Volume II, Chapter 10
Kalama Subbasin

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10.0 Kalama Subbasin

10.1 Subbasin Description

10.1.1 Topography & Geology

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

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

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

10.1.2 Climate

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

10.1.3 Land Use/Land Cover

Most of the basin is forested and nearly the entire basin is managed for commercial timber production (96%). Only 1.3% is non-commercial forest and 1.5% is cropland. Areas along the lower river have experienced industrial and residential development, resulting in channelization of the lower river. Population density and development in the watershed are low. The year 2000 population was approximately 5,300 persons (LCFRB 2001). The town of Kalama, located near the mouth, is the only urban area in the basin. A portion of the upper basin is located within the Mount St. Helens National Volcanic Monument. National Monument land is managed primarily for natural resource protection and tourism. A breakdown of land ownership and land cover in the Kalama basin is presented in Figure 10-1 and Figure 10-2. Figure 10-3 displays the pattern of landownership for the basin. Figure 10-4 displays the pattern of land cover / land-use.

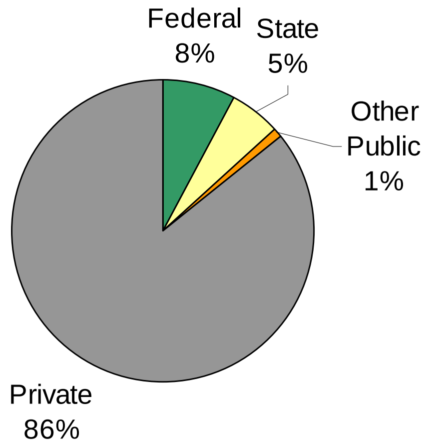


Figure 10-1. Kalama subbasin land ownership

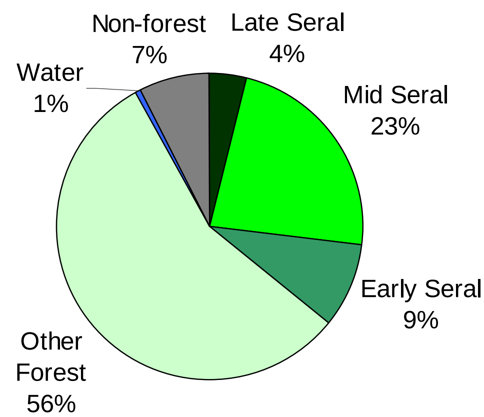


Figure 10-2. Kalama subbasin land cover

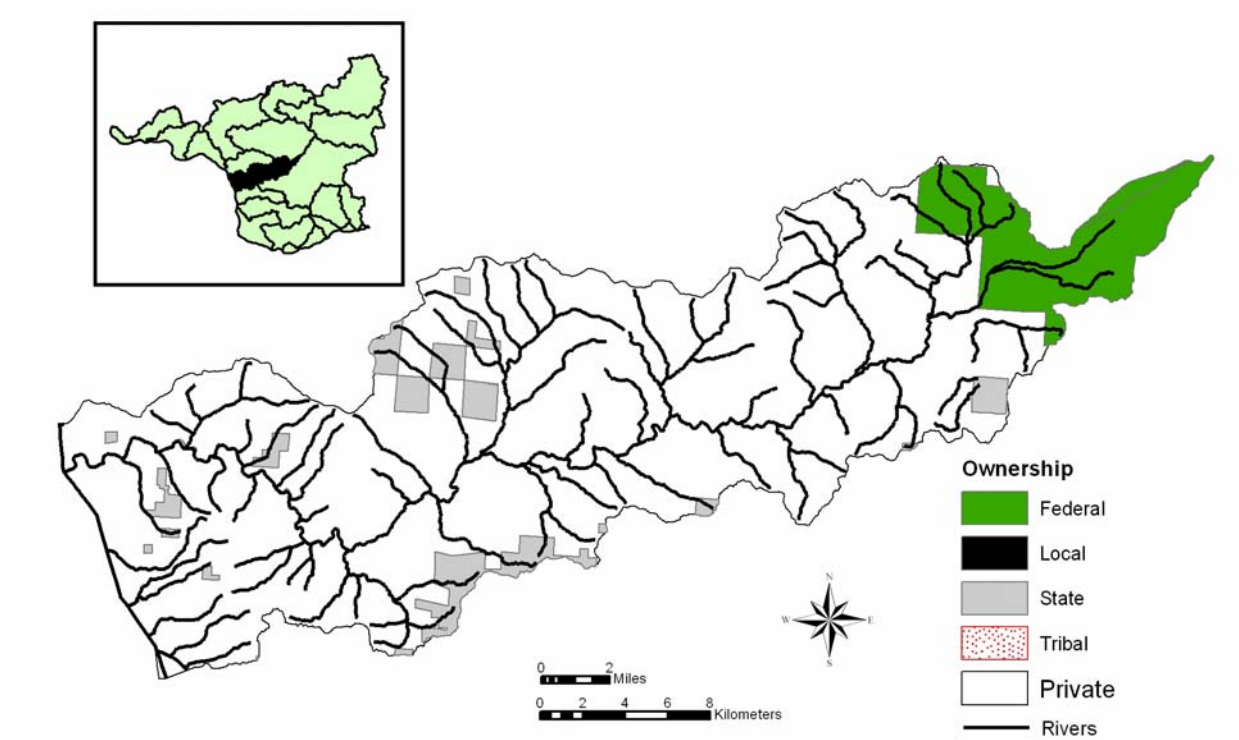


Figure 10-3. Landownership within the Kalama basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

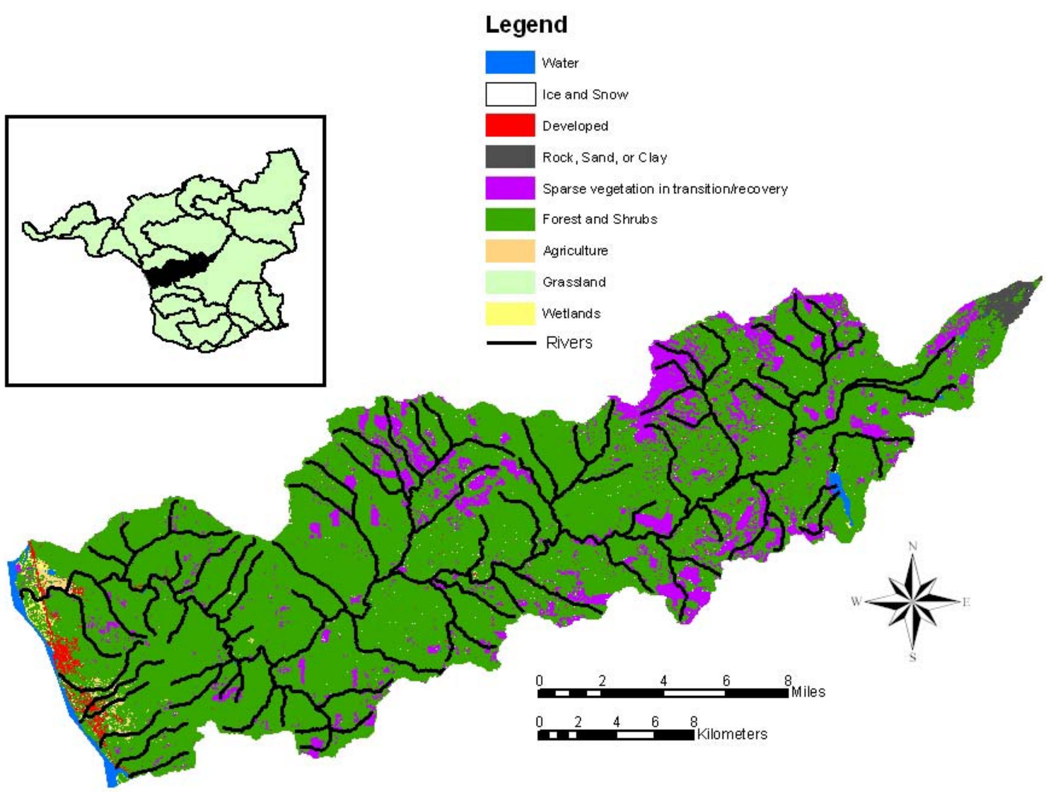
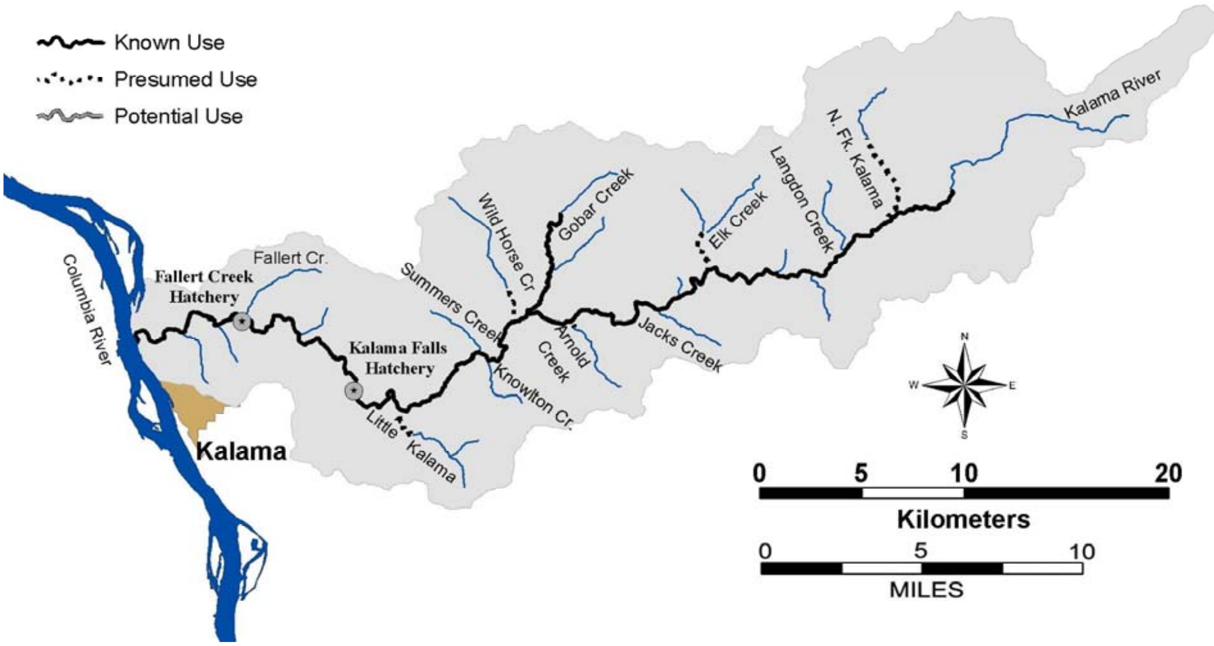


Figure 10-4. Land cover within the Kalama basin. Data was obtained from the USGS National Land Cover Dataset (NLCD).

