Lower Columbia Salmon Recovery
And
Fish & Wildlife Subbasin Plan

Volume II – Subbasin Plan
Chapter G – NF and EF Lewis

Salmon-Washougal and Lewis Rivers (WRIAS 27-28)

Watershed Management Plan

Chapter 6 Appendix – Management of Fish Habitat Conditions

Lower Columbia Fish Recovery Board

December 15, 2004

Preface

This is one in a series of volumes that together comprise a Recovery and Subbasin Plan for Washington lower Columbia River salmon and steelhead:

--	Plan Overview	*Overview of the planning process and regional and subbasin elements of the plan.*
Vol. I	Regional Plan	*Regional framework for recovery identifying species, limiting factors and threats, the scientific foundation for recovery, biological objectives, strategies, measures, and implementation.*
Vol. II	Subbasin Plans	*Subbasin vision, assessments, and management plan for each of 12 Washington lower Columbia River subbasins consistent with the Regional Plan. These volumes describe implementation of the regional plan at the subbasin level.*
		II.A. Lower Columbia Mainstem and Estuary *II.B. Estuary Tributaries* *II.C. Grays Subbasin* *II.D. Elochoman Subbasin* *II.E. Cowlitz Subbasin* *II.F. Kalama Subbasin* *II.G. Lewis Subbasin* *II.H. Lower Columbia Tributaries* *II.I. Washougal Subbasin* *II.J. Wind Subbasin* *II.K. Little White Salmon Subbasin* *II.L. Columbia Gorge Tributaries*
Appdx. A	Focal Fish Species	*Species overviews and status assessments for lower Columbia River Chinook salmon, coho salmon, chum salmon, steelhead, and bull trout.*
Appdx. B	Other Species	*Descriptions, status, and limiting factors of other fish and wildlife species of interest to recovery and subbasin planning.*
Appdx. C	Program Directory	*Descriptions of federal, state, local, tribal, and non-governmental programs and projects that affect or are affected by recovery and subbasin planning.*
Appdx. D	Economic Framework	*Potential costs and economic considerations for recovery and subbasin planning.*
Appdx. E	Assessment Methods	*Methods and detailed discussions of assessments completed as part of this planning process.*

This plan was developed by of the Lower Columbia Fish Recovery Board and its consultants under the Guidance of the Lower Columbia Recovery Plan Steering Committee, a cooperative partnership between federal, state and local governments, tribes and concerned citizens.

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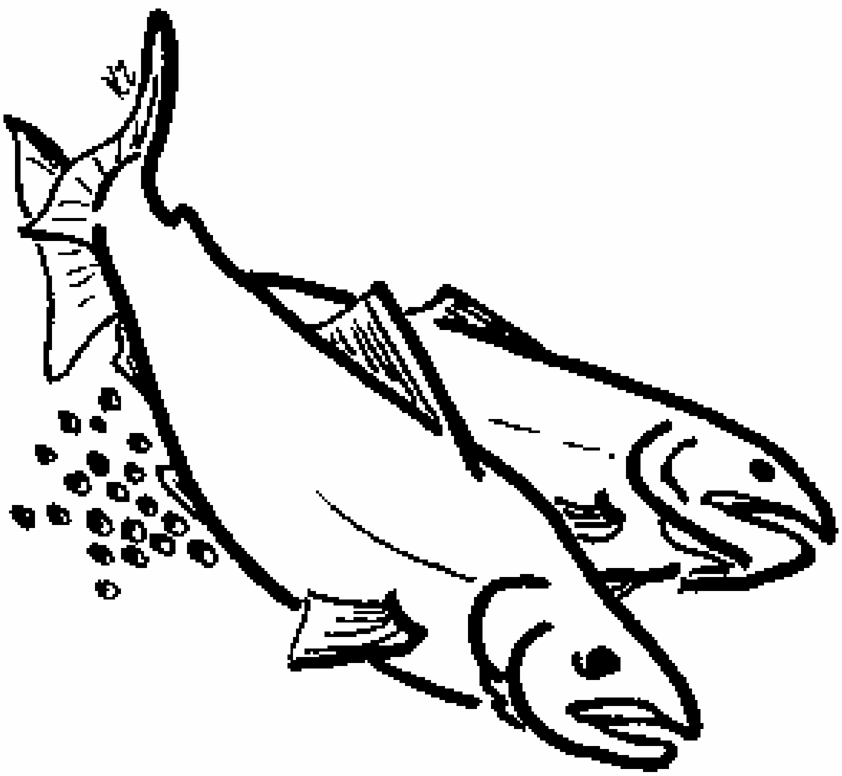
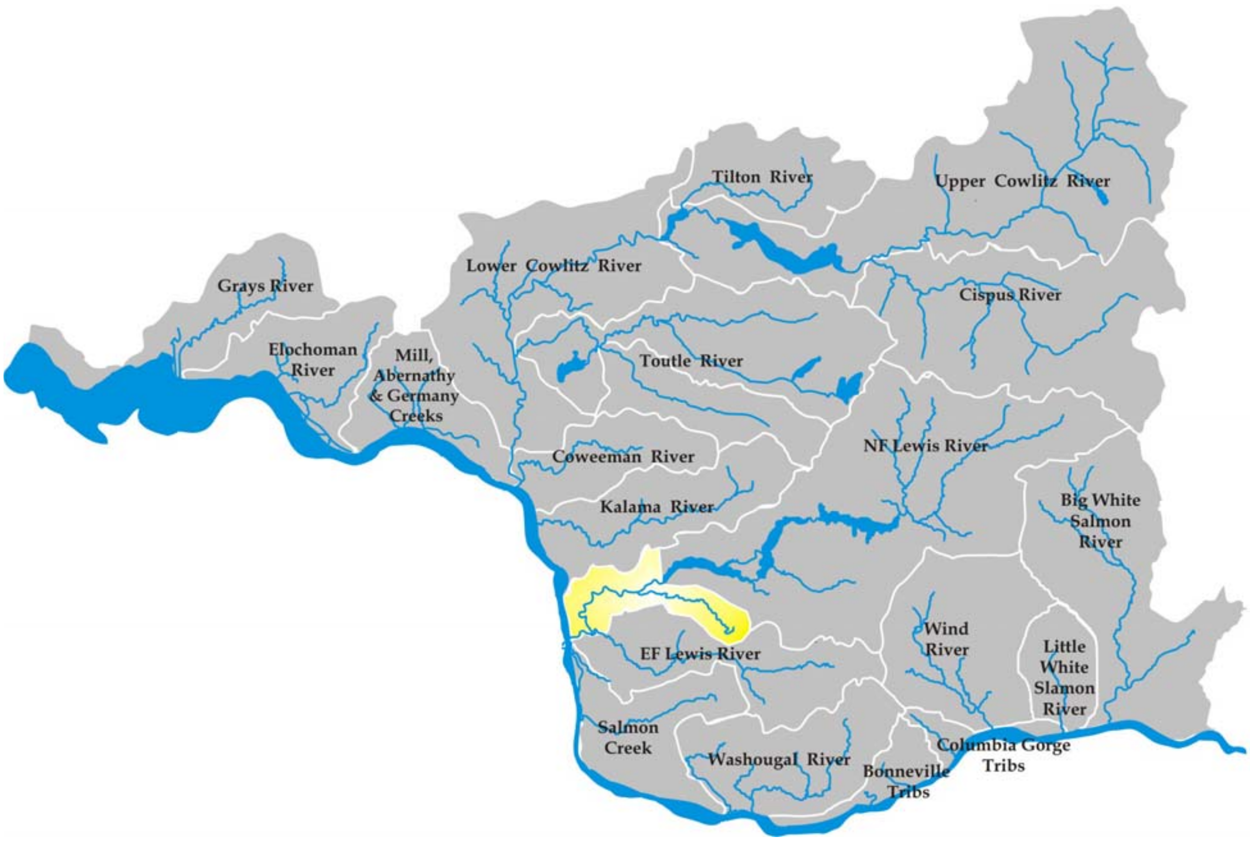


Subbasin Plan Vol. II.G.
Lewis Subbasin –
Lower North Fork Lewis River



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1.0 Lower North Fork Lewis River – Executive Summary

This plan describes a vision, strategy, and actions for recovery of listed salmon, steelhead, and trout species to healthy and harvestable levels, and mitigation of the effects of the Columbia River Hydro system in Washington lower Columbia River subbasins. Recovery of listed species and hydropower mitigation is accomplished at a regional scale. This plan for the Lower North Fork Lewis River Basin describes implementation of the regional approach within this basin, as well as assessments of local fish populations, limiting factors, and ongoing activities that underlie local recovery or mitigation actions. The plan was developed in a partnership between the Lower Columbia Fish Recovery Board (Board), Northwest Power and Conservation Council, federal agencies, state agencies, tribal nations, local governments, and others.

The Lower North Fork Lewis Basin historically supported thousands of fall Chinook, steelhead, chum, and coho. Today, numbers of naturally spawning coho, chum, and steelhead are far below historic numbers. Fall Chinook, however, have continued to persist in the lower North Fork Lewis at levels near historical numbers, but spawning habitat upstream of Merwin Dam is not available for fall Chinook. Chinook, steelhead, and chum have been listed as Threatened under the Endangered Species Act and coho is proposed for listing. The North Fork Lewis fall Chinook are healthy compared to other lower Columbia chinook populations, but are included in the listing as part of the lower Columbia ESU. The decline of other salmonid populations has occurred over decades and the reasons are many. Freshwater and estuary habitat quality has been reduced by agricultural and forestry practices. Key habitats have been isolated or eliminated by channel modifications and through diking, filling, and draining of floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has reduced productivity. Hydropower construction and operation has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

North Fork Lewis River spring Chinook and chum will need to be restored to a high level of viability and fall Chinook to above high viability to meet regional recovery objectives. Spring chinook recovery will occur in the Upper Lewis, while chum recovery and fall Chinook enhancement will occur in the Lower North Fork Lewis. Recovery to high viability means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the subbasin.

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

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact Lower North Fork Lewis River fish populations. Specific strategies, measures, actions and priorities have been developed to address these threats and limiting factors. The specified strategies identify the best long term and short term avenues for achieving fish restoration and mitigation goals. While it is understood that data, models, and theories have their limitations and growing knowledge will certainly spawn new strategies, the Board is confident that by implementation of the recommended actions in this plan, the population goals in the Lower Lewis River Basin can be achieved. Success will depend on implementation of these strategies at the program and project level. It remains uncertain what level of effort will need to be invested in each area of impact to ensure the desired result. The answer to the question of precisely how much is enough is currently beyond our understanding of the species and ecosystems and can only be answered through ongoing monitoring and adaptive management against the backdrop of what is socially possible.

1.1 Key Priorities

Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the Lower North Fork Lewis Basin. The following list identifies the most immediate priorities.

1. Manage Regulated Stream Flows through the Hydropower System

Hydro-regulation on the Lewis River has altered the natural stream flow regime below Merwin Dam. To support fish and their habitat, hydro-regulation will need to provide adequate flows for habitat formation, fish migration, water quality, floodplain connectivity, habitat capacity, and sediment transport below Merwin Dam. Due to alterations to the channel and floodplain in the lower river, the ability to restore the natural flow regime is limited and will need to occur in concert with restoration of lower river floodplain function.

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

Most lower and middle mainstem and tributary stream reaches are in agriculture, rural residential, or urban uses. Many riparian forests have been harvested or developed. Dike building and bank stabilization have heavily impacted fish habitat in the lower mainstem Lewis. Removing or modifying channel control and containment structures to reconnect the stream and its floodplain, where this is feasible and can be done without increasing risks of substantial flood damage, will restore normal habitat-forming processes to reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing. These improvements will be particularly beneficial to chum, fall Chinook, and coho. Partially restoring normal floodplain function will also help control downstream catastrophic flooding and will provide wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and riparian habitats will be protected through local land use ordinances, partnerships with landowners, and the acquisition of land, where appropriate. Restoration will be achieved by working with willing landowners, non-governmental organizations, conservation districts, and state and federal agencies.

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

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

4. Manage Forest Lands to Protect and Restore Watershed Processes

Much of the Cedar Creek Basin and the upper watersheds of several mainstem tributaries are managed for commercial timber production and have experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing sediment, and reducing riparian zones. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Habitat Conservation Plan (State-owned lands) and Forest Practices Rules (private lands) are expected to improve conditions by restoring passage, protecting riparian conditions, reducing sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead and coho.

5. Restore Passage at Culverts and Other Artificial Barriers

There are several culvert barriers and other obstructions to fish passage on small tributaries throughout the basin. Correcting passage barriers could open up as many as 16 additional miles of habitat. Further assessment and prioritization of passage barriers is needed throughout the subbasin.

6. Address Immediate Risks with Short-term Habitat Fixes

Restoration of normal watershed processes that allow a basin to restore itself over time has proven to be the most effective strategy for long term habitat improvements. However, restoration of some critical habitats may take decades to occur. In the near term, it is important to initiate short-term fixes to address current critical low numbers of some species. Examples in the Lewis basin include building of chum salmon spawning channel and construction of coho overwinter habitat with alcoves, side channels, or engineered log jams. In the absence of large-scale floodplain and channel migration zone restoration, opportunistic habitat creation and enhancement may be one of the few viable options for providing critical habitat, especially in the lower mainstem. In some cases, benefits will only be temporary but will help bridge the period until normal habitat-forming processes are reestablished.

7. Align Hatchery Priorities Consistent with Conservation Objectives

Hatcheries throughout the Columbia basin historically focused on producing fish for fisheries as mitigation for hydropower development and widespread habitat degradation. Emphasis of hatchery production without regard for natural populations can pose risks to natural population viability. Hatchery priorities must be aligned to conserve natural populations, enhance natural fish recovery, and avoid impeding progress toward recovery while continuing to provide fishery mitigation benefits. The North Fork Lewis hatchery program will produce and/or acclimate spring Chinook, early and late coho, and winter and summer steelhead for use in the North Fork Lewis Basin. Coho, winter steelhead, and spring Chinook will be used to supplement natural production in the Upper Lewis Basin, and chum supplementation will occur in the Lower Lewis and/or East Fork Lewis Basin. All species reared in the Lewis Hatchery Complex, except chum, will also provide fishery mitigation in a manner that does not pose significant risk to natural population rebuilding efforts. Fall Chinook hatchery releases in the North Fork Lewis have been discontinued to provide a natural fish refuge.

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

This near-term strategy involves limiting fishery impacts on weak natural populations to ameliorate extinction risks until a combination of measures can restore fishable natural populations. Selective fisheries for marked hatchery steelhead, spring chinook and coho will be a critical tool for limiting wild fish impacts. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models. There is no directed Columbia River or tributary harvest of ESA-listed North Fork Lewis River coho, spring chinook, chum, or steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some North Fork Lewis River salmon and steelhead are incidentally taken in mainstem Columbia River and ocean mixed stock fisheries for strong wild and hatchery runs of fall chinook and coho. These fisheries will be managed with strict limits to ensure this incidental take does not threaten the recovery of wild populations including those from the Lower North Fork Lewis. Steelhead and chum will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Fisheries on Lewis River wild fall chinook are managed to achieve an escapement goal of 5,700 natural spawners past the fisheries and to the spawning grounds. In most years, there are enough Lewis River wild fall chinook adults to conduct a directed fishery.

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

North Fork Lewis River salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the subbasin. Human impacts include drastic habitat changes in the Columbia River estuary, effects of Columbia Basin hydropower operation on mainstem, estuary, and nearshore ocean conditions, interactions with introduced animal and plant species, and altered natural predation patterns by northern pikeminnow, birds, seals, and sea lions. A variety of restoration and management actions are needed to reduce these out-of-basin effects so that the benefits in-subbasin actions can be realized. To ensure equivalent sharing of the recovery and mitigation burden, impacts in each area of effect (habitat, hydropower, etc.) should be reduced in proportion to their significance to species of interest.

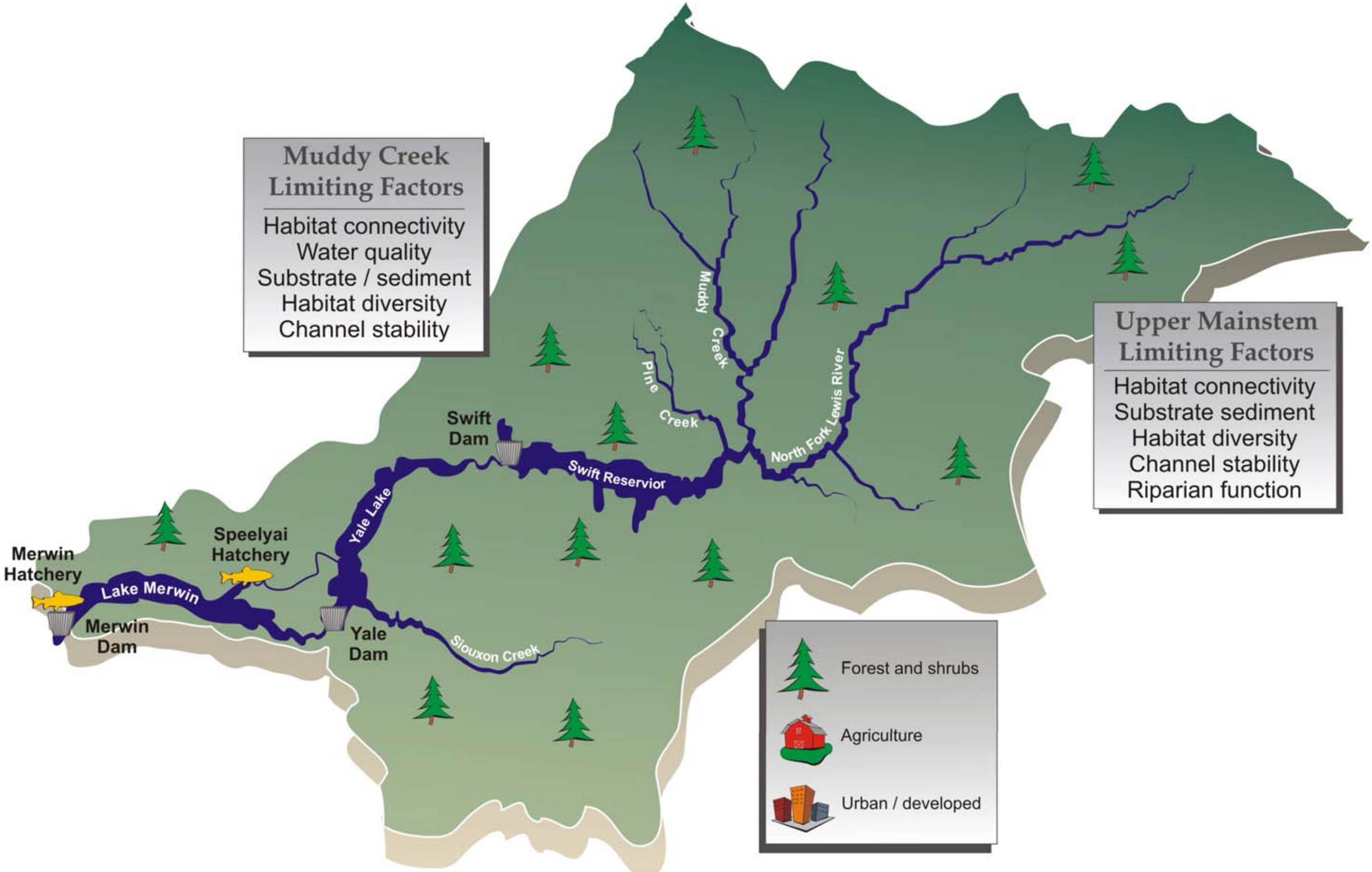


Figure 1. Key features of the Lower North Fork Lewis River subbsin including a summary of limiting fish habitat factors in different areas and the status and relative distribution of focal salmonid species.

2.0 Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's Lower North Fork Lewis River Subbasin. The plan addresses subbasin elements of a regional recovery plan for Chinook salmon, chum salmon, coho salmon, steelhead, and bull trout listed or under consideration for listing as Threatened under the federal Endangered Species Act (ESA). The plan also serves as the subbasin plan for the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program to address effects of construction and operation of the Federal Columbia River Power System.

Development of this plan was led and coordinated by the Washington Lower Columbia River Fish Recovery Board (LCFRB). The Board was established by state statue (RCW 77.85.200) in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. It is comprised of representatives from the state legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro project operators, the environmental community, and concerned citizens. A variety of partners representing federal agencies, Tribal Governments, Washington state agencies, regional organizations, and local governments participated in the process through involvement on the LCFRB, a Recovery Planning Steering Committee, planning working groups, public outreach, and other coordinated efforts.

The planning process integrated four interrelated initiatives to produce a single Recovery/Subbasin Plan for Washington subbasins of the lower Columbia:

- Endangered Species Act recovery planning for listed salmon and trout.
- Northwest Power and Conservation Council (NPCC) fish and wildlife subbasin planning for eight full and three partial subbasins.
- Watershed planning pursuant to the Washington Watershed Management Act, RCW 90-82.
- Habitat protection and restoration pursuant to the Washington Salmon Recovery Act, RCW 77.85.

This integrated approach ensures consistency and compatibility of goals, objectives, strategies, priorities and actions; eliminates redundancy in the collection and analysis of data; and establishes the framework for a partnership of federal, state, tribal and local governments under which agencies can effectively and efficiently coordinate planning and implement efforts.

The plan includes an assessment of limiting factors and threats to key fish species, an inventory of related projects and programs, and a management plan to guide actions to address specific factors and threats. The assessment includes a description of the subbasin, focal fish species, current conditions, and evaluations of factors affecting focal fish species inside and outside the subbasin. This assessment forms the scientific and technical foundation for developing a subbasin vision, objectives, strategies, and measures. The inventory summarizes current and planned fish and habitat protection, restoration, and artificial production activities and programs. This inventory illustrates current management direction and existing tools for plan implementation. The management plan details biological objectives, strategies, measures, actions, and expected effects consistent with the planning process goals and the corresponding subbasin vision.

3.0 Assessment

3.1 Subbasin Description

3.1.1 *Topography & Geology*

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).

3.1.2 *Climate*

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 2 and Figure 3.

3.1.3 *Land Use, Ownership, and 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. The State of Washington owns, and the Washington State Department of Natural Resources (DNR) manages the beds of all navigable waters within the subbasin. Any proposed use of those lands must be approved in advance by the DNR. A breakdown of land ownership and land cover/land use is included in Figure 2 and Figure 3.

3.1.4 *Development Trends*

The population of the basin is small. The 2000 population of the entire NF Lewis (including the Upper NF Lewis) 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 population of Woodland is expected to grow by 233% between 2000 and 2020. Continued population growth will increase pressures for conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions.

