Volume II, Chapter 11
Lewis River Subbasin—Lower North Fork

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11.0 Lewis River Subbasin—Lower North Fork

11.1 Subbasin Description

11.1.1 Topography & Geology

For the purposes of this assessment, the Lower North Fork Lewis basin extends from the mouth to Merwin Dam, excluding the East Fork Lewis drainage, which is covered in a separate section. Below Merwin Dam, the Lewis River flows generally west/southwest, forming the border of Cowlitz and Clark Counties. The Lewis enters the Columbia at RM 87, a few miles southwest of Woodland, Washington. The Lower Lewis drainage encompasses approximately 65,464 acres (102 mi^2).

The lower 12 miles of the mainstem flow through a broad alluvial valley characterized by agriculture and residential uses. This section is extensively channelized. Tidal influence extends to approximately RM 11. The valley narrows above RM 12 and forms a canyon between the confluence of Cedar Creek (RM 15.7) and Merwin Dam (RM 19.5). The 240-foot high Merwin Dam, completed in 1931, presents a passage barrier to all anadromous fish, blocking up to 80% of the historically available habitat. Major tributaries to the Lower Lewis include the EF Lewis, Johnson Creek, and Cedar Creek. Cedar Creek provides some of the most productive anadromous fish habitat in the North Fork basin.

The Lewis basin has developed from volcanic, glacial, and erosional processes. Mount St. Helens and Mt. Adams have been a source of volcanic material as far back as 400,000 years ago. More recent volcanic activity, including pyroclastic flows and lahars, have given rise to the current landscape. Oversteepened slopes as a result of glaciation, combined with the abundance of ash, pumice, and weathered pyroclastic material, have created a relatively high potential for surface erosion throughout the basin (USFS).

11.1.2 Climate

The climate is typified by mild, wet winters and warm, dry summers. Average annual precipitation is 73 inches at Merwin Dam and 52 inches at Battle Ground, WA (East Fork Lewis) (WRCC 2003). Most of the precipitation falls as rain between November and March.

11.1.3 Land Use/Land Cover

The bulk of the land is forested and a large percentage is managed as commercial forest. Agriculture and residential activities are found in valley bottom areas. Recreation uses and residential development have increased in recent years. The population of the basin is small. The year 2000 population was approximately 14,300 persons (LCFRB 2001). Small rural communities include Chelatchie and Amboy (Cedar Creek drainage). The largest population center is Woodland, which is situated on the lower mainstem. The majority of the basin is forested, except for valley bottom areas, which are dominated by residential and agricultural uses. Stand replacement fires, which burned large portions of the basin between 1902 and 1952, have had lasting effects on basin hydrology, sediment transport, soil conditions, and riparian function. The largest of these was the Yacolt Burn in 1902. Subsequent fires followed in 1927 and 1929. Severe flooding in 1931 and 1934 likely was exacerbated by the effect of the fires on vegetation and soils. A breakdown of land ownership and land cover is included in Figure 11-1 and Figure 11-2. Figure 11-3 displays the pattern of landownership for the basin. Figure 11-4 displays the pattern of land cover / land-use.

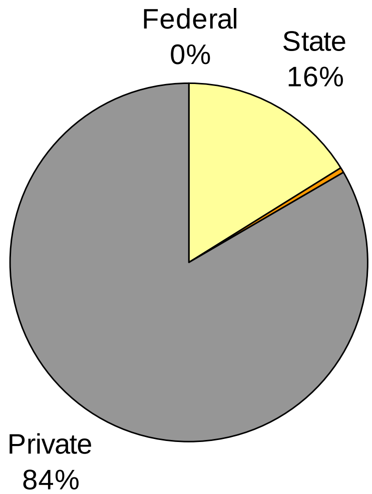


Figure 11-1. Lower North Fork Lewis River basin land ownership

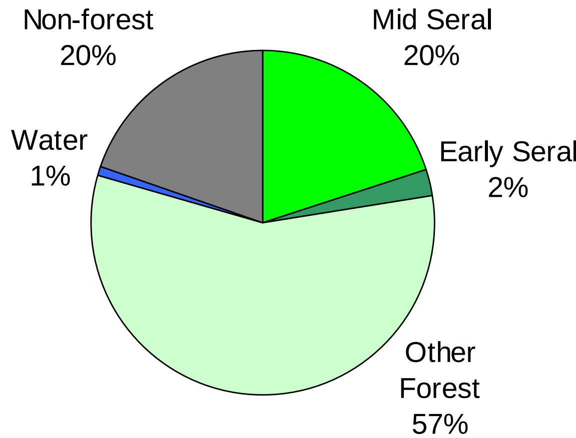


Figure 11-2. Lower North Fork Lewis River basin land cover

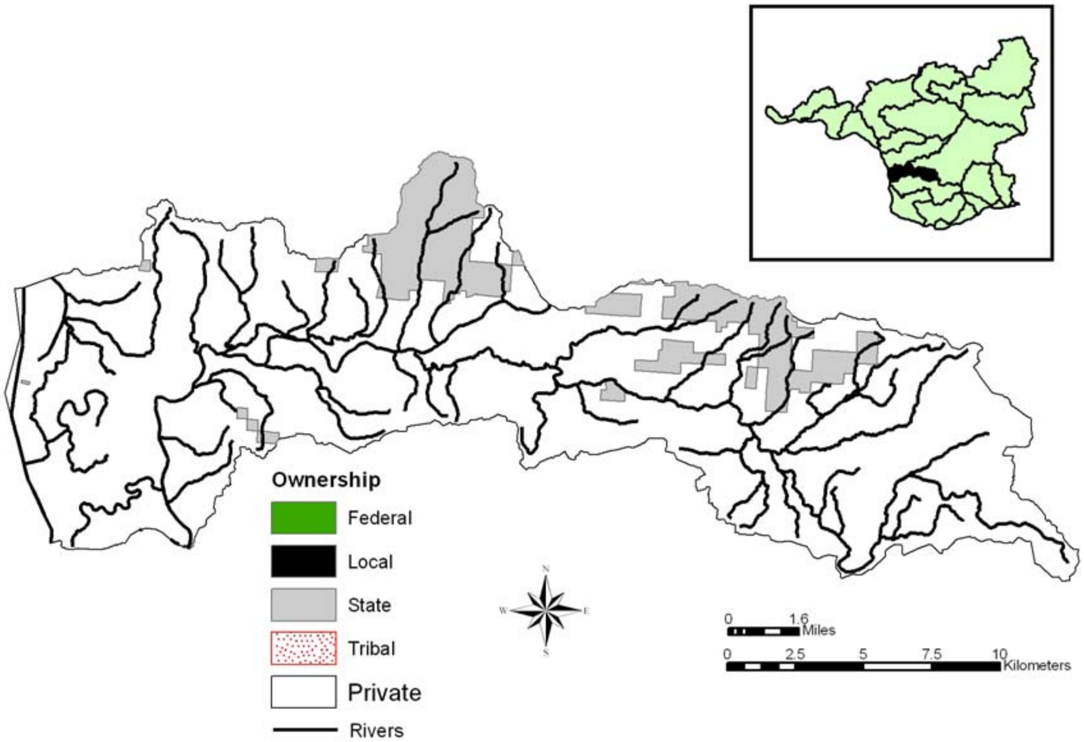


Figure 11-3. Landownership within the Lower North Fork Lewis watershed. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

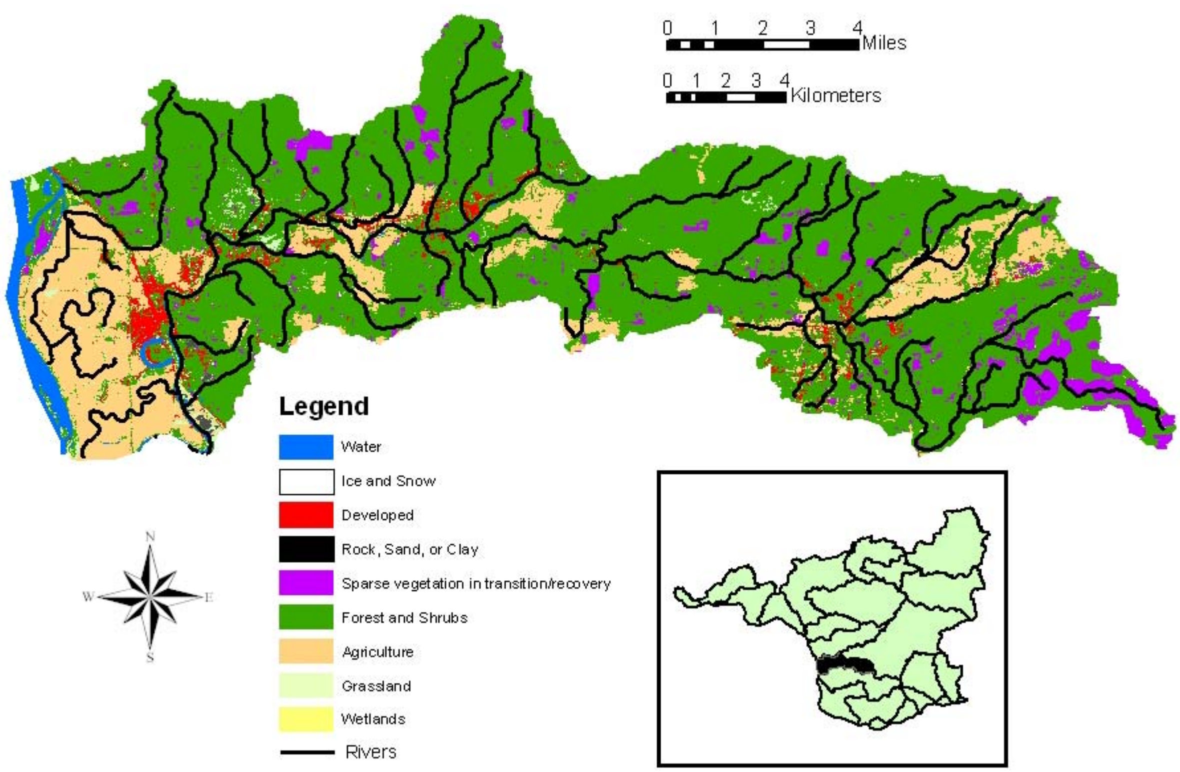
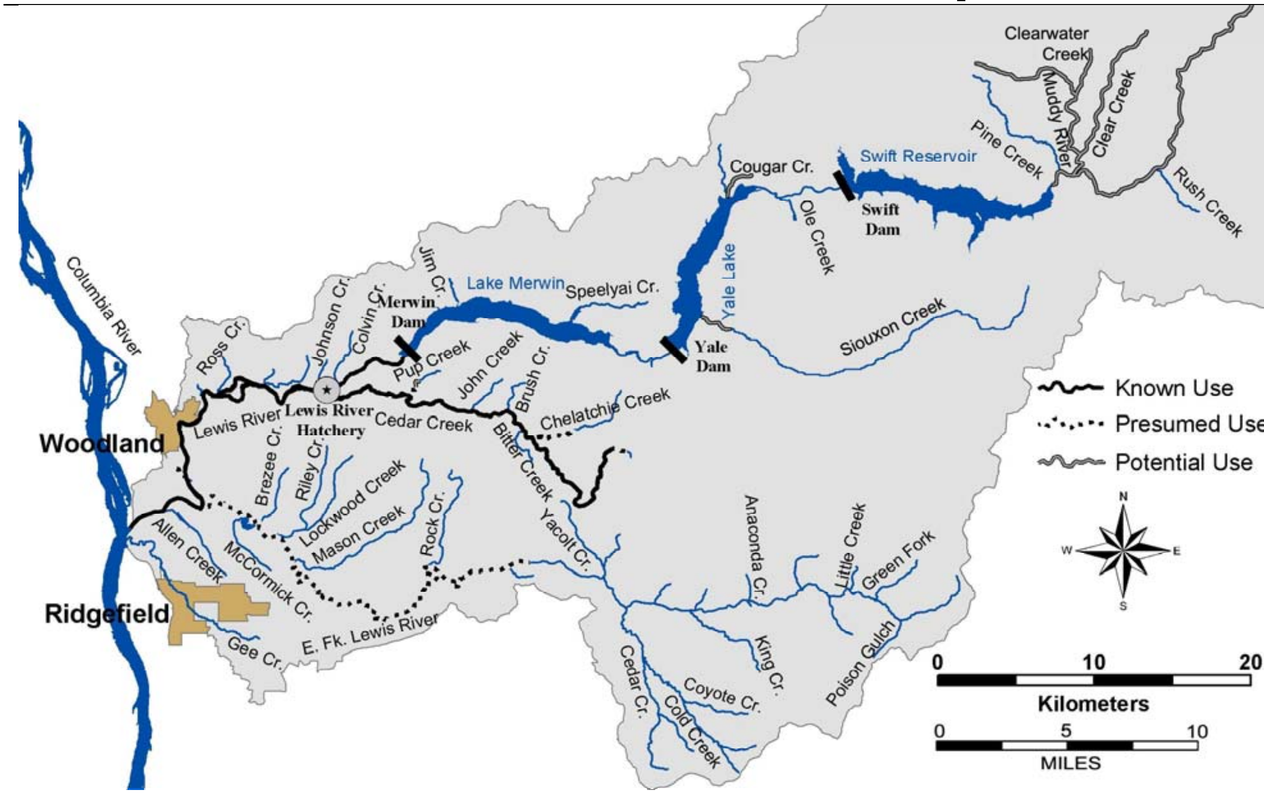


Figure 11-4. Land cover within the Lower North Fork Watershed. Data was obtained from the USGS National Land Cover Dataset (NLCD).

11.2 Focal Fish Species

11.2.1 Spring Chinook—Lewis Subbasin

ESA: Threatened 1999	SASSI: Depressed 2002

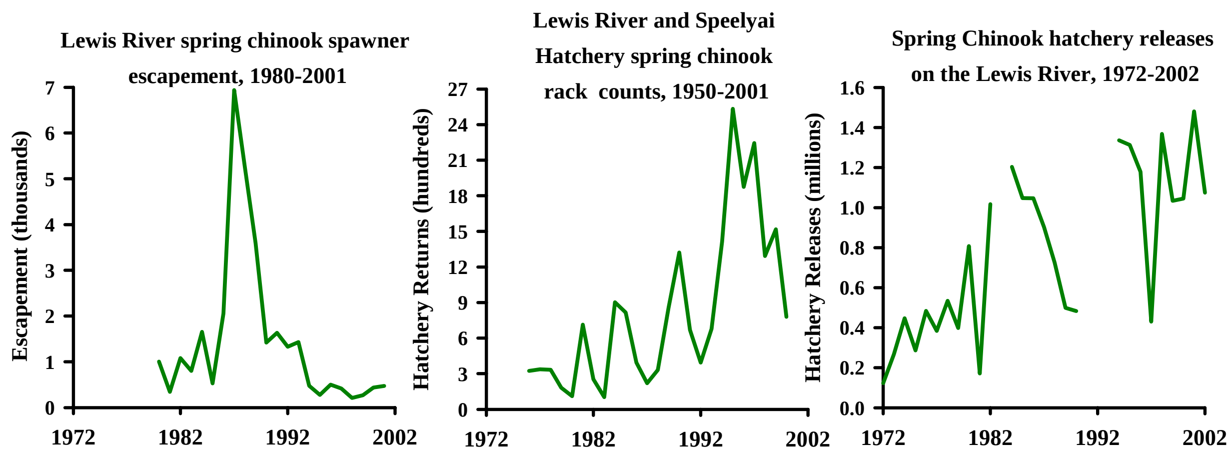


Distribution

- Historically, spring chinook were found primarily in the upper basin; construction of Merwin Dam (RM 19) in 1931 blocked access to most of the spawning areas
- Currently, natural spawning occurs in the North Fork mainstem Lewis River between Merwin Dam and the Lewis River Hatchery (~4 miles)

Life History

- Spring chinook enter the Lewis River from March through June
- Spawning in the Lewis River occurs between late August and early October, with peak activity in mid-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 54.5% and 36.8%, respectively)
- Fry emerge between December and January, 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 (ESU)
- The Lewis spring chinook stock designated based on distinct spawning distribution and spawning timing
- Genetic analysis of the NF Lewis River Hatchery spring chinook determined they were genetically similar to, but different from, Kalama and Cowlitz hatchery spring chinook stocks and significantly different from other Columbia River spring chinook

Abundance

- Reported abundance by WDF and WDF (Smoker et al 1951) indicates that at least 3,000 spring chinook entered the upper Lewis prior to the completion of Merwin Dam in 1932
- By the 1950s, only remnant (<100) spring chinook runs existed on the Lewis
- North Lewis River spawning escapements below Merwin Dam from 1980-2001 ranged from 213 to 6,939
- Native component of the stock may have been extirpated and replaced by introduced hatchery stocks; hatchery strays account for most spring chinook spawning in the North Lewis River

Productivity & Persistence

- NMFS Status Assessment for the Lewis River spring chinook indicated a 0.36 risk of 90% decline in 25 years and a 0.49 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.2
- Juvenile production from natural spawning below Merwin Dam is presumed to be low
- The Current Merwin Dam mitigation goal is to 12,800 spring chinook adults annually

Hatchery

- Lewis River Salmon Hatchery is located about RM 15 (completed in 1930.
- Spring chinook eggs were collected for hatchery production beginning in 1926; spring chinook releases into the Lewis from 1972-1990 averaged 601,184
- The hatchery has reared eggs from outside sources, primarily from the Cowlitz, but a few years in the 1970s there were fish transferred from Klickitat and Carson hatcheries