10.2 Focal Fish Species

10.2.1 Spring Chinook—Kalama Subbasin

ESA: Threatened 1999	SASSI: Depressed 2002

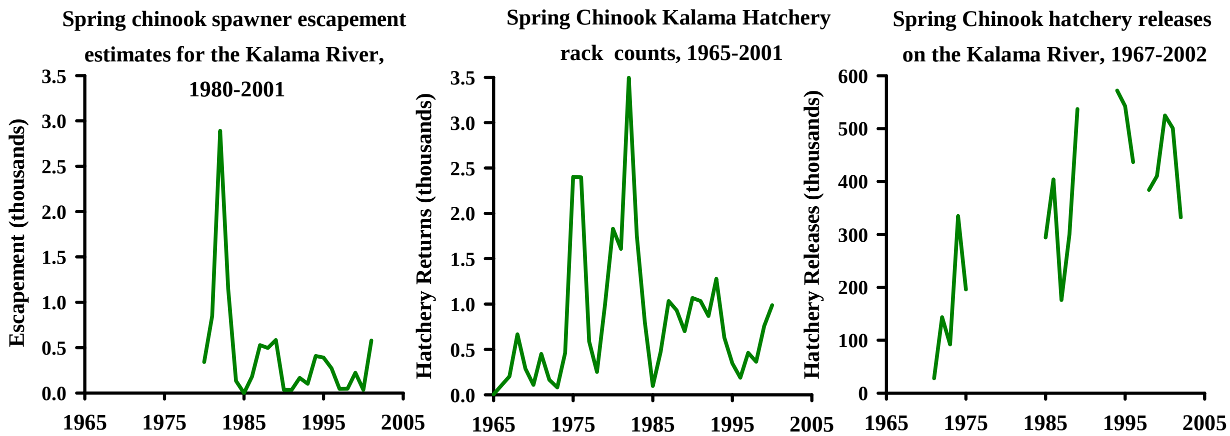


Distribution

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

Life History

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



Diversity

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

Abundance

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

Productivity & Persistence

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

Hatchery

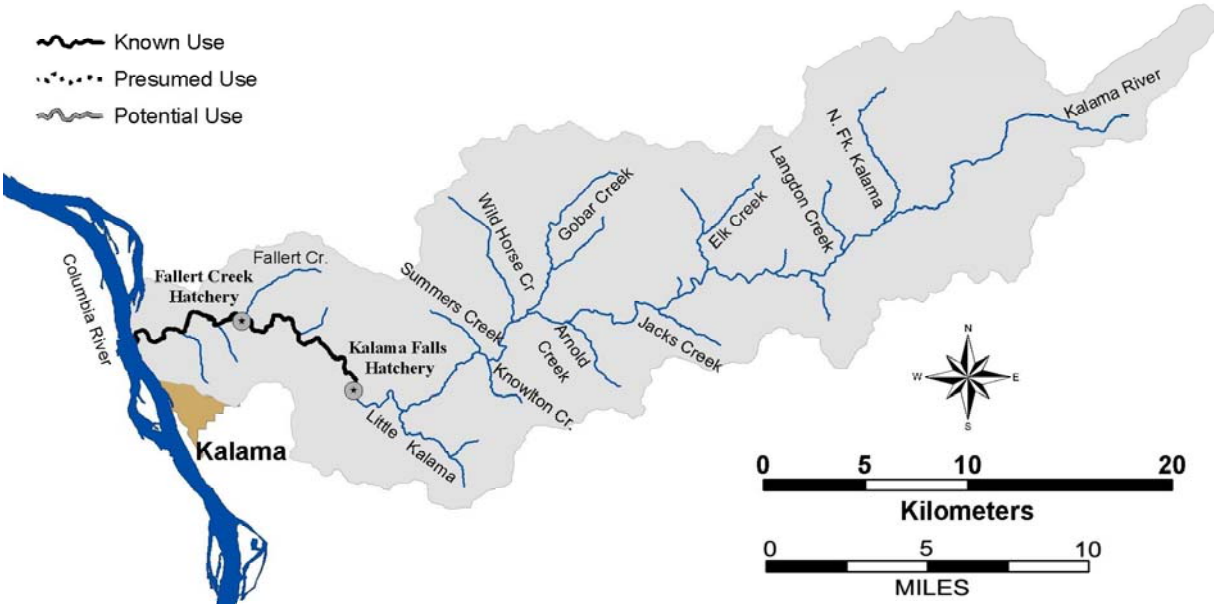
- Fallert Creek (Lower Kalama) Hatchery (RM 4.8) was completed in 1895; Kalama Falls Hatchery (RM 10.5) was completed in 1959; spring chinook have also been reared at Gobar Pond (~4 miles up Gobar Creek); hatchery brood stock is mostly native Kalama stocks with some Cowlitz sock transfers occuring
-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

Harvest

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

10.2.2 Fall Chinook—Kalama Subbasin

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



Distribution

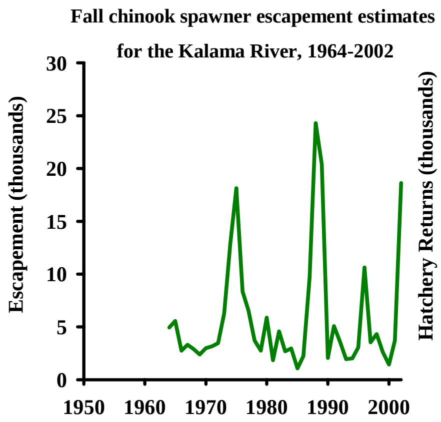
- In the Kalama River, spawning primarily occurs in the mainstem between Kalama Falls Hatchery and the I-5 Bridge (11miles); Lower Kalama Falls (10.5) is a natural barrier to upstream migration; surplus hatchery chinook are released above the falls

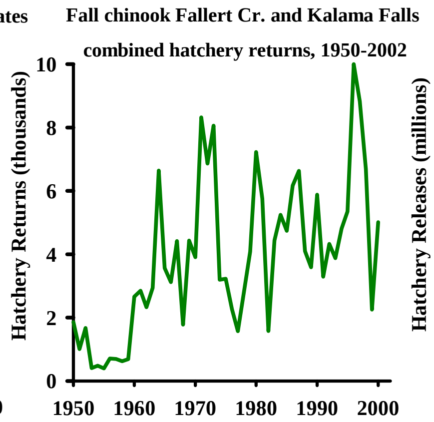
Life History

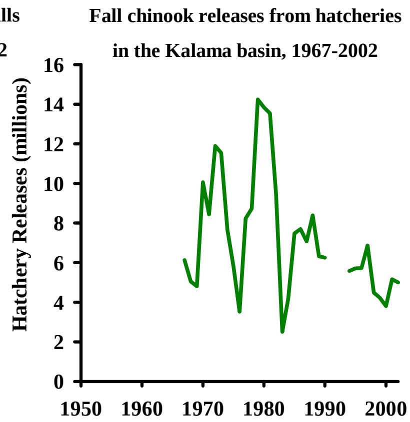
- Fall chinook upstream migration in the Columbia River occurs in mid August to mid September, partly depending on early rainfall; peak entry into the Kalama is late August to early September
- Spawning in the Kalama River occurs between late September and October; the peak is usually around mid-October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

Diversity

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







Abundance

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

Productivity & Persistence

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

Hatchery

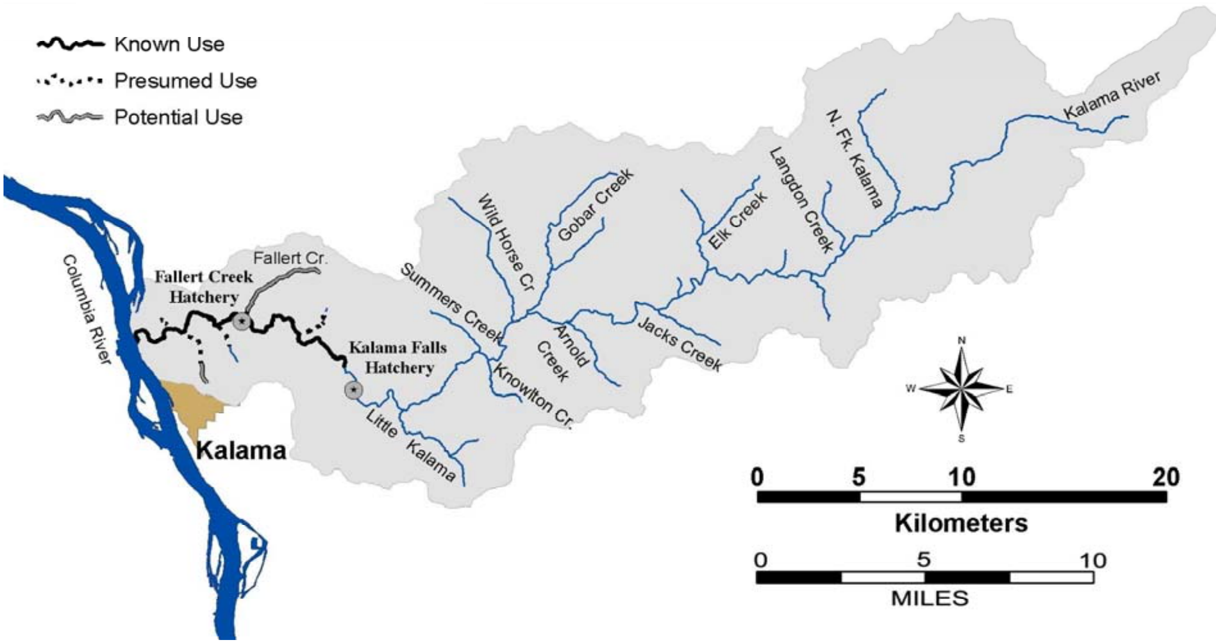
- Lower Kalama (Fallert Creek) Hatchery (RM 4.8) was completed in 1895 (the oldest hatchery in the Columbia basin); Kalama Falls Hatchery (RM 10.5) was completed in 1959
- Hatchery releases of fall chinook in the Kalama began in 1895; hatchery releases are displayed for 1967-2002
- The current hatchery program releases 5.1 million juvenile fall chinook per year into the Kalama River, 2.5 million from Fallert Creek and 2.6 million from Kalama Falls
- Hatchery adult rack returns have ranged from 1,000 to 8,000 since 1960
- Kalama Falls hatchery released upriver bright chinook salmon beginning in the 1970s as an egg bank for Snake River wild fall chinook; the last release was in 1984; a natural run of upriver brights was not established in the Kalama