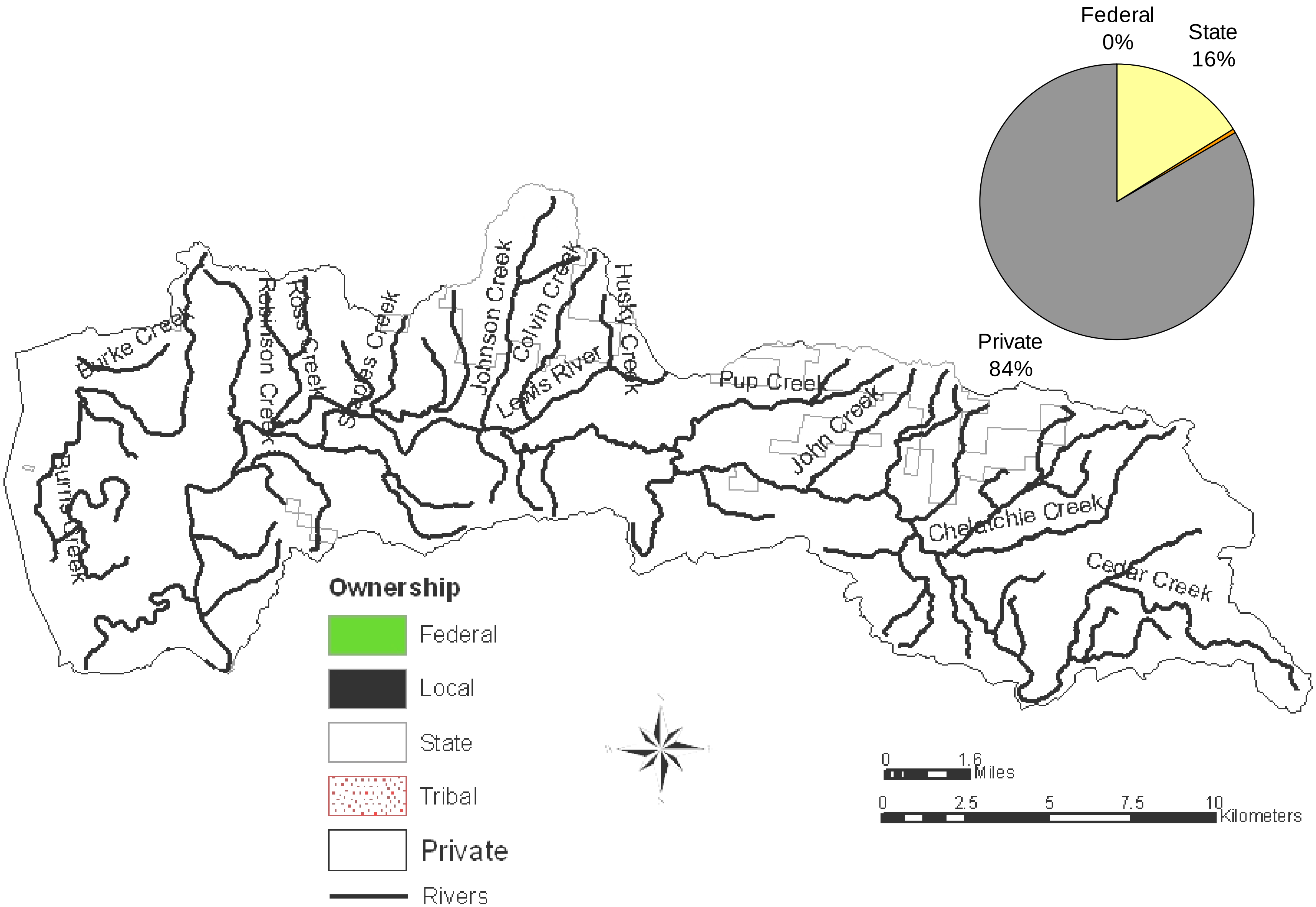


Figure 2. Landownership within the lower North Fork Lewis River basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

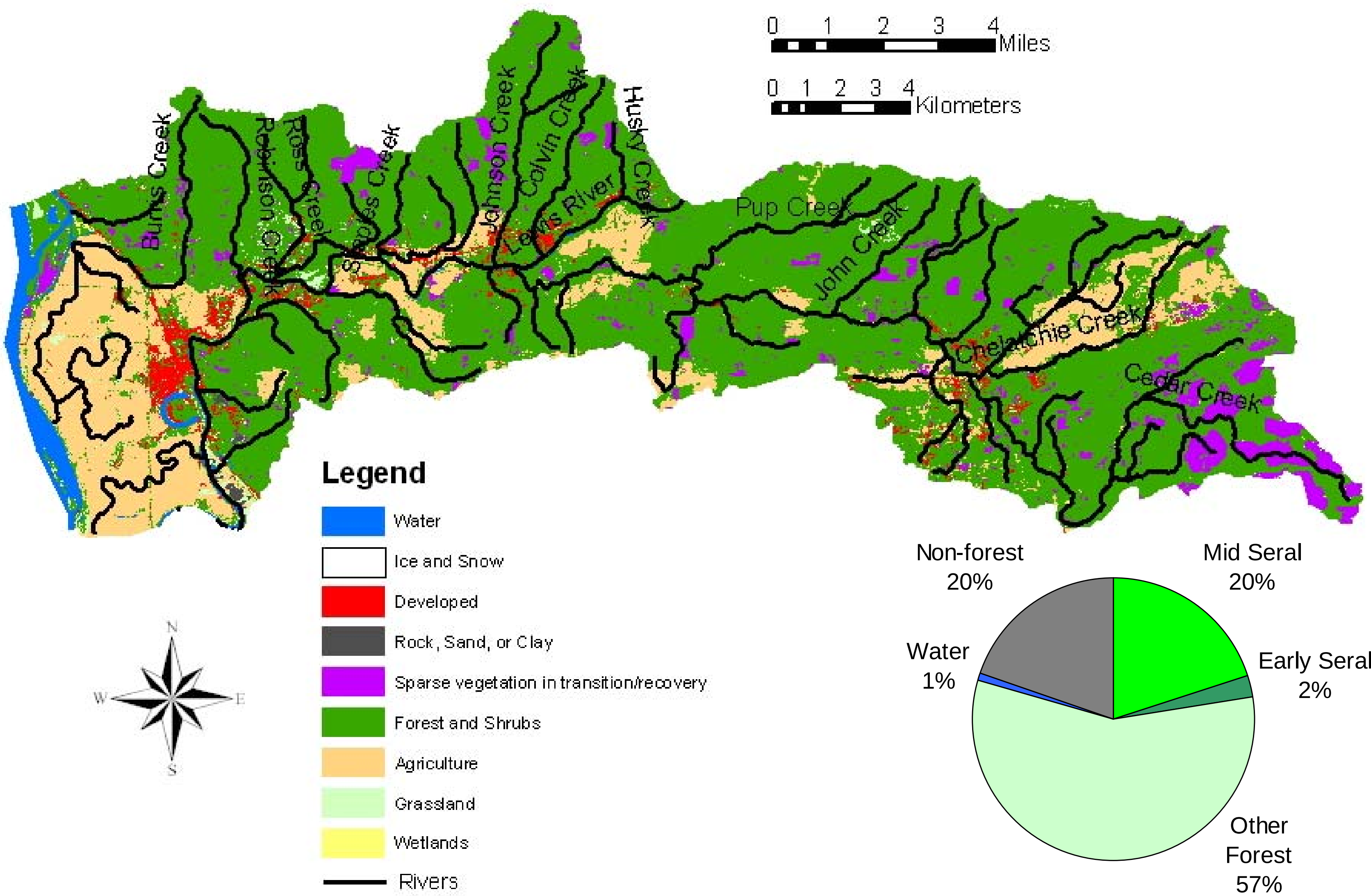


Figure 3. Land cover within the lower North Fork Lewis River basin. Vegitation cover (pie chart) derived from Landsat dat based on methods in Lunetta et al 1997. Data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the Lower North Fork Lewis Subbasin. Other species of interest were also identified as appropriate. Species were selected because they are listed or under consideration for listing under the U.S. Endangered Species Act or because viability or use is significantly affected by the Federal Columbia Hydropower system. Private Utility Hydropower System effects are significant within the Lower North Fork Lewis River basin and anadromous species are also subject to Columbia Hydrosystem effects in the Columbia River, estuary, and nears shore ocean. The Lower North Fork Lewis ecosystem supports and depends on a wide variety of fish and wildlife in addition to designated species. A comprehensive ecosystem-based approach to salmon and steelhead recovery will provide significant benefits to other native species through restoration of landscape-level processes and habitat conditions. Other fish and wildlife species not directly addressed by this plan are subject to a variety of other Federal, State, and local planning or management activities.

Focal salmonid species in the North Fork Lewis River watersheds (lower and upper North Lewis) include fall Chinook, spring Chinook, chum, coho, and summer and winter steelhead. Bull trout occur in the upper North Lewis but are not known to occur today in the lower North Lewis downstream of Merwin Dam. Fall chinook historical abundance was significant in the lower North Fork Lewis and that is the focus area for fall chinook. Spring Chinook were primarily produced in the upper North Fork Lewis and that is the focus area for spring Chinook. Winter steelhead and coho were produced in the upper and lower North Fork Lewis and they are a focus in both areas. The North Fork Lewis chum population is a subset of a larger population which also includes the East Fork Lewis. Salmon and steelhead numbers, with the exception of fall chinook, have declined to only a fraction of historical levels (Table 1). Extinction risks are significant for all focal species except fall chinook – the current health or viability of ranges from very low for spring Chinook, chum, coho and summer steelhead to medium-high for fall Chinook. Returns of spring Chinook, coho, and summer and winter steelhead include both natural and hatchery produced fish.

Table 1. Status of focal salmon and steelhead populations in the Lower North Fork Lewis River subbasin.

Focal Species	ESA Status	Hatchery Component[1]	Historical numbers[2]	Recent numbers[3]	Current viability[4]	Extinction risk[5]
Fall Chinook (a)	Threatened	No	18,000-20,000	3,200-18,000	Med+	20%
Spring Chinook (b)	Threatened	Yes	10,000-50,000	200-1,000	Very Low	60%
Chum (c)	Threatened	No	120,000-300,000[6]	<100	Very Low	70%
Coho (d)	Proposed	Yes	7,500-85,000	Unknown	Very Low	60%
Summer Steelhead	Threatened	Yes	20,000	Unknown	Very Low	80%
Winter Steelhead (d)	Threatened	Yes	6,000-24,000	Unknown	Low	50%

(a) focus is in lower North Fork Lewis
(b) focus is in upper North Fork Lewis
(c) Includes North Fork and East Fork Lewis populations
(d) Focus is in upper and lower North Fork Lewis
[1] *Significant numbers of hatchery fish are released in the subbasin.*
[2] *Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations.*
[3] *Approximate current annual range in number of naturally-produced fish returning to the subbasin.*
[4] *Propsects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.*
[5] *Probability of extinction within 100 years corresponding to estimated viability.*

[6] *Historic production for the entire Lewis Basin.*

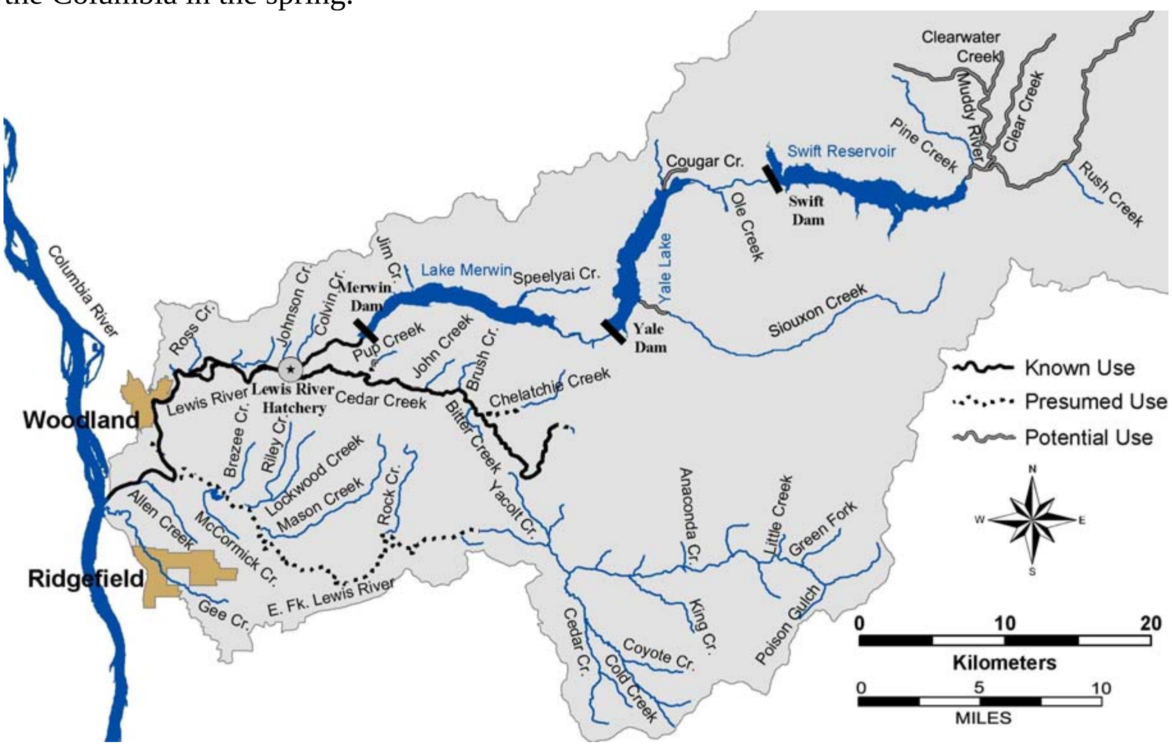
Other species of interest in the Lower North Fork Lewis Subbasin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids. Bull trout also occur in the subbasin.

Brief summaries of the population characteristics and status follow. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

3.2.1 *Spring Chinook—Lewis Subbasin*

ESA: Threatened 1999 **SASSI: Depressed 2002**

The historical North Lewis River adult population estimate is from 10,000-50,000 fish. Current natural spawning returns range from 200-1,000 and are almost entirely hatchery produced fish. Historical spawning was almost entirely in the upper Lewis Basin which was blocked by Merwin Dam in 1931. Spring Chinook are expected to be reintroduced above the hydrosystem in the near future. The majority of upper Lewis spawning habitat is above Swift Reservoir in the main North Lewis, the Muddy River, Clearwater Creek, and Clear Creek. Spawning in the lower North Lewis occurs in the first 2 miles below Merwin Dam and in Cedar Creek. Spawning occurs in late August and September. Juveniles rear in the Lewis Basin for a full year before migrating to the Columbia in the spring.

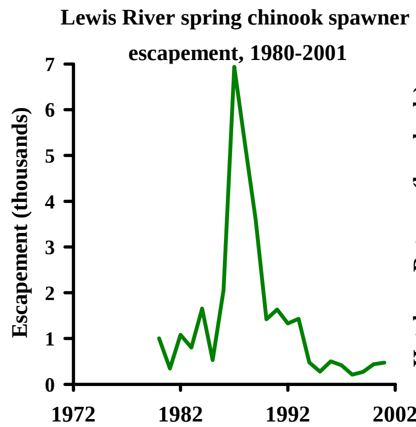


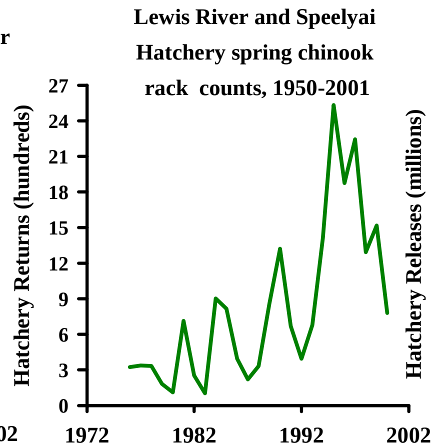
Distribution

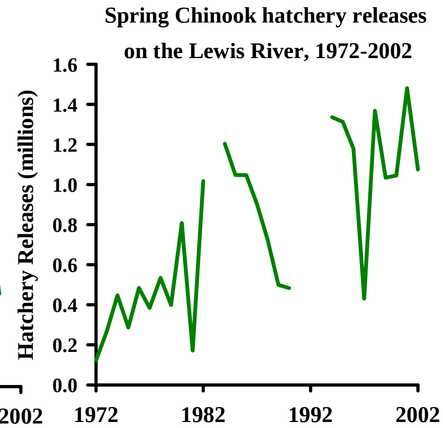
- Historically, spring chinook were found primarily in the upper basin; construction of Merwin Dam (RM 19) in 1931 blocked access to most of the spawning areas
- Currently, natural spawning occurs in the North Fork mainstem Lewis River between Merwin Dam and the Lewis River Hatchery (~4 miles)

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

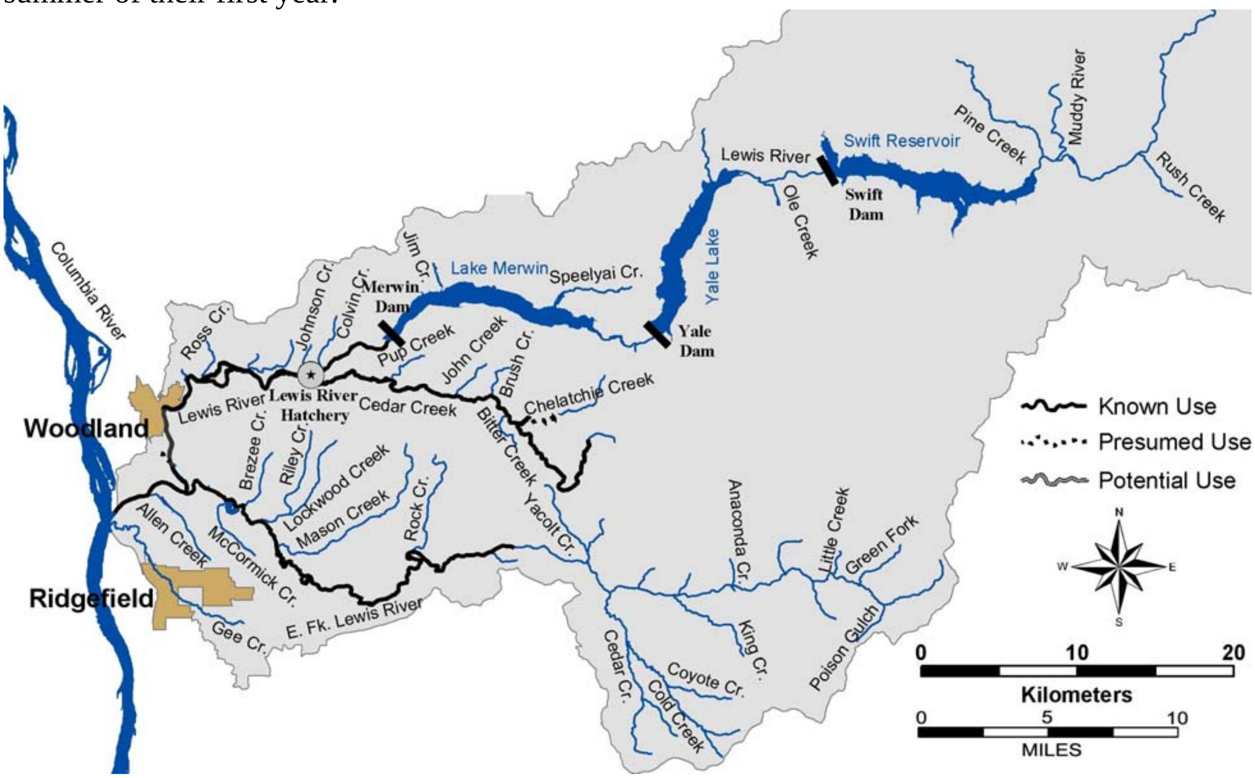
Harvest

- 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
- Tributary harvest has been selective for adipose fin clipped spring chinook since 2002. Unmarked wild spring chinook must be released.

3.2.2 *Fall Chinook—Lewis Subbasin*

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

The historical North Lewis River fall Chinook adult population is estimated from 18,000-20,000 fish. Current natural spawning returns range from 3,200-18,000. The North Lewis fall Chinook population exceeds WDFW's escapement goal in most years and was considered healthy in WDFW's 2002 stock assessment. There is no hatchery fall Chinook program in the North Lewis. Spawning is primarily concentrated in four miles of river immediately downstream of Merwin Dam. Natural spawning occurs later than most other lower Columbia fall Chinook populations, extending from late October through January and peaking in mid-November. Juvenile rearing occurs near and downstream of the spawning area, most notably in the Eagle Island area. Juveniles emerge in early spring and migrate to the Columbia in late spring and summer of their first year.



