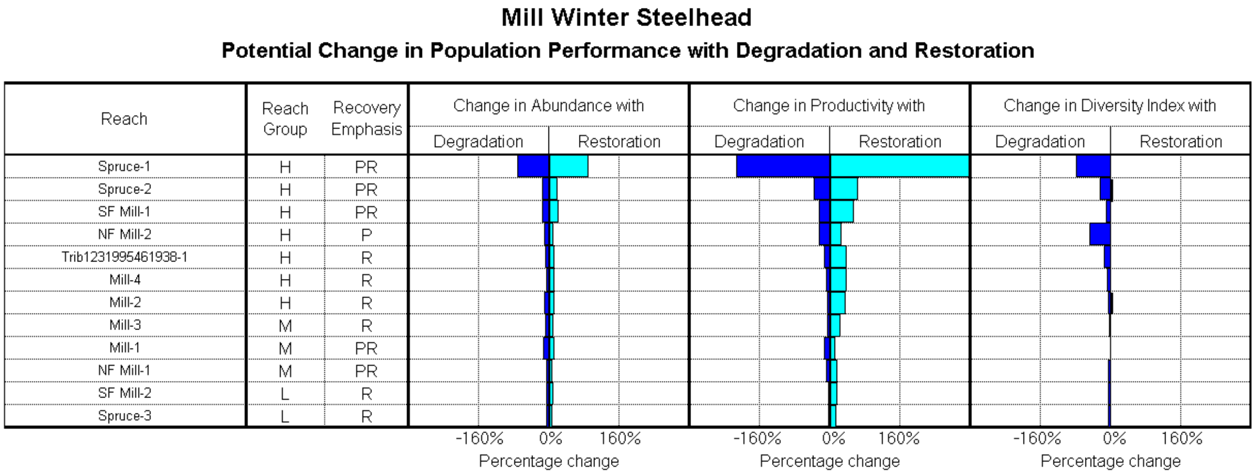


Figure 5-33. Mill Creek winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. 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 Volume VI for more information on EDT ladder diagrams.

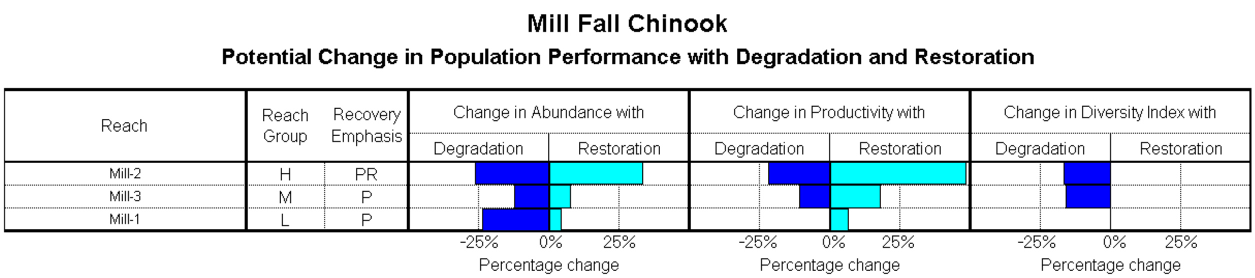


Figure 5-34. Mill Creek fall chinook ladder diagram.

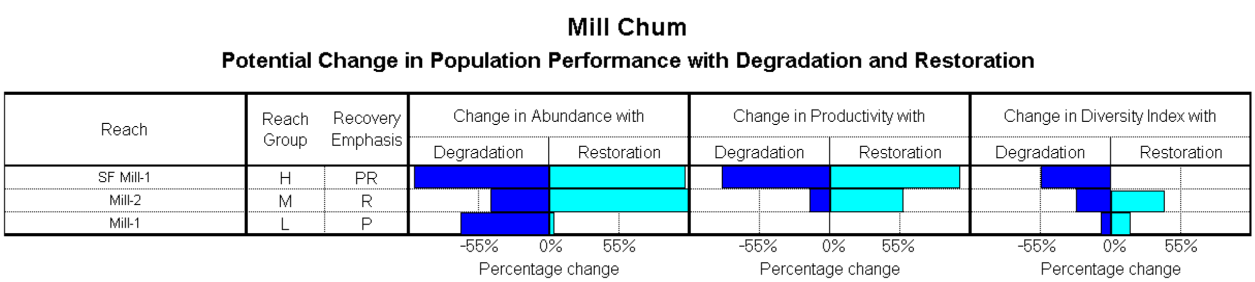


Figure 5-35. Mill Creek chum ladder diagram.

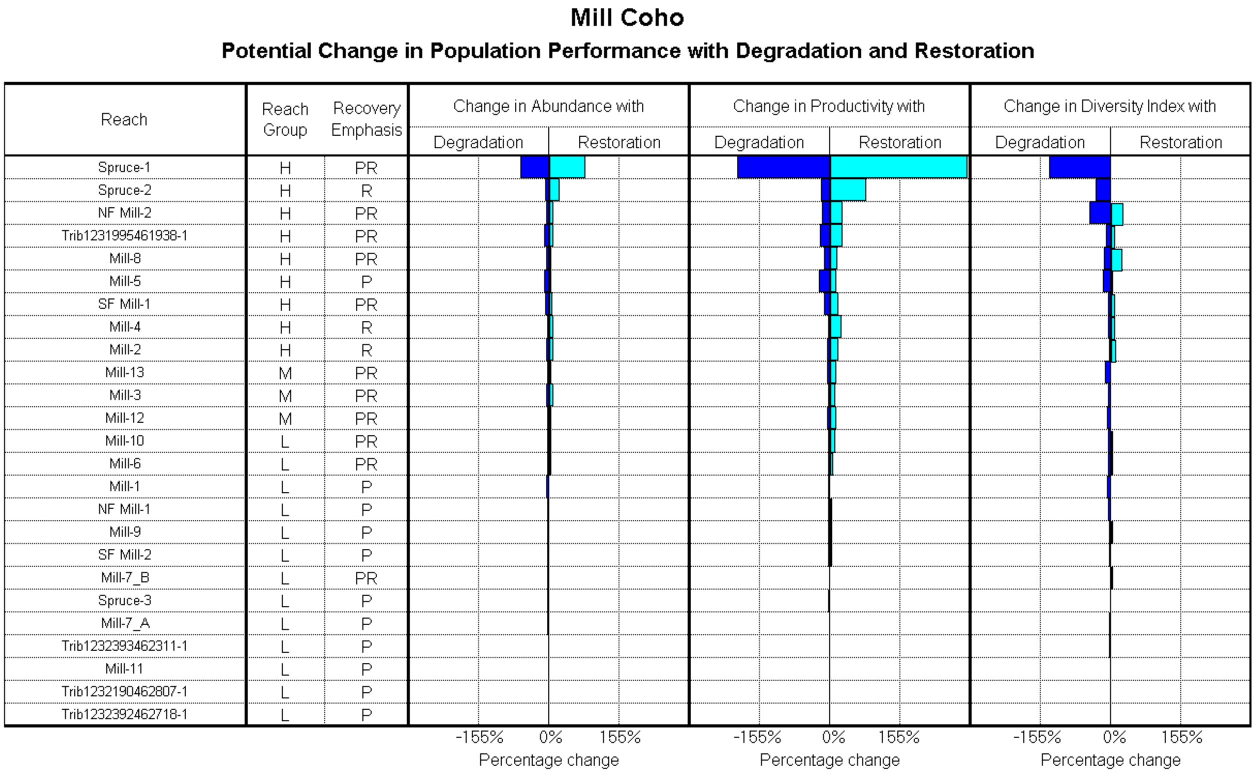


Figure 5-36. Mill Creek coho ladder diagram.