Harvest

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

10.2.3 Coho—Kalama Subbasin

ESA: Candidate 1995	SASSI: Unknown 2002

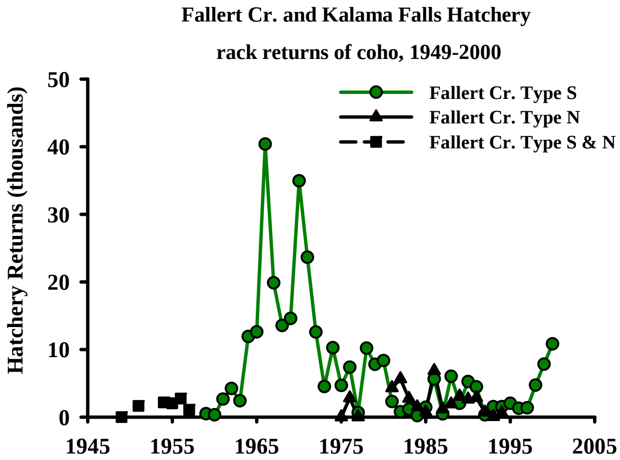


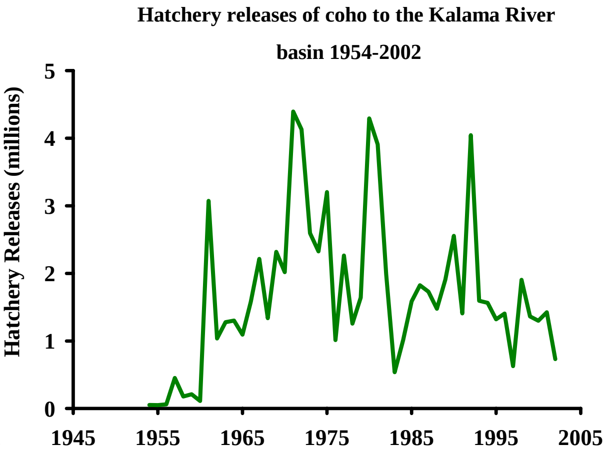
Distribution

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

Life History

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





Diversity

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

Abundance

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

Productivity & Persistence

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

Hatchery

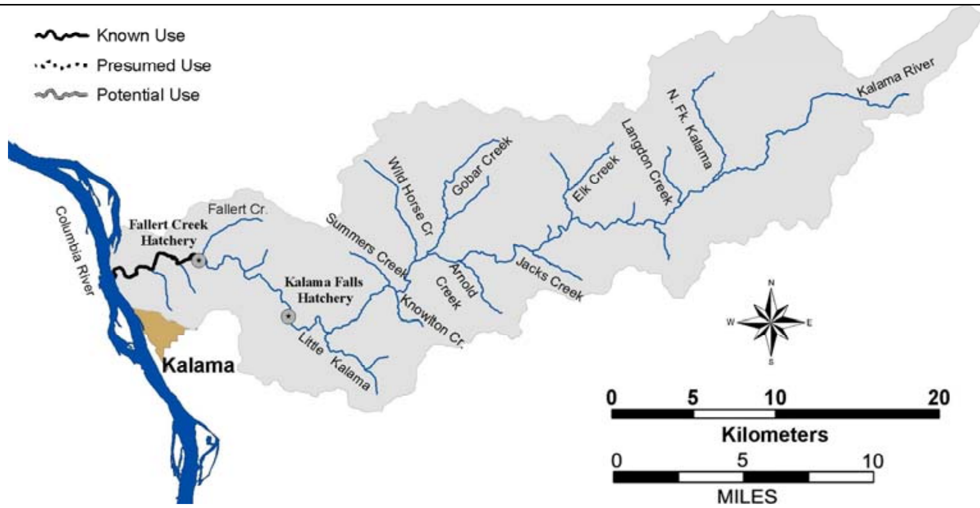
- Fallert Creek Hatchery (completed in 1895) is located about RM 4.3 and the Kalama Falls Hatchery (completed in 1959) is located at RM 10.0
- Coho have been planted in the Kalama basin since 1942; releases were increased substantially in 1967
- The coho program at the two Kalama hatchery complexes was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

Harvest

- Until recent years, natural produced coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas River wild coho
- Since 1999, returning Columbia River hatchery coho have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho in September is constrained by fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon State listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early coho, but late coho harvest can also be substantial
- An average of 1,272 coho (1979-1986) were harvested annually in the Kalama River sport fishery
- CWT data analysis of the 1995-97 Fallert Creek Hatchery early coho indicates 30% were captured in a fishery and 70% were accounted for in escapement
- CWT data analysis of 1995-97 brood Kalama Falls Hatchery late coho indicates 76% were captured in a fishery and 24% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 brood Kalama early coho are distributed between Columbia River (49%), Washington Ocean (42%), and Oregon ocean (9%) sampling areas
- Fishery CWT recoveries of Kalama late coho are distributed between Columbia River (58%), Washington ocean (32%), and Oregon ocean (10%) sampling areas

10.2.4 Chum—Kalama Subbasin

ESA: Threatened 1999	SASSI: NA



Distribution

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

Life History

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

Diversity

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

Abundance

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

Productivity & Persistence

- Current juvenile production is assumed to be low

Hatchery

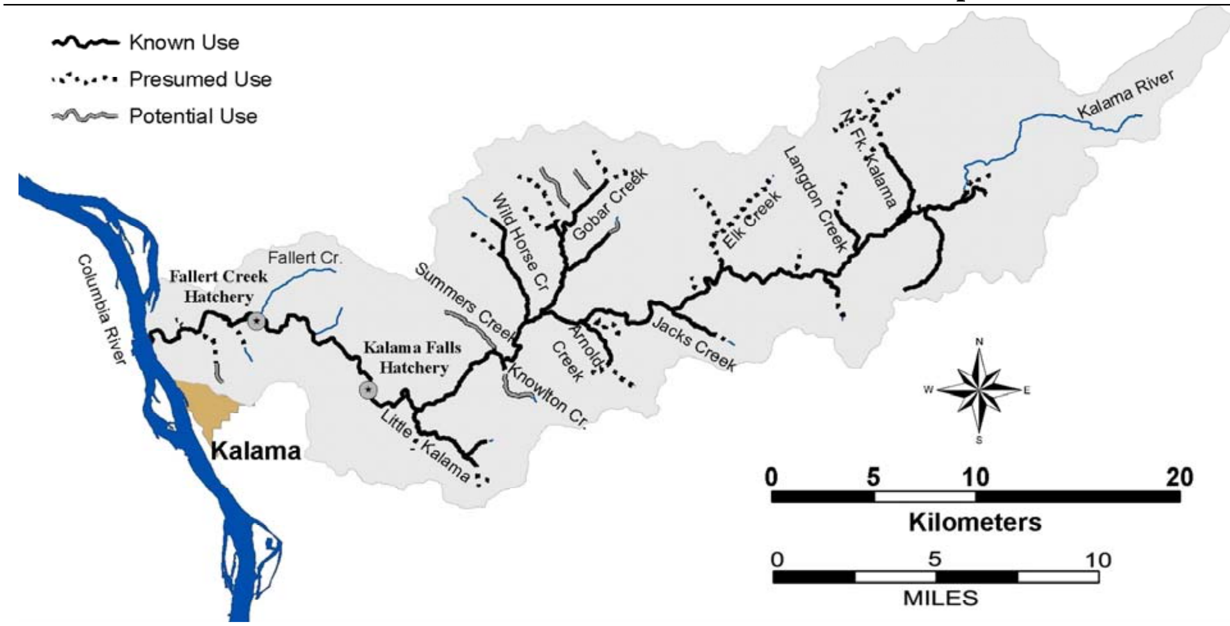
- The Fallert Creek (Lower Kalama) Hatchery and the Kalama Falls Hatchery do not produce/release chum salmon; chum salmon releases into the Kalama basin from other hatcheries have not been documented

Harvest

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

10.2.5 Summer Steelhead—Kalama Subbasin

ESA: Threatened 1998	SASSI: Depressed 2002



Distribution

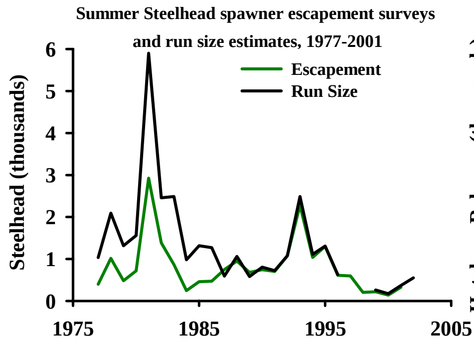
- Spawning occurs above Lower Kalama Falls in the mainstem and NF Kalama River and throughout many tributaries, including Gobar, Elk, Fossil, and Wild Horse Creeks
- A 35ft falls at RM 36.8 blocks all upstream migration

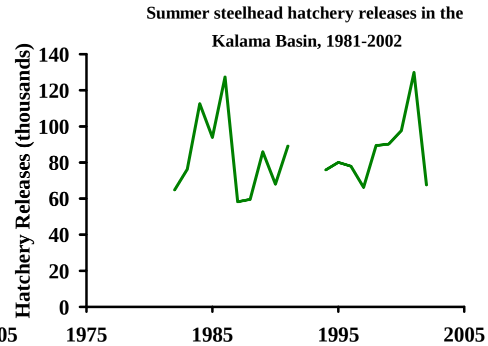
Life History

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

Diversity

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





Abundance

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

Productivity & Persistence

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

Hatchery

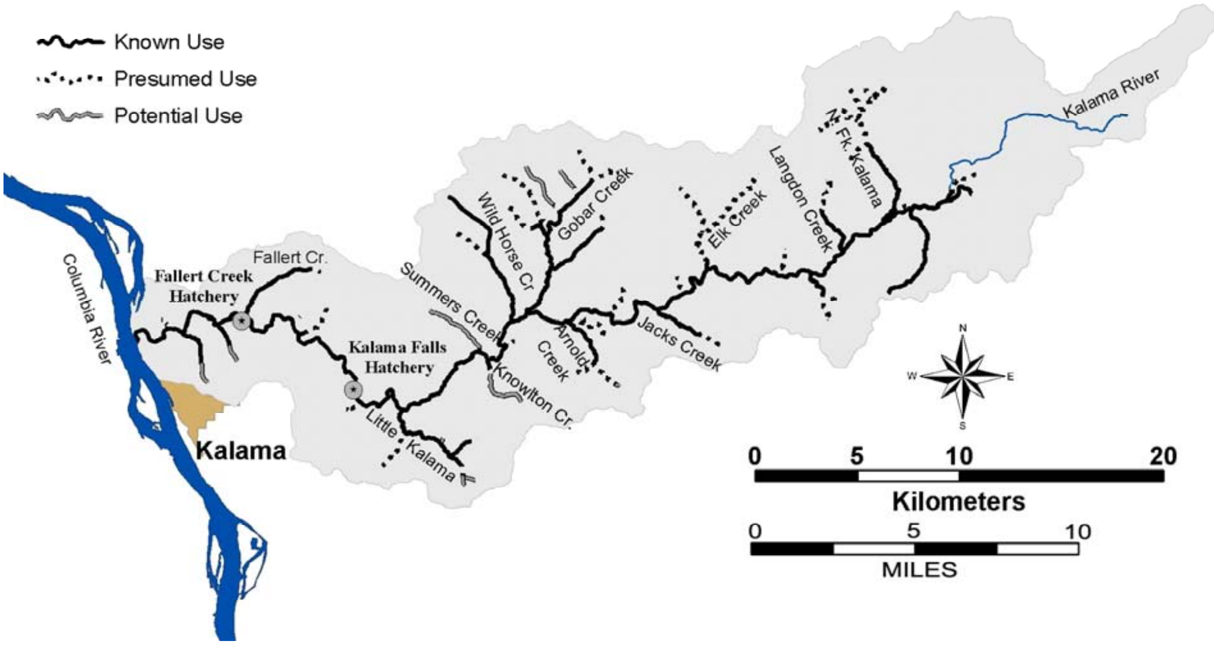
- Two hatcheries in the Kalama basin: Fallert Creek (Lower Kalama) Hatchery (RM 4.3) and Kalama Falls Salmon Hatchery (RM 10); neither hatchery produces summer steelhead
- Gobar Pond, located about 4 miles up Gobar Creek (RM 19.5), is used as a steelhead acclimation pond for 1-2 months prior to release
- Summer steelhead from Beaver Creek and Skamania Hatcheries have been transferred to Gobar Pond as yearlings; steelhead acclimated at Gobar Pond have been released directly to Gobar Creek or trucked and released directly into the Kalama River; release data are displayed from 1981-2002
- Kalama research estimates success of hatchery fish producing adult offspring was only 12% that of wild fish
- Hatchery summer steelhead usually comprise 70-80% of the spawning escapement

Harvest

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

10.2.6 Winter Steelhead—Kalama Subbasin

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



Distribution

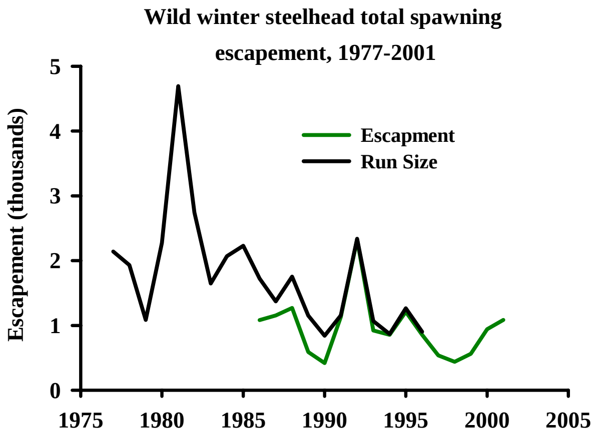
- Spawning occurs in the mainstem Kalama River and Gobar, Elk, and Fossil Creeks
- A 35 ft falls at RM 36.8 blocks all upstream migration