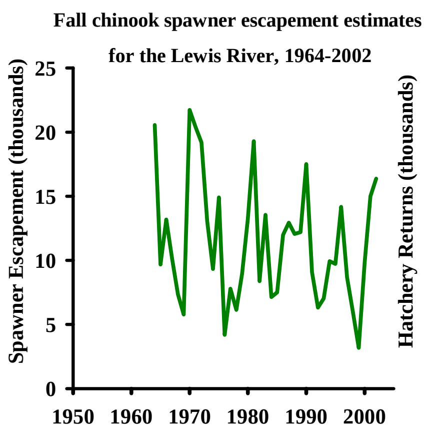
Distribution

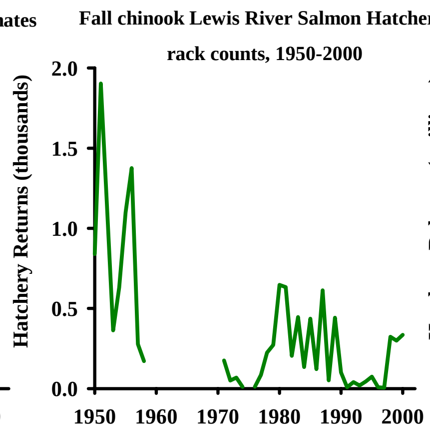
- Spawning occurs primarily in the NF Lewis River between Merwin Dam and the Lewis River Salmon Hatchery (~4 miles); some spawning has been observed in Cedar Creek
- Construction of Merwin Dam eliminated approximately half the fall chinook spawning habitat in the North Fork, which historically extended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

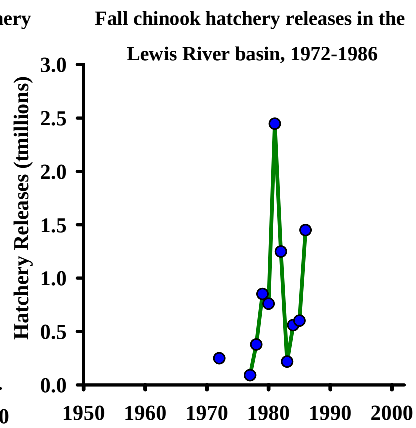
Life History

- 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

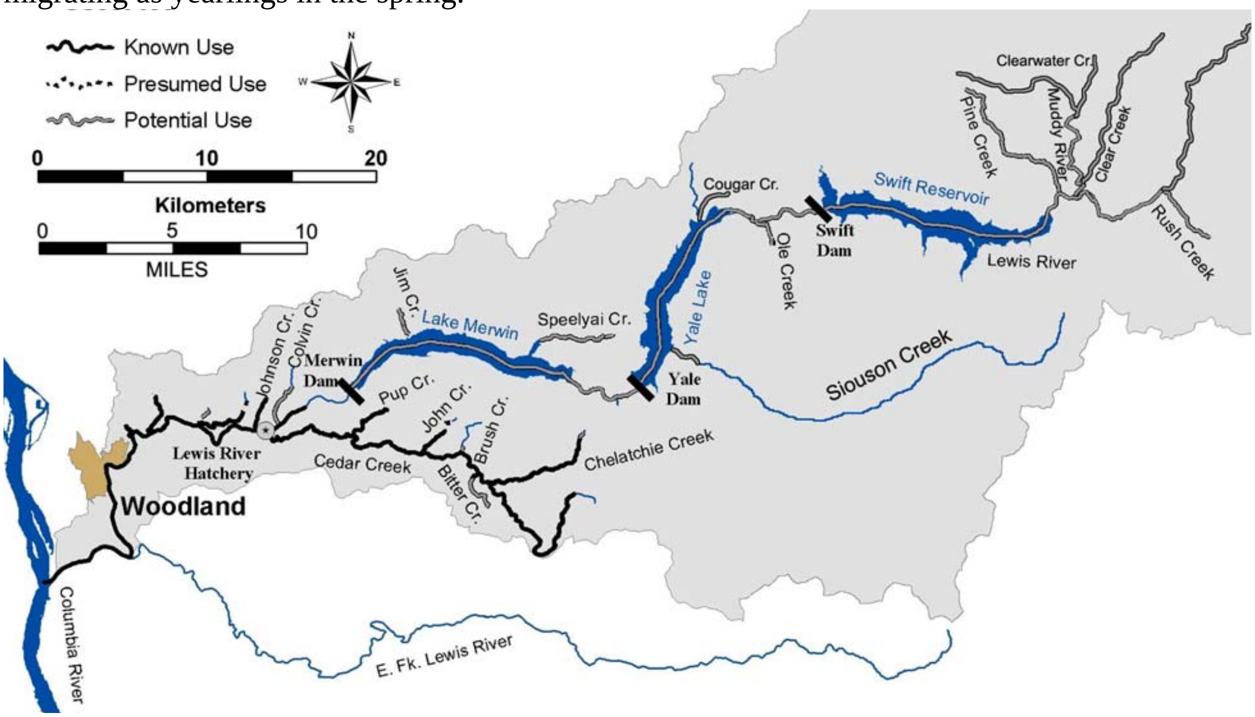
Harvest

- 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

3.2.3 *Coho—Lewis Subbasin (North Fork)*

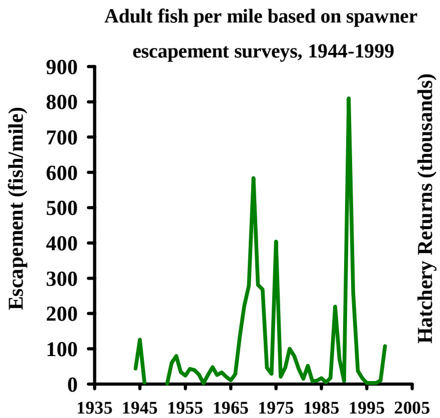
ESA: Candidate 1995	**SASSI: Unknown 2002**

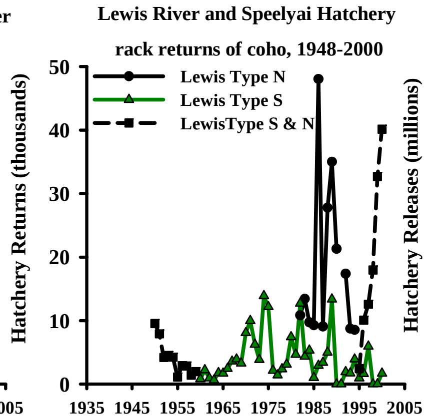
The historical North Lewis River adult population is estimated from 7,500-85,000 fish. Both early and late stocks were present historically, with early stock primarily spawning in the upper Lewis. Current returns are unknown but assumed be low and limited to the habitat downstream of Merwin Dam. Early coho are expected to be reintroduced to the habitat upstream of the hydrosystem in the near future. Natural spawning currently occurs in tributaries below Merwin Dam including Ross, Johnson, Colvin, NF and SF Chelatchie, and Cedar creeks. A number of hatchery produced fish spawn naturally. Early stock coho spawn from late October into November and late stock spawn from late November to March. Juvenile rearing occurs upstream and downstream of spawning areas. Juveniles rear for a full year in the Lewis Basin before migrating as yearlings in the spring.

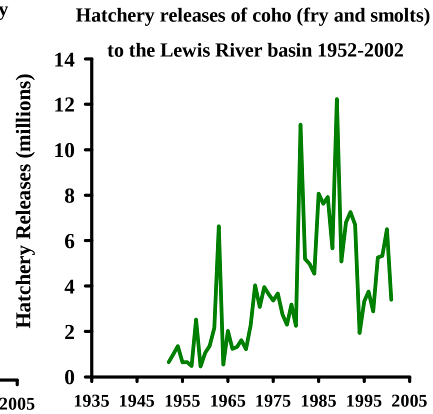


Distribution

- 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

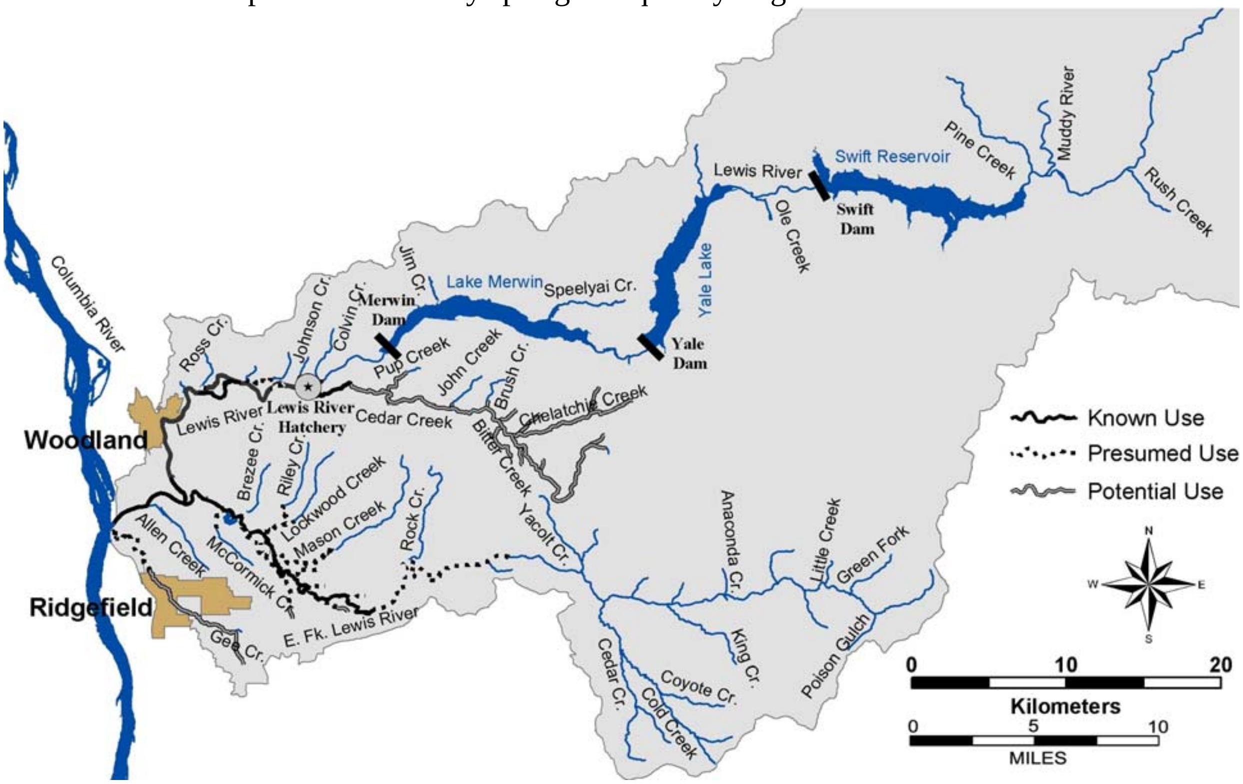
Harvest

- 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

3.2.4 *Chum—Lewis Subbasin*

ESA: Threatened 1999	SASSI: NA

Historical adult populations produced from the Lewis Basin (including the mainstem, North, and East Lewis) are estimated from 120,000-300,000. Current natural spawning is estimated at less than 100 fish. Natural spawning occurs in the lower reaches of the mainstem, North Fork, East Fork, and in Cedar Creek. Adult spawning peaks in December. Chum in the Lewis Basin are all naturally-produced as no hatchery chum are released in the area. Juveniles rear in the lower reaches for a short period in the early spring and quickly migrate to the Columbia.



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

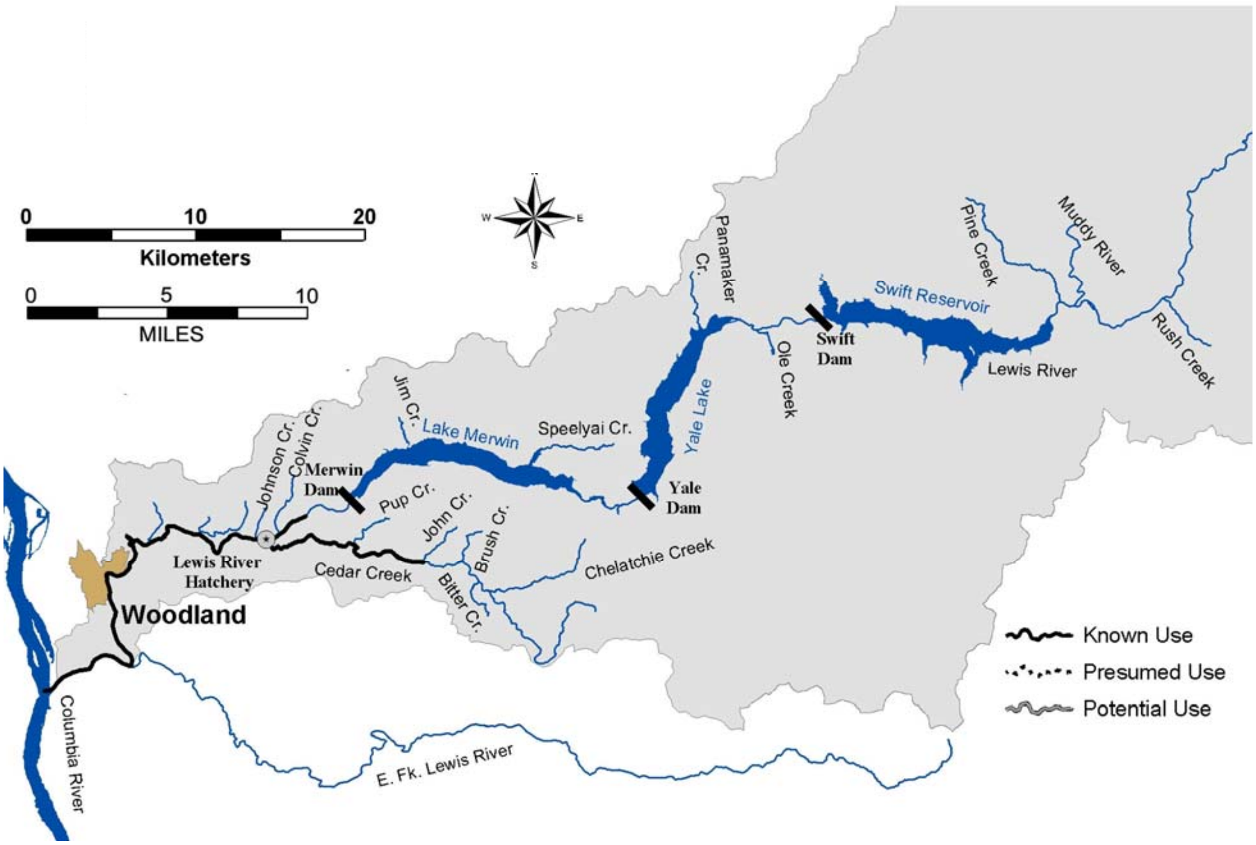
Hatchery
- Chum salmon have not been produced/released in the Lewis River

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

3.2.5 *Summer Steelhead—Lewis Subbasin (North Fork)*

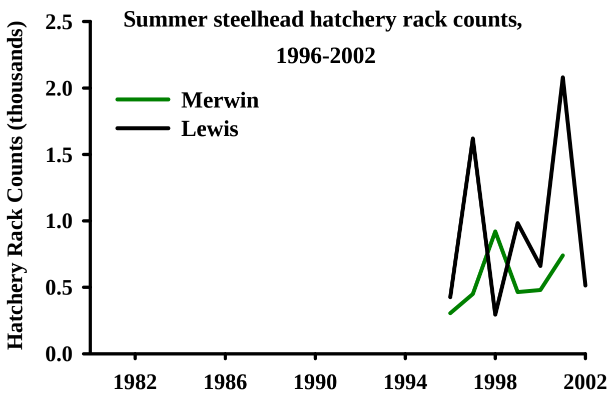
ESA: Threatened 1998	**SASSI: Unknown 2002**

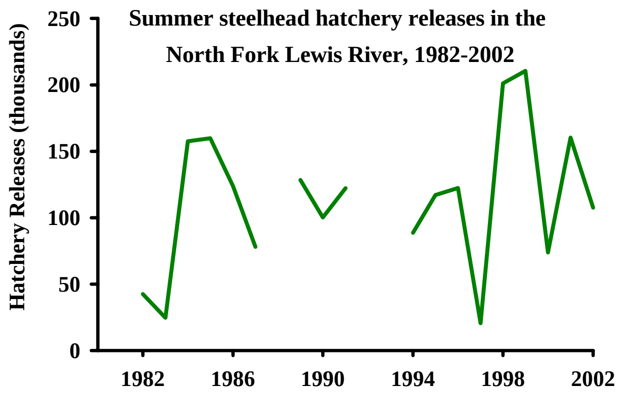
The historical North Lewis River adult population is estimated as high as 20,000 fish. Current natural spawning returns are presumed to be very low. Habitat assessments indicate that North Lewis summer steelhead were historically present upstream of Merwin Dam, but in small numbers in tributaries of Merwin Reservoir. Current spawning occurs in the lower North Lewis and tributaries below Merwin Dam, most notably in Cedar Creek. Skamania stock hatchery summer steelhead are released into the North Lewis basin for harvest opportunity. Wild summer steelhead Spawning time is March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Lewis Basin



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

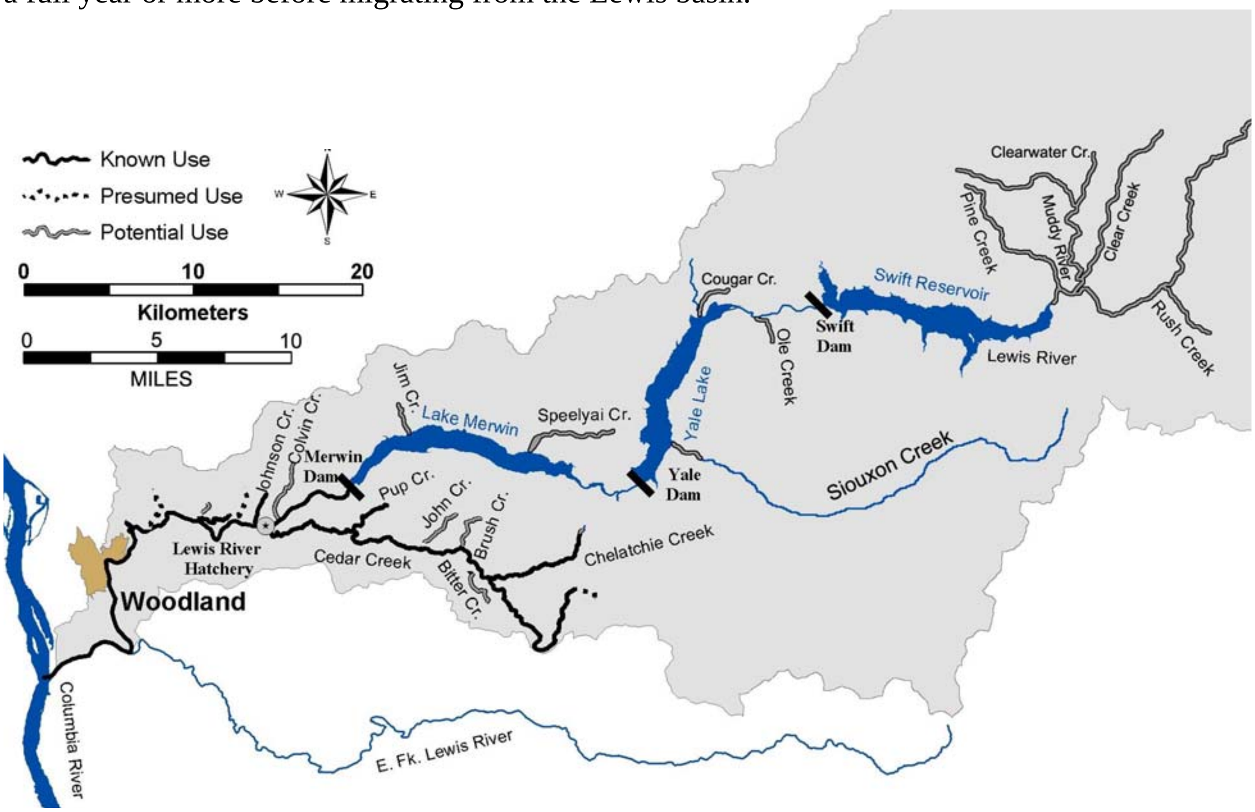
Harvest

- 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

3.2.6 *Winter Steelhead—Lewis Subbasin (North Fork)*

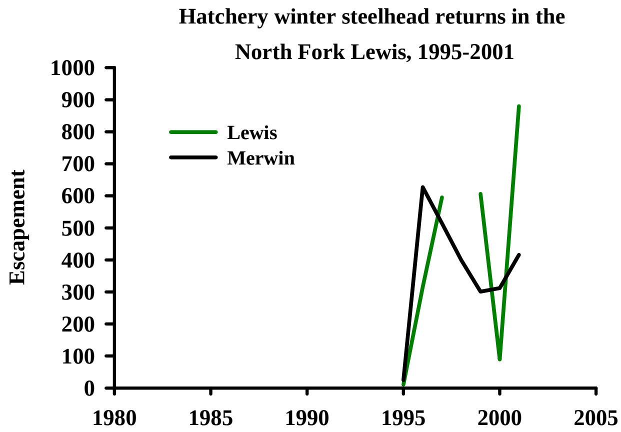
ESA: Threatened 1998	SASSI: Unknown 2002

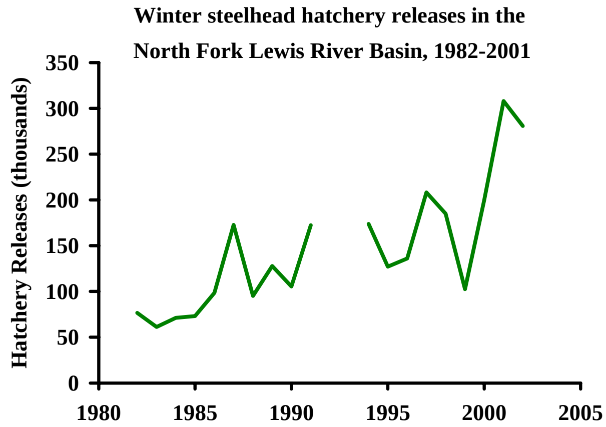
The historical North Lewis River adult population is estimated from 6,000-24,000 fish. Current natural spawning returns are presumed to be very low and are limited to habitat below Merwin Dam. Winter steelhead are expected be reintroduced to habitats upstream of the Lewis River hydrosystem in the near future, where the majority of winter steelhead habitat is available. The preferred stock for reintroduction is late-timed wild winter returning to the North Lewis and trapped at Merwin Dam. Spawning occurs in the lower North Lewis and tributaries below Merwin Dam, most notably in Cedar Creek. The majority of habitat in the upper Lewis is in the main North Lewis and tributaries upstream of Swift Dam. Spawning time is March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Lewis basin.