Winter steelhead spawn in the mainstem Germany Creek up to the headwaters, as well as in Loper Creek and John Creek. Fall chinook and chum are found in the lowest reaches of the mainstem Germany Creek. Coho distribution in the basin is not well understood, but it is assumed that they use all areas accessible. Refer to Figure 5-32 for a map of stream reaches within Mill, Abernathy and Germany Creeks.

For winter steelhead in Germany Creek, high priority reaches exist primarily in the middle and upper sections of Germany Creek (Germany 6, 8, 10, and 12-15) and in one unnamed tributary in upper Germany Creek (Figure 5-37). These high priority reaches, with the exception of Germany 8, have mixed preservation and restoration emphasis.

The high potential reaches for both fall chinook and chum exist in lower Germany Creek. For fall chinook the two high priority reaches are Germany 2 and Germany 3, each with a combined preservation and restoration emphasis (Figure 5-38). For chum, the single high priority reach is Germany 2, again with a combined preservation and restoration emphasis (Figure 5-39).

Two of the four high priority reaches identified for coho are in lower Germany Creek (Germany 2 and Germany 3) (Figure 5-40). The other two reaches are located in the middle (Germany 8) and upper (unnamed tributary) sections of the Creek. All high priority reaches for coho had a combined preservation and restoration emphasis.