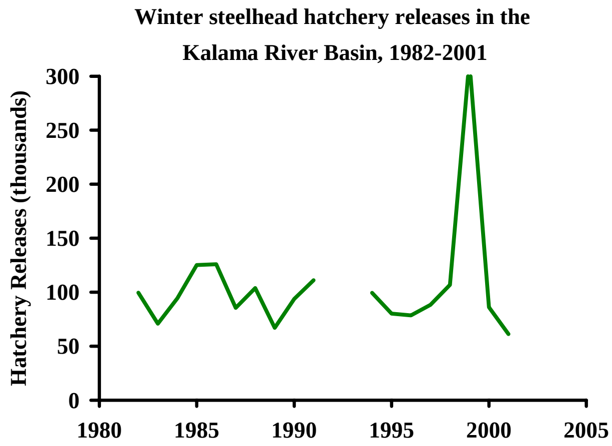
Life History

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

Diversity

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





Abundance

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

Productivity & Persistence

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

Hatchery

- Two hatcheries in the Kalama basin: Fallert Creek (Lower Kalama) Hatchery (RM 4.3) and Kalama Falls Salmon Hatchery (RM 10); neither hatchery produces winter steelhead
- Gobar Pond, located about 4 miles up Gobar Creek (RM 19.5), is used as a steelhead acclimation pond for 1-2 months prior to release
- Hatchery winter steelhead have been planted in the Kalama basin as early as 1938; consistent releases began in 1955; hatchery winter steelhead are transferred to Gobar Pond as yearlings; steelhead acclimated at Gobar Pond are released directly to Gobar Creek or trucked and released directly into the Kalama River; the Cowlitz and Beaver Creek Hatcheries have released steelhead smolts directly to the Kalama without acclimation; release data are displayed from 1982-2001
- There is some contribution to natural production from hatchery winter steelhead spawning in the Kalama River basin

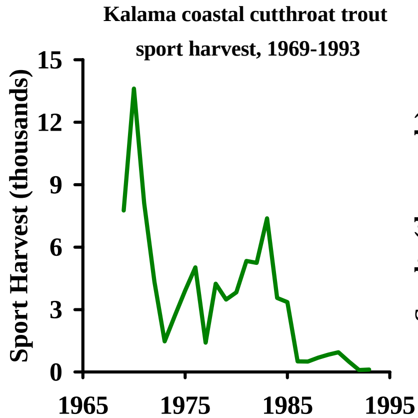
Harvest

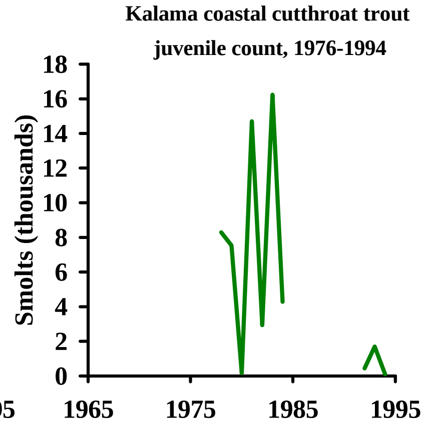
- No directed commercial or tribal fisheries target Kalama winter steelhead; incidental mortality currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Treaty Indian harvest does not occur in the Kalama River basin

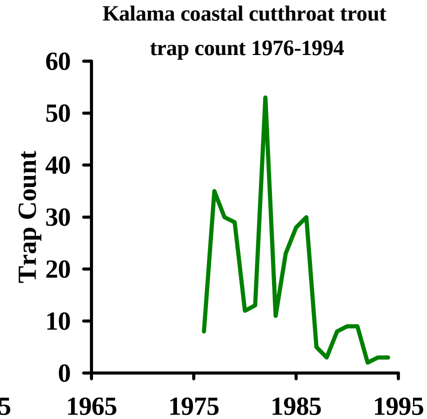
- Wild winter steelhead sport harvest in the Kalama River from 1977-1999 ranged from 4 to 2,162 (average 610); since 1990, regulations limit harvest to hatchery fish only
- ESA limits fishery impact of wild winter steelhead in the mainstem Colubia River and in the Kalama River

10.2.7 Cutthroat Trout—Kalama River Subbasin

ESA: Not Listed	SASSI: Depressed 2000







Distribution

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

Life History

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

Diversity

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

Abundance

- Declining trends in adult counts, smolt estimates, and sport catch data
- Kalama Falls fishway counts ranged from 8 to 53 cutthroat, and averaged 25 fish from 1976 to 1986
- From 1987 to 1995, counts ranged from 2 to 9 fish per year, and averaged 5
- Estimate of smolts produced above Kalama Falls from 1978 through 1984 ranged from 163 to 16,229 with a yearly average of 7,737.
- From 1992 to 1994, the range dropped to 106 to 1667 with an average of 749 smolts
- Average yearly catch of cutthroat from lower Columbia River sport creel census data averaged 4985 fish from 1969-1985, but only 521 fish from 1986-1993
- Wild cutthroat must now be released in the Kalama River sport fisheries
- No population size data for resident forms

Productivity & Persistence

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

Hatchery

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

Harvest

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

10.3 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.

- Loss of tributary habitat quality and quantity is an important impact for all species, particularly for chum. Loss of estuary habitat quality and quantity is also important, particularly for chum and winter steelhead. The combination of tributary and estuary habitat factors account for 82% and 63% of the relative impact to chum and winter steelhead, respectively.
- Harvest has a large relative impact on fall and spring chinook and coho and moderate impact on winter and summer steelhead. Harvest effects on chum are minimal.
- Hatchery impacts are substantial for coho and fall and spring chinook, and are minimal for steelhead and chum.
- Predation impacts are moderate for winter and summer steelhead, but appear less important for coho, chum, and fall and spring chinook.
- Hydrosystem access and passage impacts appear to be relatively minor for all species.

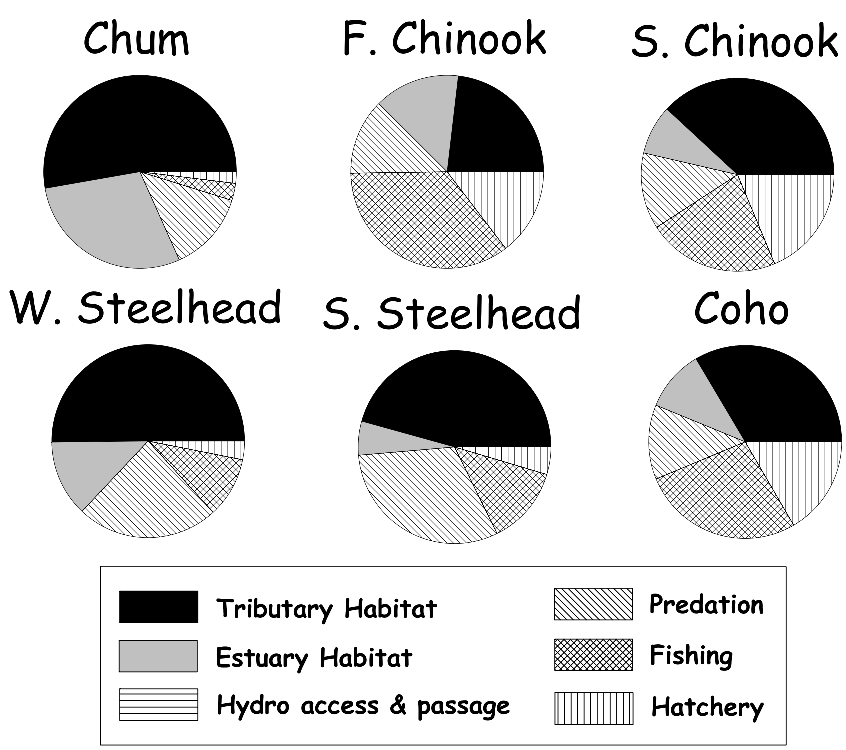


Figure 10-5. Relative index of potentially manageable mortality factors for each species in the Kalama subbasin.

10.4 Hatchery Program

The Kalama River basin has two hatchery facilities: the Lower Kalama (Fallert Creek) Hatchery at RM 4.8 was completed in 1895, and the Kalama Falls Hatchery at RM 10.5 was completed in 1959. Gobar Pond is a rearing and acclimation site on Gobar Creek, a tributary upstream of Kalama Falls Hatchery. Production goals for the entire hatchery complex are 5 million fall chinook, 500,000 spring chinook, 350,000 early run coho smolts, 350,000 late run coho smolts, 45,000 Kalama "wild" late winter steelhead smolts, 45,000 early winter steelhead smolts, 60,000 Kalama "wild" summer steelhead smolts, and 30,000 Skamania stock summer steelhead smolts (Figure 10-6). The winter and summer steelhead programs were adjusted in 1998 and 1999, respectively, to use only "wild" (adipose-present) steelhead broodstock entering the hatchery adult collection facility. The goals of the new steelhead programs are to enhance recreational harvest opportunity and to serve as a risk management tool, maintaining wild broodstock in case of a catastrophic event that negatively effects the natural population. The other hatchery programs continue to support harvest as part of the hydrosystem mitigation.

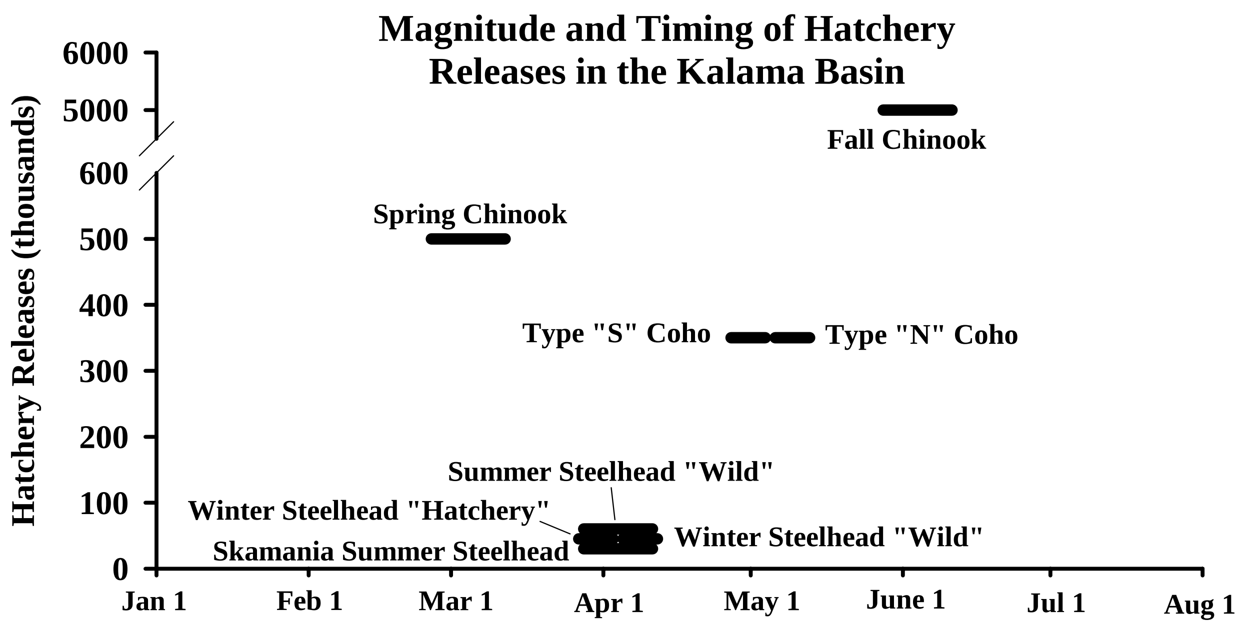


Figure 10-6. Magnitude and timing of hatchery releases in the Kalama River basin by species, based on 2003 brood production goals.