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

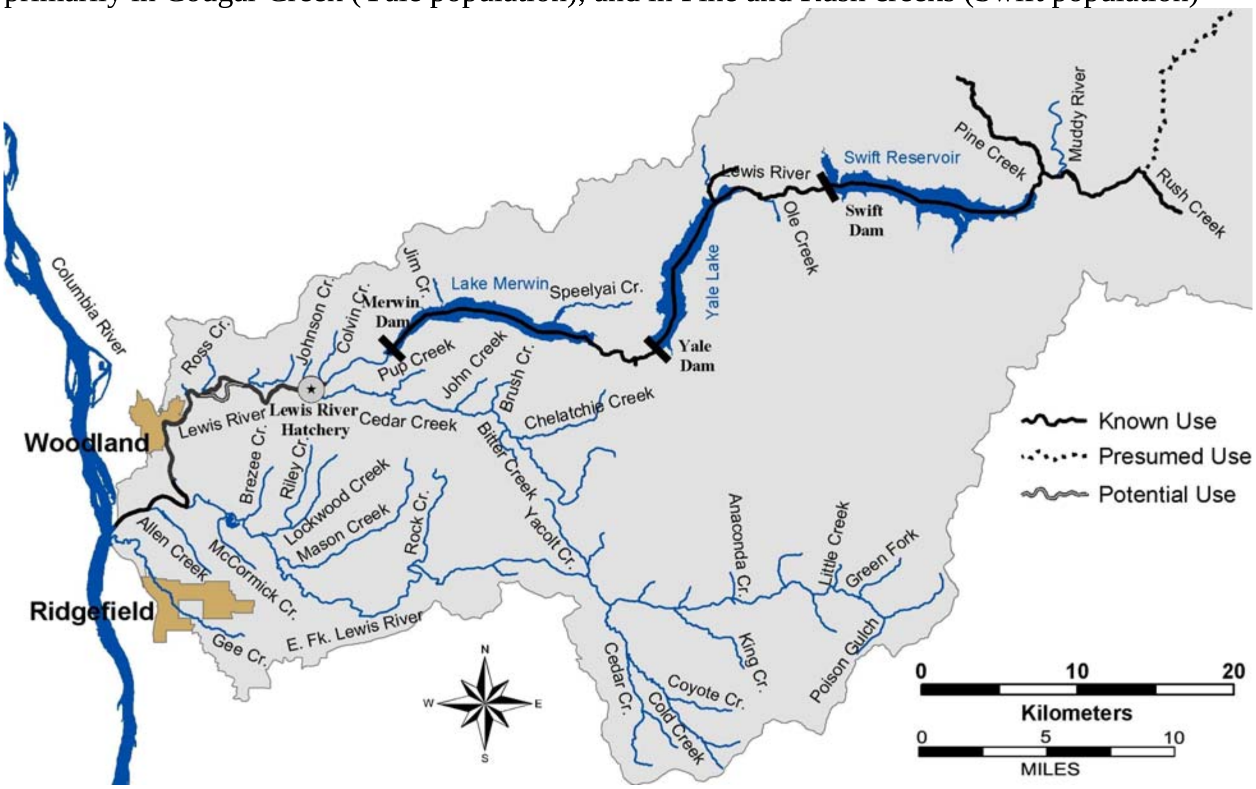
Harvest

- 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

3.2.7 *Bull Trout—Lewis River Subbasin*

ESA: Threatened 1999 **SASSI: Depressed 1998**

There may have been both fluvial and resident bull trout populations in the North Lewis River historically. The current bull trout populations in Swift and Yale reservoirs are isolated because there is no upstream passage at the dams. Genetic samples show significant differences between these populations indicating there may have been biological separation prior to construction of Swift Dam in 1958. Current peak counts of spawners in Cougar Creek range from 0-40 fish, and Swift Reservoir spawning population estimates range from 100-900 fish. Spawning occurs primarily in Cougar Creek (Yale population), and in Pine and Rush creeks (Swift population)



Distribution

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

Life History

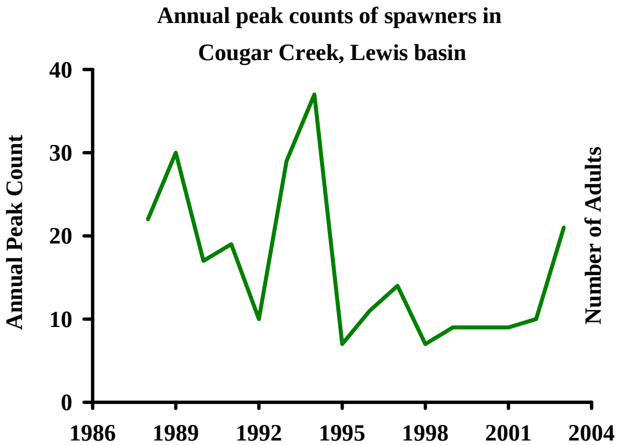
- Prior to dam construction anadromous and fluvial (rivers) forms were likely present

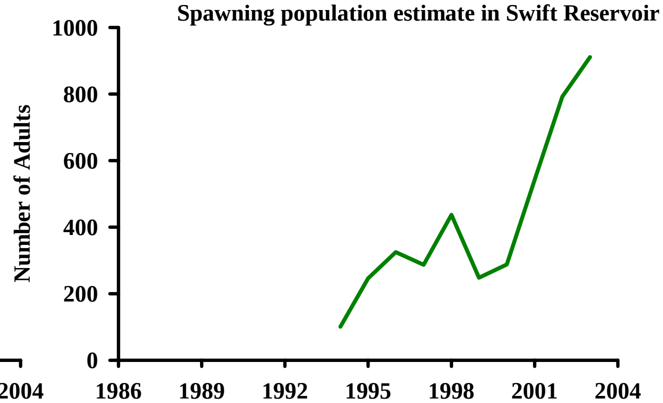
Diversity

- 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

3.2.8 *Cutthroat Trout—Lewis River Subbasin*

ESA: Not Listed	**SASSI: Unknown 2000**

Coastal cutthroat abundance in the North Lewis River has not been quantified but the population is considered depressed. Anadromous cutthroat trout are present in in the North Fork Lewis and tributaries upstream to Merwin Dam, resident forms are present throughout the basin, and adfluvial forms are present in the reservoirs. Anadromous cutthroat enter the North Lewis from July-December and spawn from December to June. Most juveniles rear 2-3 years before migrating from their natal stream.

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

3.2.9 *Other Species*

Pacific lamprey – Information on lamprey abundance is limited. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have also declined in the Lewis Basin. The UFWS coducted lamprey studies in Cedar Creek in 2000 and 2001. Their data indicates notable lamprey presence, primarily Pacific lamprey, but also western brook lamprey in Cedar Creek. The adult lamprey return from the ocean to spawn in the spring and summer. Juveniles rear in freshwater up to 6 years before migrating to the ocean.

3.3 Subbasin Habitat Conditions

This section describes the current condition of aquatic and terrestrial habitats within the subbasin. Descriptions are included for habitat features of particular significance to focal salmonid species including watershed hydrology, passage obstructions, water quality, key habitat availability, substrate and sediment, woody debris, channel stability, riparian function, and floodplain function. These descriptions will form the basis for subsequent assessments of the effects of habitat conditions on focal salmonids and opportunities for improvement.

3.3.1 *Watershed Hydrology*

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 4). 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 WDFW 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.

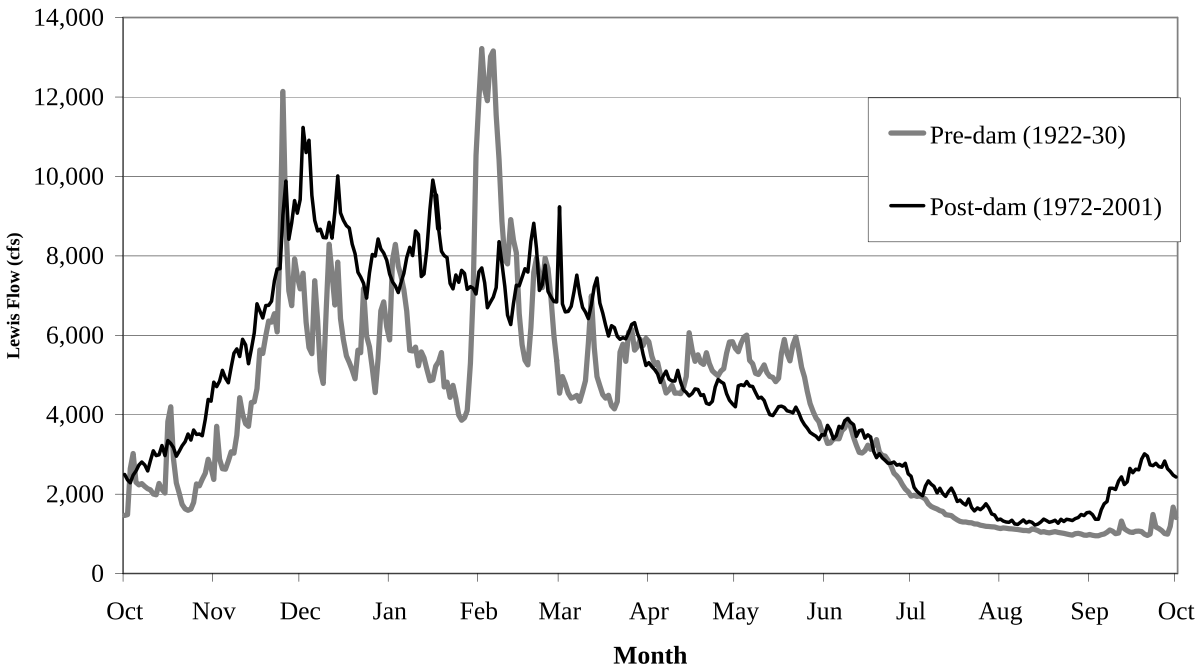


Figure 4 Lower Lewis River flow pre- and post-Merwin Dam (1931). Hydro-regulation has decreased flows in the spring and increased flows in the summer and fall. USGS Gage #14220500; Lewis River at Ariel, Wash

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).

3.3.2 *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

3.3.3 *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.

3.3.4 *Key Habitat Availability*

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).

3.3.5 *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.

3.3.6 *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.

3.3.7 *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).

3.3.8 *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.

3.3.9 *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).

3.4 Stream Habitat Limitations

A systematic link between habitat conditions and salmonid population performance is needed to identify the net effect of habitat changes, specific stream sections where problems occur, and specific habitat conditions that account for the problems in each stream reach. In order to help identify the links between fish and habitat conditions, the Ecosystem Diagnosis and Treatment (EDT) model was applied to Lower North Fork Lewis fall Chinook, chum, coho and winter steelhead. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Appendix E.

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

3.4.1 *Population Analysis*

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

Habitat-based assessments were completed 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 2). 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 5). 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 2). 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 2). 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 2).

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

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**	**P**	**PFC**	**T[1]**
Fall Chinook	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.

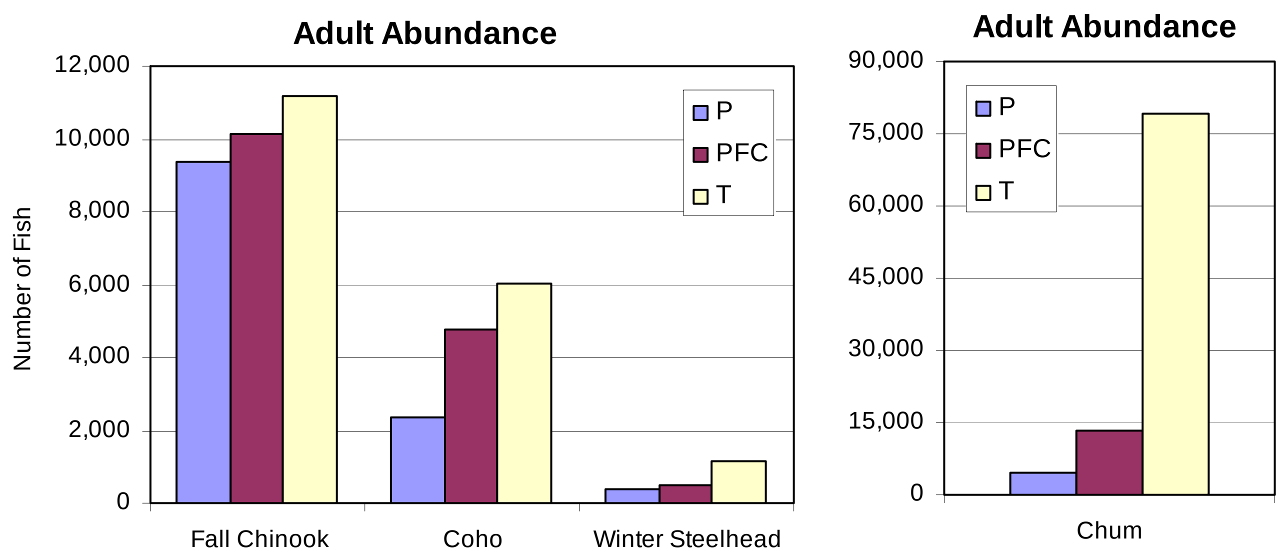


Figure 5. Adult abundance of Lower North Fork Lewis River fall chinook, coho, winter steelhead and chum based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

3.4.2 *Stream Reach Analysis*

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

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 6 for a map of EDT reaches within the lower NF Lewis basin.

Both fall Chinook and chum spawn in the Lewis mainstem. Therefore, high priority reaches for Chinook include Lewis 3-4 and Lewis 6 (Figure 7). 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 8). 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 9). All of these reaches, except Lewis 6, have a combined preservation and restoration habitat emphasis. Lewis 6 shows a preservation only emphasis.

High priority reaches for winter steelhead consist of Cedar Creek mainstem reaches (Cedar Creek 1a, 1b, 3 and 4) (Figure 10). 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.

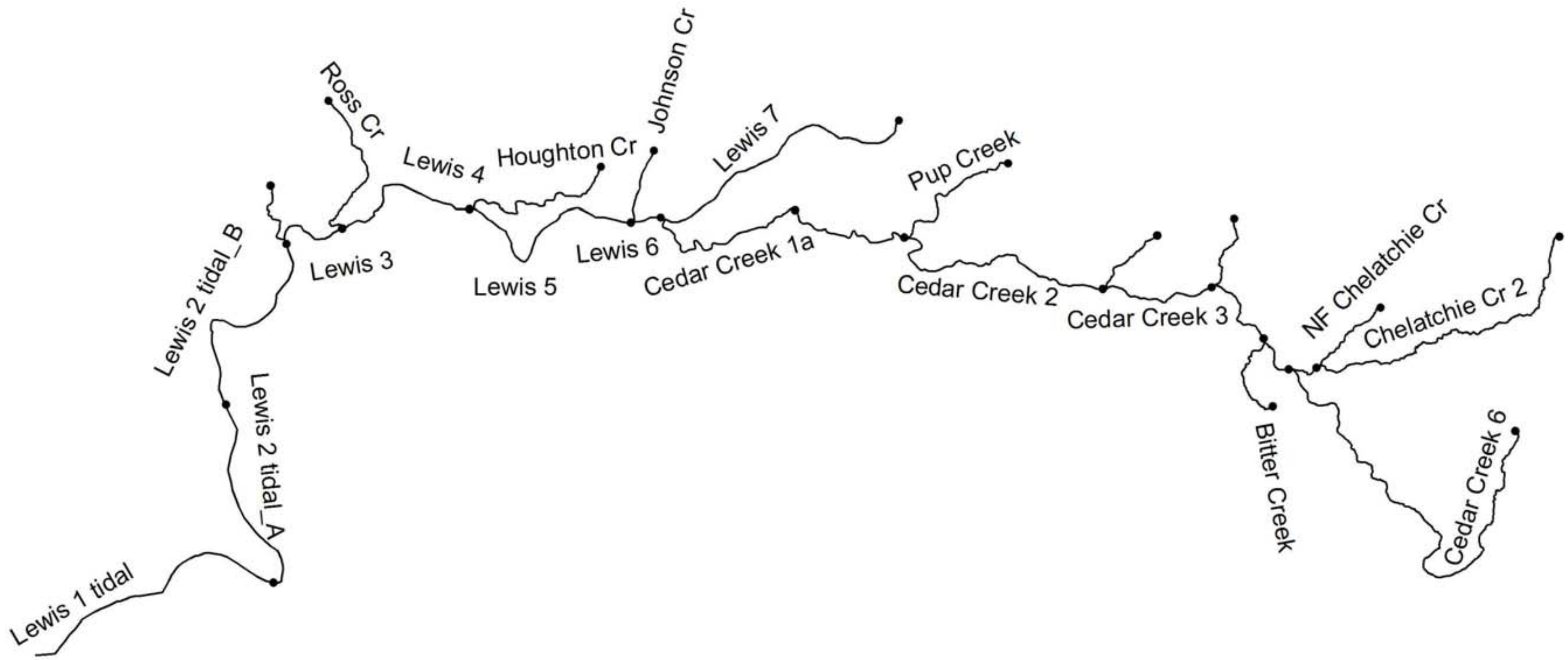


Figure 6. Lower North Fork Lewis River subbasin with EDT reaches identified. For readability, not all reaches are labeled.

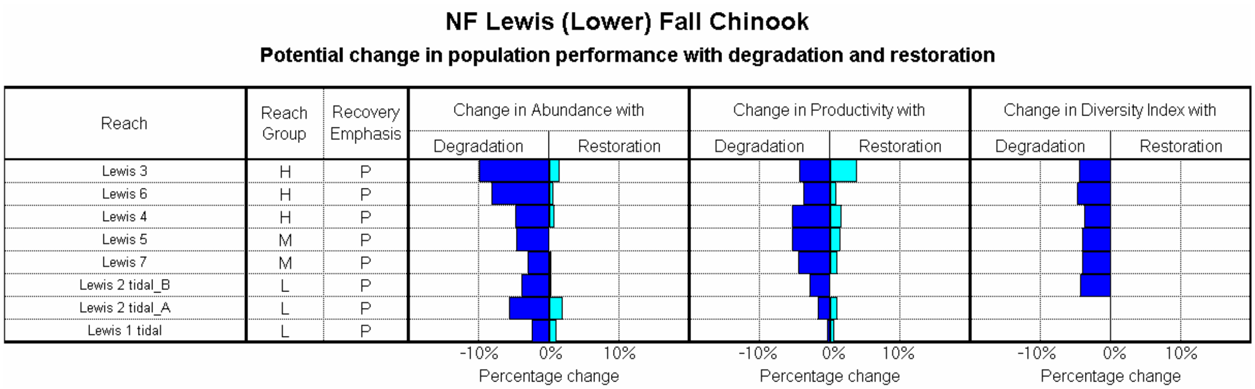


Figure 7. Lower North Fork Lewis fall chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams.

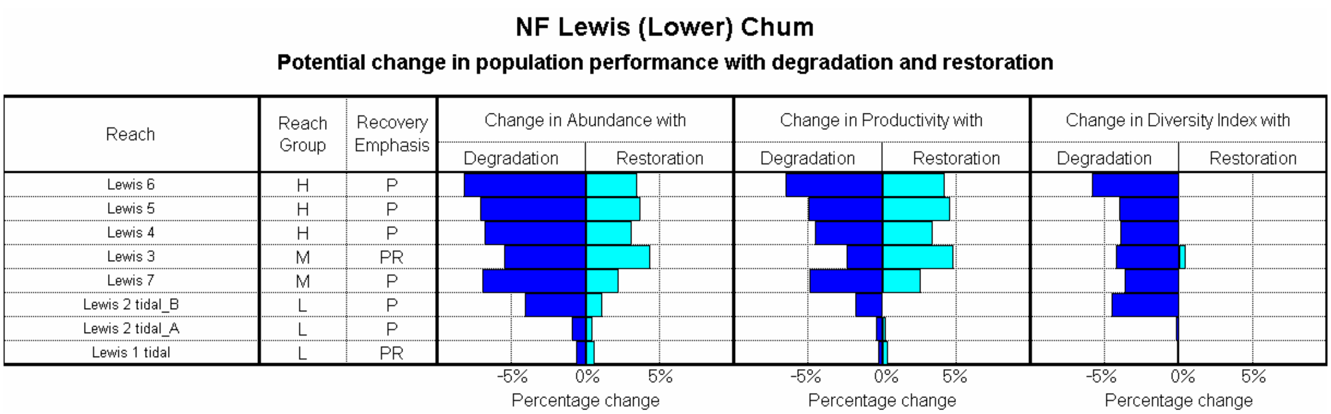


Figure 8. North Fork Lewis chum ladder diagram.

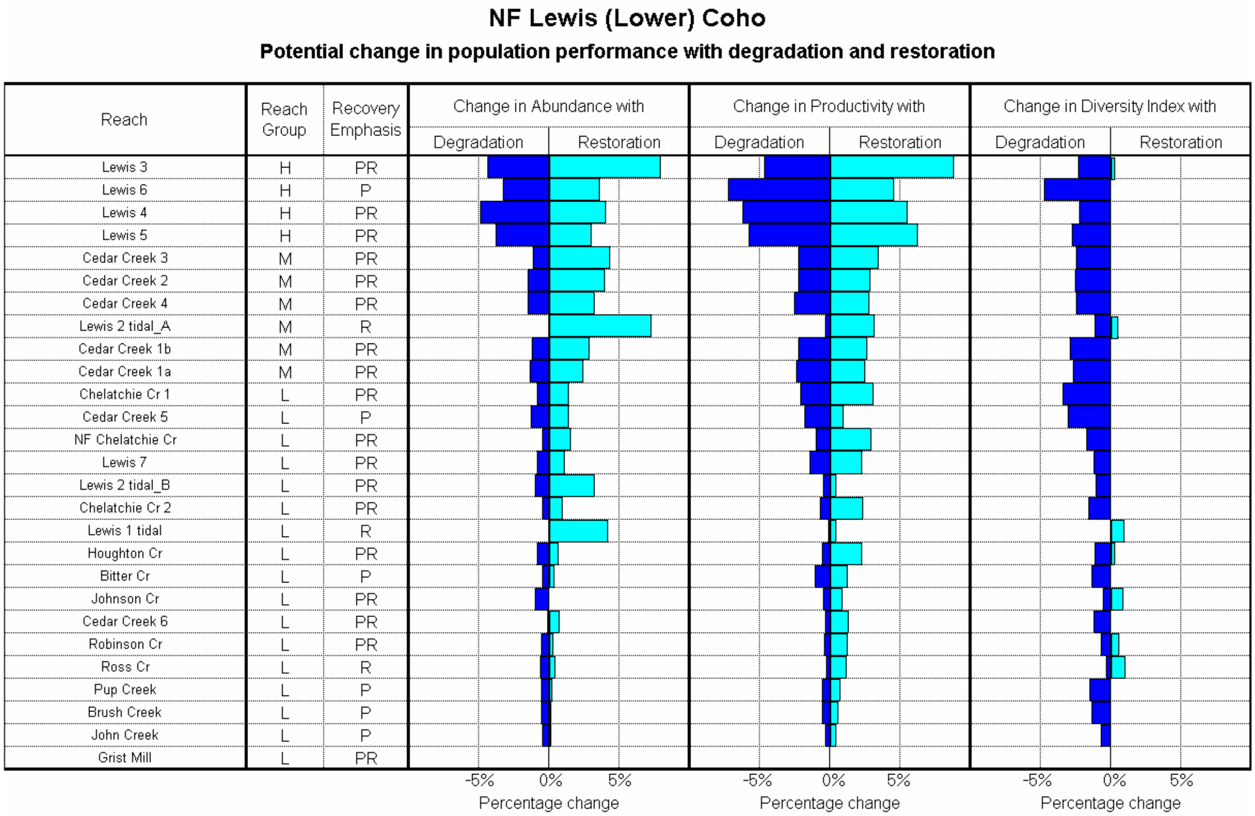


Figure 9. North Fork Lewis coho ladder diagram.