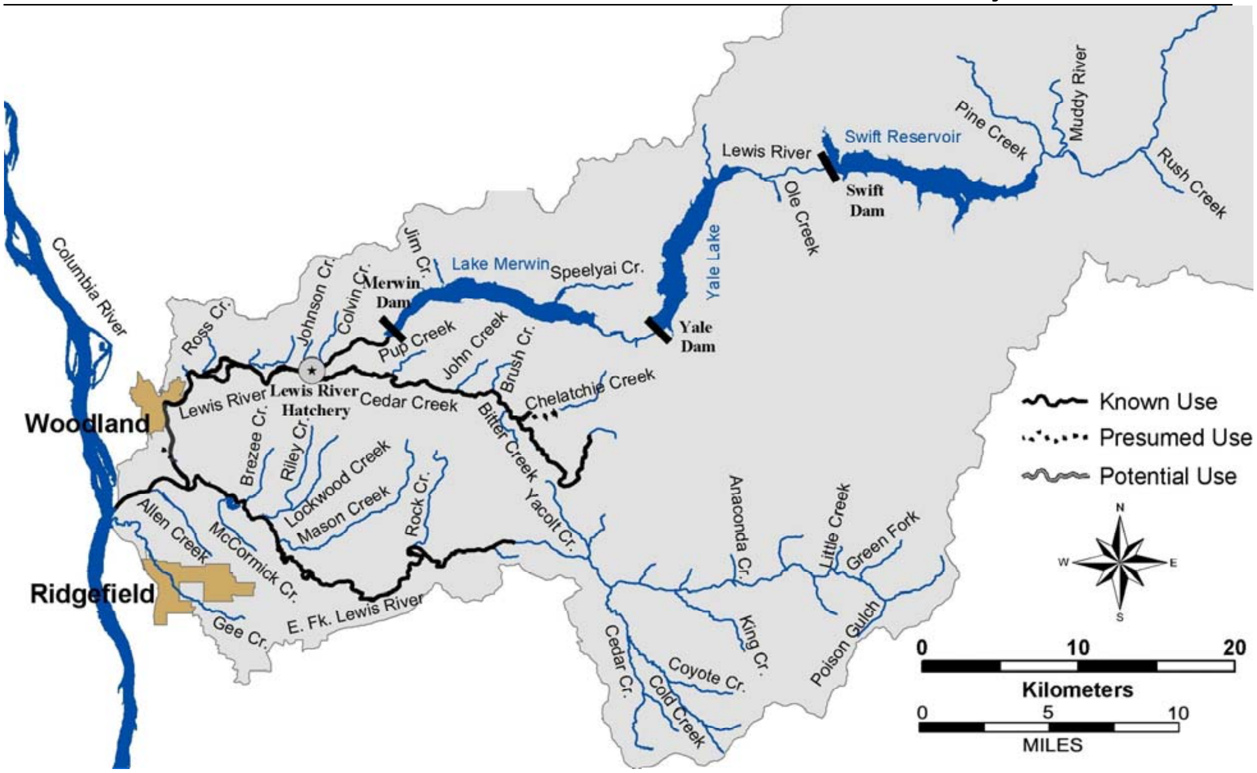
- Spring chinook broodstock return to the Lewis River Hatchery and are also trapped at Merwin Dam; a significant part of the annual return is not trapped and spawns naturally in the river below Merwin Dam

Harvest

- Spring chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial gill net and sport fisheries
- CWT data analysis of the 1989-1994 brood years indicates that 54% of the Lewis spring chinook were harvested and 46% escaped to spawn
- Fishery recoveries of the 1989-1994 brook Lewis River Hatchery spring chinook: Lewis sport (69%), Alaska (11%), British Columbia (10%), Washington Coast (5%), Columbia River (4%), and Oregon coast (1%)
- Mainstem Columbia River harvest of Lewis spring chinook was substantially reduced after 1977 when April and May spring chinook seasons were eliminated to protect upper Columbia and Snake wild spring chinook.
- Mainstem Columbia harvest of Lewis River Hatchery spring chinook increased during 2001-2002 when selective fisheries for adipose marked hatchery fish enabled mainstem spring fishing in April and in May, 2002)
- Sport harvest in the Lewis River averaged 4,600 from 1980-1994 and 900 during 1995-2002
- Tributary harvest is managed to attain the Lewis hatchery adult broodstock escapement goal

11.2.2 Fall Chinook—Lewis Subbasin

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

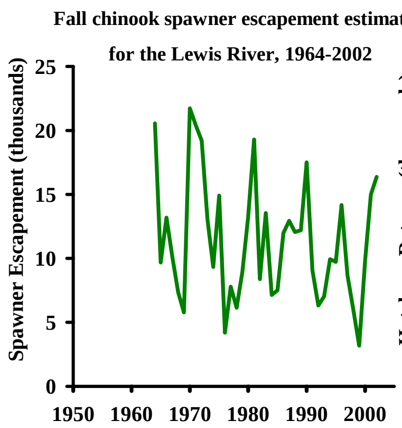


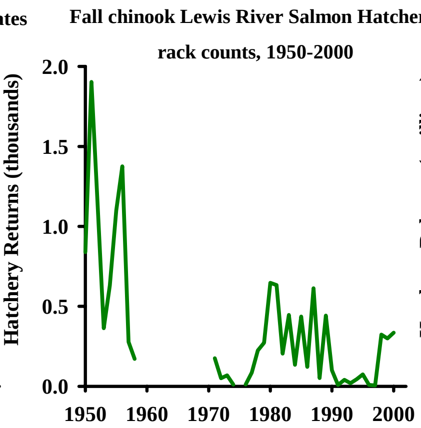
Distribution

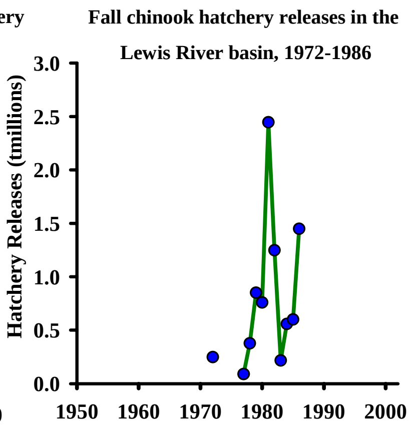
- Spawning occurs primarily in the NF Lewis River between Merwin Dam and the Lewis River Salmon Hatchery (~4 miles); some spawning has been observed in Cedar Creek
- Construction of Merwin Dam eliminated approximately half the fall chinook spawning habitat in the North Fork, which historically extended up to the Yale Dam site

Life History

- Only stock in lower Columbia River to maintain a healthy wild population with negligible hatchery influence
- Lewis River wild fall chinook enter the Columbia River from August through October; they have a broader migration time than other lower Columbia fall chinook stocks
- Lewis River entry occurs in September and October
- Natural spawning in the NF Lewis River occurs between lateOctober and January and peaks in mid-November
- Age ranges from 2-year-old jacks to 6-year-old adults, with dominant adult age of 4 and significant numbers of age 5
- Fry emerge from March to August (peak usually in April), depending on time of egg deposition and water temperature; fry spend the spring/early summer in fresh water, and emigrate in the summer as sub-yearlings







Diversity

- Late spawners in the North Fork and EF Lewis are considered a lower river wild stock within the Lower Columbia River ESU
- The Lewis River fall chinook stock designated based on distinct spawning timing, spawning distribution, and appearance
- Genetic analysis of NF Lewis River fall chinook in 1990 indicated they are genetically distinct from other Columbia River fall chinook stocks, except EF Lewis and Washougal fall chinook
- Natural escapement to the NF Lewis River comprises about 85% of the lower Columbia River wild fall chinook management stock, the remaining 15% are produced in the EF Lewis and the Sandy River in Oregon

Abundance

- Fall chinook escapement estimates by WDFW in 1951 were 5,000 adults into the Lewis River
- NF Lewis River spawning escapements from 1964-2001 ranged from 3,184 to 21,726 (average 11,232)
- North Fork Lewis escapement goal of 5,700 fish is usually exceeded

Productivity & Persistence

- WDF estimated the number of natural juvenile fall chinook emigrating from the Lewis River during 1977-79 and 1982-87 ranged from 1,540,000 to 4,650,000
- WDF demonstrated a strong relationship between spring flows at Merwin Dam and the number of juvenile fall chinook smolts produced
- Minimum flows for fall chinook spawning and rearing are included in the current hydro operations license
- NMFS Status Assessment for the Lewis River late-fall chinook indicated a 0.05 risk of 90% decline in 25 years, a 0.19 risk of 90% decline in 50 years, and a 0.0 risk of extinction in 50 years

Hatchery

- Lewis River Salmon Hatchery (completed in 1932) is located about RM 15; the Merwin Dam collection facility (completed in 1932) is located about RM 19
- Speelyai Hatchery (completed in 1958) is located on Speelyai Bay in Lake Merwin

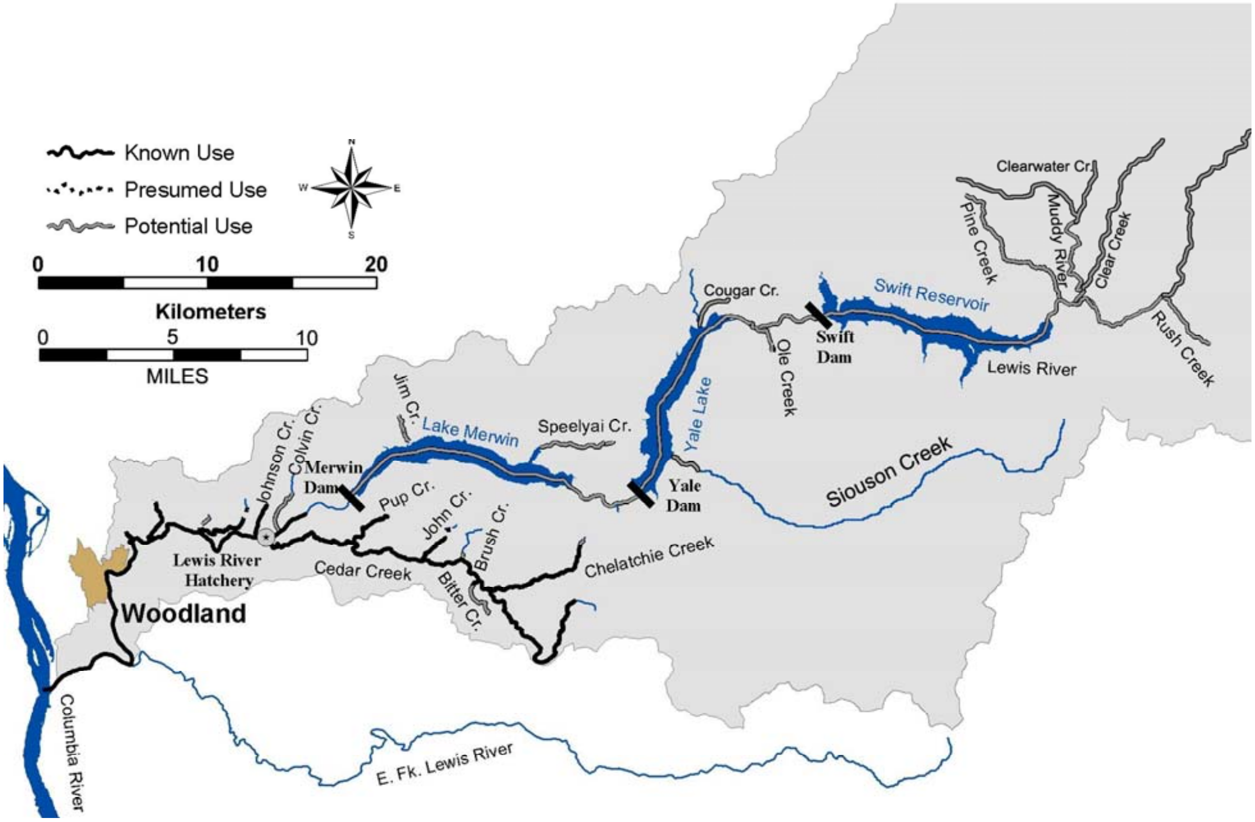
- Merwin Hatchery (completed in 1983) is located about RM 19
- Hatchery releases of fall chinook from the Lewis River Salmon Hatchery began from fish trapped at Merwin Dam collection facility in 1932; annual fall chinook releases ranged from 0 in the late 1960s and early 1970s to 3 million in 1965
- Hatchery releases were discontinued in 1986 to eliminate interactions with a healthy wild fall chinook population

Harvest

- Lewis River wild fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, and in Columbia River commercial gill net and sport fisheries
- A portion of the Lewis River wild fall chinook juveniles were captured, marked, and tagged from 1977-80 currently by WDFW and PacifiCor from 1983 to present
- Lewis River wild fall chinook distribute more northerly in the ocean than tule fall chinook, with the primary ocean harvest in British Columbia
- Lewis River wild fall chinook are also an important sport fish in the mainstem Columbia and in the Lewis River
- Lewis River chinook enter the Columbia River over a broader period of time than tule chinook and therefore are harvested in both September and October commercial fisheries
- Harvest is variable dependent on management response to annual abundance in Pacific Salmon Commission (PSC) (US/Canada), Pacific Fisheries Management Council (PFMC) (US ocean), and Columbia River Compact forums
- Total harvest is constrained by ESA limits on Snake and Coweeman wild fall chinook, Pacific Salmon Treaty agreements with Canada, and the Lewis spawning escapement goal
- Columbia River Fisheries are managed to attain a spawning escapement goal of 5,700 adults
- CWT analysis of pre 1991 broods indicate a 49% harvest rate while more recent broods (1991-94) indicate a reduced harvest rate of 28%
- Fishery recoveries of 1977-79 and 1982-84 broods were distributed between Columbia River (45%), British Columbia (31%), Alaska (13%), and Washington/Oregon ocean (10%) sampling areas
- Sport harvest in the mainstem and NF Lewis River averaged 1,400 fall chinook annually from 1980-1998

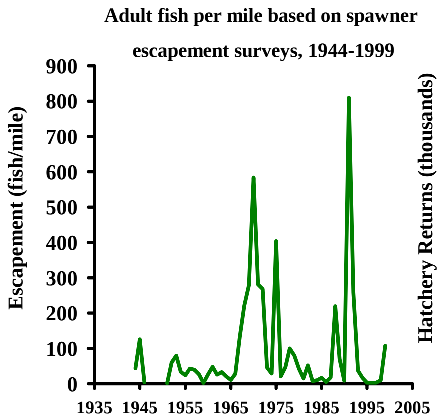
11.2.3 Coho—Lewis Subbasin (North Fork)

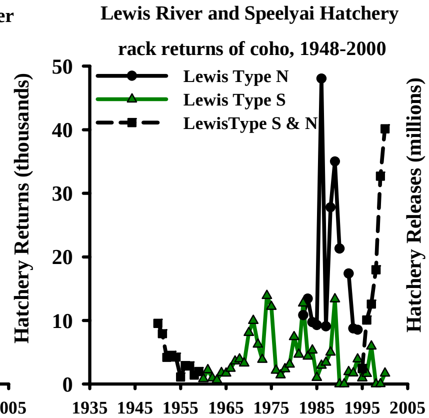
ESA: Candidate 1995	SASSI: Unknown 2002

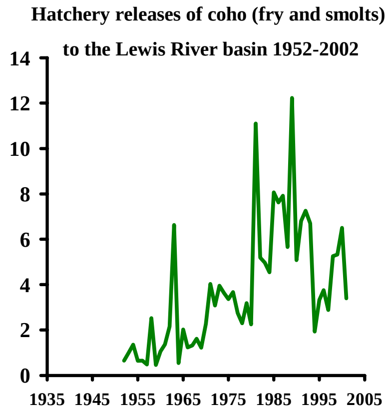


Distribution

- 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
- Coho historically spawned throughout the basin.
- Natural spawning is thought to occur in most areas accessible to coho; coho currently spawn in the North Lewis tributaries below Merwin Dam including Ross, Cedar, NF and SF Chelatchie, Johnson, and Colvin Creeks; Cedar Creek is the most utilized stream on the mainstem
- Construction of Merwin Dam was completed in 1932; coho adults were trapped and passed above Merwin Dam from 1932-1957; the transportation of coho ended after the completion of Yale Dam (1953) and just prior to completion of Swift Dam (1959)
- As part of the current hydro re-licensing process, reintroduction of coho into habitat upstream of the three dams (Merwin, Yale, and Swift) is being evaluated







Life History

- Adults enter the Columbia River from August through January (early stock primarily from mid-August through September and late stock primarily from late September through 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 present in the Lewis basin with spawning occurring from late November into March
- Early stock coho (or Type S) were historically present in the Lewis basin with spawning occurring from late October to November
- Columbia River early and late stock coho produced at Washington hatcheries are genetically similar

Abundance

- Lewis River wild coho run is a fraction of its historical size
- An escapement survey in the late 1930s observed 7,919 coho in the North Fork
- In 1951, WDF estimated coho escapement to the basin was 10,000 fish in the North Fork (primarily early run)
- Escapement surveys from 1944-1999 on the North and South Fork Chelatchie, Johnson, and Cedar Creeks documented a range of 1-584 fish/mile
- Hatchery production accounts for most coho returning to the Lewis River

Productivity & Persistence

- Natural coho production is presumed to be generally low in most tributaries
- A smolt trap at lower Cedar Creek has shown recent year coho production to be fair to good in North and South forks of Chelatchie Creek (tributary of Cedar Creek) and in mainstem Cedar Creek