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

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

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

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

Interactions—Hatchery production accounts for the majority of fall chinook returning to the Kalama River. A weir is placed annually in the lower river to collect broodstock for the hatchery program. Hatchery and natural production are not distinguishable by external marking. A portion of the return is collected for hatchery broodstock and a portion is passed above the weir to spawn naturally. The number of natural spawners is usually dependent on the total returns, after egg-take requirements are met (Figure 10-7). Juvenile fall chinook may compete with other juvenile salmonids for food and space. This competition is likely minimized by releasing fall chinook smolts that are ready to emigrate. Also, hatchery and wild fish interactions are less likely for fall chinook released from the Fallert Creek Hatchery than for releases from the Kalama Falls Hatchery, because the emigration distance within the basin is shorter.

Hatchery strays from the Kalama Hatchery program account for most spring chinook spawning in the Kalama River; wild fish abundance is generally low (Figure 10-7). Juvenile production from natural spawning is presumed to be low. Spring chinook juveniles may compete with other salmonids for food and space. However, release is timed for smolting, which should minimize time in the watershed and minimize interactions with wild juveniles.

Hatchery production accounts for most coho salmon returning to the Kalama River (Figure 10-7). Juvenile production from natural spawning is presumed to be low. Because few adult wild coho are present, the potential for interaction between wild/hatchery coho adults is likely low. Competition from hatchery coho smolts on other juvenile salmonids is a concern in the Kalama River basin. However, because smolts are released volitionally after smoltification and migrate out of the basin rapidly, competition with other salmonids in the Kalama River is likely minimized. Hatchery coho smolts rarely residualize (0.002%) so there is little concern about ongoing competition with resident fish. Additionally, significant predation by coho smolts on juvenile fall chinook may be occurring, as has been documented in the Lewis River.

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

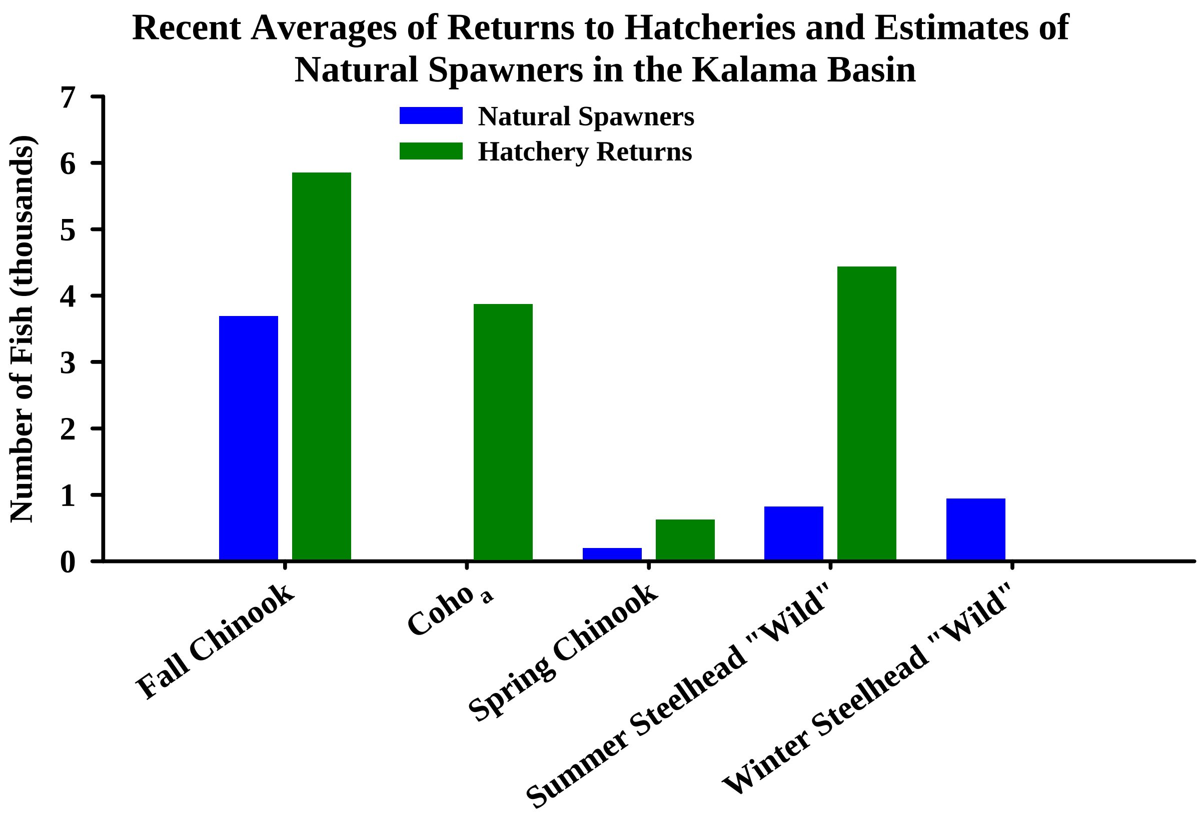


Figure 10-7. Recent average hatchery returns and estimates of natural spawning escapement in the Kalama River basin by species.

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

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

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

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

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

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

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

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

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

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

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

10.5 Fish Habitat Conditions

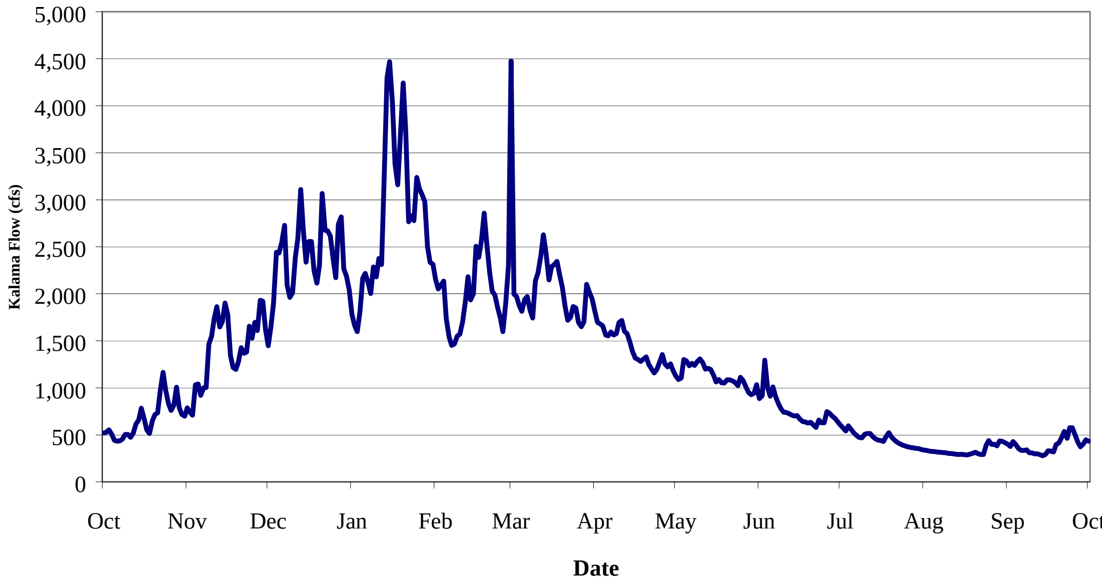
10.5.1 Passage Obstructions

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

10.5.2 Stream Flow

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

Figure 10-8. Kalama River hydrograph (1966-1975). Values are daily mean flows. The Kalama



exhibits a fall through spring rainfall dominated regime, with flows typically falling below 300 cfs in late summer. Data is from USGS Stream Gage #14223500; Kalama River Below Italian Cr. near Kalama, Wash.

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

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

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

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

Consumptive water use in the subbasin is estimated to increase from the current 308 million gallons per year (mgy) to 523 mgy by 2020. However, current and predicted future surface and groundwater use is believed to have a relatively insignificant impact on stream flows

(LCFRB 2001). The Limiting Factors Analysis, on the other hand, suggested that water withdrawal development in the lower basin could be a potential future problem (Wade 2000).

10.5.3 Water Quality

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

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

10.5.4 Key Habitat

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

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

10.5.5 Substrate & Sediment

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

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

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

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

10.5.6 Woody Debris

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

10.5.7 Channel Stability

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

10.5.8 Riparian Function

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

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

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

10.5.9 Floodplain Function

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

10.6 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 Kalama River fall chinook, spring chinook, winter steelhead, summer steelhead, chum, and coho. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Volume VI.

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.

10.6.1 Population Analysis

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

Habitat-based assessments were completed in the Kalama River subbasin for summer steelhead, winter steelhead, fall chinook, spring chinook, chum, and coho. For all modeled populations, productivity has decreased by 62-90% from historical levels, with chum and spring chinook declining the most (Table 10-1). Adult abundance trends show similar declines (Figure 10-9). Model results indicate that adult abundance of Kalama fall chinook, coho, winter steelhead and summer steelhead has declined by 43-63% from historical levels. Spring chinook and chum, however, have had the most severe declines in adult abundance, with current estimates at only 8% of historical levels. Species diversity (as measured by the diversity index) has remained constant for both fall chinook and summer steelhead (Table 10-1). However, diversity has declined by 9-21% for spring chinook, chum and winter steelhead, and by 63% for coho (Table 10-1).

Estimates of current smolt productivity have decreased from historical estimates in all populations (Table 10-1). Smolt productivity has declined most for winter steelhead and least for chum. However, in the case of chum, this seems counter-intuitive due to the fact that chum adult abundance has declined the most out of the six species. However, this relatively higher smolt productivity is merely an artifact of the way the EDT model calculates productivity. That is, the higher productivity of chum smolts is because Kalama chum now have many less trajectories (life history pathways) that are viable (those that result in return spawners); but the few trajectories that remain have higher productivities than historical trajectories (many of which were only marginally viable). Smolt abundance has decreased by 31-46% for fall chinook, winter steelhead, and summer steelhead, and by 70-83% for spring chinook, chum, and coho (Table 10-1).

Model results indicate that restoration of properly functioning habitat conditions (PFC) would benefit all species (Table 10-1). The most dramatic increase in adult abundance with restoration to PFC would be for chum and coho. Current coho abundance would increase by approximately 113% and current chum abundance by approximately 272%. Smolt numbers are also estimated to increase dramatically for all species, especially for coho, which shows a 343% increase in smolt abundance with restoration of PFC.

Table 10-1. Kalama subbasin— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

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

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

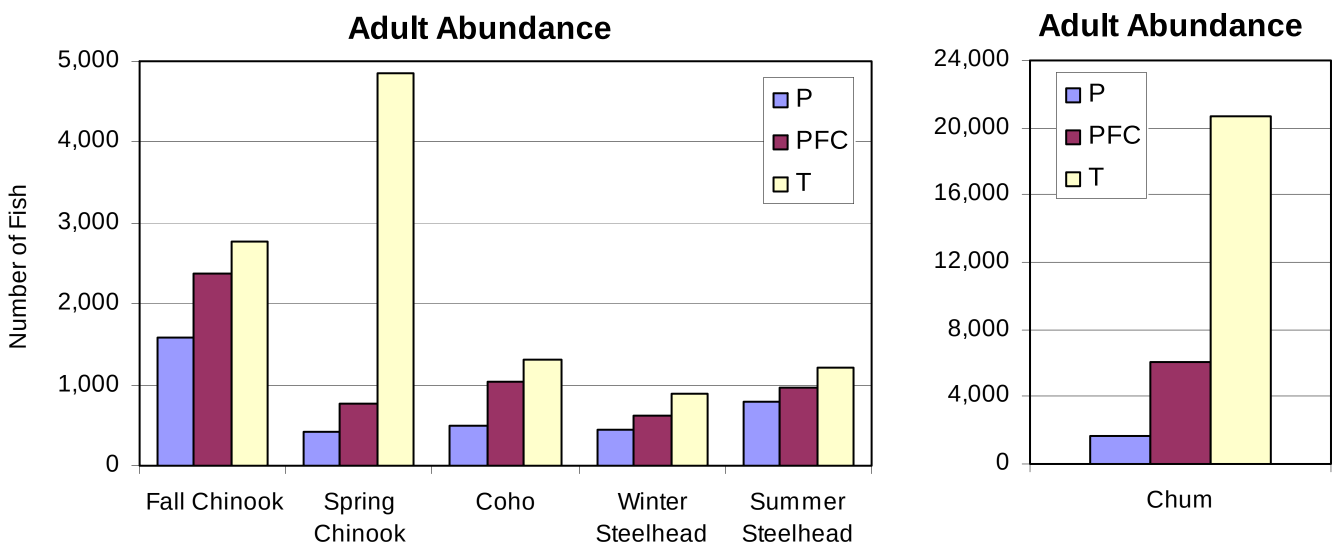


Figure 10-9. Adult abundance of Kalama fall chinook, spring chinook, coho, winter steelhead, summer steelhead and chum based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

10.6.2 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.