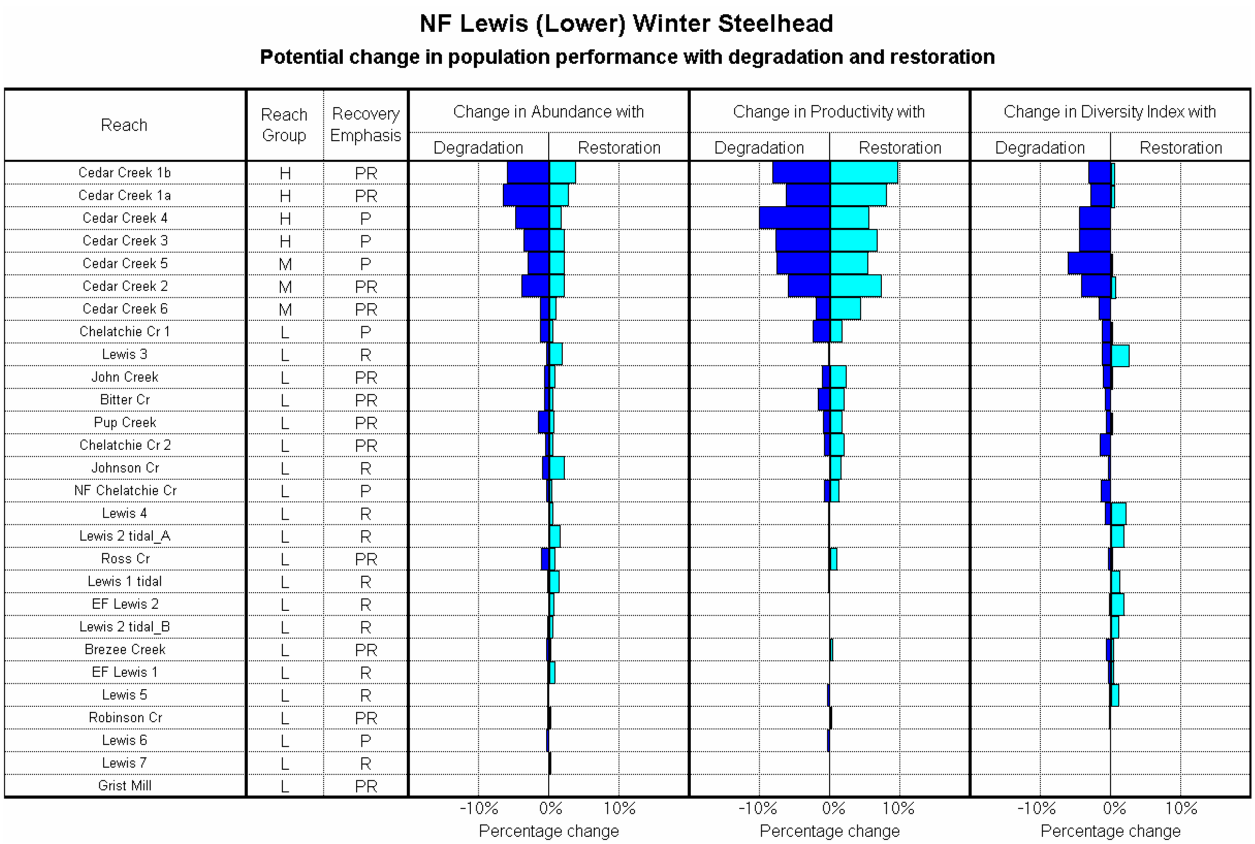


Figure 10. Lower NF Lewis River winter steelhead ladder diagram.

3.4.3 *Habitat Factor Analysis*

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the habitat factor analysis compares current/patient and historical/template habitat conditions. For each reach, EDT generates what is referred to as a "consumer reports diagram", which identifies the degree to which individual habitat factors are acting to suppress population performance. The effect of each habitat factor is identified for each life stage that occurs in the reach and the relative importance of each life stage is indicated. For additional information and examples of this analysis, see Appendix E. Inclusion of the consumer report diagram for each reach is beyond the scope of this document. A summary of the most critical life stages and the habitat factors affecting them are displayed for each species in Table 3.

Table 3. Summary of the primary limiting factors affecting life stages of focal salmonid species. Results are summarized from EDT Analysis.

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

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

The 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). 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 12) and chum (Figure 13) 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 14). Channelization (diking) and degraded riparian zones play the greatest role in these impacts.

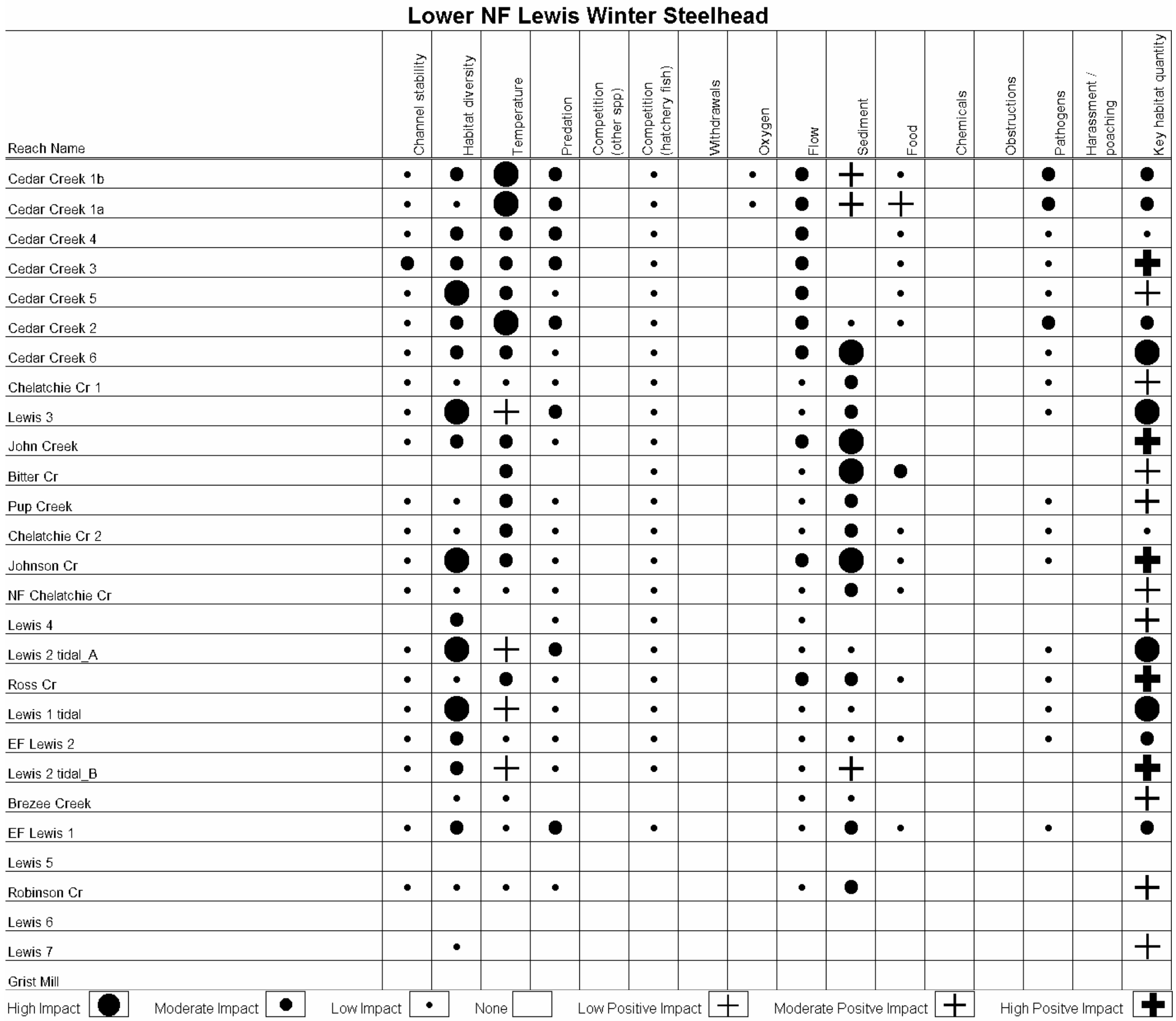


Figure 11. Lower NF Lewis winter steelhead habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, 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 Appendix E Chapter 6 for more information on habitat factor analysis diagrams.

Lower NF Lewis Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Lewis 3	Moderate	Moderate	Low	Moderate		Low			Moderate	High	Low			Low	Moderate	Moderate
Lewis 6	Low	Moderate	Low	Low		Low			Low	Low	Low			Low	Low	Low
Lewis 4	Low	Moderate	Low	Low		Low			Moderate	Low	Low				Low	High Positive
Lewis 5																
Lewis 7	Mod. Positive	Low	Low	Low					Low						Low	
Lewis 2 tidal_B	Low	Low		Low					Low	High Positive						High Positive
Lewis 2 tidal_A	Moderate	High	Mod. Positive	High	Low	Moderate			Moderate	Low	Moderate			Low	Low	High
Lewis 1 tidal	Low	Moderate	Mod. Positive	Moderate	Low	Low			Low	Low	Low			Low	Low	Moderate

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

Figure 12. Lower North Fork Lewis fall Chinook habitat factor analysis diagram.

Lower NF Lewis Chum

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Lewis 6	Low	Moderate	Low	Low					Moderate		Low				Moderate	High Positive
Lewis 5	Low	Moderate	Low	Low					Moderate		Low				Moderate	High Positive
Lewis 4	Low	Moderate	Low	Low					Moderate		Low				Moderate	Mod. Positive
Lewis 3	Low	Moderate	Low	Low					Moderate	Moderate	Low				High	High
Lewis 7	Low	Moderate	Low	Low					Moderate						Moderate	Mod. Positive
Lewis 2 tidal_B	Low	Moderate		Low					Moderate	Mod. Positive					Low	Moderate
Lewis 2 tidal_A	Low	Low		Low					Low		Low					Low
Lewis 1 tidal	Low	Low		Low					Low		Low					Low

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

Figure 13. 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	Moderate	High	Low	High		Moderate			Moderate	High	Low			Low	Low	High
Lewis 6	Low	High	Low	Low		Low			Low	Low	Low			Low		High
Lewis 4	Moderate	Moderate	Low	Moderate		Moderate			Moderate	Low	Low			Low	Low	High
Lewis 5	Low	High	Low	Low		Low			Moderate	Low	Low			Low	Low	High
Cedar Creek 3	Moderate	Moderate	Moderate	Low		Low			Moderate		Moderate			Low		Moderate
Cedar Creek 2	Moderate	Moderate	Moderate	Moderate		Low			Moderate	Low	Low			Low		High
Cedar Creek 4	Moderate	Moderate	Moderate	Low		Low			Moderate		Low			Low		Moderate
Lewis 2 tidal_A	Moderate	High	Low Positive	Moderate	Low	Moderate			Low	Low	Low			Low		High
Cedar Creek 1b	Moderate	Moderate	Moderate	Low		Low		Low	Low	Low Positive	Low			Low		Moderate
Cedar Creek 1a	Low	Moderate	Moderate	Low		Low		Low	Low	Low Positive	Low Positive			Low		Moderate
Chelatchie Cr 1	Moderate	Moderate	Low	Low		Low			Low	Moderate	Low					Moderate
Cedar Creek 5	Low	Moderate	Low	Low		Low			Low		Low					Low
NF Chelatchie Cr	Moderate	Low	Low	Low		Low			Low	High	Low					Moderate
Lewis 7		Moderate	Low	Low		Low			Low					Low		High
Lewis 2 tidal_B	Moderate	Moderate	Low Positive	Moderate		Low			Moderate	High Positive	Low			Low		High
Chelatchie Cr 2	Low	Low	Low	Low		Low			Low	Moderate	Low					Moderate
Lewis 1 tidal	Low	High	Low Positive	Moderate	Low	Low			Low	Low	Low			Low		High
Houghton Cr	Low	Low	Low			Low			Low	Low	Low					Low Positive
Bitter Cr	Low	Low	Low						Low	Moderate	Low					Low
Johnson Cr																
Cedar Creek 6	Low	Moderate	Low	Low					Low	Moderate						Moderate
Robinson Cr	Low	Low							Low	Low						Moderate Positive
Ross Cr	Low	Low	Low						Low	Low						Moderate Positive
Pup Creek	Low	Low								Low						Low
Brush Creek		Low								Low						Moderate Positive
John Creek	Low	Low								Low						Low Positive
Grist Mill																

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

Figure 14. **North Fork Lewis coho habitat factor analysis diagram.**

3.5 Watershed Process Limitations

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

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

The NF Lewis River below Merwin is composed of ten subwatersheds totaling 64,354 acres. IWA results for the Lower NF Lewis River watershed are shown in Table 4. A reference map showing the location of each subwatershed in the basin is presented in Figure 15. Maps of the distribution of local and watershed level IWA results are displayed in Figure 16.

3.5.1 *Hydrology*

Current Conditions.— 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. recooperate

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).

Predicted Future Trends.— 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.

Table 4. IWA results for the Lower North Fork Lewis River 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.

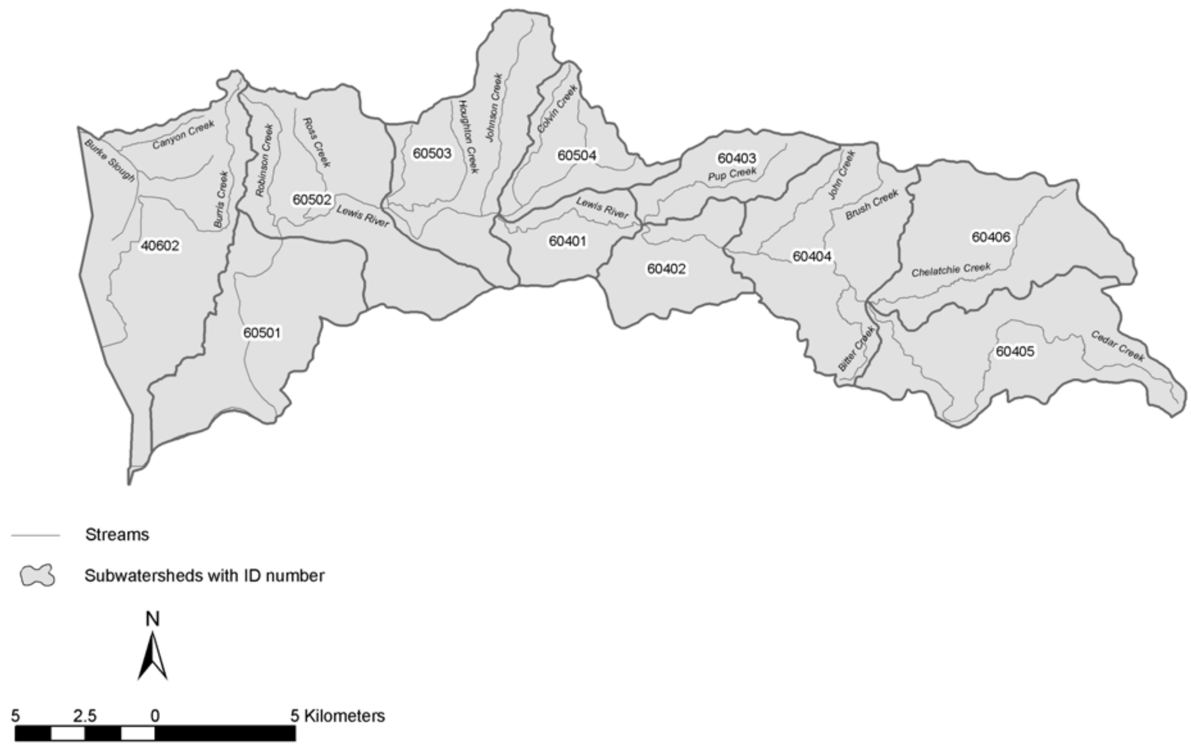


Figure 15. Map of the Lower North Fork Lewis River basin showing the location of the IWA subwatersheds.

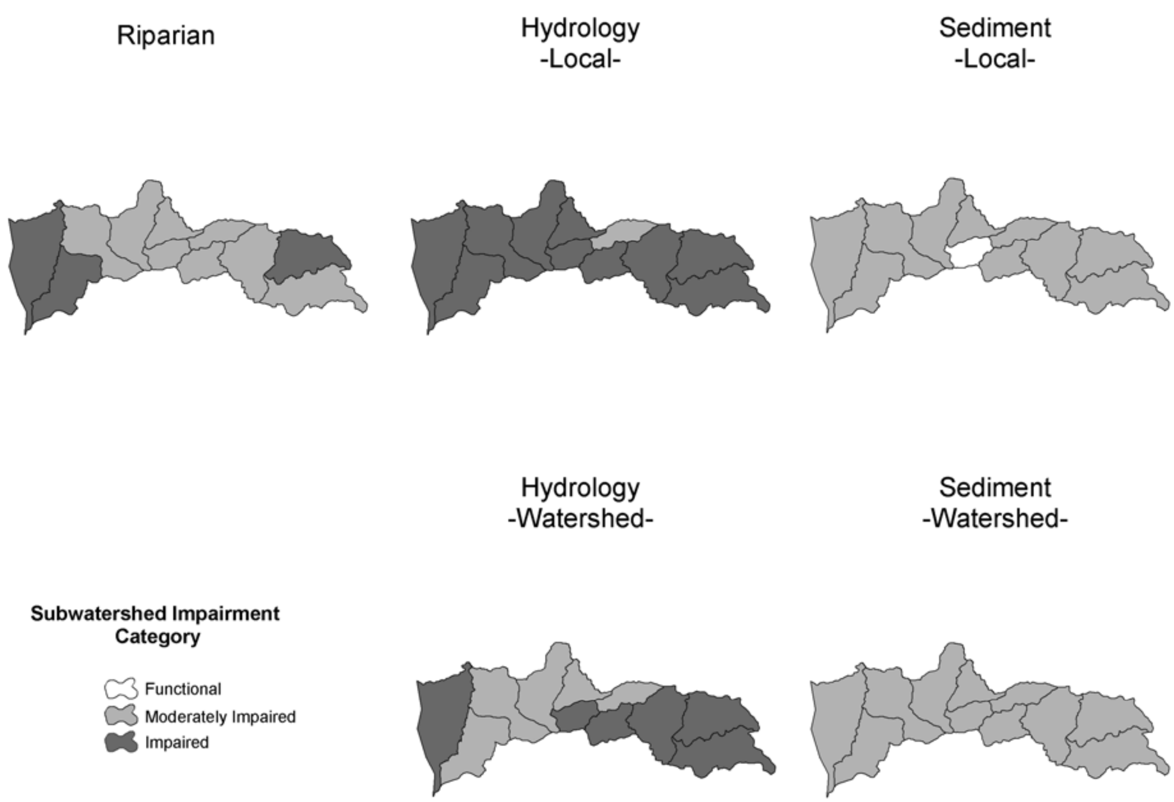


Figure 16. IWA subwatershed impairment ratings by category for the Lower North Fork Lewis River basin

3.5.2 *Sediment Supply*

Current Conditions.— 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.

Predicted Future Trends.— 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.

3.5.3 *Riparian Condition*

Current Conditions.— 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.

Predicted Future Trends.— 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.

3.6 Other Factors and Limitations

3.6.1 *Hatcheries*

Hatcheries currently release over 50 million salmon and steelhead per year in Washington lower Columbia River subbasins. Many of these fish are released to mitigate for loss of habitat. Hatcheries can provide valuable mitigation and conservation benefits but may also cause significant adverse impacts if not prudently and properly employed. Risks to wild fish include genetic deterioration, reduced fitness and survival, ecological effects such as competition or predation, facility effects on passage and water quality, mixed stock fishery effects, and confounding the accuracy of wild population status estimates. This section describes hatchery programs in the Lower North Fork Lewis Subbasin and discusses their potential effects.

There are three hatcheries operating in the North Lewis Basin: the Lewis River Salmon Hatchery, Speelyai Hatchery, and the Merwin (Ariel) Hatchery. Additionally, 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 Speelyai Hatchery production. Fish First volunteers also assist in rearing summer steelhead in the Merwin Reservoir net pens. The Lewis River hatchery facilities and programs will be used in the near future to facilitate the reintroduction of spring Chinook, coho, and winter steelhead to the habitats in the Upper Lewis Basin.

Lewis River Hatchery

The Lewis River Hatchery (since 1932) produces spring Chinook and coho for harvest as well as a sorting facility for all species trapped at Merwin Dam. The Lewis River Hatchery provides late coho eggs for the Klickitat coho program and in some years spring Chinook pre-smolts for the Deep River program. The Lewis River Hatchery also provides spring Chinook and coho for the Fish First organization's net pen program (Table 5).

The Lewis River Hatchery spring Chinook and late coho programs are primarily derived from Cowlitz stocks, and the early coho program from Toutle stock. The early winter steelhead produced at Merwin Hatchery is a composite Elochoman, Chambers Creek, and Cowlitz steelhead, and the summer steelhead are Skamania stock. The main threats from hatchery released salmon are domestication of wild fish and ecological interactions between hatchery smolts and wild fall Chinook, chum, and coho in the lower river. The main threats from hatchery steelhead are potential domestication of the naturally-produced steelhead as a result of adult interactions or ecological interactions between natural juvenile salmon and hatchery released juvenile steelhead.

Speelyai Hatchery

Speelyai Hatchery (since 1958) is located in Merwin Reservoir and is used for incubation and early rearing of spring Chinook, coho, and steelhead. Speelyai Hatchery also produces kokanee and rainbow trout for reservoir recreational fisheries. Merwin Hatchery (since 1983) produces early-timed winter and summer steelhead and rainbow trout (Table 5).

Table 5 provides information on annual production levels at Speelyai Hatchery. 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 (Figure 17).

Merwin (Ariel) Hatchery

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. Merwin Hatchery also provides summer steelhead for the Elochoman program (Table 5).

Table 5. Current Lewis Basin hatchery production.

Hatchery	Release Location	Spring Chinook	Late Coho	Early Coho	Winter Steelhead	Summer Steelhead	Kokanee	Rainbow
Lewis R.	Lower Lewis	900,000	815,000	880,000				
Speelyai	Yale Res.						93,000	
	Swift Res.							400,000
Merwin	Lower Lewis				100,000	175,000		
	Elochoman					35,000		
	Swift Res.							400,000
Fish First	Lower Lewis	150,000				50,000		
	Cedar Cr.		15,000					

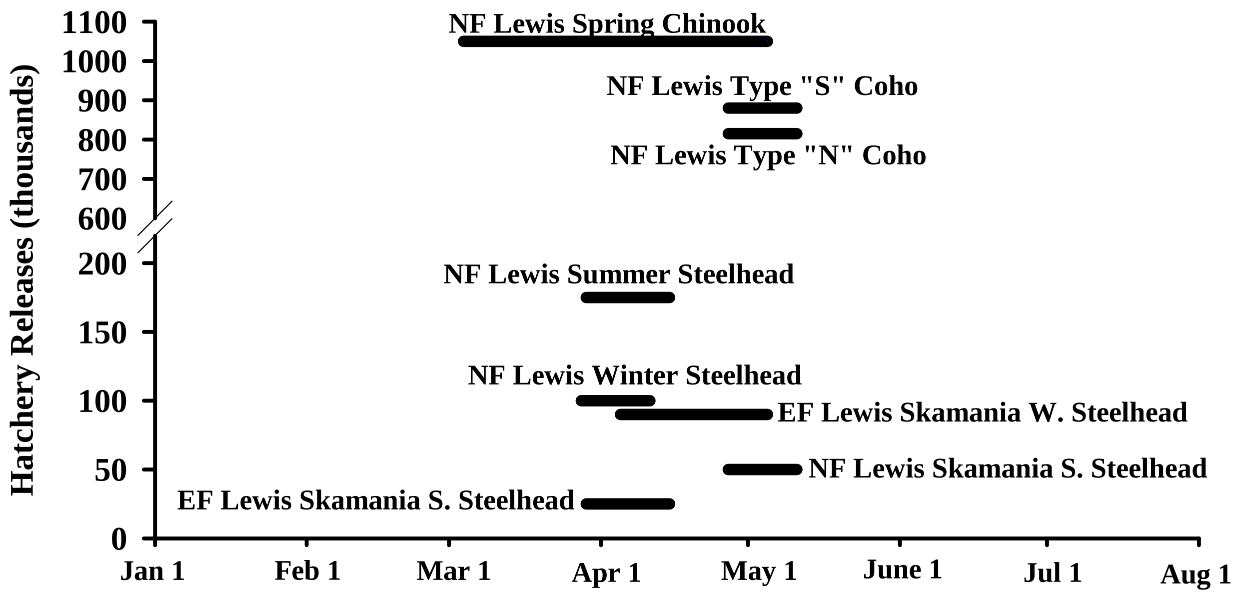


Figure 17. Magnitude and timing of hatchery releases in the Lewis River basins by species, based on 2003 brood production goals.