Hatchery

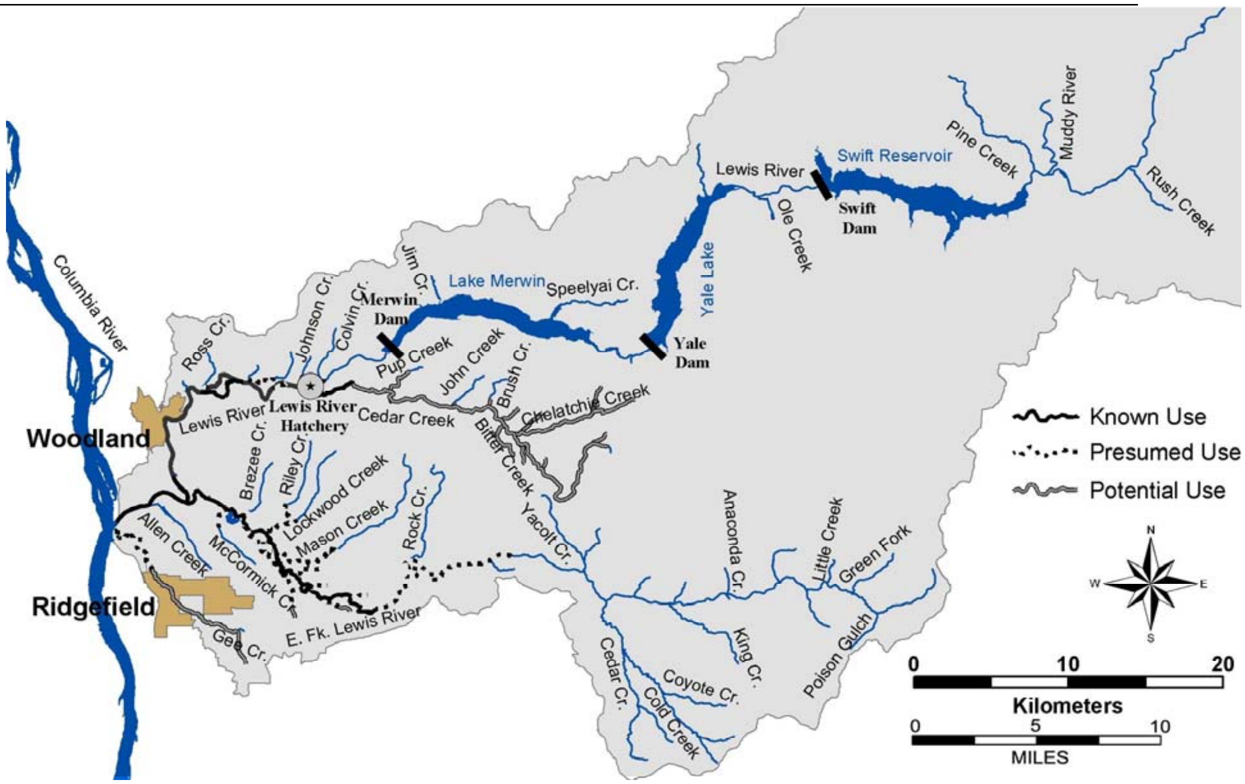
- The Lewis River Hatchery (completed in 1932) is located about RM 13; the Merwin Dam collection facility (completed in 1932) is located about RM 17; Speelyai Hatchery (completed in 1958) is located in Merwin Reservoir at Speelyai Bay; these hatcheries produce early and late stock coho and spring chinook
- Merwin Hatchery (completed in 1983) is located at RM 17 and rears steelhead, trout, and kokanee
- Coho have been planted in the Lewis basin since 1930; extensive hatchery coho releases have occurred since 1967
- The current Lewis and Speelyai hatchery programs include 880,000 early coho and 815,000 late coho smolts reared and released annually

Harvest

- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% from 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations
- Columbia River commercial coho fisheries in November were eliminated in the 1990s to reduce harvest of late Clackamas River wild coho
- Since 1999, Columbia River hatchery coho returns have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Natural produced lower Columbia coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon State listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho is constrained by fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early hatchery coho, but late hatchery coho harvest can also be substantial
- An average of 3,500 coho (1980-98) were harvested annually in the North Lewis River sport fishery
- CWT data analysis of the 1995-97 brood early coho released from Lewis River hatchery indicates 15% were captured in a fishery and 85% were accounted for in escapement
- CWT data analysis of the 1995-97 late coho released from Lewis River Hatchery indicates 42% were captured in a fishery and 58% were accounted for in escapement
- Fishery CWT recoveries of 1995-97 brood Lewis early coho were distributed between Washington ocean (58%), Columbia River (21%), and Oregon ocean (21%) sampling areas
- Fishery CWT recoveries of 1995-97 brood Lewis late coho were distributed between Columbia River (56%), Washington coast (31%), and Oregon ocean (21%) sampling areas

11.2.4 Chum—Lewis Subbasin

ESA: Threatened 1999	SASSI: NA



Distribution

- Spawning occurs in the lower reaches of the mainstem NF and EF Lewis River.
- Historically, chum salmon were common in the lower Lewis and were reported to ascent to the mainstem above the Merwin Dam site and spawn in the reservoir area
- Chum were also abundant in Cedar Creek, with at least 1,000 annual spawners (Smoker et al 1951)

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, generally from March to mid-May

Abundance

- 1951 report estimated escapement of approximately 3,000 chum annually in the mainstem Lewis and East Fork and 1,000 in Cedar Creek
- 96 chum observed spawning downstream of Merwin Dam in 1955
- In 1973, spawning population of both the Lewis and Kalama subbasins estimated at only a few hundred fish
- Annually, 3-4 adult chum are captured at the Merwin Dam fish trap

Productivity & Persistence

- Harvest, habitat degradation, and construction of Merwin, Yale, and Swift Dams contributed to decreased productivity
- WDFW consistently observed chum production in the North Lewis in March-May, 1977-1979 during wild chinook seining operations

Hatchery

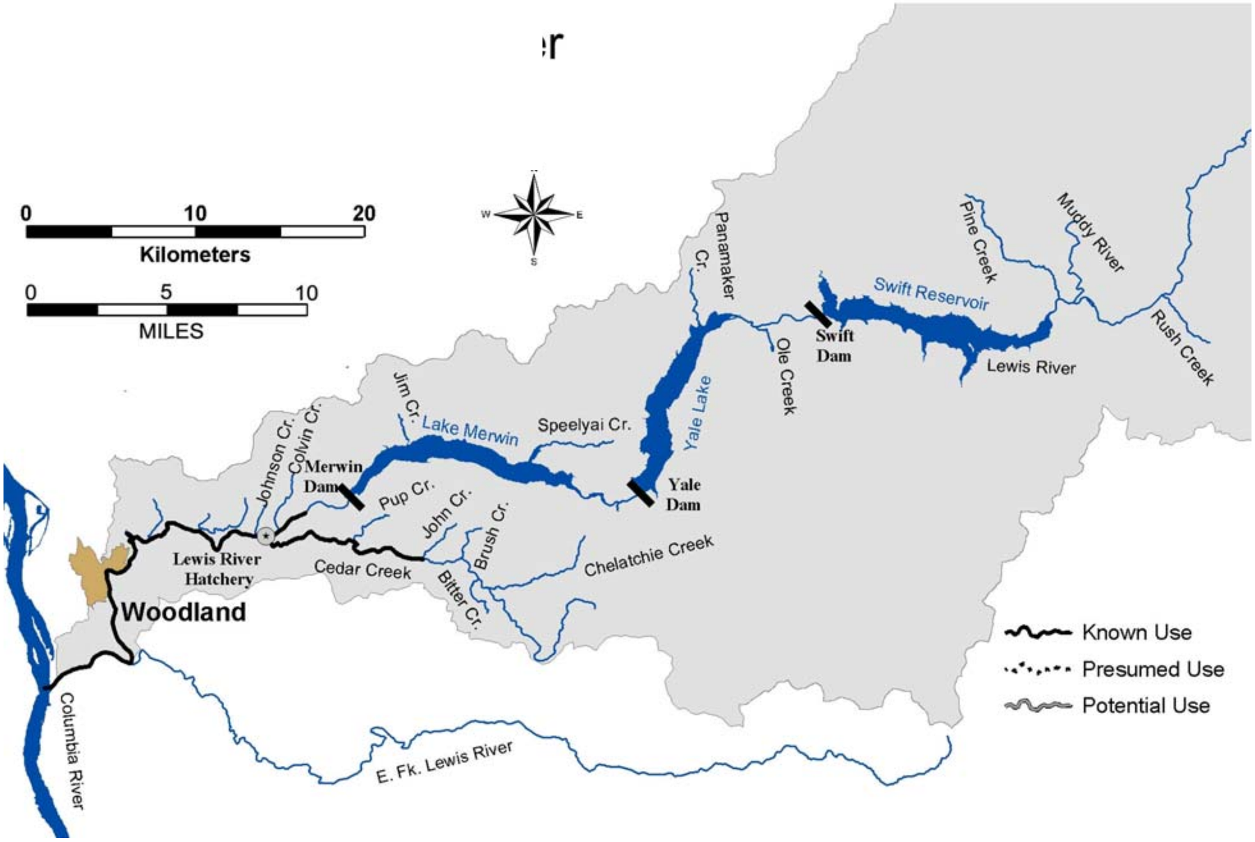
- Chum salmon have not been produced/released in the Lewis River

Harvest

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

11.2.5 Summer Steelhead—Lewis Subbasin (North Fork)

ESA: Threatened 1998 **SASSI: Unknown 2002**

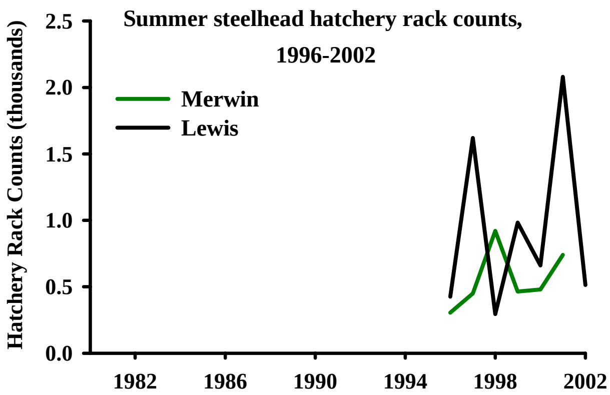


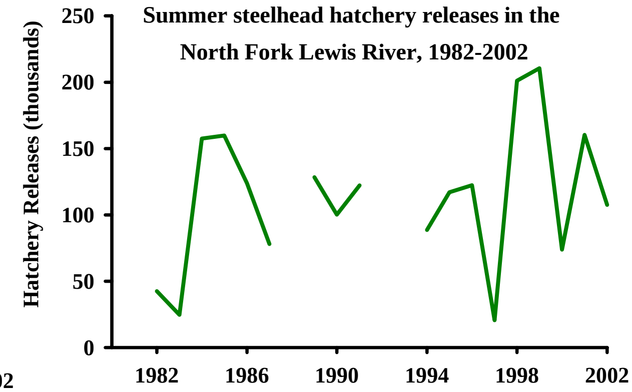
Distribution

- Spawning occurs in the NF Lewis River downstream of Merwin Dam and throughout the tributaries; natural spawning is concentrated in Cedar Creek
- Construction of Merwin Dam in 1929 blocked upstream migration; Most summer steelhead habitat above the Merwin Dam site is contained in Merwin Reservoir tributaries
- Current distribution on the NF Lewis River is from approximately RM 7 to RM 20; a dam located on Cedar Creek was removed in 1946, providing access to habitat throughout this tributary

Life History

- Adult migration timing for NF Lewis River summer steelhead is from May through November
- Spawning timing on the NF Lewis River is generally from early March through early June
- Age composition data are not available for NF Lewis River summer steelhead
- Wild steelhead fry emerge from late April through July; juveniles generally rear in fresh water for two years; juvenile emigration occurs from March to May, with peak migration in early May





Diversity

- Stock designated based on distinct spawning distribution and run timing
- Progeny from Elochoman, Chambers Creek, Cowlitz, and Skamania Hatcheries have been planted in the Lewis basin; interbreeding among wild and hatchery stocks has not been measured
- After Mt. St. Helens 1980 eruption, straying Cowlitz River steelhead may have spawned with native Lewis River stocks

Abundance

- From 1925-1933, run size was estimated at 4,000 summer steelhead
- In 1936, steelhead were reported in the Lewis River during escapement surveys
- From 1963-1967, run size estimates averaged 6,500 summer steelhead
- Wild summer steelhead escapement to the NF Lewis River was estimated at less than 50 fish in 1984
- Hatchery rack counts for summer steelhead are available from Lewis River and Merwin Hatcheries from 1996-2002
- WDFW indicated that wild summer steelhead account for less than 7% of the total North Fork run

Productivity & Persistence

- Wild fish production is believed to be low

Hatchery

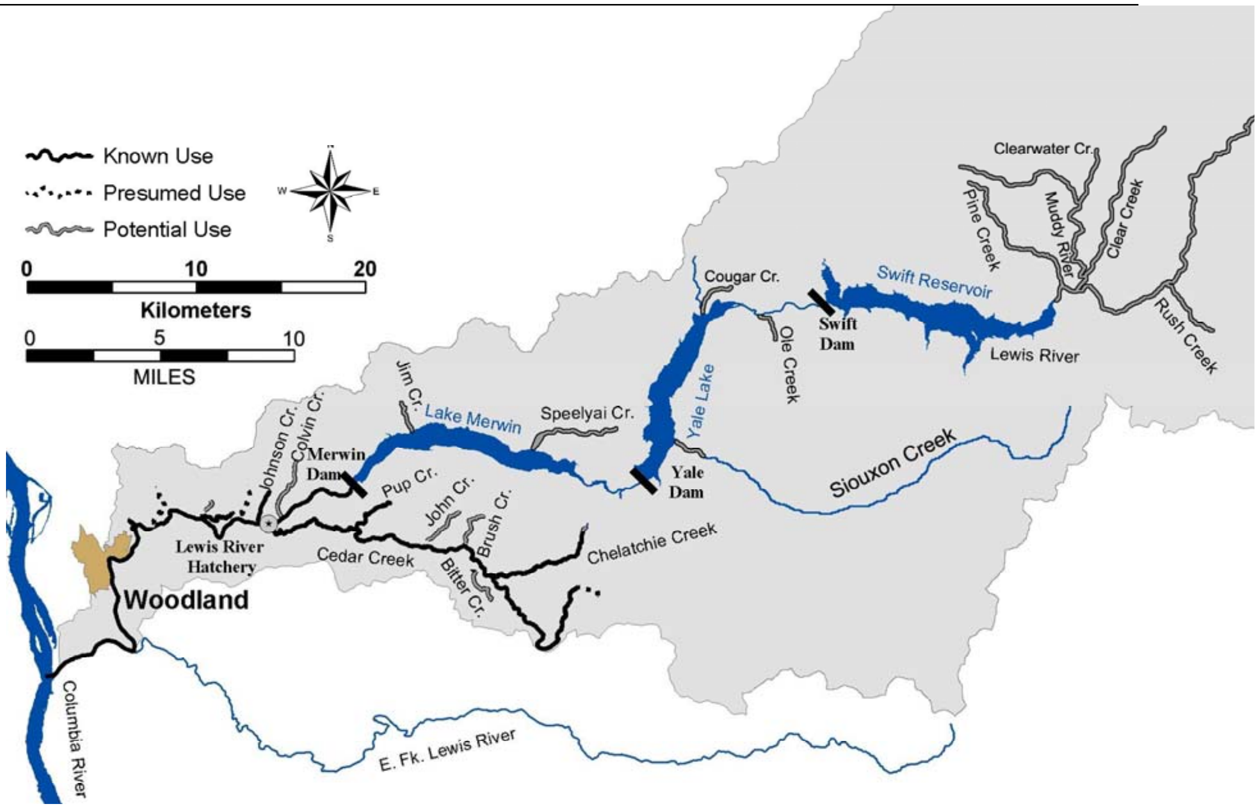
- The Lewis River Hatchery (about 4 miles downstream of Merwin Dam) and Speelyai Hatchery (Speelyai Creek in Merwin Reservoir) do not produce summer steelhead
- In the early 1990s, the Ariel (Merwin) Hatchery (for steelhead and trout) was constructed below Merwin Dam
- A net pen system has been in operation on Merwin Reservoir since 1979; annual average smolt production has been 60,000 summer steelhead; release data are displayed from 1982-2002

Harvest

- No directed fisheries target NF Lewis River summer steelhead; incidental mortality currently occurs during the Columbia River fall commercial and summer sport fisheries
- Summer steelhead sport harvest (wild and hatchery) in the Lewis River basin from 1980-1989 ranged from 3,001 to 8,700; historically, more fish in the sport fishery were caught in the East Fork but currently North Fork harvest exceed West Fork harvest; since 1986, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild summer steelhead in the mainstem Columbia River and in the Lewis River

11.2.6 Winter Steelhead—Lewis Subbasin (North Fork)

ESA: Threatened 1998	SASSI: Unknown 2002

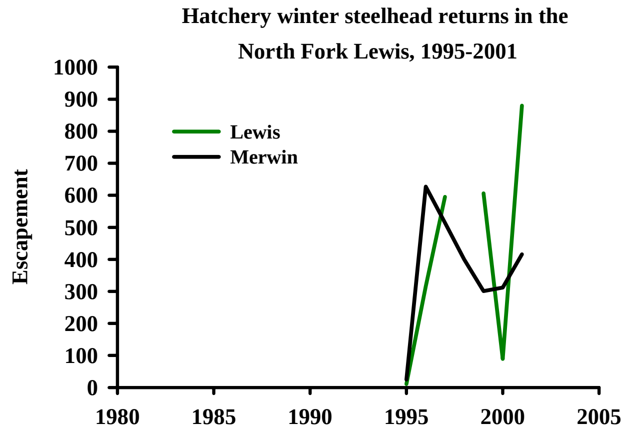


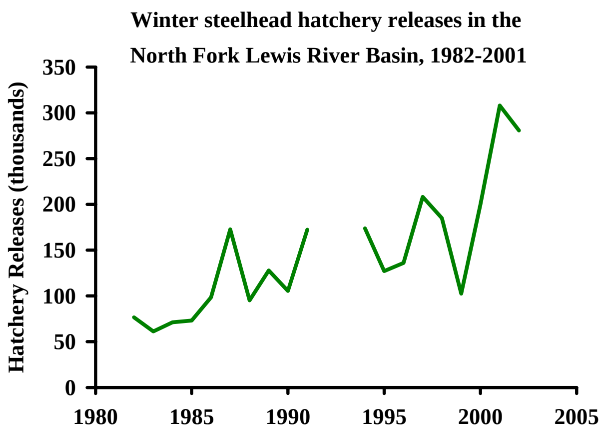
Distribution

- Spawning occurs in the NF Lewis River downstream of Merwin Dam and throughout the tributaries; natural spawning is concentrated in Cedar Creek
- Construction of Merwin Dam in 1929 blocked all upstream migration; approximately 80% of the spawning and rearing habitat are not accessible; a dam located on Cedar Creek was removed in 1946, providing access to habitat throughout this tributary

Life History

- Adult migration timing for NF Lewis winter steelhead is from December through April
- Spawning timing on the NF Lewis is generally from early March to early June
- Limited age composition data for Lewis River winter steelhead suggest that most steelhead are two-ocean fish
- Wild steelhead fry emerge from March through May; juveniles generally rear in fresh water for two years; juvenile emigration occurs from April to May, with peak migration in early May