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

High priority reaches for summer steelhead are located in the headwaters (Kalama 17-20) and the middle mainstem (Kalama 6) (Figure 10-11). The headwater and headwater tributary areas represent important spawning reaches, while the middle mainstem is particularly important for summer adult holding and parr rearing. These important reaches, except for Kalama 6, show a combined preservation and restoration habitat recovery emphasis (Figure 10-11). Kalama 6 has, by far, the highest preservation potential of any summer steelhead reach.

High priority reaches for winter steelhead also include the middle mainstem (Kalama 6 and 8-10), but due to their slightly more downstream distribution, important reaches also include portions of the lower river (Kalama 4 and 5) (Figure 10-12). The lower reaches show a habitat restoration emphasis, while the middle reaches show a combined preservation and restoration habitat recovery emphasis (Figure 10-12).

High priority reaches are similar for fall chinook (Figure 10-13), chum (Figure 10-14), and coho (Figure 10-15). These reaches are primarily located in the lower sections of the river (Kalama 2-5 and Kalama 1 tidal). For both fall chinook and chum, these reaches have either a habitat preservation emphasis or a combined preservation and restoration emphasis. However, for coho, these same reaches have a strong restoration potential only.

For spring chinook, important reaches are found throughout the middle and upper sections of the subbasin (Kalama 8-18) (Figure 10-16). All these reaches, except for Kalama 8 and 18, have a habitat preservation emphasis. Kalama 8 and 18 show a combined preservation and restoration habitat recovery emphasis (Figure 10-16).

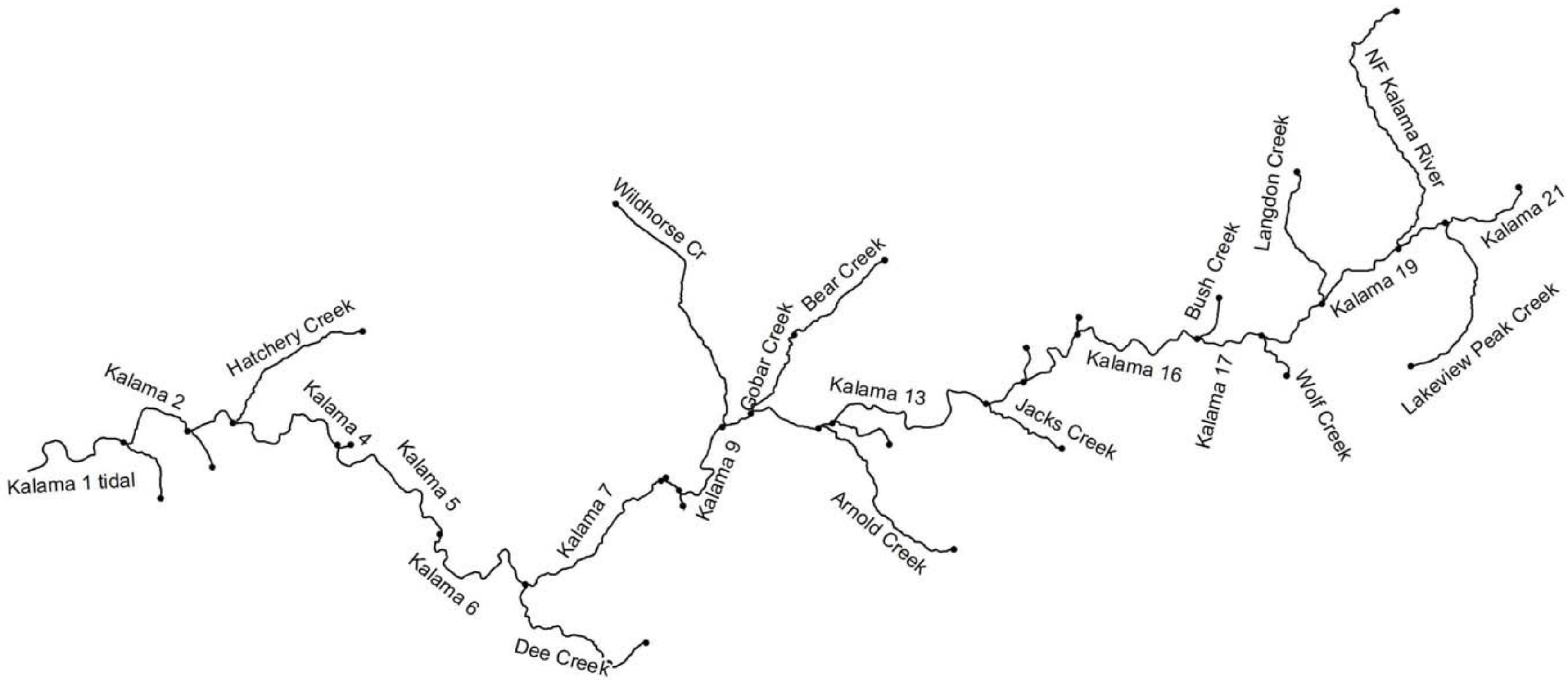


Figure 10-10. Kalama subbasin EDT reaches. Some reaches not labeled for clarity.

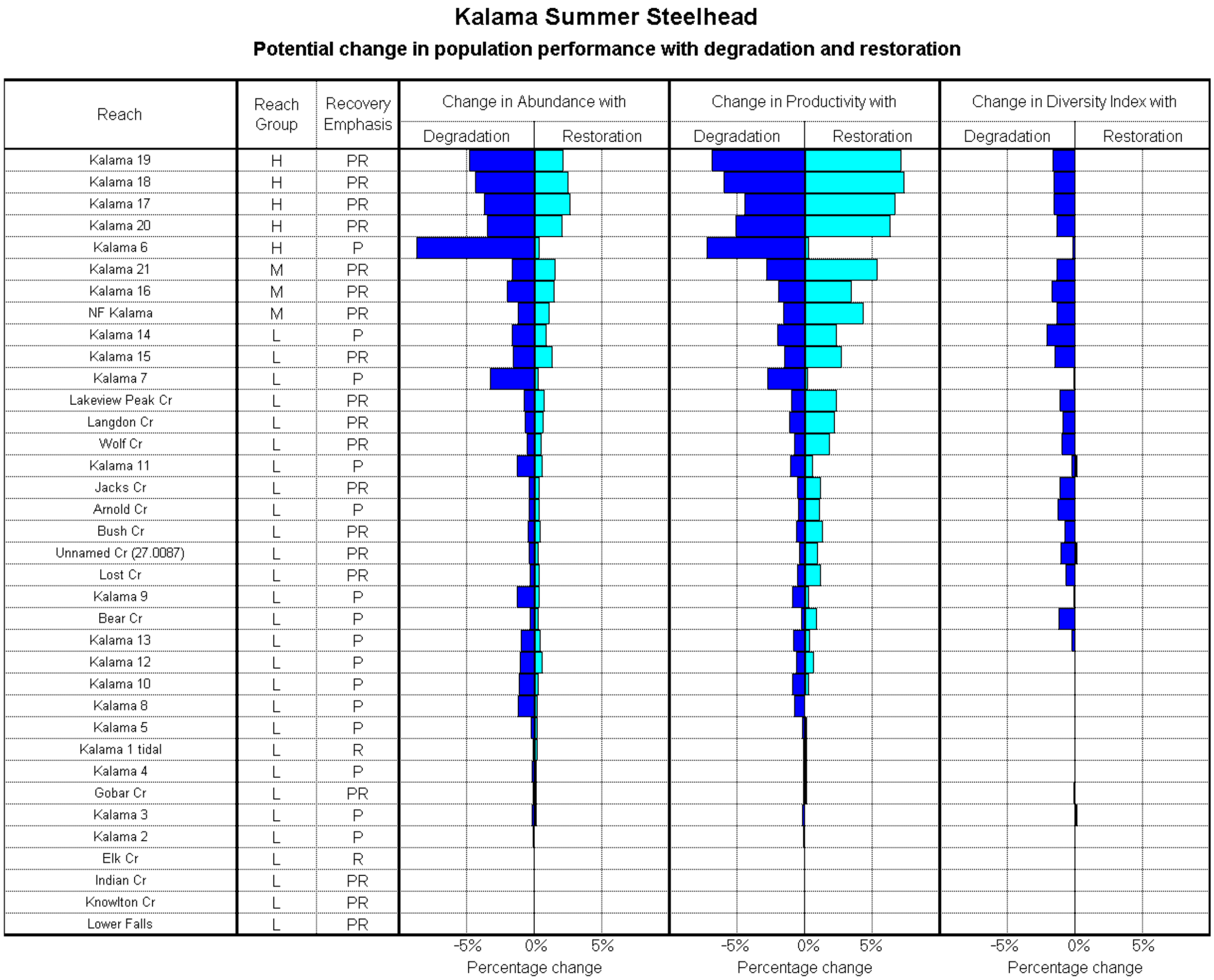


Figure 10-11. Kalama subbasin summer steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Volume VI for more information on EDT ladder diagrams.

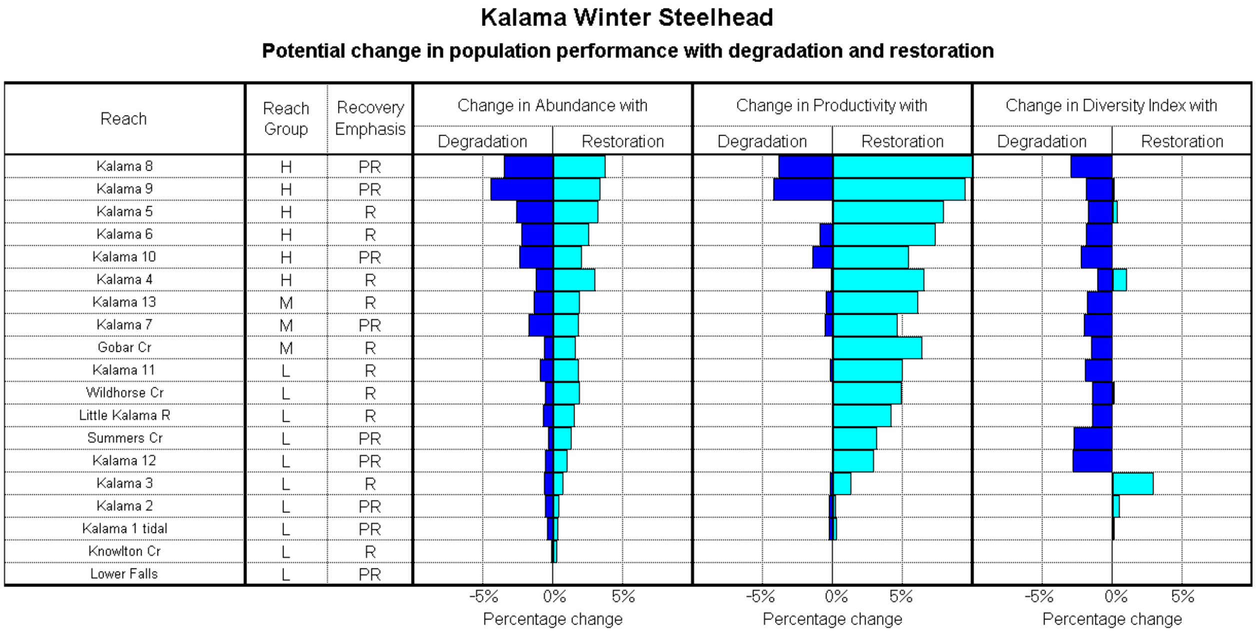


Figure 10-12. Kalama subbasin winter steelhead ladder diagram.