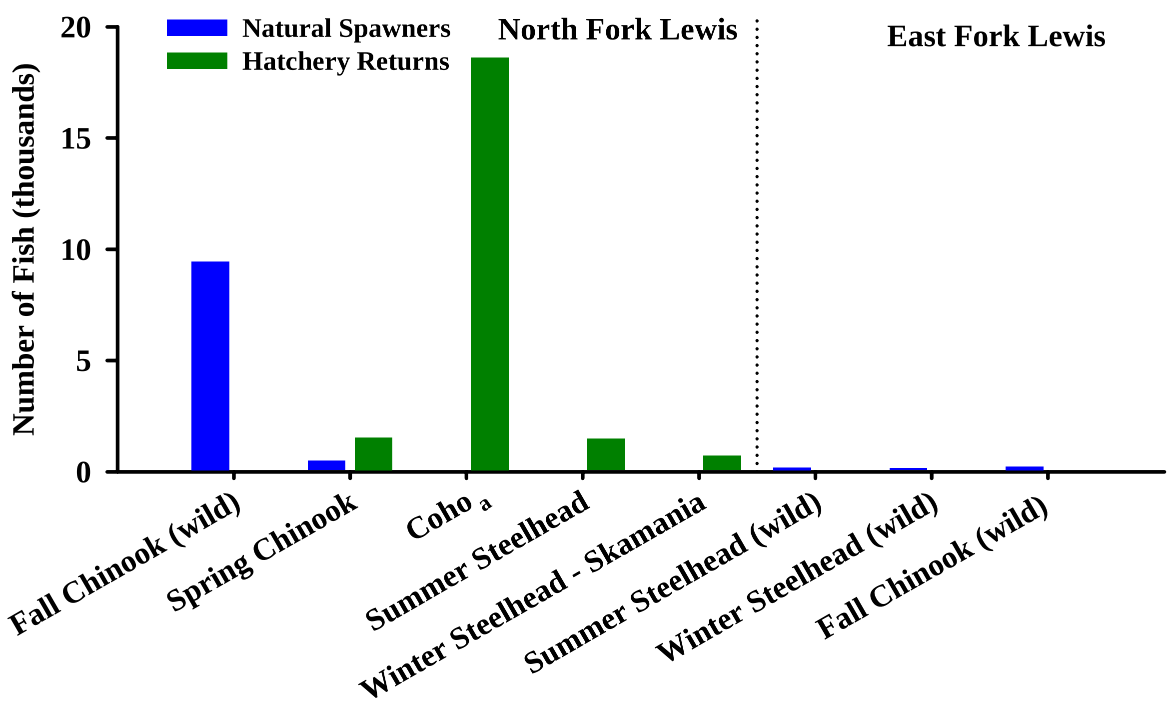


Figure 18. Recent average hatchery returns and estimates of natural spawning escapement in the Lewis River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present.

[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.

Hatchery Effects

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.

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.

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 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.

Biological Risk Assessment

The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC releated plans on the Cowlitz River and Lewis River; and 4) the federally mandated Artificial Production Review and Evaluation (APRE) process. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program. WDFW developed the Benefit-Risk Assessment Procedure (BRAP) to provide that framework. The BRAP evaluates hatchery programs in the ecological context of the watershed, with integrated assessment and decisions for hatcheries, harvest, and habitat. The risk assessment procedure consists of five basic steps, grouped into two blocks:

Policy Framework

- Assess population status of wild populations
- Develop risk tolerance profiles for all stock conditions
- Assign risk tolerance profiles to all stocks

Risk Assessment

- Conduct risk assessments for all hatchery programs
- Identify appropriate management actions to reduce risk

Following the identification of risks through the assessment process, a strategy is developed to describe a general approach for addressing those risks. Building upon those strategies, program-specific actions and an adaptive management plan are developed as the final steps in the WDFW framework for hatchery reform.

Table 6 identifies hazards levels associated with risks involved with hatchery programs in the Lower North Fork Lewis River Basin. Table 7 identifies preliminary strategies proposed to address risks identified in the BRAP for the same populations.

The BRAP risk assessments and strategies to reduce risk have been key in providing the biological context to develop the hatchery recovery measures for lower Columbia River sub-basins.

Table 6. Preliminary BRAP for hatchery programs affecting populations in the Lower North Fork Lewis River Basin.

Symbol	Description
○	Risk of hazard consistent with current risk tolerance profile.
?	Magnitude of risk associated with hazard unknown.
●	Risk of hazard exceeds current risk tolerance profile.
(grey shading)	Hazard not relevant to population

	Hatchery Program		Risk Assessment of Hazards											
			Genetic			Ecological			Demographic			Facility		
Lower North Fork Lewis Population	Name	Release (millions)	Effective Population Size	Domestication	Diversity	Predation	Competition	Disease	Survival Rate	Reproductive Success	Catastrophic Loss	Passage	Screening	Water Quality
Fall Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Late Fall Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Spring Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900	○	○	○	?	?	○	○	?	○	○	○	○
	Fish First Sp. Chinook 1+	0.150	○	○	○	?	?	○	○	?	○	○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Chum	EF Lewis S. Steelhead	0.025				?	○	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	○	○				○	○	○
	Merwin W. Steelhead	0.100				?	○	○				○	○	○
	Lewis Coho Type S	0.880				?	○	○				○	○	○
	Lewis Coho Type N	0.815				?	○	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	○	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	○	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	○	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	○	○				○	○	○
	Merwin S. Steelhead	0.175				?	○	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	○	○				○	○	○
Summer Steelhead	EF Lewis S. Steelhead	0.025	○	○	?	?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050	○	○	?	?	?	○				○	○	○
	Merwin S. Steelhead	0.175	○	○	?	?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Winter Steelhead	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080	○	○	?	?	?	○				○	○	○
	Merwin W. Steelhead	0.100	○	○	?	?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○

Table 7. Preliminary strategies proposed to address risks identified in the BRAP for Lower North Fork Lewis River Basin populations.

North Fork Lewis Population	Hatchery Program: Name	Release (millions)	Risk Assessment of Hazards: Address Genetic Risks: Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Address Ecological Risks: Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Address Demographic Risks: Culture Procedure	Research/ Monitoring	Address Facility Risks: Reliability	Improve Passage	Improve Screening	Pollution Abatement
Fall Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900						●	●		●						
	Fish First Sp. Chinook 1+	0.150						●	●		●						
	NF Lewis S. Steelhead 1+	0.050						●	●		●				–	–	
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1	0.020						●	●		●						
Late Fall Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900						●	●		●						
	Fish First Sp. Chinook 1+	0.150						●	●		●						
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1	0.020						●	●		●						
Spring Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900		●	●	●		●	●		●		●				
	Fish First Sp. Chinook 1+	0.150		●	●	●		●	●		●		●				
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1	0.020						●	●		●						

Impact Assessment

The potential significance of negative hatchery impacts within the subbasin on natural populations was estimated with a simple index based on: 1) intra-specific effects resulting from depression in wild population productivity that can result from interbreeding with less fit hatchery fish and 2) inter-specific effects resulting from predation of juvenile salmonids of other species. The index reflects only a portion of net hatchery effects but can provide some sense of the magnitude of key hatchery risks relative to other limiting factors. Fitness effects are among the most significant intra-specific hatchery risks and can also be realistically quantified based on hatchery fraction in the natural spawning population and assumed fitness of the hatchery fish relative to the native wild population. Predation is among the most significant inter-specific effects and can be estimated from hatchery release numbers by species. This index assumed that equilibrium conditions have been reached for the hatchery fraction in the wild and for relative fitness of hatchery and wild fish. This simplifying assumption was necessary because more detailed information is lacking on how far the current situation is from equilibrium. The index does not consider the numerical benefits of hatchery spawners to natural population numbers, ecological interactions between hatchery and wild fish other than predation, or out-of-basin interactions, all of which are difficult to quantify. Appendix E contains a detailed description of the method and rationale behind this index.

The indexed potential for negative impacts of hatchery spawners on wild population fitness in the Lower North Fork Lewis Subbasin is quite low (1%) for late fall Chinook where relaeases were discontinued in 1986. Fitness impact potential is substantially greater for the summer steelhead (65%), spring Chinook (45%), winter steelhead (23%), and coho (21%) fishery enhancement programs in the Lewis River. However, the high incidence of spring Chinook and coho hatchery spawners suggests that the fitness of natural and hatchery fish is now probably quite similar and natural populations might decline substantially without continued hatchery subsidy under current habitat conditions. Strategy for reintroduction of winter steelhead to the upper Lewis includes utilization of late returnig wild fish which are temporally separated from the earlier spawning hatchery stock.. Interspecific impacts from predation are estimated to range from less then 1% for coho to 15% for fall chinook.

Table 8. Presumed reductions in wild population fitness as a result of natural hatchery spawners and survival as a result of interactions with other hatchery species for Lower North Fork Lewis salmon and steelhead populations.

Population	Annual releases[a]	Hatchery fraction[b]	Fitness category[c]	Assumed fitness[d]	Fitness impact[e]	Interacting releases[f]	Interspecies impact[g]
Late Fall Chinook	0[h]	0.13	1	0.9	0.01	3,070,000	0.15
Spring Chinook	1,050,000[i]	0.90	3	0.5	0.45	--	--
Chum	0[j]	0	--	--	0	1,375,0000	0.069
Coho	1,695,000[k]	0.69	2	0.7	0.21	3,070,000	0.04
Summer Steelhead	225,000	0.93	4	0.3	0.651	0	0
Winter Steelhead	100,000	0.77	2	0.7	0.231	0	0

[a] Annual release goals.
[b] Proportion of natural spawners that are first generation hatchery fish which are strays from other basins
[c] Broodstock category: 1 = derived from native local stock, 2 = domesticated stock of native local origin, 3 = originates from same ESU but substantial divergence may have occurred, 4 = out-of-ESU origin or origin uncertain
[d] Productivity of naturally-spawning hatchery fish relative to native wild fish prior to significant hatchery influence. Because population-specific fitness estimates are not available for most lower Columbia River populations, we applied hypothetical rates comparable to those reported in the literature and the nature of local hatchery program practices.
[e] Index based on hatchery fraction and assumed fitness.
[f] Number of other hatchery releases with a potential to prey on the species of interest. Includes steelhead and coho for fall Chinook and coho. Includes spring chinook and steelhead for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.
[h] The Lewis River fall Chinook hatchery program was discontinued in 1986. There is no hatchery fall Chinook program in Salmon Creek.
[i] Current releases are in the lower Lewis. Reintroduction into the upper Lewis is also under consideration in the hydroelectric re-licensing process.
[j] There are no records of hatchery chum releases in the basin.
[k] Lewis River Hatchery goals include 880,000 early coho (type S) and 815,000 late coho (type N); fish are released in the lower Lewis River mainstem. Various possible salmonid reintroduction scenarios are currently being evaluated during the re-licensing process for the hydroelectric facilities on the Lewis River; the existing hatchery programs could become an integral part of any successful reintroduction program.

3.6.2 *Harvest*

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

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

Current fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table 9). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced spring Chinook, coho, and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

Table 9. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Spring Chinook	13	5	1	1	2	**22**	53	65
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60
Coho	<1	9	6	2	1	**18**	51	85
Steelhead	0	<1	3	0.5	5	**8.5**	70	75

Columbia River fall Chinook are subject to freshwater and ocean fisheries from Alaska to their rivers of origin in fisheries targeting abundant Chinook stocks originating from Alaska, Canada, Washington, Oregon, and California. Columbia tule fall Chinook harvest is constrained by a Recovery Exploitation Rate (RER) developed by NOAA Fisheries for management of Coweeman naturally-spawning fall Chinook. Some in-basin sport fisheries are closed to the retention of fall Chinook to protect naturally produced populations.. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

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

Harvest of Lewis River coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River as well as recreational fisheries in the Lewis River Basin. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish.

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

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

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

3.6.3 *Mainstem and Estuary Habitat*

Conditions in the Columbia River mainstem, estuary, and plume affect all anadromous salmonid populations within the Columbia Basin. Juvenile and adult salmon may be found in the mainstem and estuary at all times of the year, as different species, life history strategies and size classes continually rear or move through these waters. A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals.

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

3.6.4 *Hydropower Construction and Operation*

The three hydro-electric dams on the Lewis River are considered to be located in the upper Lewis basin. However, lower North Fork Lewis species, in particular fall Chinook, are affected by flow regimes from Lewis River hydro operations which effect spawning and rearing habitat in the lower Lewis. The quantity and quality of fall Chinook habitat in the lower Lewis can be addressed by; maintaining a flow regime, including minimum flow requirements, that enhance the spawning and rearing habitats for natural salmonid populations downstream of the North Lewis Hydrosystem. In addition, mainstem Columbia hydro operations and flow regimes affect habitat utilized by lower Lewis species in migration corridors and in the estuary. The mainstem Columbia River and estuary provide important habitats for anadromous species during juvenile and adult migrations between spawning and rearing streams and the ocean where they grow and mature. These habitats are particularly important for fall Chinook and chum which rear extensively in the Columbia mainstem and estuary. Aquatic habitats have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control.

The hydropower infrastructure and flow regulation affects adult migration, juvenile migration, mainstem spawning success, estuarine rearing, water temperature, water clarity, gas supersaturation, and predation. Dams block or impede passage of anadromous juveniles and adults. Columbia River spring flows are greatly reduced from historical levels as water is stored for power generation and irrigation, while summer and winter flows have increased. These flow changes affect juvenile and adult migration, and have radically altered habitat forming processes. Flow regulation and reservoir construction have increased average water temperature in the Columbia River mainstem and summer temperatures regularly exceed optimums for salmon. Supersaturation of water with atmospheric gases, primarily nitrogen, when water is spilled over high dams causes gas bubble disease. Predation by fish, bird, and marine mammals has been exacerbated by habitat changes. The net effect of these direct and indirect effects is difficult to quantify but is expected to be less significant for populations originating from lower Columbia River subbasins than for upriver salmonid populations. Additional information on hydropower effects can be found in the Regional Recovery and Subbasin Plan Volume I.

3.6.5 *Ecological Interactions*

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

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

3.6.6 *Ocean Conditions*

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

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

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

Recent improvements in ocean survival may portend a regime shift to generally more favorable conditions for salmon. The large spike in recent runs and a cool, wet climate would provide a respite for many salmon populations driven to critical low levels by recent conditions.

The National Research Council (1996) concluded: *"Any favorable changes in ocean conditions—which could occur and could increase the productivity of some salmon populations for a time—should be regarded as opportunities for improving management techniques. They should not be regarded as reasons to abandon or reduce rehabilitation efforts, because conditions will change again"*. Additional details on the nature and effects of variable ocean conditions on salmonids can be found in the Regional Recovery and Subbasin Plan Volume I.

3.7 Summary of Human Impacts on Salmon and Steelhead

Stream habitat, estuary/mainstem habitat, harvest, hatchery and ecological interactions have all contributed to reductions in productivity, numbers, and population viability. Pie charts in Figure 19 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Lower North Fork Lewis Basin salmon and steelhead. Impact values were developed for a base period corresponding to species listing dates. This depiction is useful for identifying which factors are most significant for each species and where improvements might be expected to provide substantial benefits. Larger pie slices indicate greater significance and scope for improvement in an impact for a given species. These numbers also serve as a working hypothesis for factors limiting salmonid numbers and viability.

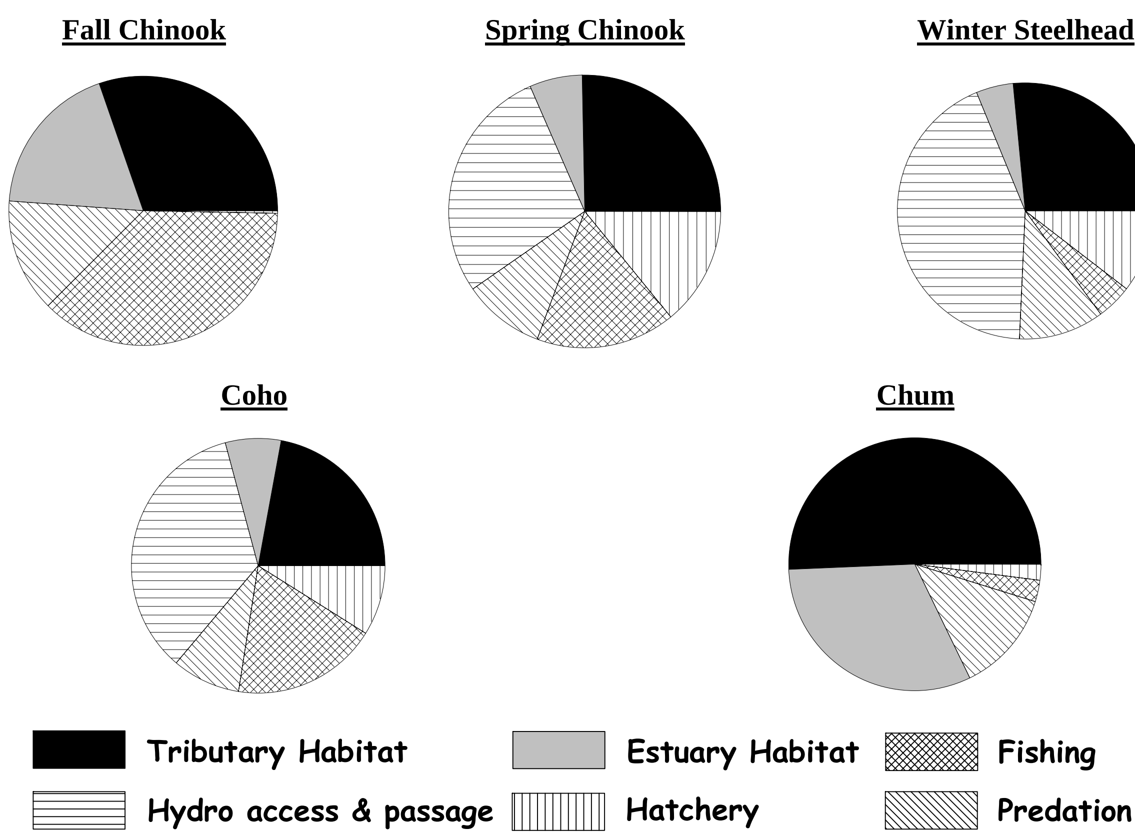


Figure 19. Relative contribution of potentially manageable impacts on Lower North Fork Lewis River salmonid populations.

This assessment indicates that current salmonid status is the result of large impacts distributed among several factors. No single factor accounts for a majority of effects on all species. Thus, substantial improvements in salmonid numbers and viability will require significant improvements in several factors. Loss of tributary habitat quality and quantity is an important impact for all species, particularly for chum. Loss of estuary habitat quality and quantity is important for all species, especially chum and fall Chinook. Harvest has a sizeable effect on fall Chinook but is relatively minor for chum and winter steelhead; harvest impact on spring Chinook and coho is intermediate. Hatchery impacts are intermediate for spring Chinook, coho, and winter steelhead, and relatively low for chum. Hydrosystem access and passage impacts are substantial for spring Chinook coho, and winter steelhead and relatively minor for fall Chinook and chum. Predation impacts are moderate for all species.

Impacts were defined as the proportional reduction in average numbers or productivity associated with each effect. Tributary and estuary habitat impacts are the differences between the pre-development historical baseline and current conditions. Hydro impacts identify the percentage of historical habitat blocked by impassable dams and the mortality associated with juvenile and adult passage of other dams. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries. Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in its relative significance. Methods and data for these analyses are detailed in Appendix E.

Potentially-manageable human impacts were estimated for each factor based on the best available scientific information. Proportions are standardized to a total of 1.0 for plotting purposes. The index is intended to illustrate order-of-magnitude rather than fine-scale differences. Only the subset of factors we can potentially manage were included in this index – natural mortality factors beyond our control (e.g. naturally-occuring ocean mortality) are excluded. Not every factor of interest is included in this index – only readily-quantifiable impacts are included.

4.0 Key Programs and Projects

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

4.1 Federal Programs

4.1.1 *NOAA Fisheries*

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

4.1.2 *US Army Corps of Engineers*

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

4.1.3 *Environmental Protection Agency*

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

4.1.4 *Natural Resources Conservation Service*

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

4.1.5 *Northwest Power and Conservation Council*

The Northwest Power and Conservation Council, an interstate compact of Idaho, Montana, Oregon, and Washington, has specific responsibility in the Northwest Power Act of 1980 to mitigate the effects of the hydropower system on fish and wildlife of the Columbia River

Basin. The Council does this through its Columbia River Basin Fish and Wildlife Program, which is funded by the Bonneville Power Administration. Beginning in Fiscal Year 2006, funding is guided by locally developed subbasin plans that are expected to be formally adopted in the Council's Fish and Wildlife Program in December 2004.

4.1.6 *Federal Energy Regulatory Commission*

Non-federal hydroelectric projects that meet certain criteria operate under licenses issued by the Federal Energy Regulatory Commission (FERC). A hydroelectric license prescribes operations and safety precautions, as well as environmental protection, mitigation and enhancements. The FERC relicensing process requires years of extensive planning, including environmental studies, agency consensus, and public involvement.

4.2 State Programs

4.2.1 *Washington Department of Natural Resources*

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

4.2.2 *Washington Department of Fish & Wildlife*

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

4.2.3 *Washington Department of Ecology*

The Department of Ecology (DOE) oversees: the Water Resources program to manage water resources to meet current and future needs of the natural environment and Washington's communities; the Water Quality program to restore and protect Washington's water supplies by preventing and reducing pollution; and Shoreline and the Environmental Assistance program for implementing the Shorelines Management Act, the State Environmental Protection Act, the Watershed Planning Act, and 401 Certification of ACOE Permits.

4.2.4 *Washington Department of Transportation*

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

4.2.5 *Interagency Committee for Outdoor Recreation*

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

4.2.6 *Lower Columbia Fish Recovery Board*

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

4.3 Local Government Programs

4.3.1 *Cowlitz County*

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

4.3.2 *Clark County*

Clark County is conducting Comprehensive Planning under the State’s Growth Management Act. Clark County manages natural resources under various programs including Critical Areas Ordinance, ESA Program, Road Operations, Parks Operations, Stormwater Management, and the Conservation Futures Program.

4.3.3 *City of Woodland*

According to the standards of the Growth Management Act, the city of Woodland has codified such designated critical areas by map and adopted development regulations to assure the conservation of such areas. The city also requires a critical area permit if the proposed development is located on a critical area or associated buffer.

4.3.4 *Cowlitz / Wahkiakum Conservation District*

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

4.3.5 *Clark Conservation District*

Clark Conservation District provides technical assistance, cost-share assistance, and project monitoring in Clark County. Clark CD assists agricultural landowners in the development of farm plans and in the participation in the Conservation Reserve Enhancement Program. Farm plans optimize use, protect sensitive areas, and conserve resources.