Diversity

- Mainstem/NF Lewis winter steelhead stock designated based on distinct spawning distribution and run timing
- Concern with wild stock interbreeding with hatchery brood stock from the Elochoman River, Chambers Creek, and the Cowlitz River
- After 1980 Mt. St. Helens eruption, straying Cowlitz River steelhead likely spawned with native Lewis stocks
- Allele frequency analysis of NF Lewis winter steelhead in 1996 was unable to determine the distinctiveness of this stock compared to other lower Columbia steelhead stocks

Abundance

- Recent analysis for re-license estimate historical abundance ranging from 5,100-10,000 annually for upper Lewis above Merwin Dam
- In 1936, steelhead were reported in the Lewis River during escapement surveys
- Wild winter steelhead escapement counts for the NF Lewis River are not available
- Escapement goal for the NF Lewis River is 698 wild adult steelhead
- Hatchery origin fish comprise most of the winter steelhead run on the NF Lewis
- WDF estimated that only 6% of the returning winter steelhead in the NF are wild fish

Productivity & Persistence

- Winter steelhead natural production is expected to be low and primarily in Cedar Creek

Hatchery

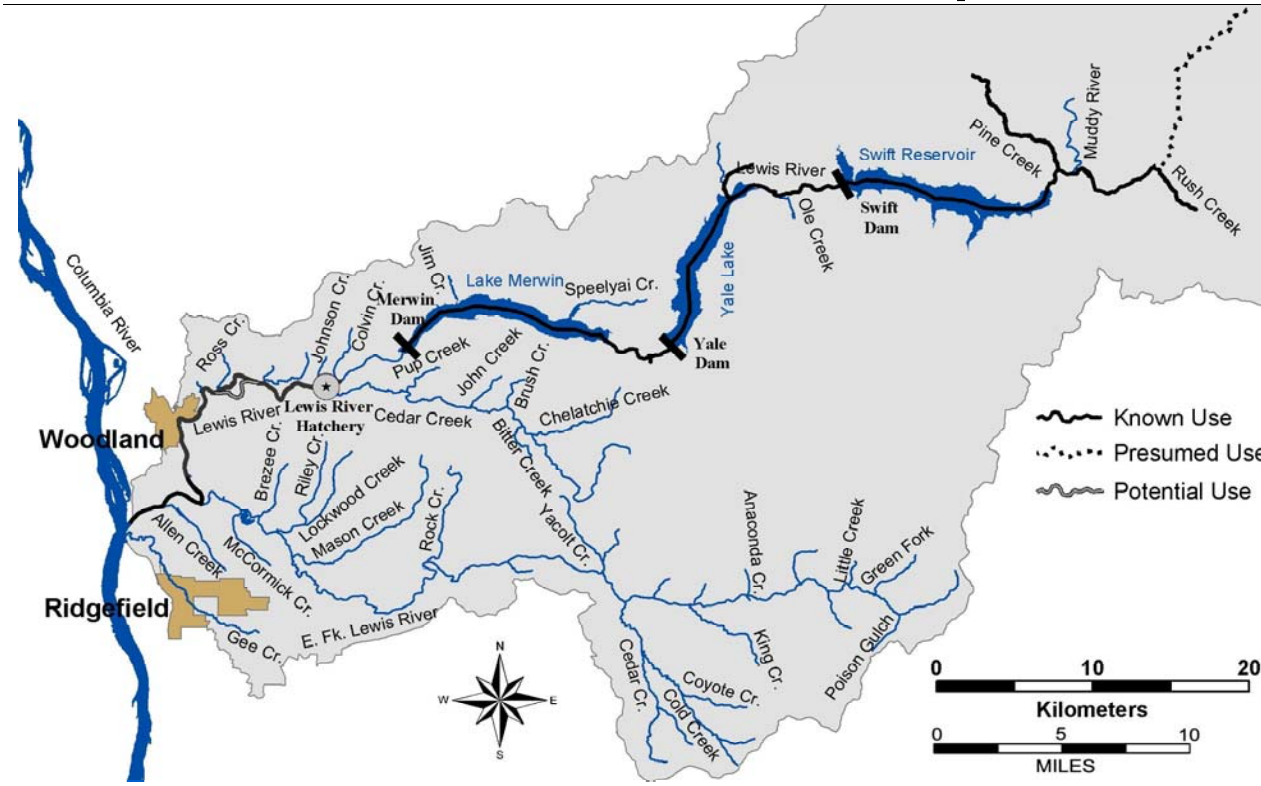
- The Lewis River Hatchery (about 4 miles downstream of Merwin Dam) and Speelyai Hatchery (Speelyai Creek in Merwin Reservoir) do not produce winter steelhead
- The Ariel (Merwin) Hatchery is located below Merwin Dam; the hatchery has been releasing winter steelhead in the Lewis basin since the early 1990s
- A net pen system has been in operation on Merwin Reservoir since 1979; annual average smolt production has been 35,000 winter steelhead; total release data are available from 1982-2001
- Hatchery fish contribute little to natural winter steelhead production in the NF Lewis River

Harvest

- No directed commercial or tribal fisheries target NF Lewis winter steelhead; incidental harvest currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Treaty Indian harvest does not occur in the Lewis River basin
- Winter steelhead sport harvest (hatchery and wild) in the NF Lewis River averaged 300 fish during the 1960s and 1970s; average annual harvest in the 1980s averaged 1,577; since 1992, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild winter steelhead in the mainstem Columbia River and in the Lewis River

11.2.7 Bull Trout—Lewis River Subbasin

ESA: Threatened 1999	SASSI: Depressed 1998



Distribution
- The reservoir populations are isolated because there is no upstream passage at the dams

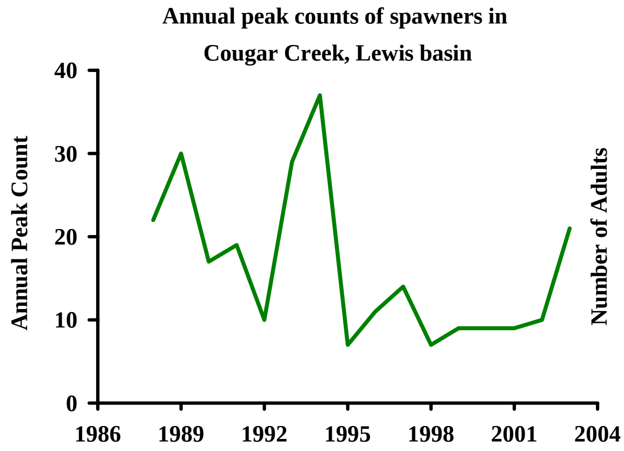
Life History
- Prior to dam construction anadromous and fluvial (rivers) forms were likely present

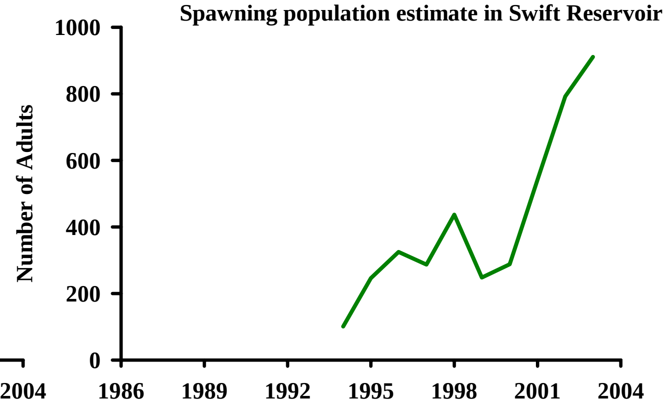
Diversity
- Genetic sampling in 1995 and 1996 showed that Lewis River bull trout are similar to Columbia River populations
- Swift samples were significantly different from Yale and Merwin samples, indicating that there may have been biological separation of upper and lower Lewis River stocks before construction of Swift Dam in 1958
- Stock designated based on geographic distribution

Abundance
- No information on bull trout abundance in the lower NF Lewis is available

Productivity & Persistence
- WDFW (1998) considers Lewis River bull trout to be at moderate risk of extinction

Hatchery
- Three hatcheries exist in the subbasin: two below Merwin Dam, and one on the north shore of Merwin Reservoir. Bull trout are not produced in the hatcheries





Harvest

- Fishing for bull trout has been closed since 1992
- Hooking mortality from catch and release of bull trout in recreational fisheries targeting other species may occur

11.2.8 Cutthroat Trout—Lewis River Subbasin

ESA: Not Listed	SASSI: Unknown 2000

Distribution

- Anadromous forms exist in the NF Lewis and its tributaries up to Merwin Dam, which blocks passage
- Adfluvial fish have been observed in Merwin, Yale and Swift Reservoirs
- Resident fish are found in tributaries throughout the North and East Fork basins

Life History

- Anadromous, fluvial, adfluvial and resident forms are present
- Anadromous river entry is from July through December
- Anadromous spawning occurs from December through June
- Fluvial, adfluvial and resident spawn timing is from February through June

Diversity

- Distinct stock based on geographic distribution of spawning areas
- Genetic analysis has shows Lewis River cutthroat to be genetically distinct from other lower Columbia coastal cutthroat collections

Abundance

- Insufficient data exist to identify trends in survival or abundance
- No data describing run size exist
- In 1998, sea-run cutthroat creel survey results showed a catch of only 20 fish
- Fish population surveys in Yale Lake tributaries showed that cutthroat trout was the most abundant salmonid species in those streams
- Cutthroat were the only salmonid found in some small Yale Lake tributaries during sampling in 1996

Hatchery

- Prior to 1999 Merwin Hatchery annually released 25,000 sea-run smolts into the NF Lewis
- The program was discontinued in 1999 due to low creel returns and concerns over potential interaction with wild fish

Harvest

- Not harvested in ocean commercial or recreational fisheries
- Angler harvest of adipose fin clipped cutthroat occurs in the mainstem Columbia downstream of the Lewis River
- Lewis River wild cutthroat (unmarked fish) must be releases in mainstem Columbia and in Lewis River sport fisheries

11.3 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.

- In general, loss of habitat quantity and quality has the highest relative impact on populations in the lower North Fork, while hydrosystem access and passage impacts are greatest for those populations that historically utilized the upper NF Lewis (i.e. winter steelhead and coho). Thus, for populations in the upper NF Lewis basin, the impact of hydrosystem access and passage minimizes the relative importance of all other potentially manageable impact factors.
- Loss of estuary habitat quantity and quality has high relative impacts on chum and moderate impacts on fall chinook and late fall chinook.
- Harvest has relatively high impacts on fall chinook and late fall chinook, while harvest impacts to spring chinook, chum, winter steelhead, and coho are relatively minor.
- Hatchery impacts are high to moderate for late fall chinook, spring chinook, winter steelhead and coho. Hatchery impacts on chum and fall chinook are relatively low.
- Impacts of predation are moderately important to coho, but are relatively minor for all populations.

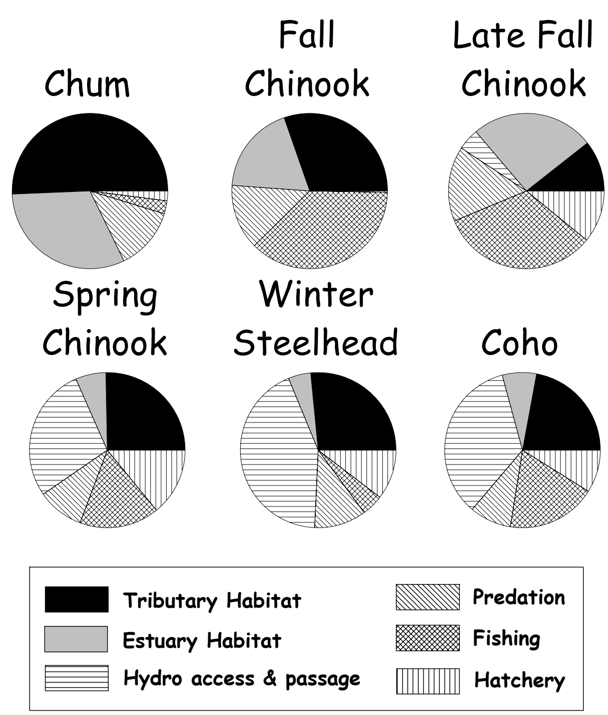


Figure 11-5. Relative index of potentially manageable mortality factors for each species in the North Fork Lewis subbasin.

11.4 Hatchery Programs

The Lewis River basin has multiple hatchery facilities, all located on the NF Lewis River (mainstem). The Lewis River Salmon Hatchery at RM 13, approximately 4 miles downstream of Merwin Dam, was completed in 1932. It has produced fall chinook, spring chinook, early (Type-S) coho, and late (Type-N) coho. The fall chinook hatchery program was discontinued in 1986 to eliminate interactions with a healthy Lewis River wild fall chinook population. Current spring chinook production goals are just over 1 million smolts (Figure 11-6); this includes 900,000 to be released at the hatchery and 150,000 to be transferred to the Fish First Organization Net Pens described below. The collection facility at Merwin Dam was also completed in 1932; adults captured at this facility are enumerated and either transferred to a hatchery for broodstock or released for harvest opportunity or supplementation of natural spawners.

The Speelyai Hatchery on Speelyai Bay in Merwin Reservoir was completed in 1958. It produces spring chinook, 880,000 Type-S, and 815,000 Type-N coho smolts in coordination with the Lewis River Salmon Hatchery (Figure 11-6). Adult spring chinook are captured at the Lewis River and Merwin Hatchery traps, transferred to Speelyai Hatchery for broodstock collection, incubation, and early rearing, and then transferred to the Lewis River Hatchery or Fish First Net Pens for final rearing and release.

The Lewis River net pen system in Merwin Reservoir has been in operation since 1979, serving as a rearing location for hatchery steelhead. A total of 50,000 summer steelhead are transferred to the net pens (from Skamania Hatchery) for release into the NF Lewis.

The Merwin (Ariel) Hatchery below Merwin Dam (at RM 16) was completed in 1983 and produces summer and winter steelhead. Merwin Hatchery steelhead releases into the Lewis River include 175,000 summer steelhead smolts and 100,000 winter steelhead smolts.

Fish First (a volunteer organization) operates spring chinook net pens at RM 10 in the NF Lewis. The annual production goal is 150,000 smolts, which are obtained from the Lewis River Salmon Hatchery production. Fish First volunteers also assist in rearing summer steelhead in the Merwin Reservoir net pens.

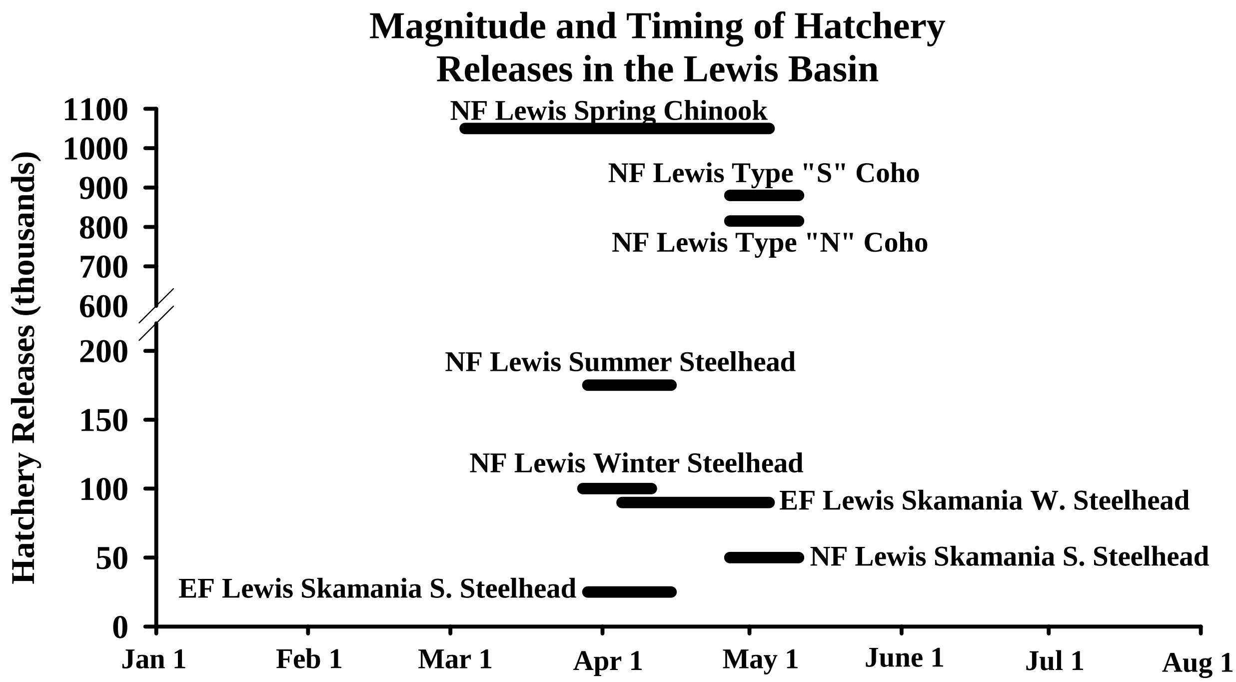


Figure 11-6. Magnitude and timing of hatchery releases in the Lewis River basin by species, based on 2003 brood production goals.

Genetics—Broodstock for the former fall chinook hatchery program likely came from native Lewis River fall chinook and the degree of influence from outside stocks is unknown. Fall chinook hatchery releases ended in 1986; Lewis River fall chinook are the only lower Columbia stock to maintain a healthy wild population with negligible hatchery influence. Genetic analysis in 1990 indicated that NF and EF Lewis River fall chinook were genetically similar and both were distinct from all other lower Columbia River fall chinook stocks.

Broodstock for the spring chinook hatchery program has come from many sources, with most broodstock originating from Cowlitz River spring chinook. Other outside broodstock sources include Carson NFH, Klickitat Hatchery, and Kalama Hatchery. Genetic analysis of NF Lewis River hatchery spring chinook indicated that they were genetically similar to, but separable from, Kalama and Cowlitz hatchery spring chinook stocks and significantly different from other lower Columbia River spring chinook stocks.