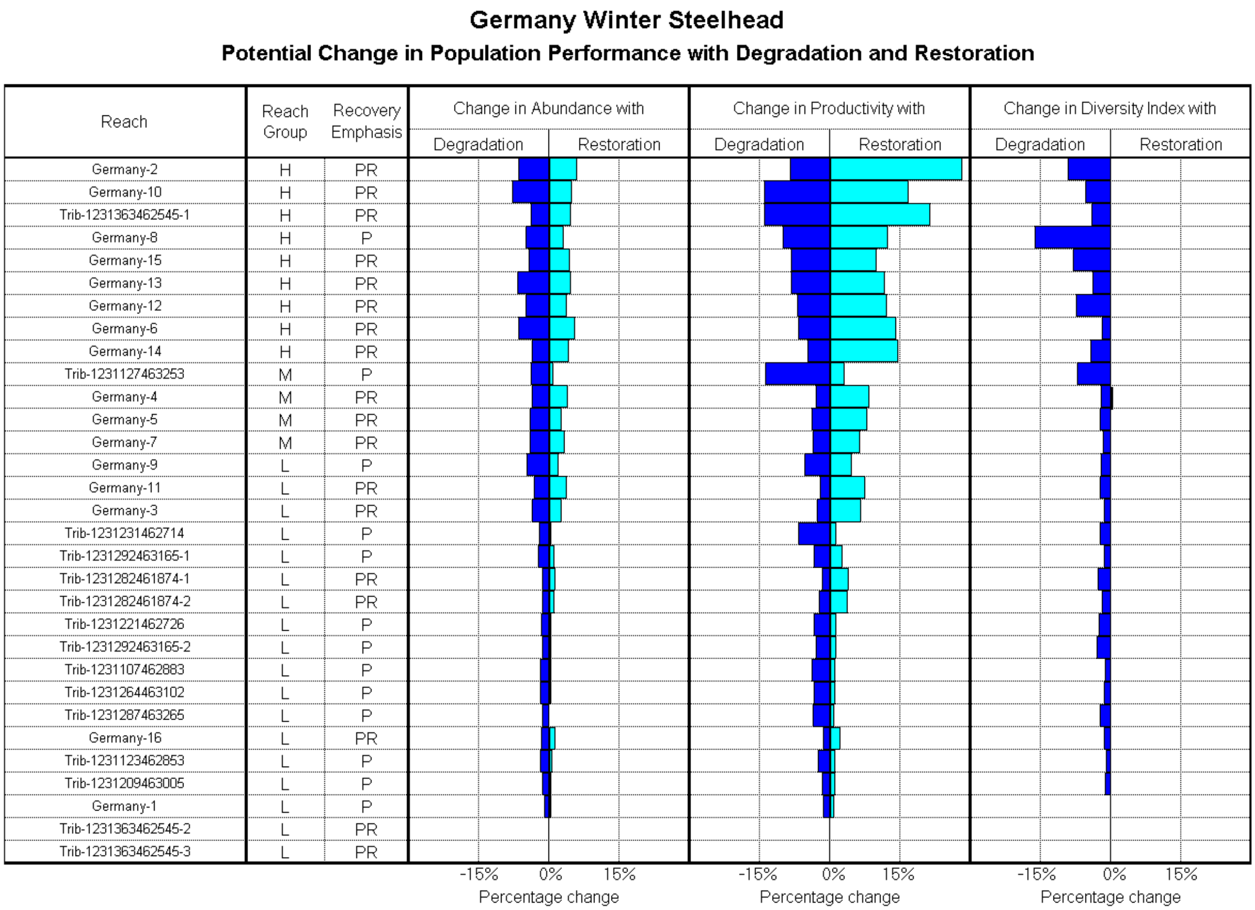


Figure 5-37. Germany Creek winter steelhead ladder diagram

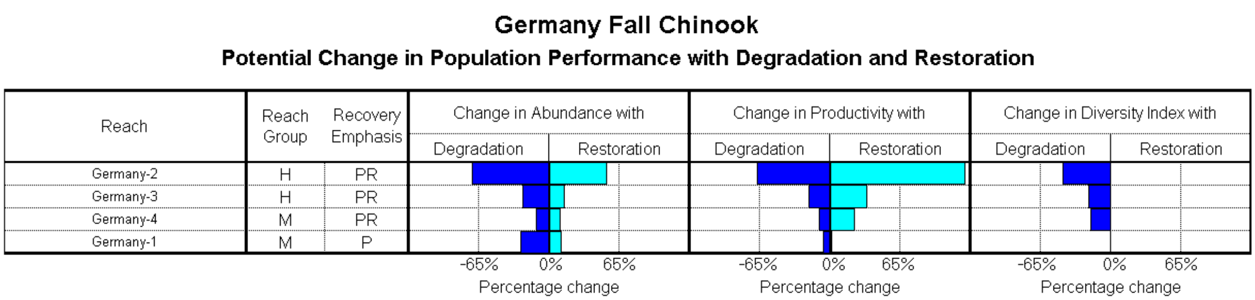


Figure 5-38. Germany Creek fall chinook ladder diagram

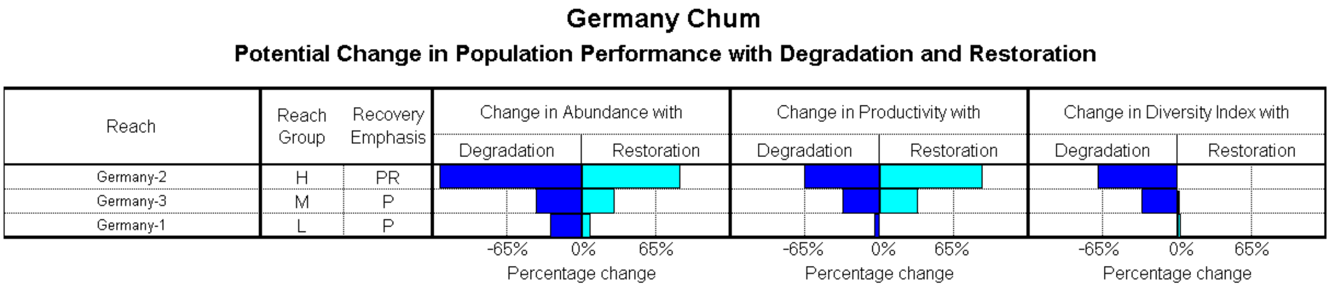


Figure 5-39. Germany Creek chum ladder diagram

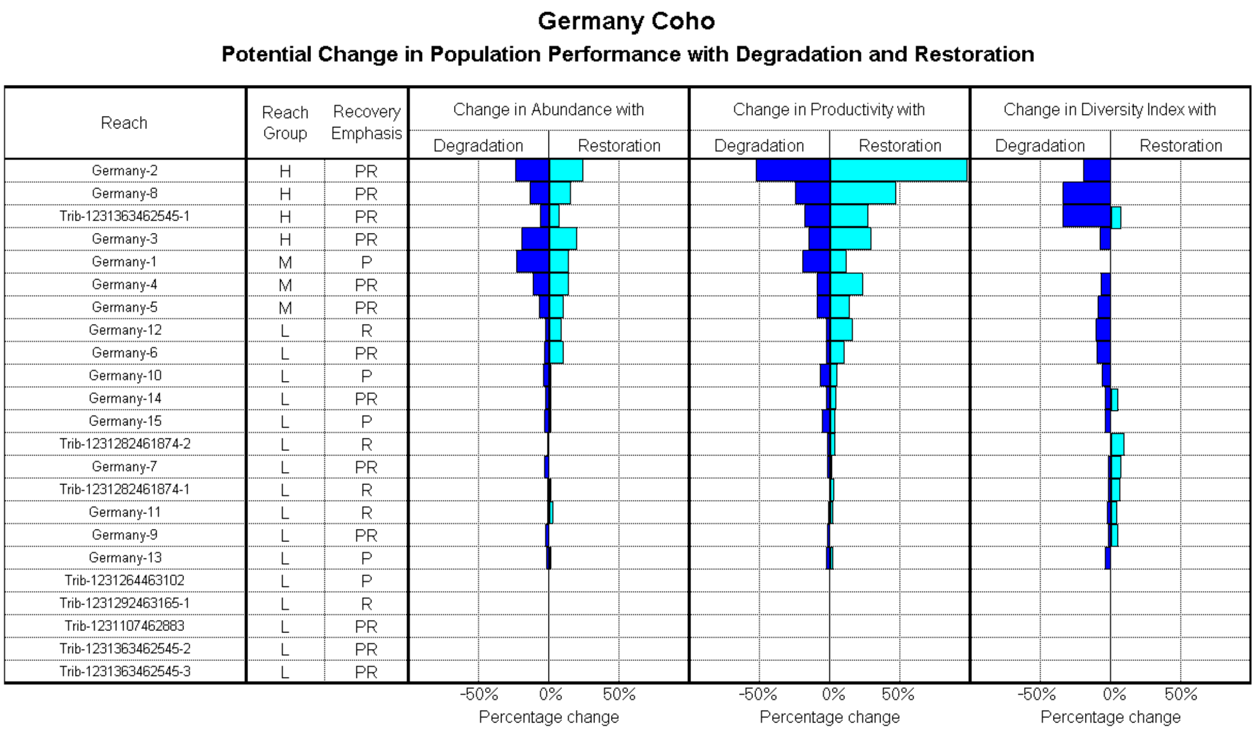


Figure 5-40. Germany Creek coho ladder diagram.

In Abernathy Creek, winter steelhead are found throughout the entire mainstem, Slide Creek and Cameron Creek, while fall chinook and chum are both found in the lower reaches of the mainstem. Coho distribution in the basin is not well understood, but it is assumed that they use all areas accessible. Refer to Figure 5-32 for a map of stream reaches within Mill, Abernathy and Germany Creeks.

High priority reaches for winter steelhead within Abernathy Creek include sections in lower and middle Abernathy Creek (Abernathy 1-2, 4-5, and 7-8), and smaller tributaries entering the middle and upper creek (Erik 2 and Midway 5) (Figure 5-41). These reaches are an even mix of those with a restoration emphasis and those with a combined preservation and restoration emphasis (Figure 5-41).

For both fall chinook and chum, the two high priority reaches, Abernathy 1 and Abernathy 2, are located below Weist Creek (Figure 5-42 and Figure 5-43). For fall chinook, Abernathy 1 has a combined preservation and restoration emphasis, and Abernathy 2 has a preservation emphasis (Figure 5-42). For chum, Abernathy 1 has a restoration emphasis and Abernathy 2 has a combined preservation and restoration emphasis (Figure 5-43).

High priority reaches for Coho in Abernathy Creek occur in select mainstem sections in lower and middle Abernathy Creek (Abernathy 2, 5, and 7) (Figure 5-44). Abernathy 2 and 7 both have a combined preservation and restoration emphasis while Abernathy 5 has only a restoration emphasis.

Abernathy Winter Steelhead
Potential Change in Population Performance with Degradation and Restoration

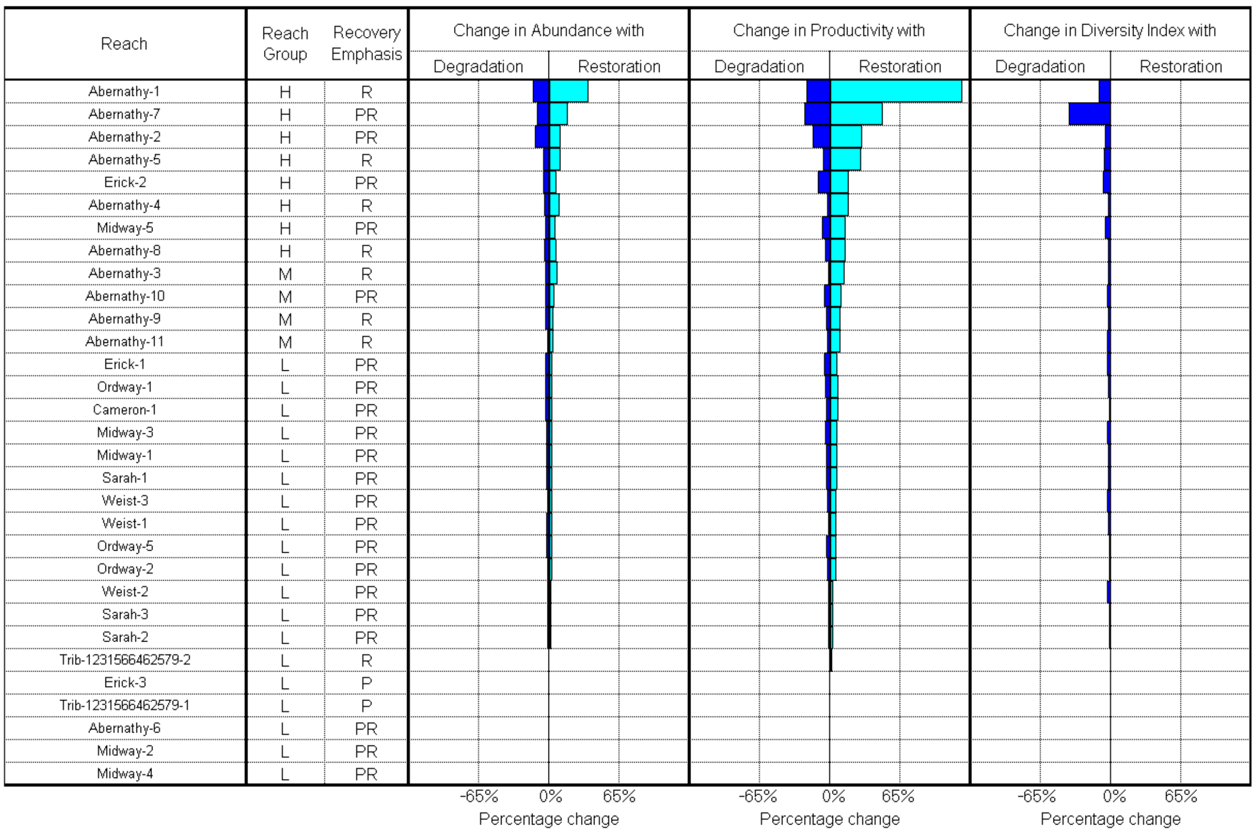


Figure 5-41. Abernathy Creek winter steelhead ladder diagram.