4.3.6 *Cowlitz County Public Utility District*

Public Utility District No. 1 of Cowlitz County is a municipal corporation of the State of Washington, formed to provide electric service within Cowlitz County. Cowlitz County PUD is a not-for-profit, consumer-owned utility serving 45,500 electric customers and 3,540 water customers in the County. Cowlitz PUD owns the Swift No. 2 hydroelectric project. Cowlitz PUD operates Swift No. 2 according to an agreement that allows PacifiCorp to manage all four hydro projects on the Lewis River in a coordinated manner.

4.4 Non-governmental Programs

4.4.1 *Columbia Land Trust*

The Columbia Land Trust is a private, non-profit organization founded in 1990 to work exclusively with willing landowners to find ways to conserve the scenic and natural values of the land and water. Landowners donate the development rights or full ownership of their land to the Land Trust. CLT manages the land under a stewardship plan and, if necessary, will legally defend its conservation values.

4.4.2 *Lower Columbia Fish Enhancement Group*

The Washington State Legislature created the Regional Fisheries Enhancement Group Program in 1990 to involve local communities, citizen volunteers, and landowners in the state's salmon recovery efforts. RFEGs help lead their communities in successful restoration, education and monitoring projects. Every group is a separate, nonprofit organization led by their own board of directors and operational funding from a portion of commercial and recreational fishing license fees administered by the WDFW, and other sources. The mission of the Lower Columbia RFEG (LCFEG) is to restore salmon runs in the lower Columbia River region through habitat restoration, education and outreach, and developing regional and local partnerships.

4.4.3 *PacifiCorp*

PacifiCorp is a power company that operates 53 hydropower facilities in Washington, Oregon, Idaho, Utah and Montana. In Washington, Oregon, Wyoming, and California, PacifiCorp operates as Pacific Power. PacifiCorp and the Cowlitz PUD operate hydroelectric facilities on the North Fork Lewis. The projects are currently undergoing relicensing pursuant to the federal Power Act using the Federal Energy Regulatory Commission's alternative licensing approach. Under this approach the utilities are working with federal agencies, local governments, tribes, community interests, and environmental organizations to develop a settlement agreement defining terms for a license.

4.5 NPCC Fish & Wildlife Program Projects

Evaluate habitat use and population dynamics of lampreys in Cedar Creek (Project 200001400)

Abstract: With emphasis on Pacific lampreys, identify and quantitatively evaluate populations of lampreys and their habitats in a stream below Bonneville Dam. Funding Status: funded 2000, 2001, 2002, recommended 2003.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Ac/ Restoration	DuPuis Chelatchie Creek Project	NF Lewis
Ac/ Restoration	Swift-Killian-Sargent Cedar Crk. Project	NF Lewis
Preservation	Doty Habitat Restoration (Cedar Creek)	NF Lewis
Preservation	Eagle Island Acquisition	NF Lewis
Restoration	Cedar Crk Riparian	NF Lewis
Restoration	Cedar Crk @ Amboy Blockage	NF Lewis
Restoration	Chelatichie Creek Restoration/Enhancement	NF Lewis
Restoration	Lockwood Recovery Enhancement	NF Lewis
Restoration	Van Breeman Reparian Restoration	NF Lewis
Restoration	Breeze Creek Culvert Design	NF Lewis
Restoration	Riley Creek Culvert Upgrade	NF Lewis
Restoration	Cedar Cr @ Cedar Creek Rd	NF Lewis
	Carter-Malinowski-Shimano Cedar Creek	NF Lewis

5.0 Management Plan

5.1 Vision

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

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

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

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

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

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

Columbia basin hydropower effects on lower North Fork Lewis Subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures and Lewis hydrosytem effects will be addressed by dam operation procedures which provide essential habitat in the lower Lewis River. Hatchery facilities in the North Fork Lewis River will also be called upon to produce fish to mitigate for hydropower impacts on Lewis stocks, where compatible with wild fish recovery.

This plan uses a planning period or horizon of 25 years. The goal is to achieve recovery of the listed salmon species and the biological objectives for other fish and wildlife species of interest within this time period. It is recognized, however, that sufficient restoration of habitat conditions and watershed processes for all species of interest will likely take 75 years or more.

5.2 Biological Objectives

Biological objectives for lower NF Lewis subbasin salmonid populations are based on recovery criteria developed by scientists on the Willamette/Lower Columbia Technical Recovery Team convened by NOAA Fisheries. Criteria involve a hierarchy of ESU, Strata, and Population standards. A recovery scenario describing population-scale biological objectives for all species in all three strata in the lower Columbia ESUs was developed through a collaborative process with stakeholders based on biological significance, expected progress as a result of existing programs, the absence of apparent impediments, and the existence of other management opportunities. Under the preferred alternative, individual populations will variously contribute to recovery according to habitat quality and the population's perceived capacity to rebuild. Criteria, objectives, and the regional recovery scenario are described in greater detail in the Regional Recovery and Subbasin Plan Volume I.

Focal populations in the lower NF Lewis subbasin are targeted to improve to a level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels.

The lower NF Lewis subbasin was identified as one of the most significant areas for salmon recovery among Washington Cascade strata subbasins based on fish population significance and realistic prospects for restoration. Recovery goals call for restoring Chinook and chum to a high or very high viability level. This level will provide for a 95% or better probability of population survival over 100 years. Winter steelhead and coho recovery goals call for restoring viability to a medium level which would provide for a 75-95% chance of survival over the next 100 years. Summer steelhead viability recovery goals are very low and provide for a less than 40% chance of persistence over the next 100 years. Cutthroat will benefit from improvements in stream habitat conditions for salmonids. Lamprey are also expected to benefit from habitat improvements in the estuary, Columbia River mainstem, and lower North Fork Lewis subbasin although specific spawning and rearing habitat requirements of lamprey are not well known.

Table 10. Current viability status of lower North Fork Lewis populations and the biological objective status that is necessary to meet the recovery criteria for the Coastal strata and the lower Columbia ESU.

Species	ESA Status	Hatchery Component	Current Viability	Current Numbers	Objective Viability	Objective Numbers
Fall Chinook	Threatened	No	Med+	3,200-18,000	High+[P]	6,500-16,600
Spring Chinook	Threatened	Yes	Very low	200-1,000	High[P]	2,200
Chum	Threatened	No	Very low	<150	High[P,X]	1,100
Winter Steelhead	Threatened	Yes	Low	Unknown	Medium[C]	300
Summer Steelhead	Threatened	Yes	Very low	Unknown	Very low[S]	150
Coho	Proposed	Yes	Very low	Unknown	Medium[C]	300

P = primary population in recovery scenario
C = contributing population in recovery scenario
S = stabilizing population in recovery scenario
X = subset of larger population

5.3 Integrated Strategy

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

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

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

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

The following table identifies population and factor-specific improvements consistent with the biological objectives for this subbasin. Per factor increments are less than the population net because factor affects are compounded at different life stages and density dependence is largely limited to freshwater tributary habitat.

Table 11. Productivity improvements consistent with biological objectives for the lower North Fork Lewis subbasin.

	Net	Per	Baseline impacts					
Species	increase	factor	Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Late Fall Chinook	110%	35%	0.16	0.39	0.07	0.24	0.50	0.17
Spring Chinook	--	--	0.81	0.20	0.90	0.31	0.53	0.45
Chum	30%	2%	0.93	0.58	0.00	0.24	0.05	0.04
Coho	na	na	na	na	na	na	na	na
Summer Steelhead	--	0%	0.59	0.59	0.50	0.24	0.10	0.65
Winter Steelhead	10%	1%	0.59	0.10	0.95	0.24	0.10	0.23

5.4 Tributary Habitat

Habitat assessment results were synthesized in order to develop specific prioritized measures and actions that are believed to offer the greatest opportunity for species recovery in the subbasin. As a first step toward measure and action development, habitat assessment results were integrated to develop a multi-species view of 1) priority areas, 2) factors limiting recovery, and 3) contributing land-use threats. For the purpose of this assessment, limiting factors are defined as the biological and physical conditions serving to suppress salmonid population performance, whereas threats are the land-use activities contributing to those factors. Limiting Factors refer to local (reach-scale) conditions believed to be directly impacting fish. Threats, on the other hand, may be local or non-local. Non-local threats may impact instream limiting factors in a number of ways, including: 1) through their effects on habitat-forming processes – such as the case of forest road impacts on reach-scale fine sediment loads, 2) due to an impact in a contributing stream reach – such as riparian degradation reducing wood recruitment to a downstream reach, or 3) by blocking fish passage to an upstream reach.

Priority areas and limiting factors were determined through the technical assessment, including primarily EDT analysis and the Integrated Watershed Assessment (IWA). As described later in this section, priority areas are also determined by the relative importance of subbasin focal fish populations to regional recovery objectives. This information allows for scaling of subbasin recovery effort in order to best accomplish recovery at the regional scale. Land-use threats were determined from a variety of sources including Washington Conservation Commission Limiting Factors Analyses, the IWA, the State 303(d) list, air photo analysis, the Barrier Assessment, personal knowledge of investigators, or known cause-effect relationships between stream conditions and land-uses.

Priority areas, limiting factors and threats were used to develop a prioritized suite of habitat measures. Measures are based solely on biological and physical conditions. For each measure, the key programs that address the measure are identified and the sufficiency of existing programs to satisfy the measure is discussed. The measures, in conjunction with the program sufficiency considerations, were then used to identify specific actions necessary to fill gaps in measure implementation. Actions differ from measures in that they address program deficiencies as well as biophysical habitat conditions. The process for developing measures and actions is illustrated in Figure 20 and each component is presented in detail in the sections that follow.

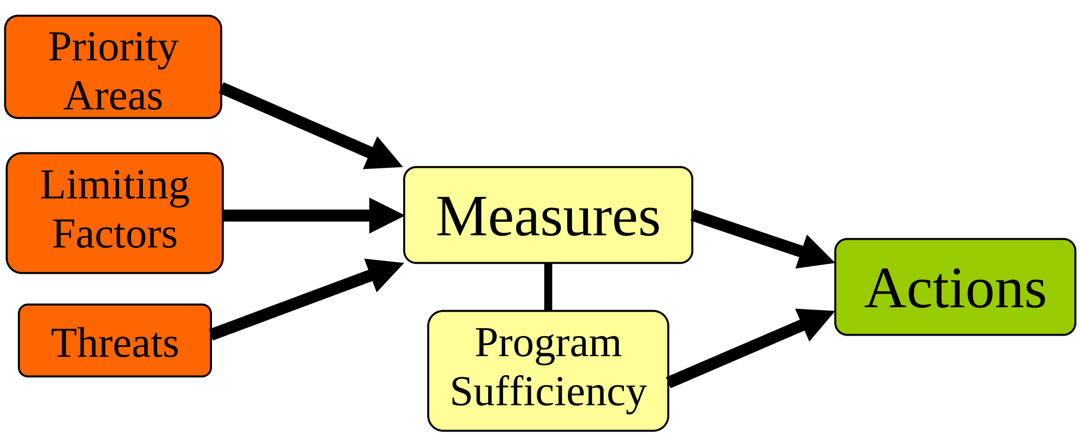


Figure 20. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Areas, Limiting Factors and Threats*

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

Summary

Decades of human activity in the Lower North Fork Lewis River Basin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, stream habitat conditions within the Lower Lewis Basin have a high impact on the health and viability of salmon and steelhead relative to other limiting factors. The following bullets provide a brief overview of each of the priority areas in the basin. These descriptions are a summary of the reach-scale priorities that are presented in the next section. These descriptions summarize the species most affected, the primary limiting factors, the contributing land-use threats, and the general type of measures that will be necessary for recovery. A tabular summary of the key limiting factors and land-use threats can be found in Table 12.

- **Middle mainstem Lewis** *(reaches Lewis 3-7)* – The most critical reaches in the middle mainstem Lewis lie between Ross Creek and Merwin Dam. These reaches are most important for chum, fall Chinook, and coho. Winter steelhead also utilize these reaches. The middle mainstem basin is largely in private land ownership with some areas of state forest land. Hydropower operations, agriculture, and rural development have the greatest impacts. The recovery emphasis is for preservation as well as restoration. Effective recovery measures in the middle mainstem will involve managing regulated flows from the hydropower system, addressing agricultural and rural/suburban development impacts to floodplains and riparian areas, and ensuring that land-use planning effectively protects habitat and watershed processes.
- **Cedar Creek** *(reaches Cedar 1a, 1b, 3, & 4)* – Cedar Creek reaches are most important for winter steelhead, though other species make limited use of these habitats. Lower Cedar Creek (mouth to Pup Creek) (Cedar Creek 1a) and the reach downstream of the Chelatchie Creek confluence (Cedar Creek 3) are the most critical. Forest practices on private commercial timber lands in the upper watershed have impacted sediment supply and hydrologic processes in Cedar Creek reaches. Agriculture and rural residential uses have impacted riparian areas and floodplains. Recovery measures will need to address agricultural impacts along stream corridors and forest practices in the upper basin.

Table 12. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the middle mainstem (MM) and Cedar Creek (CC) portions of the lower NF Lewis Basin. Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors			Threats		
	MM	CC		MM	CC
Habitat connectivity			***Agriculture/grazing***		
Blockages to off-channel habitats	✓		Clearing of vegetation	✓	✓
Habitat diversity			Riparian grazing	✓	✓
Lack of stable instream woody debris	✓	✓	Floodplain filling	✓	✓
Altered habitat unit composition	✓	✓	***Rural/suburban development***		
Loss of off-channel and/or side-channel habitats	✓	✓	Clearing of vegetation	✓	✓
Channel stability			Floodplain filling	✓	✓
Bed and bank erosion	✓	✓	Increased impervious surfaces	✓	✓
Channel down-cutting (incision)	✓	✓	Increased drainage network	✓	
Riparian function			Roads – riparian/floodplain impacts	✓	
Reduced stream canopy cover	✓	✓	***Forest practices***		
Reduced bank/soil stability	✓	✓	Timber harvests –sediment supply impacts	✓	✓
Exotic and/or noxious species	✓	✓	Timber harvests – impacts to runoff	✓	✓
Reduced wood recruitment	✓	✓	Riparian harvests (historical)	✓	✓
Floodplain function			Forest roads – impacts to sediment supply	✓	✓
Altered nutrient exchange processes	✓	✓	Forest roads – impacts to runoff	✓	✓
Reduced flood flow dampening	✓	✓	***Channel manipulations***		
Restricted channel migration	✓	✓	Bank hardening	✓	✓
Disrupted hyporheic processes	✓	✓	Channel straightening	✓	✓
Stream flow			Artificial confinement	✓	✓
Altered magnitude, duration, or rate of change	✓	✓	Clearing and snagging (historical)	✓	
Alterations to the temporal pattern of stream flow	✓		Dredge and fill activities	✓	
Water quality			***Hydropower operations***		
Altered stream temperature regime	✓	✓	Flow manipulation	✓	
Bacteria		✓	Changes to sediment transport dynamics	✓	
Substrate and sediment			Changes to stream temperature regime	✓	
Excessive fine sediment	✓	✓			
Disrupted sediment transport processes (hydro)	✓				
Embedded substrates		✓			

Specific Reach and Subwatershed Priorities

Specific reaches and subwatersheds have been prioritized based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. Reaches have been placed into Tiers (1-4), with Tier 1 reaches representing the areas where recovery measures would yield the greatest benefits towards accomplishing the biological objectives. The reach tiering factors in each fish population's importance relative to regional recovery objectives, as well as the relative importance of reaches within the populations themselves. Reach tiers are most useful for identifying habitat recovery measures in channels, floodplains, and riparian areas. Reach-scale priorities were initially identified within individual populations (species) through the EDT Restoration and Preservation Analysis. This resulted in reaches grouped into categories of high, medium, and low priority for each population (see Stream Habitat Limitations section). Within a subbasin, reach rankings for all of the modeled populations were combined, using population designations as a weighting factor. Population designations for this subbasin are described in the Biological Objectives section. The population designations are 'primary', 'contributing', and 'stabilizing'; reflecting the level of emphasis that needs to be placed on population recovery in order to meet ESA recovery criteria.

Spatial priorities were also identified at the subwatershed scale. Subwatershed-scale priorities were directly determined by reach-scale priorities, such that a Group A subwatershed contains one or more Tier 1 reaches. Scaling up from reaches to the subwatershed level was done in recognition that actions to protect and restore critical reaches might need to occur in adjacent and/or upstream upland areas. For example, high sediment loads in a Tier 1 reach may originate in an upstream contributing subwatershed where sediment supply conditions are impaired because of current land use practices. Subwatershed-scale priorities can be used in conjunction with the IWA to identify watershed process restoration and preservation opportunities. The specific rules for designating reach tiers and subwatershed groups are presented in Table 13. Reach tier designations for this basin are included in Table 14. Reach tiers and subwatershed groups are displayed on a map in Figure 21. A summary of reach- and-subwatershed-scale limiting factors is included in Table 15.

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

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

Table 14. Reach Tiers in the lower North Fork Lewis River Basin

Tier 1	Tier 2	Tier 3	Tier 4
Lewis 3 Lewis 4 Lewis 6	Cedar Creek 1a Cedar Creek 1b Cedar Creek 3 Cedar Creek 4 Lewis 5 Lewis 7	Cedar Creek 2 Cedar Creek 5 Cedar Creek 6 Lewis 2 tidal_A	Bitter Creek Brezee Creek Brush Creek Chelatchie Cr 1 Chelatchie Cr 2 EF Lewis 1 EF Lewis 2 Grist Mill Houghton Cr John Creek Johnson Cr Lewis 1 tidal Lewis 2 tidal_B NF Chelatchie Cr Pup Creek Robinson Cr Ross Cr

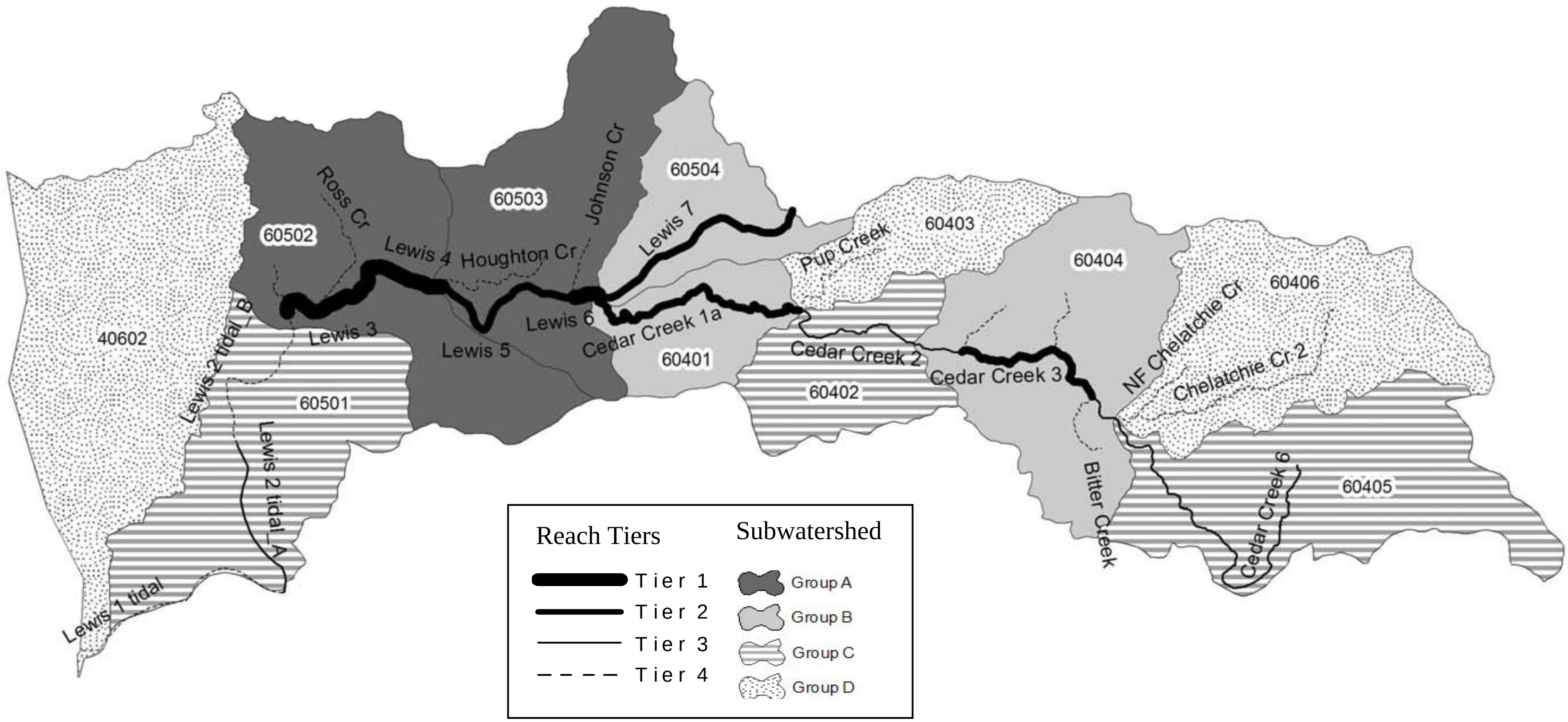


Figure 21. Reach tiers and subwatershed groups in the Lower North Fork Lewis Basin. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities at the reach scale are useful for identifying stream corridor recovery measures. Priorities at the subwatershed scale are useful for identifying watershed process recovery measures. Watershed process recovery measures for stream reaches will need to occur within the surrounding (local) subwatershed as well as in upstream contributing subwatersheds.

Table 15. Reach- and subwatershed-scale limiting factors in priority areas. The table is organized by subwatershed groups, beginning with the highest priority group. Species-specific reach priorities, critical life stages, high impact habitat factors, and recovery emphasis (P=preservation, R=restoration, PR=restoration and preservation) are included. Watershed process impairments: F=functional, M=moderately impaired, I=impaired. Species abbreviations: ChS=spring Chinook, ChF=fall Chinook, StS=summer steelhead, StW=winter steelhead.