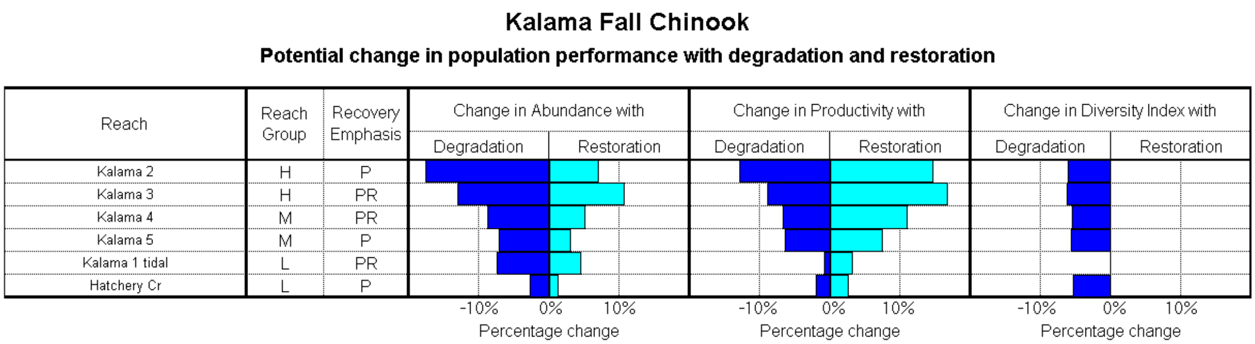


Figure 10-13. Kalama subbasin fall chinook ladder diagram.

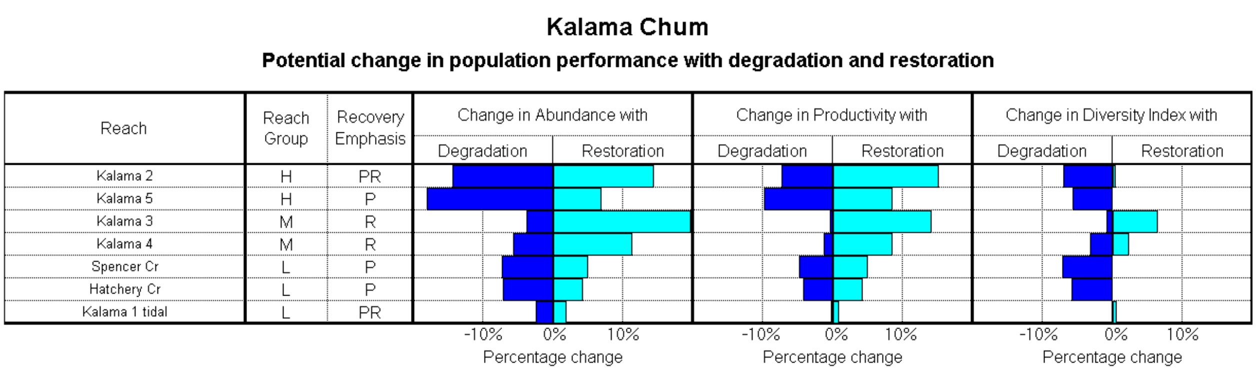


Figure 10-14. Kalama subbasin chum ladder diagram.

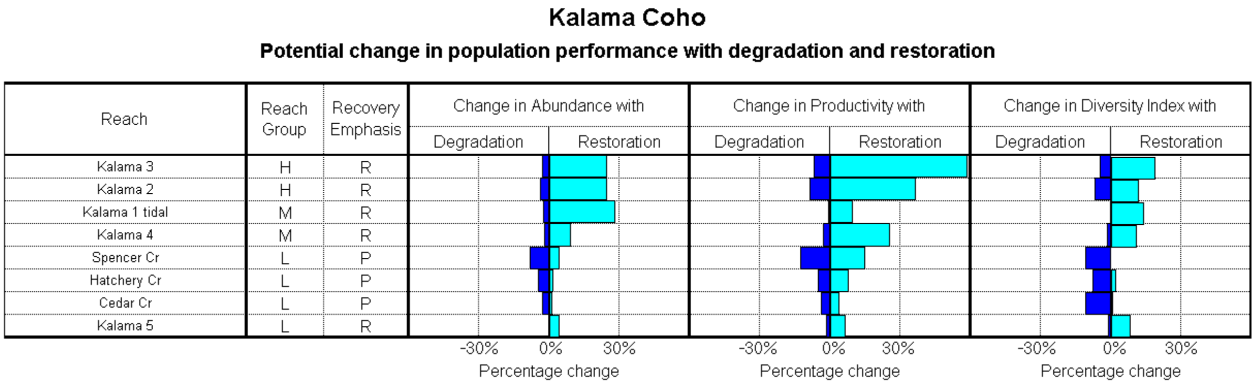


Figure 10-15. Kalama subbasin coho ladder diagram.

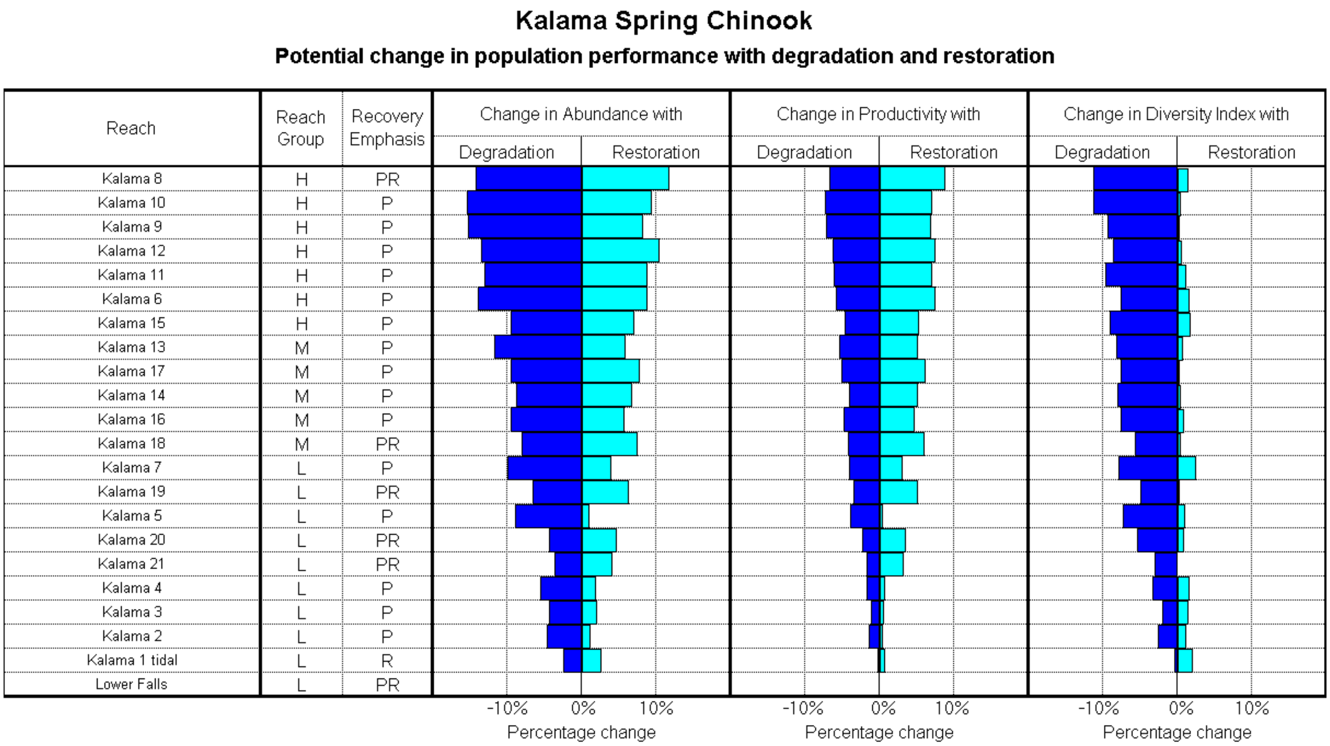


Figure 10-16. Kalama subbasin spring chinook ladder diagram.

10.6.3 *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.

The key summer steelhead reaches in the headwaters and headwater tributaries are affected by degraded habitat diversity, sediment, and flow conditions, with lesser impacts due to channel stability and key habitat quantity (Figure 10-17). Degraded conditions affecting habitat diversity are attributable to low instream large wood quantities and young riparian forests. Sediment and flow conditions are related to the intense timber harvests that have occurred in this basin and the associated road network. Many upper basin subwatersheds have over 6 miles of road per square mile. These are some of the highest road densities in the region. Vegetation conditions are also poor, with most of the upper basin forests in stand initiation or early-seral stages. In four out of eight upper subwatersheds assessed in the 1996 Upper Kalama Watershed Analysis (USFS 1996), peak flows were estimated to be elevated over historical levels due to vegetation and road conditions. Channel stability conditions are related to flow alterations and degraded riparian forests. The food resource has been affected by the removal of overhanging tree canopies. Minor predation and competition impacts are related to an ongoing steelhead reproductive success study in the watershed.

Restoration of winter steelhead habitat should focus on the middle mainstem, middle tributaries, and the lower river reaches. The primary degraded attributes in these areas include sediment, habitat diversity, and flow (Figure 10-18). Once again, sediment and flow conditions are related to logging and road densities. Road densities are very high in the middle mainstem and tributary subwatersheds. The Lower Gobar Creek subwatershed has one of the highest road densities of any forested subwatershed in the region, with 7.4 miles of road per square mile. Non-vegetated or shrub vegetated (i.e. stand initiation) forestland makes up 74% of this subwatershed.

High priority reaches for fall chinook (Figure 10-19), chum (Figure 10-20) and coho (Figure 10-21) are similar. As such, so are the restoration priorities, which include impacts from fine sediment, habitat diversity, key habitat, and channel stability. Upper basin logging and road densities contribute to elevated fine sediment levels. A lack of large wood, artificial confinement, and degraded riparian forests contribute to poor channel stability and habitat diversity conditions.

Model results indicate that restoration of spring chinook habitat should focus primarily on improving sediment, habitat diversity, channel stability, and flow issues (Figure 10-22). The cause of these impacts are similar to those mentioned above.

Kalama Summer Steelhead

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

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

Figure 10-17. Kalama subbasin summer steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Volume VI for more information on habitat factor analysis diagrams.