Coho broodstock collection comes from adults returning to the Lewis River Salmon Hatchery and the Merwin Hatchery trap facility. WDFW and Fish First have started a small research and enhancement program for wild late coho. This 15,000-smolt and 75,000-fry release program used wild adults collected at the grist mill trap on Cedar Creek.

Broodstock for the winter steelhead hatchery program originated from a mixture of Beaver Creek and Skamania hatchery winter steelhead stocks; Chambers Creek and Cowlitz hatchery stocks also have been released in the basin. Current broodstock collection comes from adults returning to the Lewis River and Merwin hatchery traps. Allele frequency analysis of NF and EF Lewis River winter steelhead was unable to determine the distinctiveness of either stock compared to other lower Columbia River winter steelhead stocks. In recent years, wild late winter steelhead have been collected at Merwin Trap and returned to the Lewis River below Merwin Dam. These wild fish may be used in the future as a brood source for reintroduction of winter steelhead to natural habitats upstream of Swift Dam.

Broodstock for the summer steelhead hatchery program originated from Skamania and Klickitat River crosses; Beaver Creek, Chambers Creek, and Cowlitz River summer steelhead stocks have also been released in the basin. Current broodstock collection comes from adults returning to the Lewis River and Merwin hatchery traps.

Interactions—Hatchery spring chinook account for most spring chinook spawning in the Lewis River (Figure 11-7); juvenile production from natural spawning is presumed to be low. The native component of the spring chinook stock may have been extirpated and replaced by the hatchery stocks so wild and hatchery spring chinook interactions are expected to be minimal. Hatchery spring chinook are released to the Lewis River as smolts; some predation by hatchery-origin smolts may occur on naturally produced salmonids in the system. However, the potential for these interactions is limited to the duration of the smolt emigration. Large releases of hatchery spring chinook smolts may attract additional predators causing increased predation on wild fish, but wild fish may benefit from the presence of large numbers of hatchery fish because wild fish usually have better predator avoidance capabilities. Because the Lewis River fall chinook population represents the majority of fall chinook natural production in the lower Columbia River, any negative interactions with fall chinook are a substantial concern. Additionally, spring chinook are currently part of a proposed reintroduction program in the upper Lewis River basin as part of the basin's hydrosystem relicensing efforts. Because of these potentially conflicting issues, spring chinook smolt release sites for the reintroduction program are being investigated in locations below the natural production areas for fall chinook to minimize any potential negative interaction between spring chinook smolts and fall chinook juveniles.

Hatchery production accounts for most coho returning to the Lewis River (Figure 11-7). Natural production is presumed to be low, although hatchery coho released above Swift Reservoir have successfully spawned in the upper basin tributaries and wild smolts produced from Cedar Creek have been monitored in recent years. Hatchery coho salmon are released to the Lewis River as smolts; some predation by hatchery-origin smolts may occur on naturally produced salmonids in the system. However, the potential for these interactions is minimized by the limited duration of the smolts' emigration to the Columbia estuary. As the reintroduction of coho into available habitat in the upper Lewis River is being evaluated through the basin's hydrosystem relicensing effort, interaction of first generation hatchery fish with hatchery-established natural fish will be an important relationship to monitor. Additionally, coho smolt release sites for the reintroduction program are being investigated in locations below the natural production areas for fall chinook to minimize any potential negative interaction between coho smolts and fall chinook juveniles.

Most NF Lewis River winter steelhead originate from the hatchery program (Figure 11-7); natural production is likely low. Until wild steelhead production is reestablished, interactions between wild and hatchery adult winter steelhead will be low. At Lucia Falls in the EF Lewis River, winter steelhead return data in the late 1970s and early 1980s indicated that the wild portion of the run ranged from 35 to 74%; more recent data (1991-1996) suggests that 49% of spawning winter steelhead were wild fish (LCSCI 1998). Because of the mixture of wild and hatchery fish in the EF Lewis adult return, there is potential for competition for suitable spawning sites, most notably between hatchery summer and wild winter steelhead. Juvenile production levels from winter steelhead natural spawning are unknown. Hatchery winter steelhead smolts may compete with or prey upon other salmonids in the Lewis River; the degree of this risk depends upon the number, size, release time, and stream residence time of the hatchery fish. Interactions between hatchery winter steelhead smolts and other juvenile salmonids are minimized by releasing smolts that migrate through the system quickly, unless smolts residualize. If hatchery winter steelhead and other salmonids occupy the same habitat, the large number of hatchery smolts may provide other salmonids some protection from predators.

Most summer steelhead on the NF Lewis River are of hatchery origin (Figure 11-7) so interactions between wild and hatchery adult summer steelhead are likely minimal. In the EF Lewis River, data in the late 1970s and early 1980s indicated that the portion of wild summer steelhead in the run at Lucia Falls averaged 27%; more recent data (1991-1996) suggests that 30% of spawning summer steelhead were wild fish (LCSCI 1998). Because of the mixture of wild and hatchery fish in the EF Lewis adult return, there is potential for competition between hatchery and wild summer steelhead for suitable spawning sites, but spawning site competition is even more likely between hatchery summer and wild winter steelhead. Juvenile production levels from summer steelhead natural spawning are thought to be moderate. Hatchery summer steelhead smolts may compete with or prey upon other salmonids in the Lewis River; the degree of this risk depends upon the number, size, release time, and stream residence time of the hatchery fish. Interactions between hatchery summer steelhead smolts and other juvenile salmonids are minimized by releasing smolts that migrate through the system quickly, unless smolts residualize. If hatchery summer steelhead and other salmonids occupy the same habitat, the large number of hatchery smolts present may provide other salmonids some protection from predators.

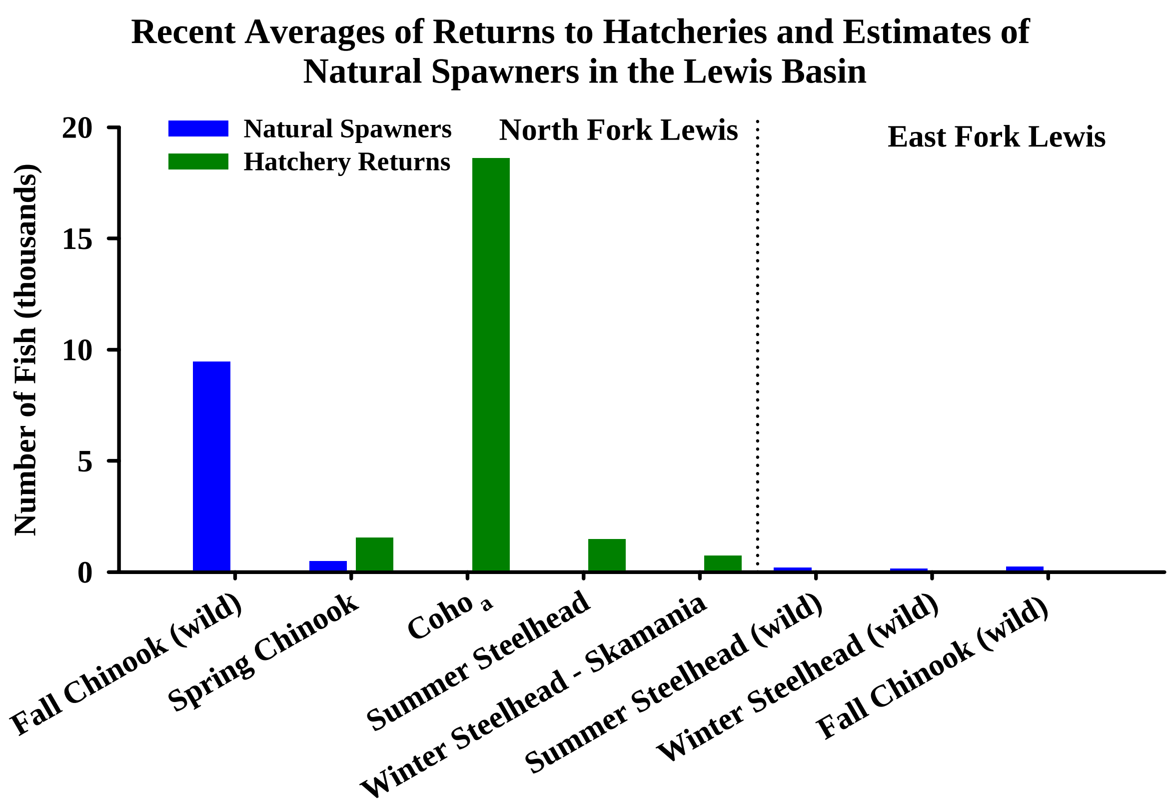


Figure 11-7. Recent average hatchery returns and estimates of natural spawning escapement in the Lewis River basin by species.

The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from the period 1992 to the present. Calculation of each average utilized a minimum of 5 years of data.

[a] A natural stock for this species and basin does not exist based on populations identified in WDFW's 2002 SASSI report; escapement data do not exist.

Water Quality/Disease—Water for the Lewis River Salmon Hatchery comes directly from the Lewis River; this site serves as the primary final rearing site for hatchery spring chinook in the basin. Because the facility is located downstream of multiple hydroelectric generation facilities, influent dissolved gas levels have been a problem. The hatchery is equipped with four degassing towers that are efficient in treating incoming water. Effluent is monitored under the hatchery's NPDES permit. Fish health is monitored continuously by hatchery staff; a fish pathologist visits monthly. The area fish health specialist inspects fish prior to release.

Water for the Speelyai Hatchery comes directly from Speelyai Creek; the facility serves as the primary location for adult broodstock holding and spawning, incubation, and early rearing for the spring chinook hatchery program. Water quality, clarity, and temperature are good; flow to the rearing ponds is about 9,200 gpm. Effluent is monitored under the hatchery's NPDES permit. Adults being held for broodstock collection are inoculated twice with erythromycin. Daily 1-hour standard formalin drip treatments combat fungus problems in the adult holding pond. During the incubation process, eggs are water-hardened in iodophor for viral pathogens; formalin is used to control fungus outbreaks. Disease control procedures are conducted according to the Fish Health Policy. Water for the Merwin Hatchery comes directly from Lake Merwin; water clarity is generally good and water temperatures range from 42-61°F. All water to the hatchery is ozonated and runs through a stripper, entrained gasses are removed, and the water is well-oxygenated. Lake Merwin water is used for adult holding, incubation, and rearing; flow to the rearing ponds is approximately 5,000 gpm. Effluent from the facility is monitored according to the hatchery's NPDES permit. Adults being held for broodstock collection are treated with formalin, hydrogen peroxide, or a combination to control fungus growth. During the incubation process, eggs are water hardened in iodophor for viral pathogens; formalin is used to control fungus outbreaks. Fish health is monitored continuously by hatchery staff; a fish pathologist visits monthly. Disease control procedures during incubation and rearing are conducted according to the Fish Health Policy. The area fish health specialist inspects fish prior to release.

Mixed Harvest—The spring chinook hatchery program at the Lewis River Hatchery complex provides harvest opportunities to mitigate losses resulting from hydroelectric development in the basin. 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 of Lewis River spring chinook indicate a 54% exploitation rate; 46% of the adult return was accounted for in escapement. Most of the harvest occurred in the Lewis River sport fishery. Exploitation of wild fish during the same period likely was similar. Currently all spring chinook are externally marked with an adipose fin-clip to allow for selective fisheries. Selective fisheries in the mainstem and tributaries in recent years have increased harvest of Lewis River hatchery spring chinook while maintaining minimal harvest impacts on wild spring chinook. The mainstem Columbia River spring chinook sport fisheries were reopened into April–May (after closure in 1978) as a result of the ability to selectively harvest marked hatchery fish and release wild fish. Lower Columbia commercial fisheries were also extended to late March as a result of selective fishing regulations applied to the commercial fishery.

The purpose of the Lewis River Hatchery complex coho salmon program is to provide harvest opportunities to mitigate for the losses resulting from hydroelectric development in the basin. Historically, naturally produced coho from the Columbia River were managed like hatchery fish and subjected to similar exploitation rates. The combined ocean and Columbia

River harvest of Columbia River-produced coho ranged from 70% to over 90% from 1970–83. Ocean fisheries were limited in the mid-1980s and Columbia River commercial fisheries were adjusted in the 1990s to protect several wild coho stocks. Columbia River coho exploitation rates during 1997 and 1998 averaged 48.8%. CWT data analysis of the 1995–1997 brood years of Lewis River Type-S and Lewis River Type-N coho indicate a 15% exploitation rate on early run coho and a 42% exploitation rate on late run coho; 85% and 58% of the adult return was accounted for in escapement for early and late-run coho, respectively. Currently all coho are externally marked with an adipose fin-clip to allow for selective fisheries. With the advent of selective fisheries for hatchery fish, exploitation of wild coho is expected to be extremely low, while hatchery fish can be harvested at a higher rate. Lewis River wild coho benefit from ESA limitations for Oregon Coastal Natural coho in ocean fisheries and for Oregon lower Columbia coho in Columbia River fisheries.

The purpose of the summer and winter steelhead hatchery programs is to provide harvest opportunity to mitigate for fish lost as a result of hydroelectric development in the Lewis River basin, benefiting lower Columbia and Lewis River sport fisheries. Before 1986, exploitation rates of wild and hatchery steelhead likely were similar. However, selective harvest regulations on sport fisheries in the lower Columbia River since 1984 and in the Lewis River since 1992 have targeted hatchery steelhead and limited harvest of wild steelhead. Hatchery steelhead harvest rates are estimated at 70% in the North Lewis and 40% in the EF Lewis, while wild steelhead harvest impacts are estimated at 6 percent in the NF Lewis and 5% in the EF Lewis.

Passage—Adult collection facilities at Lewis River consist of a volunteer ladder with a "V" weir that prevents the escape of captured fish. Because adults are volunteers to the ladder, trap avoidance is possible. Traps are opened at various times of the year to collect fish during the entire length of each run. The Lewis River Hatchery trap is 200'x7'x5' with a flow of 3,500 gpm. Fish that escape the Lewis hatchery trap can encounter Merwin Dam trap, four miles upstream of the Lewis Hatchery. There is no adult passage at Merwin Dam although reintroduction of salmon and steelhead to the upper watershed is planned during the next hydro-license period. No other hatchery facility in the basin has an adult collection system, except a trap at the grist mill on Cedar Creek.

Supplementation—The only purpose of each hatchery program of the Lewis Complex has been to provide harvest opportunity to mitigate for the loss of adult fish resulting from hydroelectric development in the Lewis River basin. However, the new hydro-license is expected to include an integrated hatchery program for harvest and also supplementation to reintroduce natural coho, winter steelhead, and spring chinook to the upper Lewis watershed. The hatcheries will develop appropriate broodstocks for supplementation and provide facilities which will enable both harvest and natural reintroduction goals to be achieved.

11.5 Fish Habitat Conditions

11.5.1 Passage Obstructions

All anadromous passage has been blocked by the 240-ft high Merwin Dam since shortly after its construction in 1931. This facility blocked approximately 80% of the available habitat for steelhead, approximately 50% of the spawning habitat for fall chinook, and virtually eliminated the natural run of spring chinook (WDF 1993, McIssac 1990).

Culvert related passage problems are located on Johnson, Cedar, Beaver, John, Brush, and Unnamed Creeks. Other passage problems exist on Robinson, Ross, and Pup Creeks.

11.5.2 Stream Flow

Mean annual streamflow for the entire Lewis River system is approximately 6,125 cubic feet per second (cfs). Average annual flow measured below Merwin Dam is 4,849 cfs. Flow is dominated by winter rains, though summer flow in the Lower North Fork is slightly augmented by glacier melt in the upper basin. Flow in the lower North Fork is controlled by releases from Merwin Dam according to power needs and licensing agreements between PacifiCorp and the Federal Energy Regulatory Commission (FERC) that have established flow requirements for fish. The terms of new licenses are currently being renegotiated.

Hydropower regulation has altered the hydrograph of the lower mainstem (Figure 11-8). Pre-dam data reveals peaks due to fall/winter rains, winter rain-on-snow, and spring snowmelt. Post-dam data shows less overall flow variation, with a general increase in winter flows due to power needs. Post-dam data shows a decrease in spring snowmelt flows due to reservoir filling in preparation for dry summer conditions, and an increase in fall flows due to reservoir drawdown in preparation for winter rains. The risk of extreme summer low flows that are potentially detrimental to fish in the lower river has been reduced in the post-dam era due to reservoir storage and summer release. The risk of extreme winter peaks has also been reduced, with the tradeoff being the reduction of potentially beneficial large magnitude channel-forming flows.

Modification of flow volumes below Merwin Dam affects channel habitat. Since 1985, the dam operator, PacifiCorp, and the WDF and WDW have studied the relationship between spring flows and fall chinook habitat in the lower Lewis River and evaluated the need to modify spring flow provisions in the licensing agreement. In 1995, Article 49 of the licensing agreement was amended to provide for increased minimum flows of 2,700 cfs in April, May, and June (WDFW 1998). The long-term effects on channel morphology and sediment supply have not been thoroughly investigated.