Abernathy Fall Chinook
Potential Change in Population Performance with Degradation and Restoration

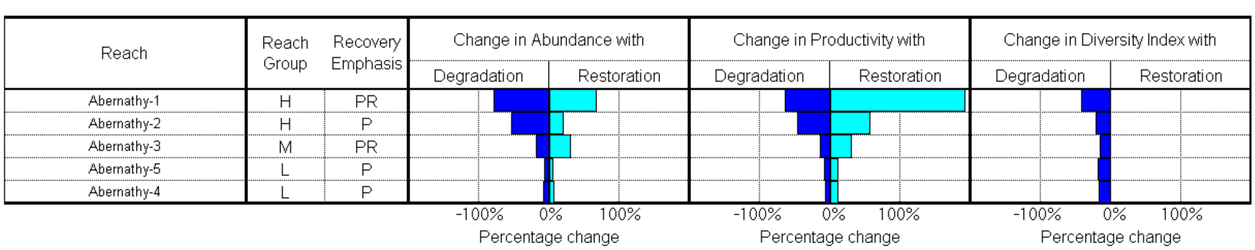


Figure 5-42. Abernathy Creek fall chinook ladder diagram.

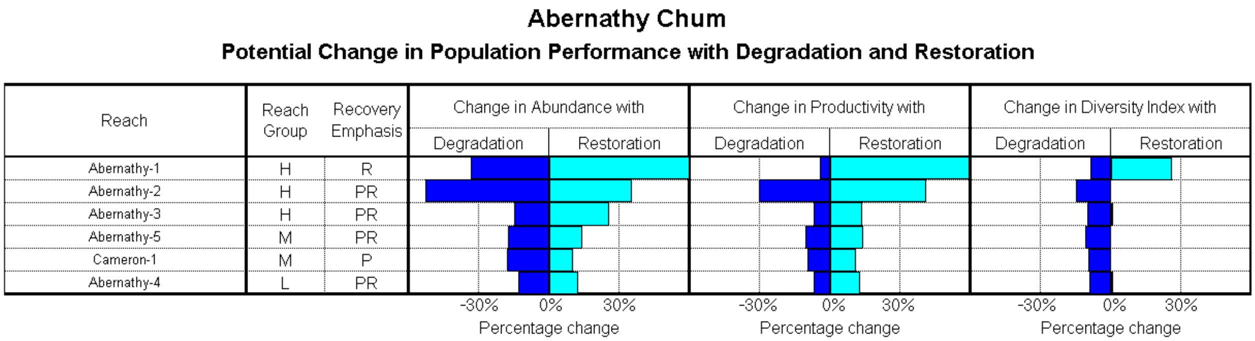


Figure 5-43. Abernathy Creek chum ladder diagram.

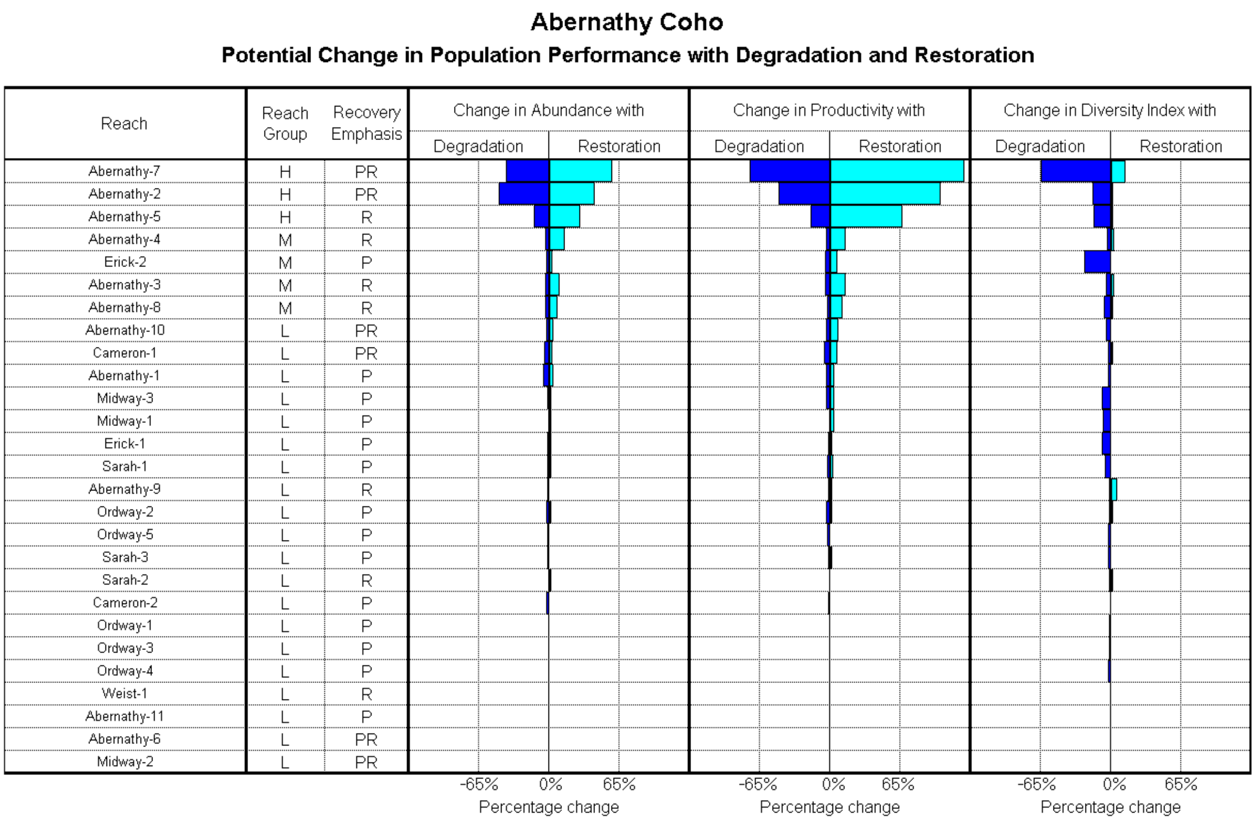


Figure 5-44. Abernathy Creek coho ladder diagram.

5.6.2.3 Habitat Factor Analysis

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the 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 winter steelhead are in Spruce Creek and the lower sections of South Fork and North Fork Mill Creek. Habitat diversity, flow, sediment, and channel stability all have substantial negative impacts in these areas (Figure 5-45). Reduced riparian function and low levels of large woody debris contribute to habitat diversity problems. Riparian function problems result from narrow buffer widths due to residential development and roads adjacent to the streams. Sediment problems result from land use practices and high road densities in the upper basin increasing sediment loads which aggrade in lower basin reaches. 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.

Fall chinook and chum habitat restoration is most important in Mill Creek just below Spruce Creek. Habitat diversity and sediment are the factors most contributing to degradation of this reach (Figure 5-46 and Figure 5-47). The causes of these impacts are similar to those described for winter steelhead.