Kalama 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
Kalama 8	Low	High	Moderate	Low		Low			Moderate	High				Low		Moderate Positive
Kalama 9	Low	High	Low	Low		Low			Moderate	High				Low		Moderate Positive
Kalama 5	Low	Moderate	Moderate	Moderate		Low			Moderate	Moderate	Moderate Positive			Moderate	Low	High Positive
Kalama 6	Low	Moderate	Moderate	Low		Low			Moderate	Moderate	Low			Low		Moderate Positive
Kalama 10	Low	High	Low	Low		Low			Moderate	High				Low		Moderate Positive
Kalama 4	Low	High	Moderate	Moderate		Low			Moderate	Moderate				Low	Low	High Positive
Kalama 13	Low	High							Moderate	High						High Positive
Kalama 7	Low	Moderate	Low	Low		Low			Moderate	High				Low		Moderate Positive
Gobar Cr	Low	Moderate	Low	Low		Low			Moderate	Moderate	Low					Low
Kalama 11	Low	Moderate	Low	Low		Low			Moderate	Moderate	Low			Low		Moderate Positive
Wildhorse Cr	Low	Moderate	Low						Moderate	Moderate	Low					
Little Kalama R	Low	Moderate	Low						Moderate	Moderate	Low					
Summers Cr	Low	Moderate	Low						Moderate	High	Low					Moderate Positive
Kalama 12	Low	Moderate		Low					Low	Moderate	Low					Moderate Positive
Kalama 3	Low	Moderate	Low	Low					Low	Low				Low	Low	Moderate
Kalama 2		Low	Low	Low					Low							
Kalama 1 tidal		Low		Low					Low	Low						Moderate
Knowlton Cr		Low							Low							
Lower Falls																

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

Figure 10-18. Kalama subbasin winter steelhead habitat factor analysis diagram.

Kalama 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
Kalama 2	Moderate	Moderate	Moderate	Low					Low	High					Low	Low
Kalama 3	Moderate	High	Low	Low					Moderate	High				Low	Moderate	Moderate
Kalama 4	Moderate	Moderate	Low	Low					Low	Moderate					Low	Moderate Positive
Kalama 5	Moderate	Low	Low	Low					Low	High					Low	Moderate Positive
Kalama 1 tidal	Low	Moderate		Low	Low	Low			Low	Low	Low			Low	Low	Moderate
Hatchery Cr	Low	Low		Low					Low	Moderate						Low

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

Figure 10-19. Kalama subbasin fall chinook habitat factor analysis diagram.

Kalama 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
Kalama 2	Low	High		Low					Moderate	Moderate	Low				Moderate	Low
Kalama 5	Low	Moderate		Low					Low	Moderate	Low Positive				Low	Low Positive
Kalama 3	Low	High		Low					Moderate	Moderate					Moderate	High
Kalama 4	Low	Moderate		Low					Low	Moderate					Moderate	Low Positive
Spencer Cr		Moderate							Low	Moderate						Low
Hatchery Cr	Low	Moderate							Low	Low	Low					Low
Kalama 1 tidal	Low	Low		Low					Low							Low

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

Figure 10-20. Kalama subbasin chum habitat factor analysis diagram.

Kalama 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
Kalama 3	Moderate	High	Low	Low		Low			Low	Moderate				Low	Low	High
Kalama 2	Moderate	High	Low	Low		Low			Low	Moderate	Low			Low	Low	Low Positive
Kalama 1 tidal	Low	High	Low	Moderate	Low	Low			Low	Low	Low			Low		High
Kalama 4	Low	Moderate	Low	Low					Low	Low				Low	Low	Moderate
Spencer Cr	Low	Moderate							Low	Moderate						Moderate
Hatchery Cr	Low	Low							Low	Low						Low
Cedar Cr	Low	Low							Low	Low						Low
Kalama 5	Low	Moderate		Low					Low	Low				Low		Moderate

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

Figure 10-21. Kalama subbasin coho habitat factor analysis diagram.

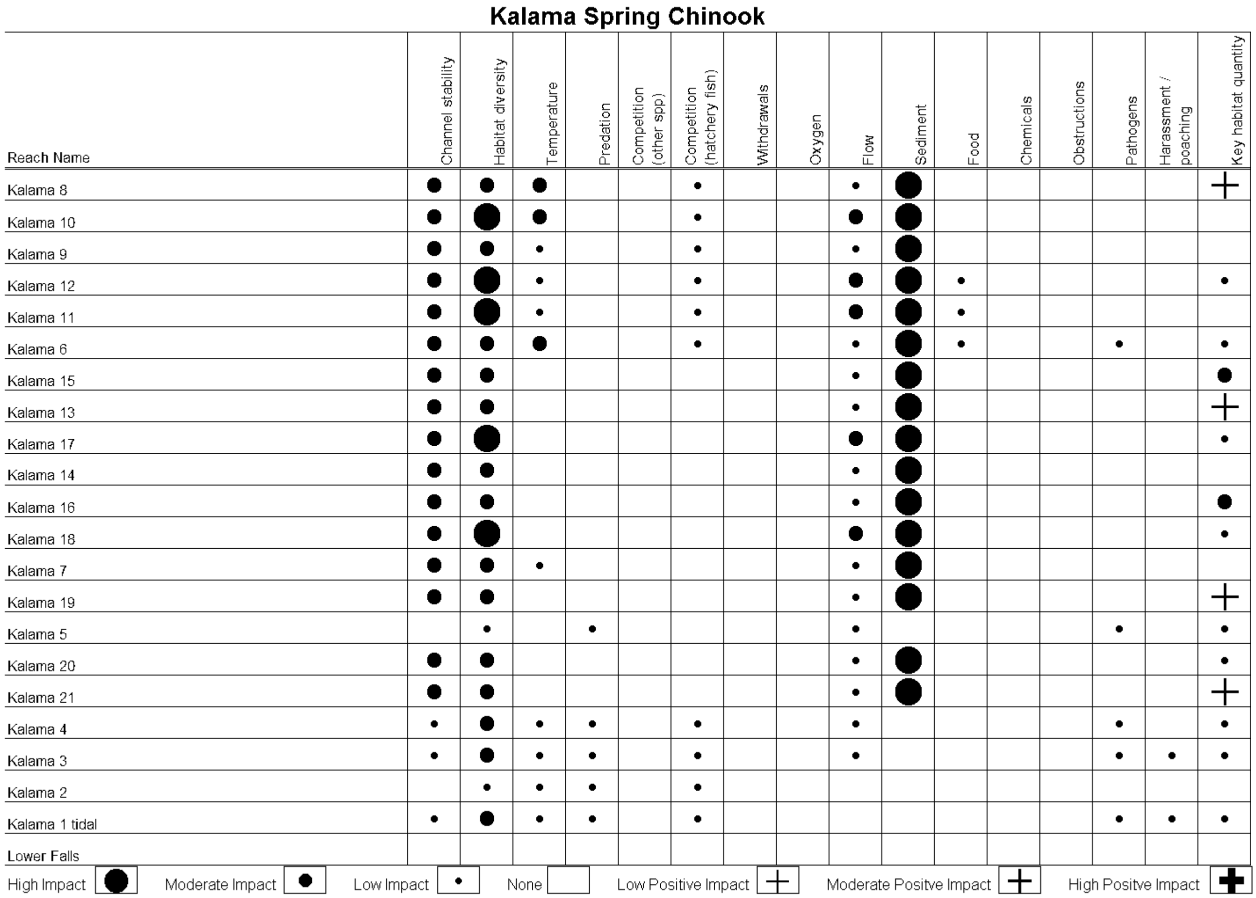


Figure 10-22. Kalama subbasin spring chinook habitat factor analysis diagram.

10.7 Integrated Watershed Assessments

The Kalama watershed has been subdivided into 18 LCFRB recovery planning subwatersheds, 17 of which are part of the Kalama River system while one encompasses small independent tributaries to the Columbia River. The Kalama watershed is comprised primarily of two ecological zones based on rain or snow dominated precipitation. Six subwatersheds are located in the rain-dominated zone, the remainder lie in more snow dominated areas.

Subwatersheds in the Kalama basin can be organized into three groups: upstream mainstem and tributary subwatersheds upstream of and including Elk Creek; lower mainstem subwatersheds between Elk Creek and the Little Kalama River; and the tidally influenced Kalama mainstem and the Little Kalama River including Hatchery Creek.

10.7.1 Results and Discussion

IWA results were calculated for all subwatersheds in the Kalama River watershed. IWA results are calculated at the local level (i.e., within 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). IWA results for each subwatershed are presented in Table 10-2. A reference map showing the location of each subwatershed in the basin is presented in Figure 10-23. Maps of the distribution of local and watershed level IWA results are displayed in Figure 10-24. Hydrologic conditions are mostly impaired at the local and watershed levels. Sediment conditions are moderately impaired or functional, and riparian conditions are almost entirely moderately impaired. These results are described in more detail below.

Table 10-2. IWA results for the Kalama watershed.

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

Notes:

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800010#####.

[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 10-23. Map of the Kalama basin showing the location of the IWA subwatersheds

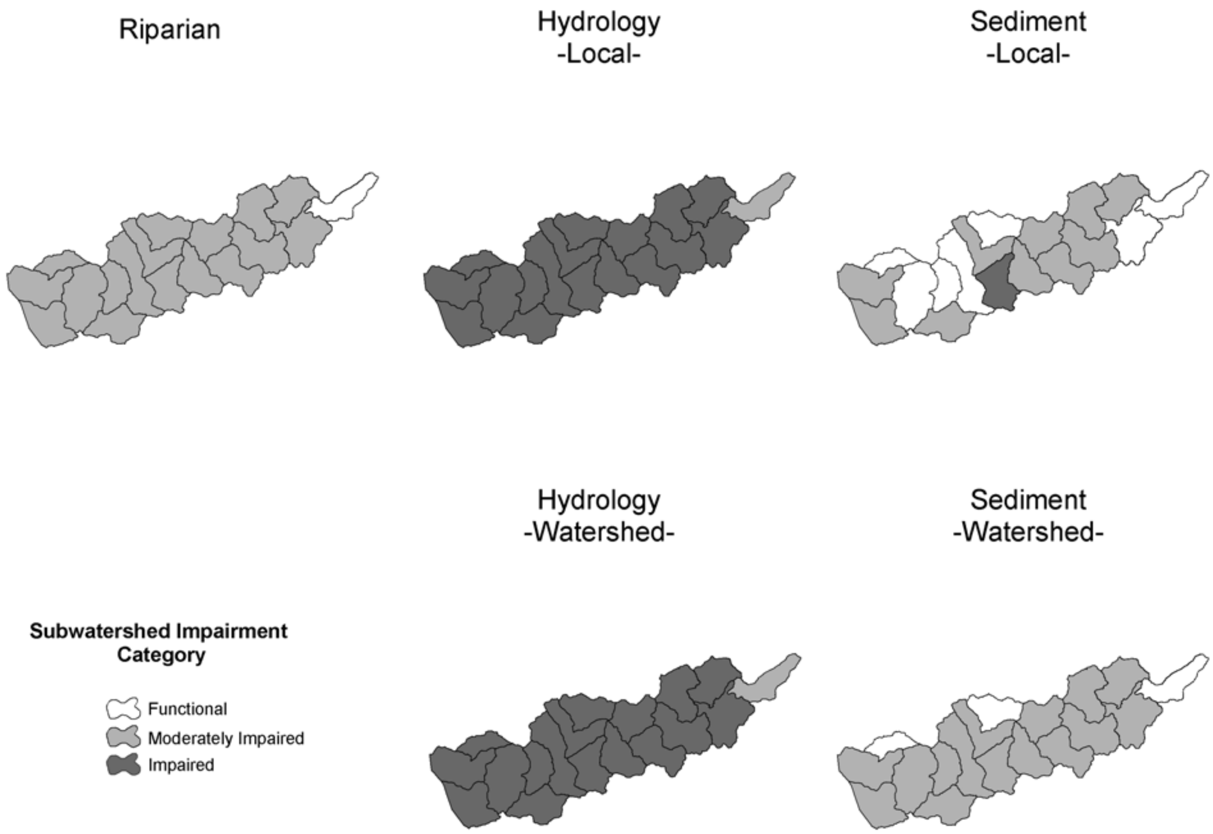


Figure 10-24. IWA subwatershed impairment ratings by category for the Kalama basin.

10.7.1.1 Hydrology

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

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

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

10.7.1.2 Sediment Supply

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

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

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

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

10.7.1.3 Riparian Condition

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

10.7.2 Predicted Future Trends

10.7.2.1 Hydrology

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

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

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

10.7.2.2 Sediment

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

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

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

10.7.2.3 Riparian

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

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

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