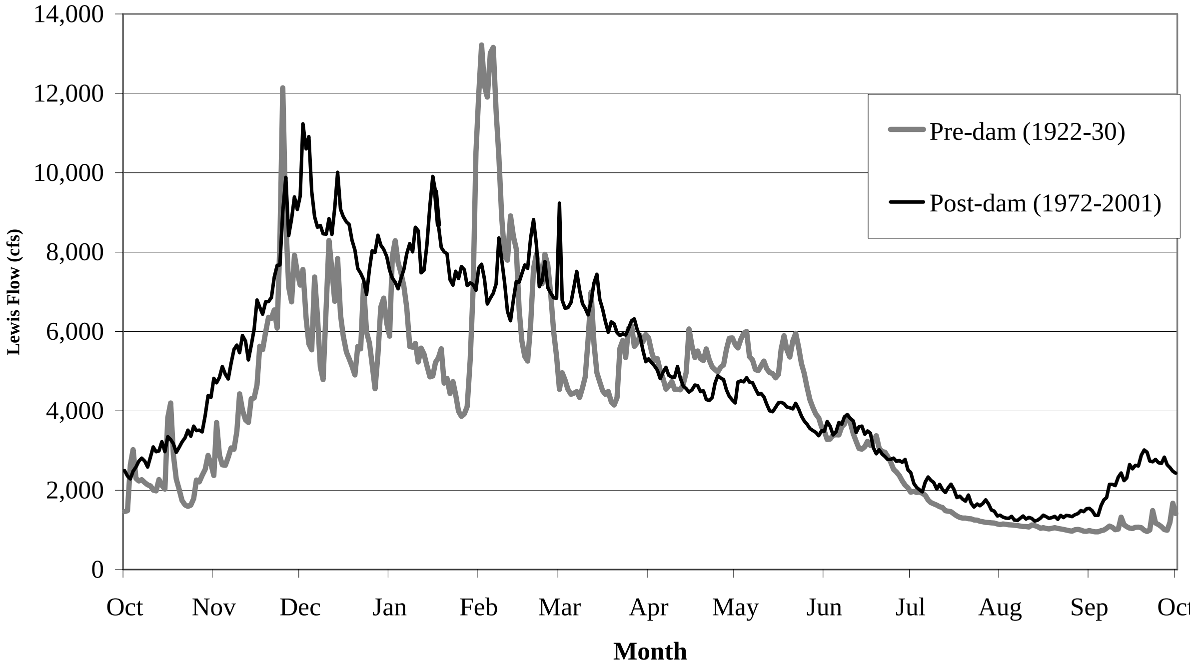


Figure 11-8. Lower Lewis River flow pre- and post-Merwin Dam (1931). Hydro-regulation has decreased flows in the spring and increased flows in the summer and fall. USGS Gage #14220500; Lewis River at Ariel, Wash.

The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that 9 of the 11 subwatersheds in the lower NF Lewis are "impaired" with regards to runoff conditions. Only one subwatershed, Pup Creek, has "moderately impaired" runoff conditions. Impaired runoff conditions are related to young forest vegetation, high road densities, and watershed imperviousness.

An instream flow analysis on Cedar Creek using the toe-width methodology indicated that sufficient flows for steelhead spawning become limited in June, and juvenile rearing is very limited June through October (Caldwell 1999). The current 672 million gallons per year (mgy) water use is expected to increase by 573 mgy by 2020; however, current and future water use is believed to be insignificant when compared to base flows throughout the year (LCFRB 2001).

11.5.3 Water Quality

Water temperatures at Amboy and at the mouth of Cedar Creek often exceed 61ºF (16ºC) in the summer and sometimes reach 73º-77ºF (23°-25°C) (PacifiCorp 1999 as cited in Wade 2000), potentially impacting steelhead juveniles. High temperatures have been attributed to agriculture, grazing, water withdrawals, surface runoff, residential development, forestry operations, and the construction of illegal dams and diversions throughout the basin. Water quality information is lacking for other lower Lewis tributaries.

11.5.4 Key Habitat

Pool habitat in the mainstem below Merwin Dam is affected by Columbia River backwater in the lower 7 miles and is bedrock controlled by a canyon between RM 15 and

Merwin Dam. The Limiting Factors Analysis TAG expressed concerns about adequate pool habitat on Cedar Creek (above RM 4.4) and North Fork Chelatchie Creek. There is a lack of published data and knowledge of other areas (Wade 2000).

Side channel habitat has been removed from the lower seven miles of the mainstem due to diking. Areas of good side channel habitat exist between RM 7 and RM 15. Information on side channel habitat condition for the upper basin is unavailable (Wade 2000).

11.5.5 Substrate & Sediment

The lower 11 miles of the mainstem is a tidally influenced backwater of the Columbia consisting of fine substrate. Little data exists for the major spawning areas between RM 11 and RM 15. A 1998 spawning gravel survey 0.3 and 0.6 miles below Merwin Dam concluded that sediment had not accumulated in spawning gravel (Stillwater Sciences 1998). The spawning area from RM 15 to the dam is not affected because the dam captures most fine sediment (Wade 2000).

TAG members noted concerns of substrate fines in Cedar Creek (above RM 4.4) and in South Fork Chelatchie Creek. Livestock access and residential development in the Cedar Creek system is seen as a potential source of fine sediments (Wade 2000).

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results indicate that 10 of the 11 subwatersheds in the lower NF Lewis basin are “moderately impaired” with regards to sediment supply and one subwatershed is “functional” (lower Cedar Creek). Sediment supply conditions are impaired due to high road densities, stream adjacent roads, and degraded riparian conditions.

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.

11.5.6 Woody Debris

LWD quantities and recruitment potential in the mainstem and tributaries were considered poor by the Limiting Factors Analysis (LFA) technical advisory group (TAG) (Wade 2000). This has been attributed to logging, stream cleanouts, and poor riparian conditions.

11.5.7 Channel Stability

There are bank stability problems on the mainstem between RM 7 and RM 15, particularly along the golf course (RM 12) and across from Eagle Island. A large slide 2 miles upstream of the hatchery intake on Colvin Creek was the result of a large DNR clear-cut. Sediment input to the stream degraded water quality to the point that hatchery staff removed 1 million eggs to other hatcheries. The LFA TAG noted bank stability problems on Cedar Creek from RM 4.4 to RM 11.2, particularly between Brush Creek (RM 9.3) and one half mile short of Amboy due to past and present land uses in the area. Bank stability concerns were also identified on Amboy, SF Chelatchie, and NF Chelatchie Creeks (Wade 2000).

11.5.8 Riparian Function

The Washington State Conservation Commission conducted an assessment of riparian conditions in the lower basin using 1994 and 1996 aerial photos. Riparian areas with a forested width of less than 75 ft or dominated by hardwoods were categorized as having poor riparian conditions. Poor conditions were identified along the lower mainstem where agricultural and residential uses dominate. River mile 9.9 to 11.7 has large areas of minimal vegetation, often dominated by scotch broom. Conditions improve above RM 15 (Wade 2000).

Poor conditions exist along Robinson, Johnson, and Ross Creeks. Poor conditions also exist between Pup and Chelatchie Creeks on the Cedar, due likely to grazing and residential development. Canopy cover between Amboy and Yacolt on Cedar Creek is considered fair though conditions upstream have been extensively impacted by logging. Conditions on the NF and SF Chelatchie are considered generally poor (Wade 2000).

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, 8 of the 11 subwatersheds are rated as “moderately impaired” with regards to riparian function; the remainder are rated as “impaired”. Two of the three impaired subwatersheds are located in the lower basin and the other is the Chelatchie Creek basin. Past riparian timber harvesting, roadways, agriculture, and development have degraded riparian forests.

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.

11.5.9 Floodplain Function

Extensive diking along the lower 7 miles protects farmland and residential uses. It is estimated that greater than 50% of the historical floodplain has been disconnected from the river. Rip-rapped banks between RM 7 and RM 15 protect roads and residential areas. Connections to floodplains and off-channel habitats exist in places (Wade 2000).

11.6 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 lower Lewis River fall chinook, winter 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.

11.6.1 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 lower North Fork Lewis basin for winter steelhead, fall chinook, chum and coho. Model results indicate current fall chinook productivity is approximately 76% of historical levels (Table 11-1). Winter steelhead, chum, and coho productivities have declined further, to 22%, 29%, and 44% of historical levels, respectively. Current adult abundance values are also sharply lower than historical levels (Figure 11-9). Chum appear to have suffered the greatest decline in abundance, to only 6% of historical estimates. The historical to current change in the diversity index is somewhat less dramatic for all species (Table 11-1). Current chum diversity is estimated at 79% of historical, while fall chinook, coho, and winter steelhead diversity have experienced a 25%, 11% and 50% decrease, respectively.

Model results indicate that current smolt productivities have declined from historical levels for all species (Table 11-1). Similarly, smolt abundance levels have decreased. Current smolt abundance is estimated at 84% of historical levels for fall chinook, 61% for winter steelhead, 38% for coho, and only 16% of historical levels for chum (Table 11-1).

Model results indicate that restoration of PFC conditions would accrue modest to large benefits in adult abundance depending on species. Chum abundance would increase 206%, while coho abundance would increase over 100% (Table 11-1). Smolt abundance levels would also increase if PFC conditions were achieved. Restoration of PFC would have the greatest effect on chum smolt abundance, which would increase 138% from current levels.

Table 11-1. Lower NF Lewis — Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	9,388	10,134	11,200	11.2	12.3	14.7	0.75	0.75	1.00	886,535	918,159	1,047,550	506	539	680
Chum	4,418	13,511	79,061	2.7	6.5	9.3	0.79	1.00	1.00	3,133,646	7,443,617	19,208,380	832	880	987
Coho	2,367	4,771	6,025	5.2	8.9	11.9	0.88	0.99	0.99	54,883	112,226	142,734	121	205	274
Winter Steelhead	367	505	1,161	5.3	12.2	24.7	0.40	0.39	0.80	6,171	8,488	10,142	98	224	253

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

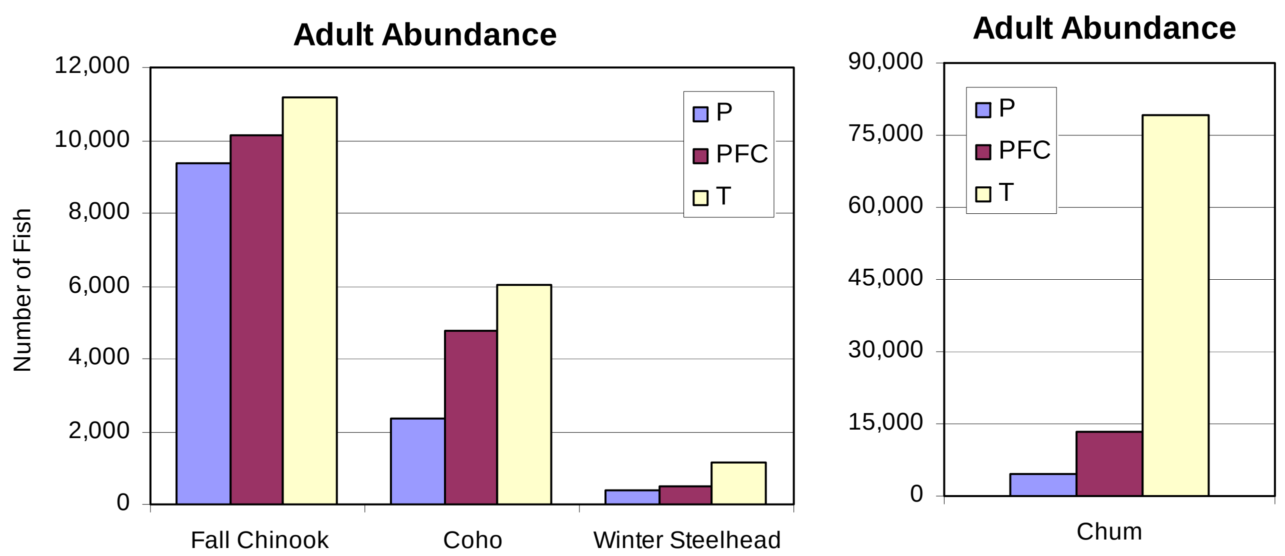


Figure 11-9. Lower NF Lewis— Adult abundance of upper NF Lewis fall chinook, coho, winter steelhead and chum based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

11.6.2 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.

Winter steelhead occupy the greatest amount of lower NF Lewis stream reaches, extending up to Merwin Dam on the mainstem and including many reaches within the Cedar Creek system. Fall chinook and chum use primarily just mainstem habitats from the mouth up to Merwin Dam. See Figure 11-10 for a map of EDT reaches within the lower NF Lewis basin.

High priority reaches for winter steelhead consist of Cedar Creek mainstem reaches (Cedar Creek 1a, 1b, 3 and 4) (Figure 11-11). These reaches represent spawning and rearing habitats utilized by this population. The lowest two Cedar Creek reaches (Cedar Creek 1a and 1b) both show a combined preservation and restoration recovery emphasis, while mainstem reaches Cedar Creek 3 and 4 show a preservation emphasis.

Both fall chinook and chum, unlike steelhead, spawn in the Lewis mainstem. Therefore, high priority reaches for chinook include Lewis 3-4 and Lewis 6 (Figure 11-12). All reaches modeled for fall chinook show a strong habitat preservation emphasis. For chum, the high priority reaches include Lewis 6, Lewis 5, and Lewis 4 (Figure 11-13). As with fall chinook, all the reaches modeled show a strong habitat preservation emphasis.

Coho in the lower NF Lewis also have high priority reaches in mainstem areas. Coho high priority reaches are located from Lewis 3 to Lewis 6 (Figure 11-14). All of these reaches, except Lewis 6, have a combined preservation and restoration habitat emphasis. Lewis 6 shows a preservation only emphasis.

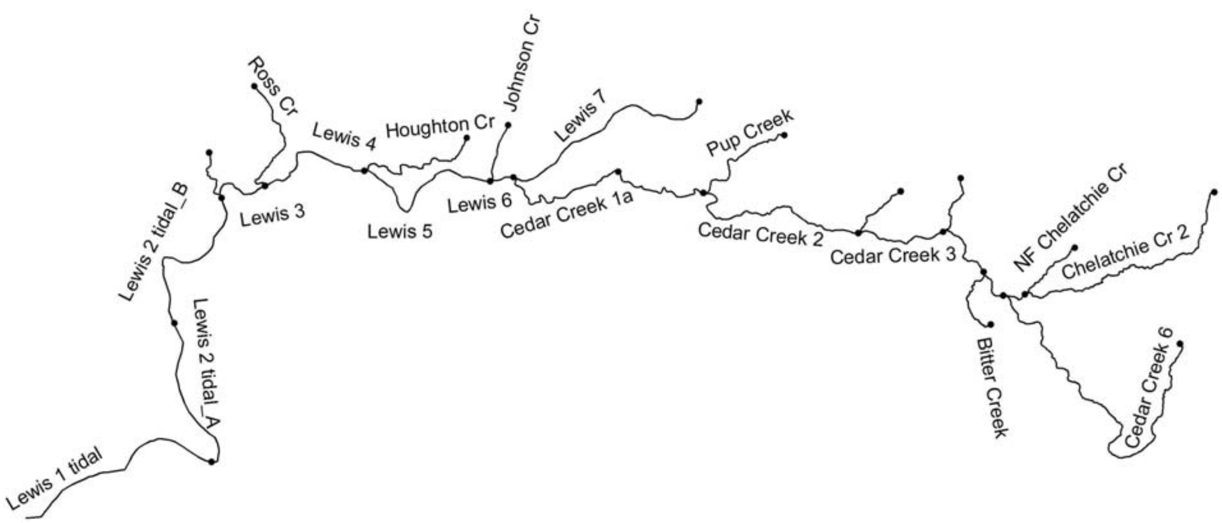


Figure 11-10. Lower North Fork Lewis EDT reaches. Some reaches are not labeled for clarity.

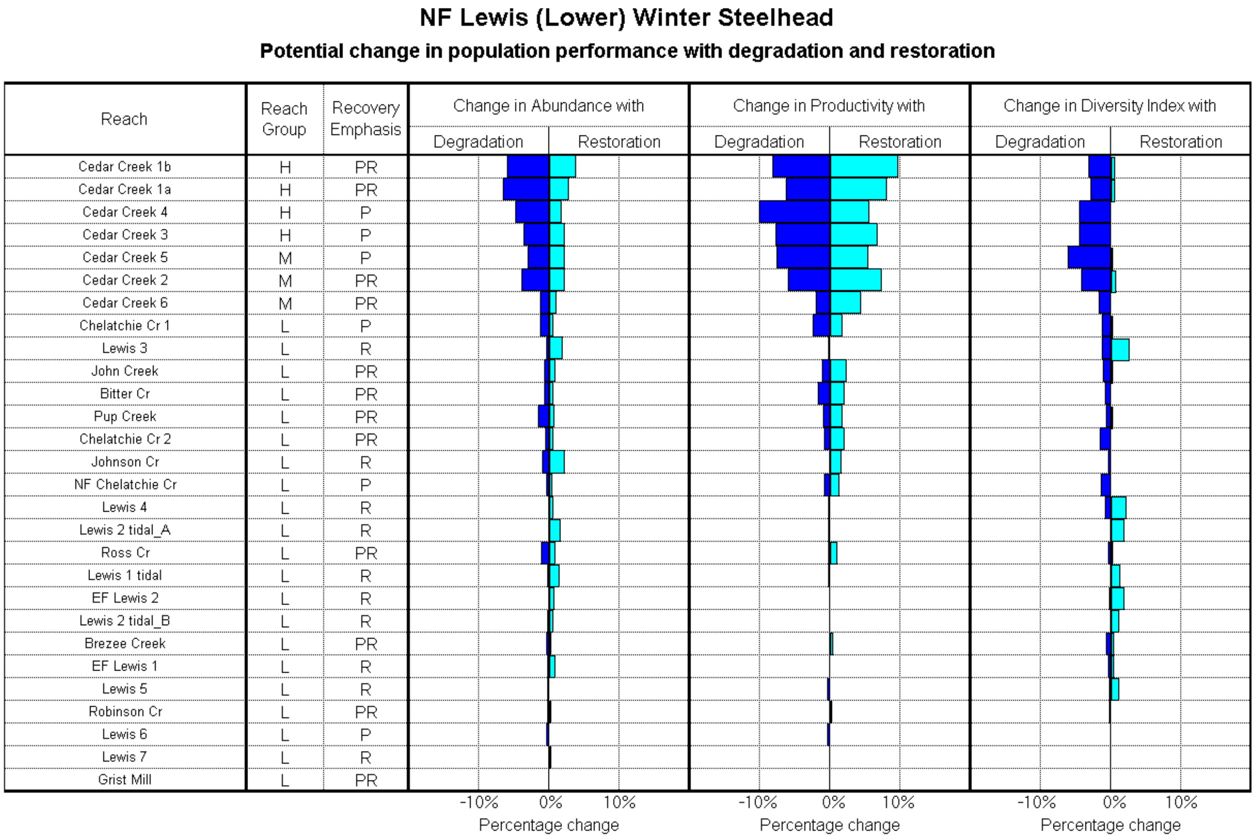


Figure 11-11. Lower NF Lewis River winter steelhead ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current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

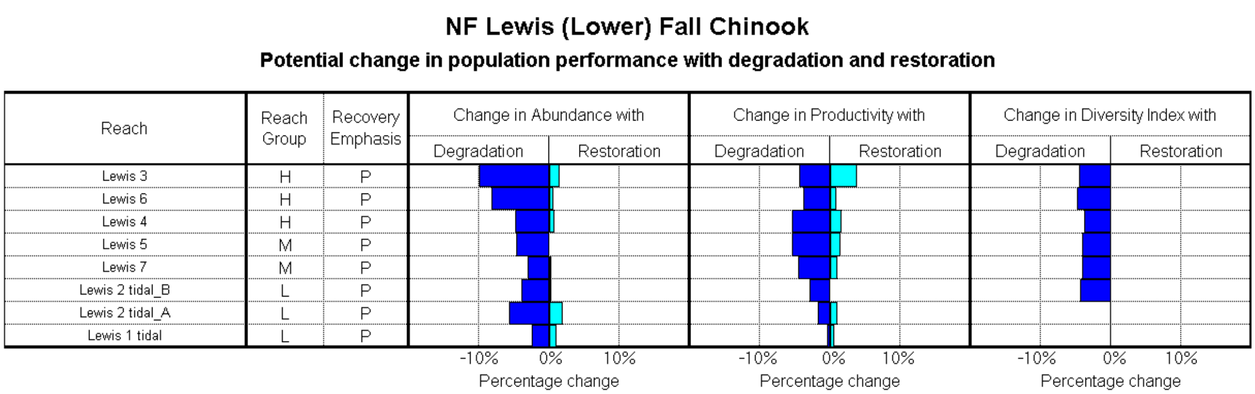


Figure 11-12. Lower North Fork Lewis fall chinook ladder diagram.