Key coho restoration reaches are generally located in middle and lower Mill Creek, lower North and South Fork Mill Creek, and Spruce Creek. A loss of habitat diversity, sedimentation, and decreased key habitat quantity are the primary limiting conditions in these reaches (Figure 5-48). The loss of habitat diversity is expressed as a lack of side channel habitat resulting from residential development and roads along the streams.

Mill Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Spruce-1	High	High	High	Low					High	High	Moderate			Low		
Spruce-2	Moderate	Moderate	Low						Moderate	High	Low					
SF Mill-1	Moderate	Moderate	Low	Low					Moderate	Moderate	Low					
NF Mill-2	Low	Moderate							Low	Moderate	Low					Low Positive
Trib1231995461938-1	Moderate	Moderate							Low	Moderate	Low					Low Positive
Mill-4	Low	Moderate							Moderate	Moderate	Low					Low
Mill-2	Low	Moderate	Low						Low	Moderate	Low				Low	
Mill-3	Low	Low	Low	Low					Low	Moderate	Low					
Mill-1	Low	Moderate	Low	Low					Low		Low			Low	Low	
NF Mill-1	Low	Low							Low		Low					Low Positive
SF Mill-2	Low	Low							Low	Low	Low					Low Positive
Spruce-3		Moderate							Low	Low	Low					Low Positive

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

Figure 5-45. 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 degree to which overall population abundance would be affected if the habitat

attributes were restored to template conditions. See section VOLUME VI for more information on habitat factor analysis diagrams.

Mill Fall Chinook

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

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

Figure 5-46. Mill Creek fall chinook habitat factor analysis diagram.

Mill Chum

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

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

Figure 5-47. Mill Creek chum habitat factor analysis diagram.

Mill Coho

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Spruce-1	High	High	Moderate						High	High	High					High
Spruce-2	Moderate	High	Low						Moderate	High	Moderate					High
NF Mill-2	Moderate	Moderate							Low	Moderate	Low					Moderate
Trib1231995461938-1	Moderate	Moderate							Low	Moderate	Low					Moderate
Mill-8	Low	Moderate							Low	Low	Low					High Positive
Mill-5	Moderate	Moderate							Low	Moderate	Low					Low
SF Mill-1	Low	Moderate							Low	Moderate	Low					Moderate
Mill-4	Low	High							Low	Moderate	Low					Moderate
Mill-2	Low	Moderate							Low	Low	Low				Low	Moderate
Mill-13	Low	Moderate							Low	Moderate	Low					Moderate
Mill-3	Low	Moderate	Low						Low	Moderate	Low					Moderate
Mill-12	Low	Moderate							Low	Moderate	Low					Moderate
Mill-10	Low	Moderate							Low	Moderate	Low					Low
Mill-6	Low	Moderate							Low	Moderate	Low					Low
Mill-1		Low							Low							
NF Mill-1		Low														Low
Mill-9		Low														
SF Mill-2	Low	Low								Low						Low
Mill-7_B																
Spruce-3		Low								Low						Low
Mill-7_A																
Trib1232393462311-1																
Mill-11																
Trib1232190462807-1																
Trib1232392462718-1																

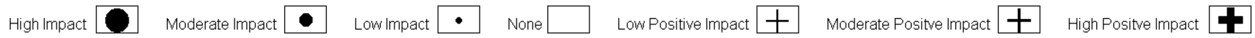


Figure 5-48. Mill Creek coho habitat factor analysis diagram.

In Germany Creek, the highest priority restoration areas for winter steelhead are primarily in the middle and upper mainstem. Habitat diversity, sediment, and flow have the largest negative impacts in these reaches (Figure 5-49). High fine sediment loads in the lower basin have resulted from deposition from contributions in upper reaches, and from riparian degradation in agricultural sections. Flow issues are related to high road densities in the basin. Habitat diversity reductions are partially attributable to land use and stream management practices that have channelized and simplified the stream. Removal of LWD has also reduced habitat diversity in these critical reaches. A road along the stream contributed to numerous negative impacts in the key restoration reaches including lost habitat diversity, increased temperature, increased sediment, and lost key habitat.

Important restoration reaches for fall chinook and chum are in lower Germany Creek. These reaches have been most negatively influenced by increased sediment levels and low habitat diversity (Figure 5-50 and Figure 5-51). The causes for these impacts are the same as those cited for winter steelhead restoration reaches.

The highest restoration potential for coho exists throughout the mainstem Germany Creek where reaches have been negatively impacted by increased sediment, decreased habitat diversity, and altered temperatures (Figure 5-52). The cause of these impacts is the same as those cited for winter steelhead restoration reaches.

Germany Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Germany-2		Low	High	Low					Moderate	High	Low			Moderate	Low	Low Positive
Germany-10	Low	High	Moderate						High	High	Moderate			Low		Low Positive
Trib-1231363462545-1	Moderate	High	Low						Moderate	High	Low					High Positive
Germany-8		Moderate	Low	Low Positive					Moderate	High	Moderate			Low		
Germany-15	Moderate	High	Low			Low			Moderate	Low	Low					Moderate
Germany-13	Low	High	Low			Low			High	High	Moderate					Low Positive
Germany-12		High	Low	Low Positive		Low			Moderate	High	Moderate					Low Positive
Germany-6		Moderate	High	Moderate					Moderate	High	Moderate			Moderate		Low
Germany-14	Low	High	Low						Moderate	High	Low					Moderate
Trib-1231127463253	Low	Moderate							Low	Low	Low					Low Positive
Germany-4	Low	Moderate	Moderate	Low					Moderate	Moderate	Low			Low		Low
Germany-5		Low	Moderate	Low					Moderate	High	Low			Low		Low
Germany-7	Low	High	Low						Moderate	Moderate	Low					
Germany-9		Moderate	Low	Low Positive					Moderate	High	Low					
Germany-11	Low	High	Low						Moderate	Moderate	Low					Low Positive
Germany-3	Low	Low	Moderate	Low					Moderate	High	Low			Low		Low Positive
Trib-1231231462714		Low							Low	Low						Low Positive
Trib-1231292463165-1	Low	Moderate							Moderate	Low	Low					Low Positive
Trib-1231282461874-1	Low	Moderate							Moderate	Moderate	Low					Low Positive
Trib-1231282461874-2	Low	Moderate							Low	Moderate	Low					Moderate Positive
Trib-1231221462726		Low							Low	Low						Low Positive
Trib-1231292463165-2		Low							Low	Low						Low Positive
Trib-1231107462883		Low							Low	Low						Low Positive
Trib-1231264463102		Low							Low	Low						Low Positive
Trib-1231287463265		Low							Low	Low						Low Positive
Germany-16	Low	Moderate							Moderate	Low	Low					Low
Trib-1231123462853	Low	Low							Low	Low	Low					Low Positive
Trib-1231209463005		Low							Low	Low	Low					Low Positive
Germany-1	Low	Low	Low	Low					Low							

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

Figure 5-49. Germany Creek winter steelhead habitat factor analysis diagram.

Germany Fall Chinook

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

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

Figure 5-50. Germany Creek fall chinook habitat factor analysis diagram.

Germany Chum

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

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

Figure 5-51. Germany Creek chum habitat factor analysis diagram.

Germany Coho

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Germany-2	Moderate	High	High	Low					Moderate	High	Moderate			Low	Low	Low
Germany-8	Moderate	High	Low						Moderate	High	Moderate					Moderate
Trib-1231363462545-1	Moderate	Moderate							Low	Moderate	Low					Moderate
Germany-3	Moderate	High	High	Low					Moderate	High	Moderate			Low		Moderate
Germany-1	Moderate	High	Moderate	Moderate					Moderate	Low	Moderate			Low	Low	Low
Germany-4	Moderate	High	Moderate	Low					Moderate	High	Moderate			Low		Moderate
Germany-5	Low	Moderate	Moderate	Low					Moderate	High	Moderate			Low		Moderate
Germany-12	Low	High				Low			Moderate	High	Low					Moderate
Germany-6	Low	High	Moderate	Low					Low	High	Moderate					Moderate
Germany-10	Low	Low							Low	Moderate	Low					
Germany-14	Low	Low								Low						Low
Germany-15	Low	Low								Low						Low
Trib-1231282461874-2																
Germany-7		Low														
Trib-1231282461874-1	Low	Low							Low	Low						Low
Germany-11	Low	Moderate							Low	Low						Low
Germany-9		Low								Low						
Germany-13	Low	Low							Low	Low						Low
Trib-1231264463102																
Trib-1231292463165-1																

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

Figure 5-52. Germany Creek coho habitat factor analysis diagram.

Winter steelhead restoration reaches in Abernathy Creek are scattered throughout the lower and middle mainstem Abernathy Creek. Impacts to these reaches have resulted from degradation of the following habitat features: sediment, flow, habitat diversity, and temperature (Figure 5-53). 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.

Important restoration reaches for fall chinook and chum are in Abernathy Creek below Weist Creek. These reaches have been most negatively influenced by increased sediment levels, lower habitat diversity, and loss of key habitat (Figure 5-54 and Figure 5-55). Causes of impacts are the same as those described for winter steelhead restoration reaches.

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 5-56). Causes for these impacts are the same as those described for winter steelhead, fall chinook and chum restoration reaches.

Abernathy Winter Steelhead

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

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

Figure 5-53. Abernathy Creek winter steelhead habitat factor analysis diagram.

Abernathy Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Abernathy-1	Moderate	High	Low	Moderate					Low	High	Low				Moderate	Moderate positive
Abernathy-2	Low	Moderate	Low	Low					Low	High	Low				Low	Moderate positive
Abernathy-3	Moderate	Moderate	Low	Low					Moderate	High	Low					High
Abernathy-5	Low	Low	Low						Low	High						Low
Abernathy-4	Low	Low							Low	Moderate						Low

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

Figure 5-54. Abernathy Creek fall chinook habitat factor analysis diagram.

Abernathy 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
Abernathy-1	Low	High		Moderate					Low	High	Low				Moderate	Moderate positive
Abernathy-2	Low	High		Low					Low	High	Low				Moderate	Moderate positive
Abernathy-3	Low	High							Low	High						High
Abernathy-5	Low	Moderate							Low	High						Low
Cameron-1	Low	Moderate							Low	Moderate						Low
Abernathy-4	Low	Moderate							Low	Moderate					Low	Low

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

Figure 5-55. Abernathy Creek chum habitat factor analysis diagram.

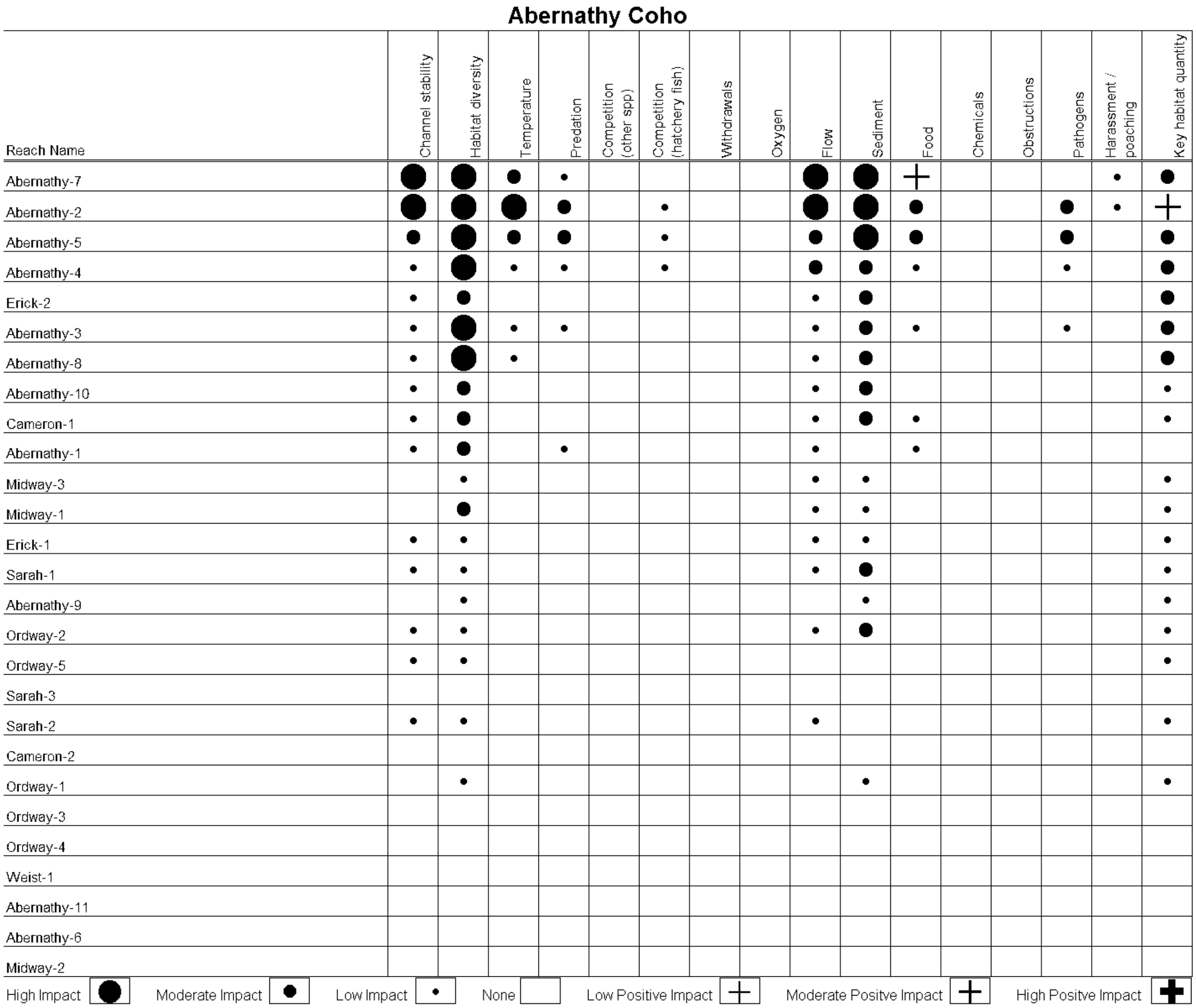


Figure 5-56. Abernathy Creek coho habitat factor analysis diagram.

5.7 Integrated Watershed Assessment (IWA)

For the purposes of this analysis, the Elochoman subbasin has been divided into two watersheds: the Skamokawa-Elochoman watershed, and the Mill-Abernathy-Germany watershed. They are treated here in separate sections.

5.7.1 Skamokawa-Elochoman Watershed

The Skamokawa-Elochoman watershed is a composite watershed that incorporates two primary stream drainages, the Skamokawa and Elochoman Rivers. Other important drainages include Jim Crow Creek, Alger Creek, Risk Creek, and Nelson Creek. For the purpose of the IWA analysis, the Skamokawa-Elochoman watershed is divided into 17 LCFRB recovery planning subwatersheds.

5.7.1.1 Results and Discussion

IWA results for the Elochoman - Skamokawa watershed are shown in Table 5-6. As indicated, IWA results are calculated for each subwatershed at the local level (i.e., within a subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). A reference map showing the location of each subwatershed in the basin is presented in Figure 5-57. Maps of the distribution of local and watershed level IWA results are displayed in Figure 5-58.