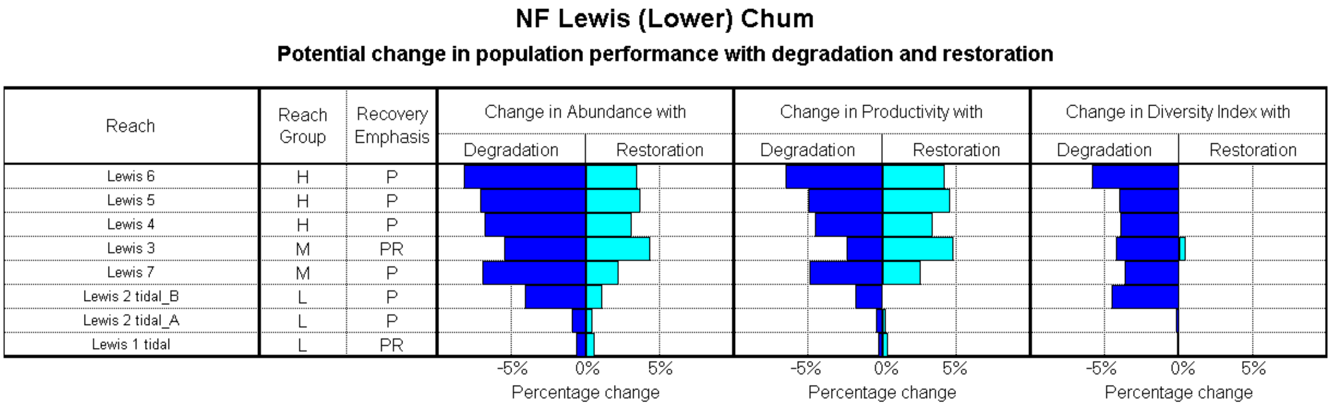


Figure 11-13. North Fork Lewis chum ladder diagram.

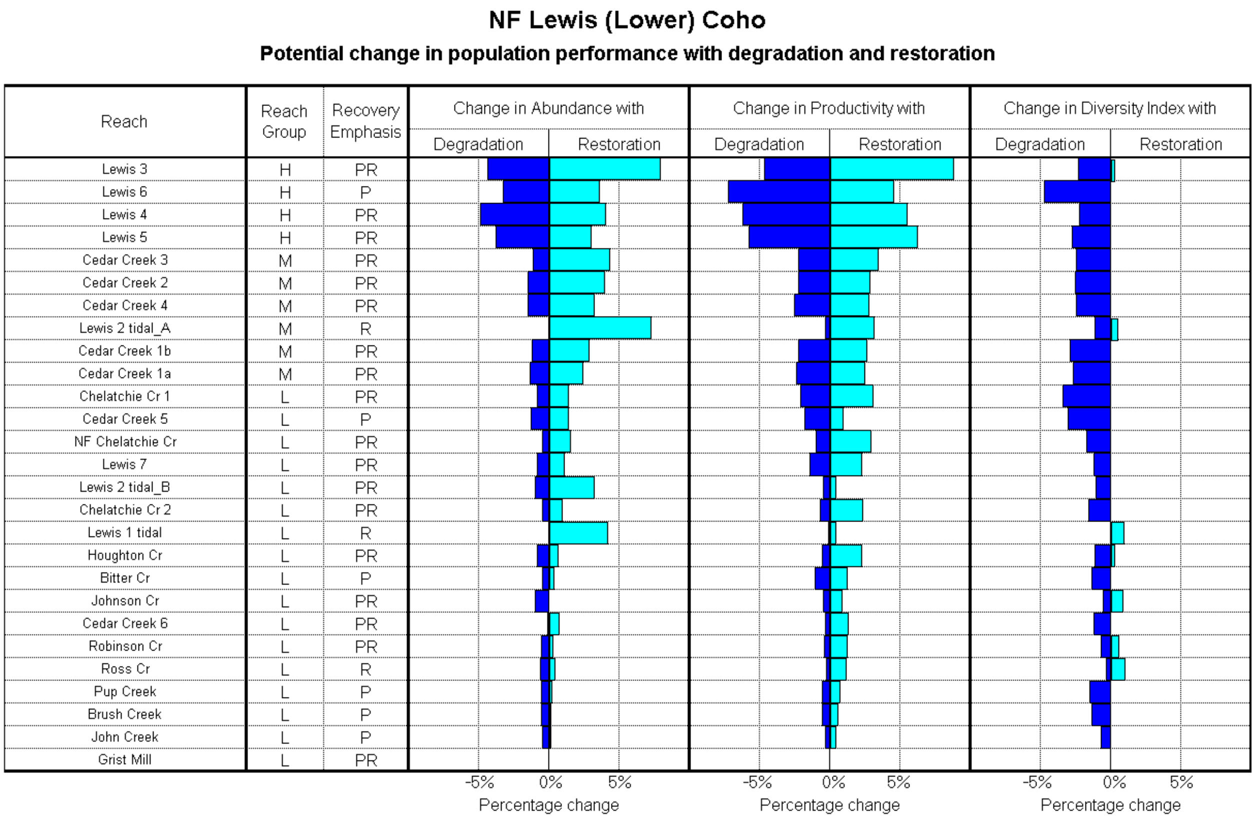


Figure 11-14. North Fork Lewis coho ladder diagram.

11.6.3 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 high priority reaches for winter steelhead are in the middle Cedar area. In this area, temperature and habitat diversity have had the greatest impact (Figure 11-15). Lesser impacts are related to sediment, key habitat, and flow. The Limiting Factor Analysis TAG identified middle Cedar Creek as having high gravel embeddedness. Cattle grazing and residential impacts were noted as contributing to degraded fine sediment conditions. Habitat diversity is low due to low LWD levels and degraded riparian zones throughout the Cedar system. Riparian degradation also contributes to high stream temperatures. Riparian zones have been impacted by logging and residential development (Wade 2000).

Fall chinook (Figure 11-16) and chum (Figure 11-17) restoration efforts are best focused on the middle Lewis mainstem (Lewis 3- 7), where sediment, habitat diversity, flow, and harassment have impacted the population. This alluvial channel currently has some of the best side channel habitat available, yet the quantity of these habitats has been reduced considerably since the historical condition. Habitat diversity is degraded due to highly denuded riparian vegetation, invasive plant species, and low LWD quantities. Temperature is a problem due to lack of canopy cover. Channel stability is low due to riparian impacts. Predation impacts are related to the hatchery program and harassment levels are high due to the close proximity to population centers and ease of access.

High priority reaches for coho are located on the lower and middle Lewis mainstem (Lewis 3-5) and Cedar Creek (Cedar Creek 2-4). In these reaches, key habitat and habitat diversity have the greatest impacts (Figure 11-18). Channelization (diking) and degraded riparian zones play the greatest role in these impacts.

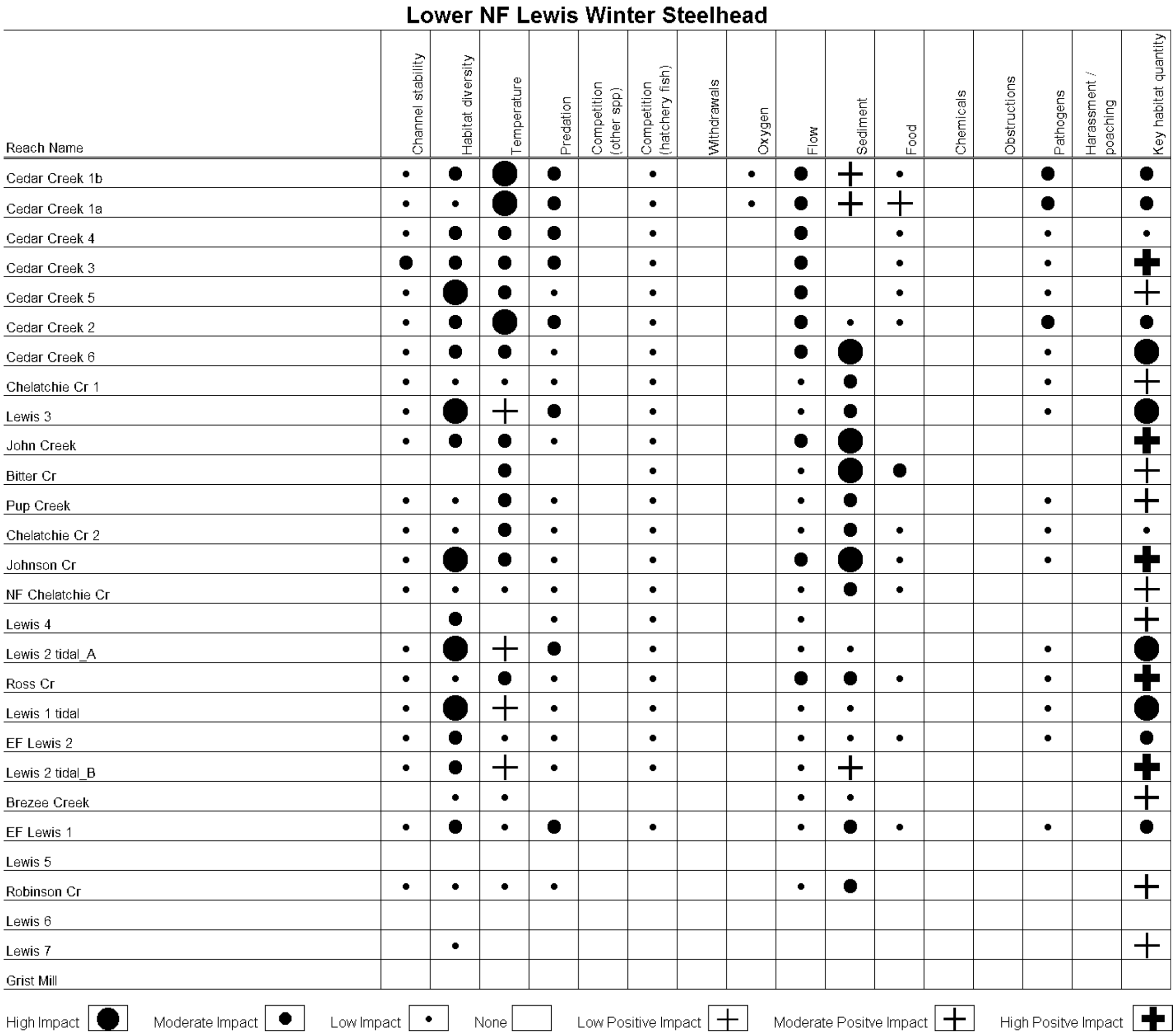


Figure 11-15. Lower NF Lewis winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Volume VI for more information on habitat factor analysis diagrams.

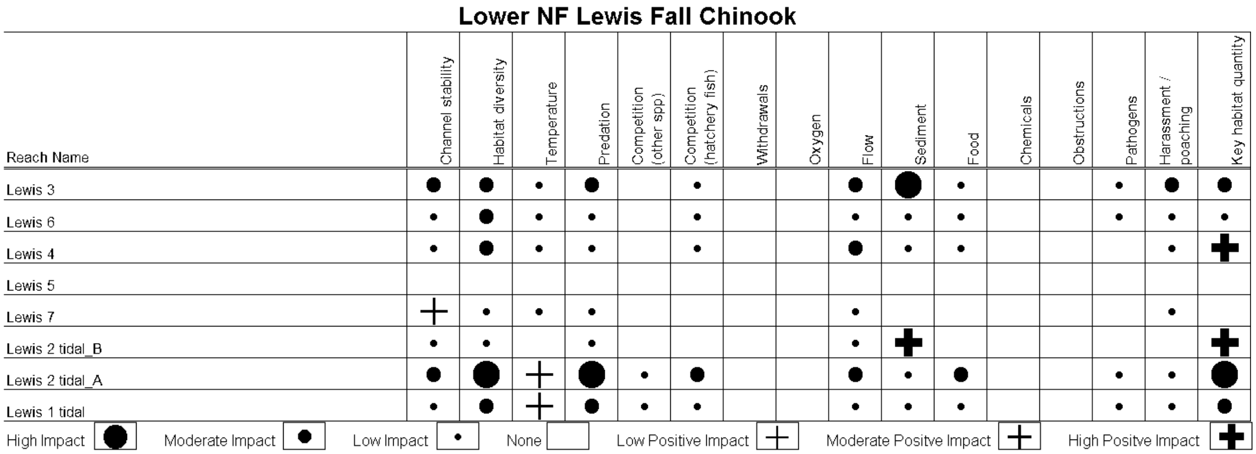


Figure 11-16. Lower North Fork Lewis fall chinook habitat factor analysis diagram

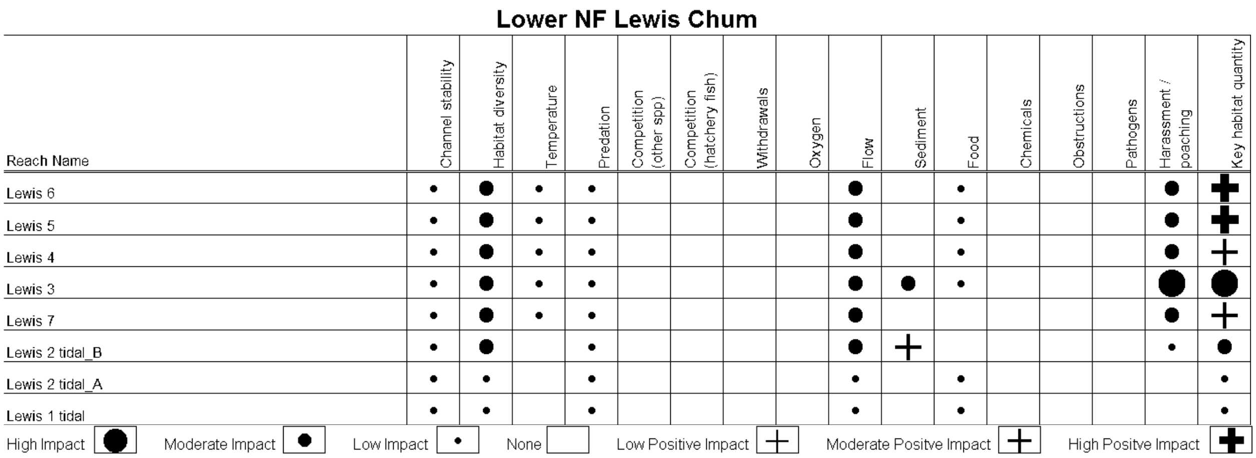


Figure 11-17. North Fork Lewis chum habitat factor analysis diagram.

Lower NF Lewis 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
Lewis 3	Mod	High	Low	High		Mod			Mod	High	Low			Low	Low	High
Lewis 6	Low	High	Low	Low		Low			Low	Low	Low			Low		High
Lewis 4	Mod	Mod	Low	Mod		Mod			Mod	Low	Low			Low	Low	High
Lewis 5	Low	High	Low	Low		Low			Mod	Low	Low			Low	Low	High
Cedar Creek 3	Mod	Mod	Mod	Low		Low			Mod		Mod			Low		Mod
Cedar Creek 2	Mod	Mod	Mod	Mod		Low			Mod	Low	Low			Low		High
Cedar Creek 4	Mod	Mod	Mod	Low		Low			Mod		Low			Low		Mod
Lewis 2 tidal_A	Mod	High	Low +	Mod	Low	Mod			Low	Low	Low			Low		High
Cedar Creek 1b	Mod	Mod	Mod	Low		Low		Low	Low	Low +	Low			Low		Mod
Cedar Creek 1a	Low	Mod	Mod	Low		Low		Low	Low	Low +	Low +			Low		Mod
Chelatchie Cr 1	Mod	Mod	Low	Low		Low			Low	Mod	Low					Mod
Cedar Creek 5	Low	Mod	Low	Low		Low			Low		Low					Low
NF Chelatchie Cr	Mod	Low	Low	Low		Low			Low	High	Low					Mod
Lewis 7		Mod	Low	Low		Low			Low					Low		High
Lewis 2 tidal_B	Mod	Mod	Low +	Mod		Low			Mod	High +	Low			Low		High
Chelatchie Cr 2	Low	Low	Low	Low		Low			Low	Mod	Low					Mod
Lewis 1 tidal	Low	High	Low +	Mod	Low	Low			Low	Low	Low			Low		High
Houghton Cr	Low	Low	Low			Low			Low	Low	Low					Low +
Bitter Cr	Low	Low	Low						Low	Mod	Low					Low
Johnson Cr																
Cedar Creek 6	Low	Mod	Low	Low					Low	Mod						Mod
Robinson Cr	Low	Low							Low	Low						Low +
Ross Cr	Low	Low	Low						Low	Low						Mod +
Pup Creek	Low	Low								Low						Low
Brush Creek		Low								Low						Low +
John Creek	Low	Low								Low						Low +
Grist Mill																

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

Figure 11-18. North Fork Lewis coho habitat factor analysis diagram.