Table 5-6. IWA results for the Skamokawa-Elochomam-watershed

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

Notes:

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

[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional

M: Moderately impaired

I: Impaired

[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.

[d] Subwatersheds upstream from this subwatershed.

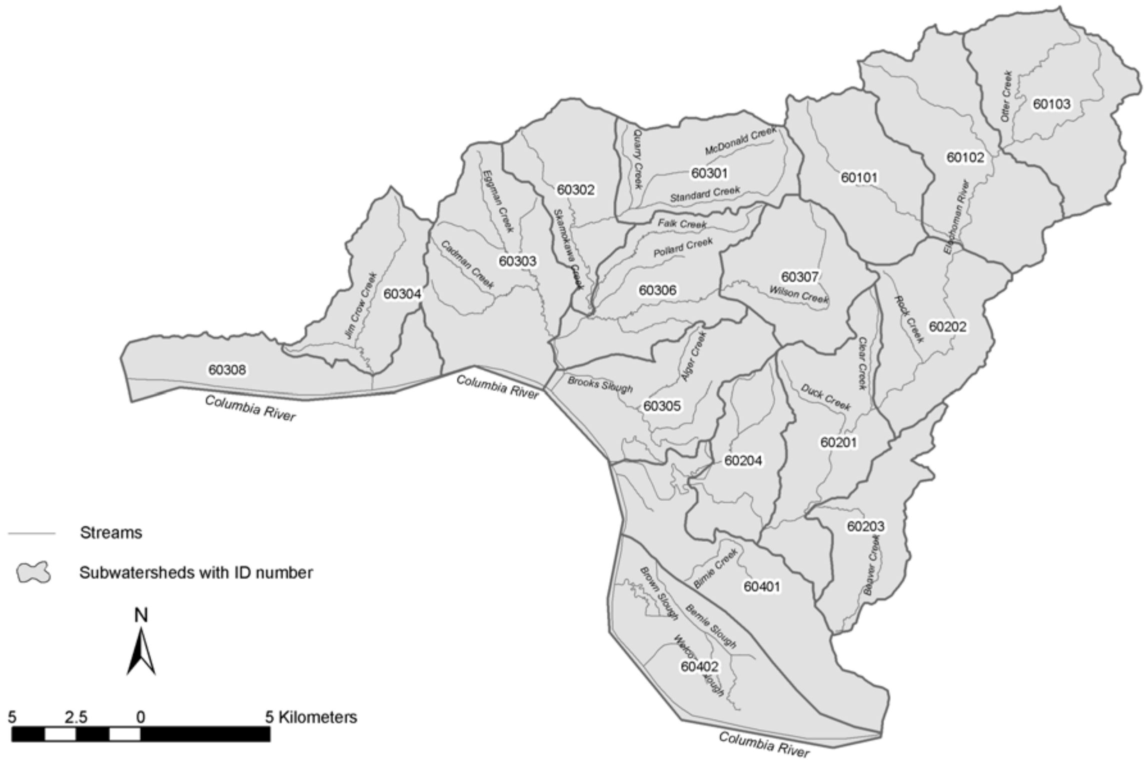


Figure 5-57. Map of the Elochoman-Skamokawa watershed showing the location of the IWA subwatersheds.

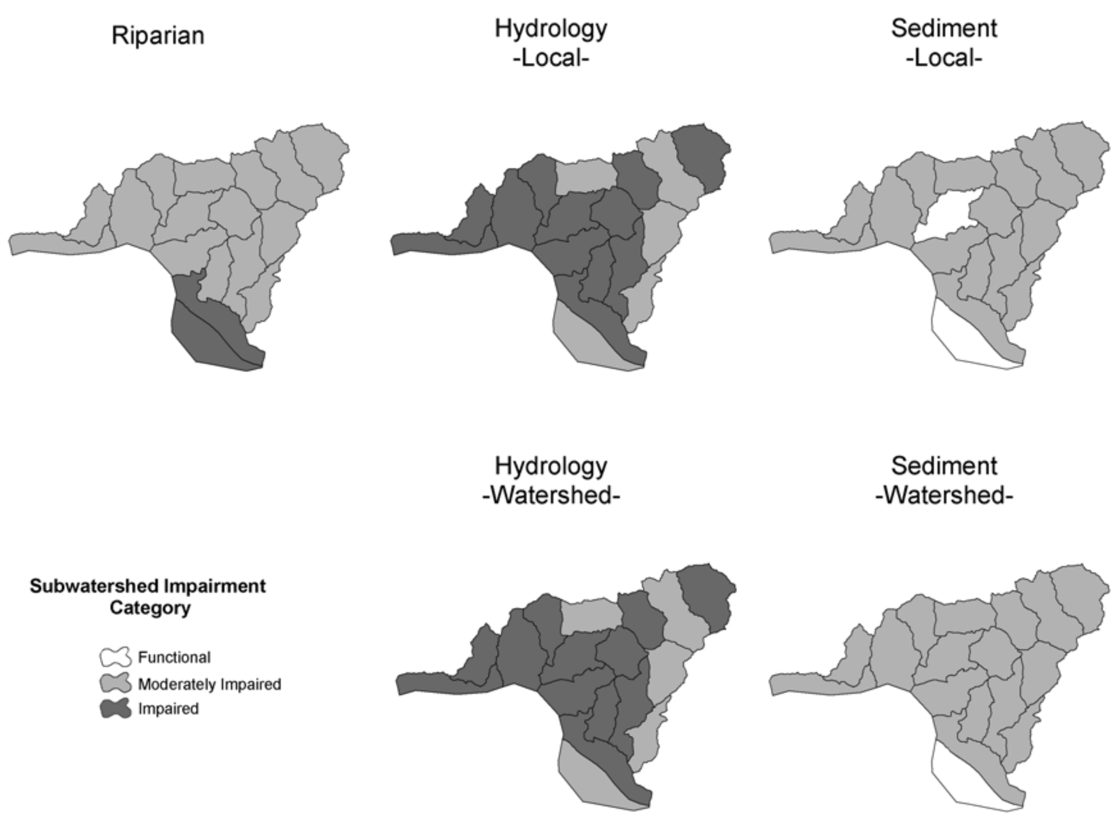


Figure 5-58. IWA subwatershed impairment ratings by category for the Elochoman Skamokawa watershed.

5.7.1.1.1 Hydrology

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

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

The majority of land-use in the Elochoman drainage is timber production on private timber lands. Only two subwatersheds have significant area in public ownership. These are Beaver Creek (60203) and the middle mainstem Elochoman (60202), which are 72% and 48% WDNR lands, respectively. Remaining subwatersheds are predominantly in private timber lands.

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

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

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

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

5.7.1.1.2 Sediment Supply

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

In the Elochoman basin, riparian zones are generally degraded due to historical and current land use practices, which in combination with degraded hydrologic conditions is a source of widespread bank and channel erosion (Wade 2002, WDW 1990). High road densities in upland areas are also significant sources of sediment loading, particularly when located on sensitive slopes in areas with extensive timber harvest. The North Elochoman Watershed Analysis identified shallow rapid landslides associated with forest practices and high road densities as major contributors of fine sediment to the stream system (WDNR 1996). The IWA results generally corroborate the findings of the watershed analysis.