11.7 Integrated Watershed Assessment (IWA)

The Lewis River is the centerpiece of WRIA 27, originating in SW Washington's Cascade Mountains, gathering rainfall, snowmelt and glacial runoff from the forested slopes of Mt. Adams and Mt. St. Helens. The river drains a total of 1,043 sq mi (667,742 acres), flowing to the southwest for approximately 93 miles before joining with the Columbia River. For the purposes of the IWA, the Lewis River subbasin is divided into three watersheds: the NF Lewis River—below Merwin Dam, the NF Lewis River—above Merwin Dam, and the EF Lewis River. Thus, the NF Lewis River is divided into two watersheds separated by the Merwin dam at RM 19.

The NF Lewis River below Merwin is composed of ten subwatersheds totaling 64,354 acres. An additional subwatershed associated with an independent tributary to the Columbia River is also discussed within this chapter (Burris Creek, 40602). Note that all composite watershed-level statistics are calculated without the inclusion of Burris Creek.

In addition to approximately 19 miles of mainstem, the watershed includes Cedar Creek, a major tributary system with five subwatersheds totaling 36,000 acres, or roughly 55% of the watershed, as well as several smaller tributaries to the North Fork, such as Robinson Creek, Johnson Creek and Ross Creek. These smaller mainstem tributaries are included within the four subwatersheds that contain segments of the North Fork. The subwatershed immediately below Merwin dam (60504) features a confined channel with banks composed primarily of bedrock and moderately forested slopes. Proceeding downstream, the mainstem becomes less confined, featuring a readily identifiable floodplain, more erodable streambanks and increasing streamside development. The lowest portions of the watershed are almost entirely deforested, heavily developed, and marked by the substantial revetment of the stream channel with dikes, levees and rip rap.

Interpretation of IWA results in the North Fork requires a clear understanding of the implications resulting from the watershed division at Merwin Dam. The four mainstem subwatersheds below Merwin Dam are profoundly influenced by the dams upstream. Total drainage areas for these subwatersheds total in excess of 500,000 acres, while the subwatersheds themselves range from 3,800 – 8,800 acres in size. Total annual discharge is not substantially affected by the dams, but the hydrograph is dramatically altered from its natural condition on seasonal, monthly, weekly and daily timescales. Sediment and large-wood processes are severely retarded by the hydro-system. However, conditions at the watershed level are rated in the IWA as if the watershed indeed terminates at Merwin Dam. That is to say that mainstem areas are influenced by upstream effects only to the base of Merwin Dam. This simplification is a necessity for facilitating the quantitative analysis, but the analysis herein will include a brief discussion of the implications. A partial exception is made for hydrology at the watershed scale, as discussed below.

The watershed is primarily a low-elevation, rainfall-dominated system with relatively low levels of natural erodability as estimated by geologic conditions and slope. However, current conditions feature substantially elevated indices of erodability that are nearly double the background levels. Only 4% of the watershed is in the rain-on-snow zone, almost exclusively in the headwaters of Cedar Creek (subwatershed 60405). However, for the mainstem subwatersheds, roughly 30% of the contributing drainage area is in the rain-on-snow zone when areas above Merwin Dam are included in the analysis. The signature of rain-on-snow events is quite different below major storage dams due to their influence on flood peak flows, episodic sediment input and debris transport. However, the impact of rain-on-snow events is truncated by the storage of peak flows in the reservoirs.

11.7.1.1 Results and Discussion

IWA results were calculated for all subwatersheds in the lower NF Lewis 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). A summary of the results is shown in Table 11-2. The local and watershed level results are also shown in Figure 11-19 and Figure 11-20. In general, local hydrologic conditions are impaired and local sediment and riparian conditions are moderately impaired. The results are similar for watershed level conditions, with the exception of hydrology, in which case several watersheds move from impaired to moderately impaired once upstream conditions are considered.

Table 11-2. IWA results for the North Fork Lewis – Below Merwin watershed

Subwatershed [a]	Local Process Conditions [b]			Watershed Level Process Conditions [c]		Upstream Subwatersheds [d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
40602	I	M	I	I	M	60401, 60402, 60403, 60404, 60405, 60406, 60501, 60502, 60503, 60504
60501	I	M	I	M	M	60401, 60402, 60403, 60404, 60405, 60406, 60502, 60503, 60504
60502	I	M	M	M	M	60401, 60402, 60403, 60404, 60405, 60406, 60503, 60504
60503	I	M	M	M	M	60401, 60402, 60403, 60404, 60405, 60406, 60504
60504	I	M	M	M	M	none
60401	I	F	M	I	M	60402, 60403, 60404, 60405, 60406
60403	M	M	M	M	M	none
60402	I	M	M	I	M	60404, 60405, 60406
60404	I	M	M	I	M	60405, 60406
60405	I	M	M	I	M	none
60406	I	M	I	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.

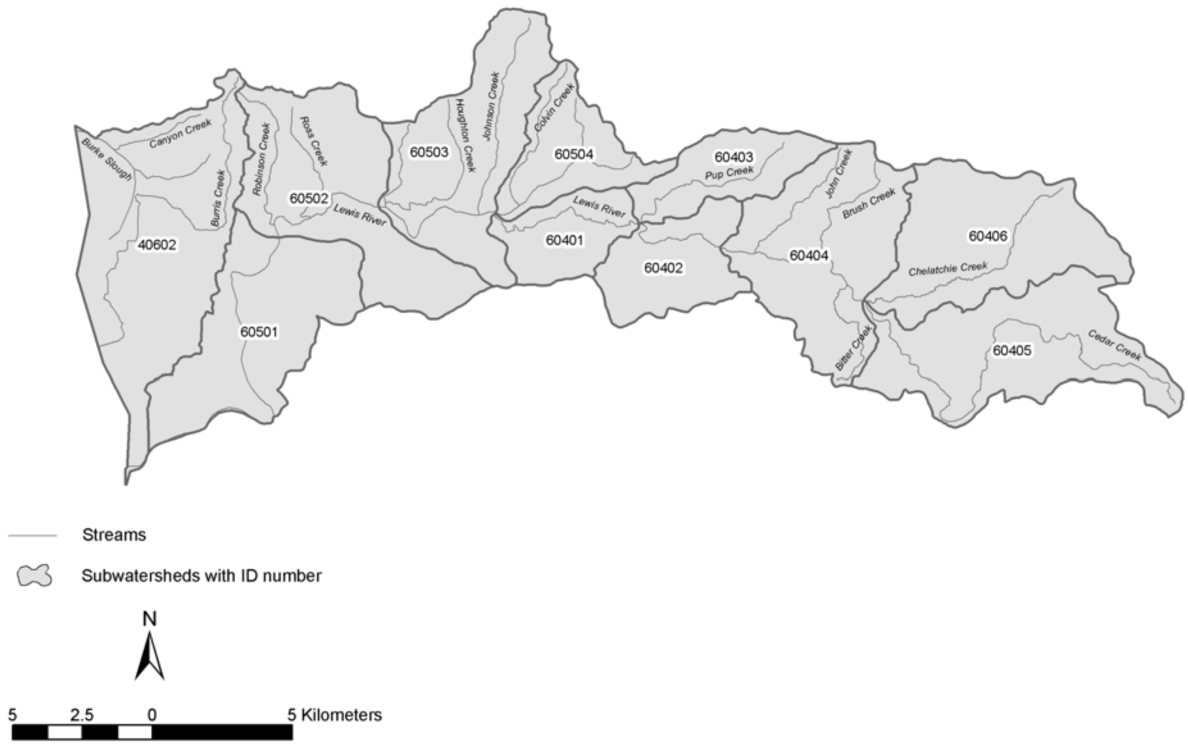


Figure 11-19. Map of the Lower North Fork Lewis Basin showing the location of the IWA subwatersheds.

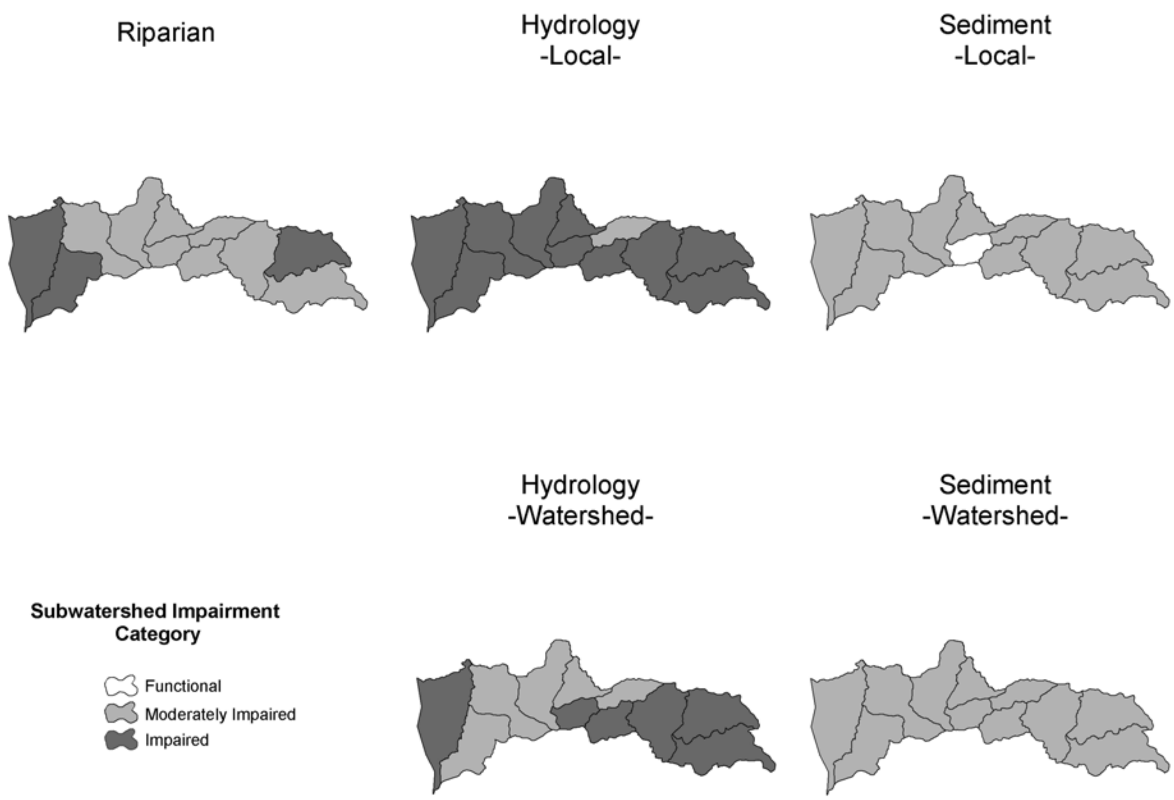


Figure 11-20. IWA subwatershed impairment ratings by category for the Lower North Fork Lewis Basin.

11.7.1.1.1 Hydrology

Local hydrologic conditions are poor throughout the watershed, with 10 out of 11 subwatersheds falling into the impaired category. Only Pup Creek, a tributary to Cedar Creek, is rated as moderately impaired. It is important to note here that local hydrologic conditions in the IWA are evaluated on the basis of several localized indicators, such as the extent of impervious area, land cover, road density and urban zoning classifications. This intra-watershed approach, while informative regarding local sources of impairment, may overstate the impacts of localized effects for a large river like the Lewis. Conversely, conditions in small tributaries within those subwatersheds are almost exclusively governed by within-subwatershed conditions.

Watershed level conditions are rated as moderately impaired in all mainstem subwatersheds, and impaired in the Cedar Creek drainage and in Burris Creek (40602). Watershed level hydrologic conditions are somewhat better on average than the aggregation of within-watershed upstream effects would suggest, with all mainstem reaches considered only moderately impaired at the watershed scale. The IWA method for hydrology in the lower NF Lewis departs from the standardized method in other watersheds in order to account for the dominant influence of the dams on mainstem hydrology.

The natural hydrograph of the lower mainstem has been altered by hydro-regulation; however, flow releases at certain times of the year are designed to benefit fall chinook. In addition, subwatersheds above Merwin Dam are for the most part hydrologically functional. The lower mainstem subwatersheds therefore receive a moderately impaired rating as opposed to an impaired rating. Recall, however, that several small tributaries to the mainstem are subsumed in these mainstem subwatersheds. The watershed scale analysis does not logically apply to these small, terminal streams that are nearly unaffected by conditions outside the subwatershed. Conditions in these areas are best described by the local, intra-watershed characterization.

For the mainstem sections of subwatersheds 60501, 60502, 60503 and 60504, dam operations are the dominant factor influencing river hydrology. In addition, extensive channel modifications (artificial confinement and bank hardening) in the lower reaches have divorced the mainstem from its floodplain, reducing hydrologic and habitat connectivity while increasing risk of bed scour during high flow events. Wetlands that were once abundant in subwatersheds 60501 and 60502 no longer exist. High proportions of lower mainstem subwatersheds fall within the designated urban growth areas around communities such as Woodland. The two mainstem subwatersheds furthest downstream (60501, 60502) are largely developed, contain only 6% mature forest cover, and contain very small amounts of publicly owned lands (7% and 2% for 60501 and 60502, respectively).

The Cedar Creek drainage is also severely impaired hydrologically but due to different factors. Cedar Creek is dominated by timber activities on private and public lands. Mature forest cover is present over only about 24% of the drainage, with the highest coverage (51%) in the Pup Creek subwatershed. Seventy percent of the Cedar Creek drainage is in commercial timber production, with only 13% of the subwatershed under public ownership. Individual subwatersheds range from 41% designated commercial harvest (60401, lower Cedar Creek) to 95% (60403, Pup Creek).

11.7.1.1.2 Sediment

Local sediment conditions are impaired throughout the watershed with the single exception of subwatershed 60401 in lower Cedar Creek, which is rated functional. Natural erodability is relatively low in all subwatersheds, but conditions relative to the background level are rated moderately impaired to in all cases, with borderline impaired conditions present in some cases. As a low elevation, low gradient, low rain-on-snow proportion watershed, sediment impairment is largely caused by high road density, streamside road density, stream crossing density and impaired riparian conditions including substantial channel modifications. These problems are likely to be exacerbated in subwatersheds where hydrologic and riparian conditions are also impaired, such as Cedar Creek.

Sediment conditions are rated as moderately impaired at the watershed level in all Cedar Creek subwatersheds. Lower Cedar Creek (60401), which is rated locally functional for sediment conditions, is rated moderately impaired at the watershed level due to the influence of degraded areas upstream. All upstream subwatersheds in the Cedar Creek drainage are rated as moderately impaired for sediment.

Extensive channel modifications have starved the river of sediment in some areas while causing local sedimentation from bank erosion in other areas. Natural levels of erodability in the watershed are quite low, but intensive development and associated anthropogenic processes contribute to moderate impairment levels. Mainstem subwatersheds are also profoundly affected by the lack of sediment input from the upper watershed due to the presence of the dams.

11.7.1.1.3 Riparian

Functional riparian subwatershed conditions are entirely absent within the watershed, with three subwatersheds exhibiting substantially impaired conditions, including Chelatchie Creek, Burris Creek and the furthest downstream subwatershed of the mainstem North Fork. The causes are different in each case and tend to reflect the unique conditions in each area. Riparian degradation in the Cedar Creek drainage is related primarily to forest practices on both private and public lands.

The lower mainstem areas (60501, 60502) of the North Fork are characterized in large part by the nearly complete absence of riparian vegetation due to dikes, rip rap and other channel revetments. Denuded streambanks starve the river of organic debris inputs, remove potential sources of LWD, contribute to elevated stream temperatures and promote bank and channel erosion. Greater than 50% of subwatershed 60501 lies in the FEMA floodplain, but the river is largely disconnected from its floodplain by dikes and levees.

Burris Creek suffers many of the same riparian symptoms as the lower North Fork mainstem. Roughly 68% of the subwatershed is contained within the FEMA floodplain with minimal mature forest cover and scant levels of public ownership.

11.7.1.2 Predicted Future Trends

11.7.1.2.1 Hydrology

Absent efforts to remove channel modifications and restore the natural floodplain, mainstem hydrologic conditions are unlikely to improve in the foreseeable future. Small tributaries within mainstem subwatersheds (e.g., Johnson Creek, Houghton Creek, Robinson Creek) are likely to experience further hydrologic degradation due to local-level changes in landscape conditions, including full build-out of areas zoned for growth, higher road densities, and additional impervious surfaces.

Hydrologic conditions in the upper Cedar Creek/Chalatchie Creek drainage are expected to remain relatively stable or to slightly improve as new forest practices regulations begin to have an effect. Lower Cedar Creek subwatersheds (60401) may experience further degradation due to development pressures in areas that are zoned for development but have not been built out.

11.7.1.2.2 Sediment Supply

While localized management actions may improve conditions in smaller tributaries, mainstem sediment processes are likely to remain at moderately impaired levels due to cumulative upstream effects, local development effects, and the impact of hydro-regulation. The mainstem is expected to continue to lack coarse sediments due to the dams and to experience elevated fine sediment due to land use practices. Prospects for localized improvement are better in the upper mainstem subwatersheds (60503 and 60504) due to a much higher percentage of both mature forest cover (27% and 32%, respectively) and percentage of land in public ownership (47% and 42%, respectively) as compared to subwatersheds 60501 and 60502. These lands are managed almost entirely by the WDNR.

In the Cedar Creek drainage, sediment processes are expected to trend towards gradual improvement as improved forestry and road management practices take effect. However, if residential development expands in these areas, sediment conditions could trend towards further degradation.

11.7.1.2.3 Riparian Condition

In the lower mainstem subwatersheds, impaired riparian conditions are likely to persist due to existing streamside road densities, channel alterations, and increasing development pressure. Reconnection of the river with its historical floodplain is likely to be difficult to achieve due to development pressures in urban growth areas, high levels of private ownership, and potential displacement of established land-uses and existing structures.

In the Cedar Creek drainage, forest management on both public and private lands is expected to improve, leading to a gradual improvement in riparian conditions over the next 20 years. Impaired riparian conditions are expected to persist or worsen in lower mainstem subwatersheds due to existing streamside road densities, channel alteration, and increasing development pressures.

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