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

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

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

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

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

5.7.1.1.3 Riparian Condition

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

5.7.1.2 Predicted Future Trends

5.7.1.2.1 Hydrology

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

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

5.7.1.2.2 Sediment Supply

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

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

5.7.1.2.3 Riparian Condition

Riparian conditions throughout most of the basin are expected to improve over time due to improved forest practices that aim to protect riparian areas. In the lower mainstem and estuarine areas of the watershed, the potential for riparian recovery is relatively limited due to the extent of channelization. Therefore, riparian conditions are generally predicted to trend stable. Tidal water areas at the mouth of the Skamokawa and Jim Crow Creek (60304 and 60405) are being managed as wildlife refuges. Actual conditions in these areas are not accurately reflected by the riparian ratings which average conditions over the entire subwatershed. Riparian conditions in these subwatersheds should trend towards improvement over the next 20 years.

5.7.2 Mill-Abernathy-Germany Watershed

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.

5.7.2.1 Results and Discussion

IWA results for the Mill-Abernathy-Germany watershed are shown in Table 5-7. As indicated, IWA results are calculated for each subwatershed at the local level (i.e., within a subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). A reference map showing the location of each subwatershed in the basin is presented in Figure 5-59. Maps of the distribution of local and watershed level IWA results are displayed in Figure 5-60.

Table 5-7. IWA results for the Mill-Abernathy-Germany basin.

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

Notes:
[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800030#####.
[b] WA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional
M: Moderately impaired
I: Impaired

[c] WA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.
[d] Subwatersheds upstream from this subwatershed

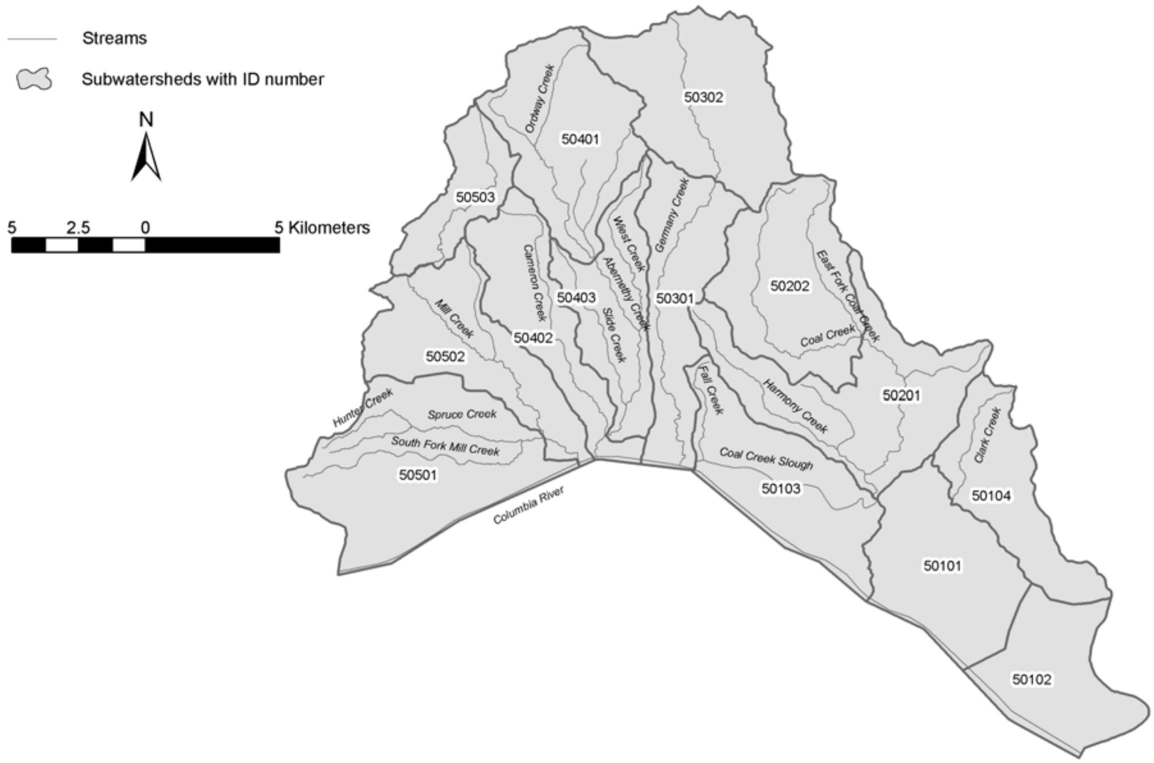


Figure 5-59. Map of the Mill-Abernathy-Germany watershed showing the location of the IWA subwatersheds.

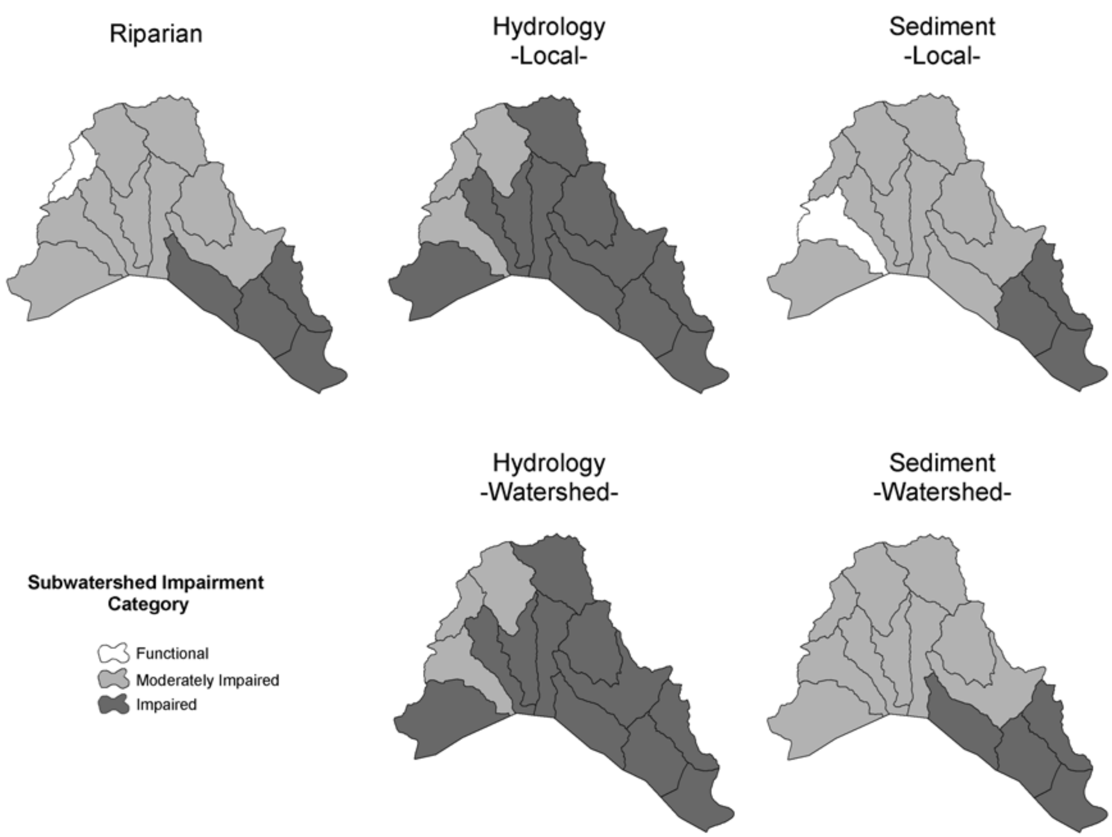


Figure 5-60. IWA subwatershed impairment ratings by category for the Mill-Abernathy-Germany watershed.

5.7.2.1.1 Hydrology

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.

5.7.2.1.2 Sediment Supply

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.

5.7.2.1.3 Riparian Condition

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.

5.7.2.2 Predicted Future Trends

5.7.2.2.1 Hydrology

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.

5.7.2.2.2 Sediment Supply

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.

5.7.2.2.3 Riparian Condition

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.

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