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local) Hydrology	Watershed processes (local) Sediment	Watershed processes (local) Riparian	Watershed processes (watershed) Hydrology	Watershed processes (watershed) Sediment
A	60503	Cedar Creek 1a Houghton Cr Johnson Cr Lewis 5 Lewis 6	ChF	Lewis 6	Spawning Egg incubation Fry colonization	none	P	I	M	M	M	M
			StW	Cedar Creek 1a	Egg incubation 0-age active rearing 1-age active rearing	temperature	PR					
			Coho	Lewis 5 Lewis 6	Fry colonization 0-age active rearing 1-age active rearing Prespawning holding 0-age inactive Prespawning migrant	habitat diversity key habitat quantity	PR					
			Chum	Lewis 5 Lewis 6	Spawning Egg incubation Fry colonization Prespawning holding	none	P					
	60502	Lewis 2 tidal_B Lewis 3 Lewis 4 Robinson Cr Ross Cr	ChF	Lewis 3 Lewis 4	Egg incubation Fry colonization 0-age active rearing Prespawning holding	sediment	P	I	M	M	M	M
			StW	none								
			Coho	Lewis 3 Lewis 4	Egg incubation Fry colonization 0-age active rearing Prespawning migrant Prespawning holding	habitat diversity predation sediment key habitat quantity	PR					
			Chum	Lewis 4	Spawning Egg incubation Prespawning holding	none	P					
B	60504	Lewis 7	ChF StW Coho Chum	none none none none				I	M	M	M	M
	60404	Bitter Cr Brush Creek Cedar Creek 2 Cedar Creek 3 Cedar Creek 4 Cedar Creek 5 John Creek	StW	Cedar Creek 3 Cedar Creek 4	Egg incubation 0-age active rearing 0,1-age inactive 1-age active rearing	none	P	I	M	M	I	M
			Coho	none								
	60401	Cedar Creek 1a Cedar Creek 1b Grist Mill	StW	Cedar Creek 1a Cedar Creek 1b	Egg incubation 0-age active rearing 1-age active rearing	temperature	PR	I	F	M	I	M
			Coho	none								
C	60501	Lewis 1 tidal Lewis 2 tidal_A	All	none				I	M	I	M	M
	60405	Cedar Creek 6	StW	none				I	M	M	I	M
			Coho	none								
	60402	Cedar Creek 2	StW	none				I	M	M	I	M
			Coho	none								
D	60406	Chelatchie Cr 1 Chelatchie Cr 2 NF Chelatchie Cr	StW	none				I	M	I	I	M
			Coho	none								
	60403	Pup Creek	StW	none				M	M	M	M	M
			Coho	none								
	40602	Lewis 1 tidal	All	none				I	M	I	I	M

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the Lower North Fork Lewis Basin and are necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin (Section 3.0) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the Lower North Fork Lewis Basin are presented in priority order in Table 16. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the subbasin. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

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

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following prioritized approaches: 1) protect existing functional habitats and the processes that sustain them, 2) allow no further degradation of habitat or supporting processes. 3) re-connect isolated habitat, 4) restore watershed processes (ecosystem function), 5) restore habitat structure, and 6) create new habitat where it is not recoverable. These priorities have been adjusted for the specific circumstances occurring in the Lower North Fork Lewis Basin. These priorities are adjusted depending on the results of the technical assessment and on the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

5.4.3 *Habitat Actions*

The prioritized measures and associated gaps are used to develop specific Actions for the subbasin. These are presented in Table 17. Actions are different than the measures in a number of ways: 1) actions have a greater degree of specificity than measures, 2) actions consider existing programs and are therefore not based strictly on biophysical conditions, 3) actions refer to the agency or entity that would be responsible for carrying out the action, and 4) actions are related to an expected outcome with respect to the biological objectives. Actions are not presented in priority order but instead represent the suite of activities that are all necessary for recovery of listed species. Priority for implementation of these actions will consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table 16. Prioritized measures for the Lower North Fork Lewis Basin.

#1 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	All Species	The mainstem Lewis below Merwin Dam has been heavily altered due to adjacent land uses including agriculture, residential development, transportation corridors, and industry. The mainstem is heavily channelized in many areas. The flow regime has been altered through hydro-regulation. Tributary streams, in particular Cedar Creek, have been altered by agriculture, rural residential development, and past riparian timber harvest. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation
Reaches: Lewis 3-7; Cedar Creek 1a, 1b, 3, 4
2nd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NOAA Fisheries	ESA Section 7 and Section 10	✓	
US Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program, Aquatic Lands Authorization	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Clark County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
City of Woodland	Comprehensive Planning, Water Supply		✓
Clark Conservation District / Natural Resources Conservation Service (NRCS)	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, Control		✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements		✓

Program Sufficiency and Gaps

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

#2 – Protect hillslope processes

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

Priority Locations

1st- Functional subwatersheds contributing to Tier 1 or 2 reaches (functional for sediment *or* flow according to the IWA – local rating)
Subwatersheds: 60401
2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 60502, 60503, 60504, 60403, 60402, 60404, 60406, 60405
3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 40602, 60501

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
Clark County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
City of Woodland	Comprehensive Planning		✓
Clark Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓

Program Sufficiency and Gaps

Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands (agriculture and developed), local governments comprehensive planning is the primary nexus for protection of hillslope processes. Local governments can control impacts through zoning that protects existing uses, through stormwater management ordinances, and through tax incentives to prevent agricultural and forest lands from becoming developed. These protections are especially important in the lower NF Lewis basin due to expanding growth. There are few to no regulatory protections of hillslope processes that relate to agricultural practices; such deficiencies need to be addressed through local or state authorities. Protecting hillslope processes on agricultural lands would also benefit from the expansion of technical assistance and landowner incentive programs (NRCS, Conservation Districts).

#3 – Manage regulated stream flows to provide for critical components of the natural flow regime

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Provide adequate flows for specific life stage requirements (i.e. fry to smolt rearing for fall chinook) B. Address geomorphic effects of hydro-regulation (i.e. channel-forming flows, spawning gravel recruitment)	• Alterations to the temporal pattern of stream flow • Altered stream temperature regime • Disrupted sediment transport processes • Lack of channel-forming flows	• Hydropower operations – changes to flow regime, sediment transport, and stream temperature	All species	Hydro-regulation on the Lewis River has altered the natural stream flow regime below Merwin Dam. In general, summer, fall, and winter flows have increased, spring flows have decreased, and flood (pulse) flows have decreased in frequency and magnitude. To support fish and their habitat, hydro-regulation will need to provide adequate flows for habitat formation, fish migration, water quality, floodplain connectivity, habitat capacity, and sediment transport below Merwin Dam.

Priority Locations

Lower mainstem Lewis (Lewis 1-tidal to Lewis 7)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Federal Energy Regulatory Commission (FERC)	Hydroelectric Relicensing Program	✓	
PacifiCorps	Hydropower Operations		✓
Cowlitz PUD	Hydropower Operations		✓
USFWS	Hydroelectric Relicensing Program	✓	
NOAA Fisheries	Hydroelectric Relicensing Program	✓	
WA Department of Ecology (WDOE)	Water Quality Program (Water Quality Certification-section 401)	✓	
WDFW	Hydroelectric Relicensing Program	✓	

Program Sufficiency and Gaps

PacifiCorps, Cowlitz PUD, FERC, NOAA Fisheries, USFWS, WDFW, and other stakeholders are currently involved in negotiations as part of the hydropower re-licensing process for the Lewis hydropower system. Instream flow assessment has focused chiefly on spring flows that are important for rearing of fall chinook juveniles. In most years, spring flows are significantly reduced from historical levels as the reservoirs are filled in anticipation of low summer rainfall, thus reducing habitat capacity for juvenile chinook (particularly in the Eagle Island area that contains the most important juvenile rearing habitat). Flow prescriptions will need to ensure there is ample habitat capacity and quality for juvenile chinook in all but the driest of years. There has been relatively little focus on the effects of flow regime alteration on other aquatic species, an issue that warrants further investigation. Flow regulation has decreased the volume of peak flows during the winter and spring that were historically important for habitat formation, sediment transport, and for conveying smolts downstream. However, due to heavy channel confinement in the lower river, peak flows are less effective at habitat formation and spring flushing flows may convey juveniles out of the system prematurely since refuge habitats have been lost. For these reasons, the ability to restore channel-forming and flushing flows is limited and will need to occur in concert with restoration of floodplain function. The effect of mainstem dams on spawning gravel recruitment to the lower river is another issue that needs attention and possible restoration measures over the long-term.

#4 - Restore floodplain function and channel migration processes in the mainstem and major tributaries

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

Priority Locations

1st- Tier 1 reaches with hydro-modifications (obtained from EDT ratings)
Reaches: Lewis 3-4
2nd- Tier 2 reaches with hydro-modifications
Reaches: Lewis 5; Cedar Creek 3
3rd- Other reaches with hydro-modifications
Reaches: Lewis 1-tidal, 2-tidal_A, 2-tidal_B; Robinson Cr; Ross Cr; Johnson Cr; Cedar Creek 6; Chelatchie Cr 2

Key Programs

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

Program Sufficiency and Gaps

There currently are no program that set forth strategies for restoring floodplain function and channel migration processes in the Lower NF Lewis Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. The level of floodplain and CMZ impairment in the Lower NF Lewis and the importance of these processes to listed fish species put an increased emphasis on restoration. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs and government entities to conduct projects. Floodplain restoration projects are often expensive, large-scale efforts that require partnerships among many agencies, NGOs, and landowners. Building partnerships is a necessary first step toward floodplain and CMZ restoration.

#5 – Restore access to habitat blocked by artificial barriers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access to isolated habitats blocked by culverts, dams, or other barriers	• Blockages to channel habitats • Blockages to off-channel habitats	• Dams, culverts, in-stream structures	All species	As many as 16 miles of potentially accessible habitat are blocked by culverts or other barriers. The blocked habitat is believed to be marginal in the majority of cases and no individual barriers in themselves account for a significant portion of blocked miles. Passage restoration projects should focus only on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Colvin Creek; Bitter Creek
2nd- Other small tributaries with blockages

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, Family Forest Fish Passage, State Forest Lands HCP		✓
WDFW	Habitat Program		✓
Washington Department of Transportation / WDFW	Fish Passage Program		✓
City of Woodland	Roads		✓
Cowlitz County	Roads		✓
Clark County	Roads		✓

Program Sufficiency and Gaps

The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Clark and Cowlitz Counties both have public works programs that address barrier removal projects. Past efforts have corrected major blockages and have identified others in need of repair. Additional funding is needed to correct remaining blockages. Further monitoring and assessment is needed to ensure that all potential blockages have been identified and prioritized.

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

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

Priority Locations

1st- Mainstem Lewis and Cedar Creek
Reaches: Lewis 1-tidal to Lewis 5; Cedar Creek 3-5
2nd- Other reaches that may have potential for off-channel and side-channel habitat restoration or creation

Key Programs

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

Program Sufficiency and Gaps

There are no regulatory mechanisms for creating or restoring off-channel and side-channel habitat. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

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

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: 60502, 60503, 60504, 60403, 60402, 60404, 60406, 60405, 60401

2nd- Moderately impaired or impaired subwatersheds contributing to other reaches
Subwatersheds: 40602, 60501

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Clark Conservation District / NRCS	Agricultural land habitat restoration programs		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Agricultural land habitat restoration programs		✓
Clark County	Stormwater Management		✓
Cowlitz County	Stormwater Management		✓
NGOs, tribes, agencies, landowners	Habitat Projects		✓
City of Woodland	Stormwater Management		✓

Program Sufficiency and Gaps

Forest management programs including the new Forest Practices Rules (private timber lands) and the WDNR HCP (state timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements for private timber lands are expected to actively address road-related impairments within a 15 year time-frame. While these strategies are believed to be largely adequate to protect watershed processes, the degree of implementation and the effectiveness of the prescriptions will not be fully known for at least another 15 or 20 years. Of particular concern is the capacity of some forest land owners, especially small forest owners, to conduct the necessary road improvements (or removal) in the required timeframe. Additional financial and technical assistance would enable small forest landowners to conduct the necessary improvements in a timeline parallel to large industrial timber land owners. Ecological restoration of existing developed and agricultural lands occurs relatively infrequently and there are no programs that specifically require restoration in these areas. Restoring existing developed and farmed lands can involve retrofitting facilities with new materials, replacing existing systems, adopting new management practices, and creating or re-configuring landscaping. Means of increasing restoration activity include increasing landowner participation through education and incentive programs, building support for projects on public lands/facilities, requiring Best Management Practices through permitting and ordinances, and increasing available funding for entities to conduct restoration projects.

#8 - Restore riparian conditions throughout the basin

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

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Clark Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious weed control		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring riparian conditions; however, existing programs will afford protections that will allow for the *passive* restoration of riparian forests. These protections are believed to be adequate for riparian areas on forest lands that are subject to Forest Practices Rules or the State forest lands HCP. Other lands receive variable levels of protection and passive restoration through Clark County, Cowlitz County, and the City of Woodland's Comprehensive Plans. Many degraded riparian zones in urban, agricultural, rural residential, or transportation corridor uses will not passively restore with existing regulatory protections and will require active measures. Riparian restoration in these areas may entail livestock exclusion, tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Exclude livestock from riparian areas B. Increase riparian shading C. Decrease channel width-to-depth ratios D. Reduce delivery of chemical contaminants to streams E. Address leaking septic systems	• Altered stream temperature regime • Bacteria • Chemical contaminants	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to rural development and agriculture • Leaking septic systems • Chemical contaminants from agricultural and developed lands	• All species	There are several stream segments that are known as having concerns for temperature impairment (WDOE 2004). Fecal coliform bacteria, while more of a human health concern than a fish health concern, is also an issue in the basin. Cedar Creek is listed on the 2002-2004 draft 303(d) list for fecal coliform bacteria impairment. Excluding livestock from riparian areas is particularly important in the heavily grazed lowland areas. Leaking septic systems may be contributing to bacteria levels in areas with concentrated rural residential development. The degree of impact of agricultural pollutants is unknown and needs further assessment.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 draft list)
Reaches: Cedar Creek 1b (bacteria)
2nd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Clark Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Clark County Health Department	Septic System Program		✓
Cowlitz County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

The WDOE Water Quality Program manages the State 303(d) list of impaired water bodies. There is one listing in the lower Lewis River and several areas of concern (WDOE 2004). A Water Quality Clean-up Plan (TMDL) is required by the WDOE and it is anticipated that the TMDL will adequately set forth strategies to address the bacteria impairment in Cedar Creek. It will be important that the strategies specified in the TMDLs are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin, especially regarding temperature and agricultural pollutants.

#10 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve flows during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Lower NF Lewis Basin have been identified as part of Watershed Planning for WRIA 27 (LCFRB 2004). Strategies include water rights closures, setting of minimum flows, and drought management policies. This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hydropower regulation and hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WRIA 27/28 Watershed Planning Unit	Watershed Planning	✓	
City of Woodland	Water Supply Program	✓	
Washington Department of Ecology	Water Resources Program		✓

Program Sufficiency and Gaps

The Water Resources Program of the WDOE, in cooperation with the WDFW and other entities, manages water rights and instream flow protections. A collaborative process for setting and managing instream flows was launched in 1998 with the Watershed Planning Act (HB 2514), which called for the establishment of local watershed planning groups who's objective was to recommend instream flow guidelines to WDOE through a collaborative process. The current status of the planning effort is to adopt a watershed management plan by December 2004. Instream flow management in the Lower NF Lewis Basin will be conducted using the recommendations of the WRIA 27/28 Planning Unit, which is coordinated by the LCFRB. Draft products of the WRIA 27/28 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the planning unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies. Ecology should implement the recommendations of the WRIA 27/28 Planning Unit with respect to instream flow rule development.

#11 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Large wood installation projects could benefit habitat conditions in many areas although watershed processes contributing to wood deficiencies should be considered and addressed prior to placing wood in streams. Other structural enhancements to stream channels may be warranted in some places, especially in lowland alluvial reaches that have been simplified through channel straightening and confinement.

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, agencies, landowners	Habitat Projects		✓
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Clark Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, Farm Planning, Conservation Programs (e.g. CREP)		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring channel stability and structure. Passive restoration is expected to slowly occur as a result of protections afforded to riparian areas and hillslope processes. Past projects have largely been opportunistic and have been completed due to the efforts of local NGOs, landowners, and government agencies; such projects are likely to continue in a piecemeal fashion as opportunities arise and if financing is made available. The lack of LWD in stream channels, and the importance of wood for habitat of listed species, places an emphasis on LWD supplementation projects. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

#12 – Limit intensive recreational use during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Limit intensive recreational use of stream channels during adult holding and spawning periods	• Harassment	• Harassment	Chum, fall chinook, coho	The Lower NF Lewis River between Woodland, WA and Merwin Dam is heavily used for recreational purposes. There is harassment potential that was identified through the EDT analysis, but the specific degree of the harassment threat needs to be further evaluated.

Priority Locations

Lower NF Lewis mainstem between Woodland, WA and Merwin Dam

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Clark County	Parks and Recreation		✓
Cowlitz County	Parks and Recreation		✓
WDFW	Enforcement Program		✓

Program Sufficiency and Gaps

There currently is little policy in place directly aimed at managing recreational use of the river to prevent harassment during critical periods. A more thorough evaluation of the harassment threat is warranted.

Table 17. Habitat actions for the Lower North Fork Lewis River Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L-Lew 1. Manage regulated stream flows to provide for critical components of the natural flow regime	Expansion of existing program or activity	PacifiCorp, Cowlitz County PUD, FERC, WDFW, NOAA Fisheries, USFWS	3	High: Lower mainstem Lewis River	High: Adequate flows for life stage requirements and habitat-forming processes	High
L-Lew 2. Expand standards in local government comprehensive plans to afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Clark County, Cowlitz County, City of Woodland	1 & 2	High: Applies to all private lands under county jurisdiction (residential, agricultural, and forest lands)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
L-Lew 3. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of agriculture and timber lands to developed uses through zoning regulations and tax incentives (consistent with urban growth boundaries)	Expansion of existing program or activity	Clark County, Cowlitz County, Woodland	1 & 2	High: Applies to all private lands under county jurisdiction (residential, agricultural, and forest lands)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
L-Lew 4. Conduct floodplain restoration where feasible along the mainstem and in major tributaries that have experienced channel confinement. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, C/WCD, CCD, NGOs, WDFW, LCFRB, USACE, LCFEG	4, 5, 8, 9 & 11	High: Lower mainstem Lewis and lower portion of major tributaries	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
L-Lew 5. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Clark County, Cowlitz County, Woodland, WDOE	1	Medium: Applies to privately owned floodprone lands under county jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
L-Lew 6. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
L-Lew 7. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed management	Expansion of existing program or activity	Cowlitz County, Clark County, Woodland	1, 7, 8, & 9	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
L-Lew 8. Increase technical assistance to landowners and increase landowner	Expansion of existing	NRCS, C/WCD, CCD, WDNR,	1, 2, 4, 5, 6, 7, 8, 9, 10 & 11	High: Private lands. Applies to lands in	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium

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

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	program or activity	WDFW, LCFEG, Cowlitz County, Clark County, Woodland		agriculture, rural residential, and forestland uses throughout the basin		
L-Lew 9. Create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, C/WCD, CCD	6	Medium: Lower mainstem Lewis	High: Increased habitat availability for spawning and rearing	Medium
L-Lew 10. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 5, 7, 8 & 9	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
L-Lew 11. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, City of Woodland	7	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
L-Lew 12. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Cowlitz CD, Clark CD, LCFEG	4, 5, 6, 7, 8, 9 & 11	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
L-Lew 13. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 5 & 7	Low: Small private timberland owners	High: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
L-Lew 14. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Cowlitz CD, Clark CD, LCFEG	1 & 8	High: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
L-Lew 15. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Clark County, Cowlitz County WSDOT, City of Woodland, LCFEG	5	Medium: As many as 16 miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
L-Lew 16. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 5, 7, 8 & 9	Medium: State timber lands in the Lower NF Lewis Basin (approximately 16% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L-Lew 17. Address water quality issues through the development and implementation of water quality clean up plans (TMDLs)	**Expansion of existing program or activity**	**WDOE**	**9**	**Medium: streams with temperature concerns and streams on 303(d) list**	**Medium: Protection and restoration of water quality**	**Low**
L-Lew 18. Limit intensive recreational use of the mainstem Lewis during critical periods	**Expansion of existing program or activity**	**Clark County, Cowlitz County, WDFW**	**12**	**Low: Key reaches in the mainstem Lewis**	**Medium: Increased survival of salmonids**	**Low**

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the Lower North Fork River Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery measures in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. The recovery strategy includes a mixture of conservation programs and mitigation programs for lost fishing benefits. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the Lower NF Lewis Basin are displayed by species in Table 18. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 18. Summary of natural production and fishery enhancement strategies to be implemented in the lower North Fork Lewis River Basin.

		Species					
		Fall Chinook	**Spring Chinoo**	**Coho**	**Chu m**	**Winter Steelhea**	**Summer Steelhead**
Natural Production Enhancement	**Supplementation**				✓		
	Hatch/Nat Conservation 1/						
	Isolation						
	Refuge	✓					
Fishery Enhancement	**Hatchery Production**		✓	✓		✓	✓

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

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

Natural Refuge Watersheds: In this strategy, certain sub-basins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These refugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural population on fitness and our ability to measure natural population productivity and will be key indicators of natural population status within the ESU. The lower North Fork Lewis River Basin would be a refuge area for natural fall Chinook

Hatchery Supplementation: This strategy utilizes hatchery production as a tool to assist in rebuilding depressed natural populations. Supplementation would occur in selected areas that are producing natural fish at levels significantly below current capacity or capacity is expected to increase as a result of immediate benefits of habitat or passage improvements. This is intended to be a temporary measure to jump start critically low populations and to bolster natural fish numbers above critical levels in selected areas until habitat is restored to levels where a population can be self sustaining. This strategy would include chum in the North Fork Lewis Basin.

Hatchery/Natural Isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of spring and fall chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This strategy would not be included in near-term measures for the lower North Fork Lewis Basin but could be considered in the future for coho and steelhead in Cedar Creek and winter steelhead in the upper Lewis basin. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations.

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

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

The Lewis Hatchery Complex will be operated to include natural production enhancement strategies for Lewis River chum as well as support natural spring Chinook, coho, and winter steelhead reintroduction in the Upper North Fork Lewis. The Lewis River Hatchery Complex will continue to support spring Chinook, coho, and steelhead fisheries with hatchery releases in the Lewis River Subbasin. Fall chinook will not be included as a hatchery harvest program in the Lewis River Subbasin. This plan adds seven new conservation programs at the Lewis River Hatchery Complex (Table 19).

Table 19. A summary of conservation and harvest strategies to be implemented through Lewis River Hatchery Complex programs.

		Stock
Natural Production Enhancement	Supplementation	U. Lewis Spring Chinook √
		L. Lewis Chum √
		E Fk. Lewis Chum √
		U. Lewis Winter Steelhead √
		U. Lewis Coho √
	Hatch/Nat Conservation 1/	U. Lewis Spring Chinook √
	Isolation	U. Lewis Winter Steelhead
	Broodstock development	Lewis River chum√
Fishery Enhancement	In-basin releases (final rearing site)	Lewis Early Coho
		Lewis Late Coho
		Lewis Spring Chinook
		Merwin Summer Steelhead
		Merwin Winter Steelhead
		Skamania Summer Steelhead
	Out of Basin Releases (final rearing site)	

1/ May include integrated and/or isolated strategy over time.
√ Denotes new program

5.5.2 *Hatchery Measures and Actions*

Hatchery strategies and measures are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within Lewis River Subbasin facilities have been evaluated in detail through the WDFW Benefit-Risk Assessment Procedure (BRAP) relative to risks to natural populations. The BRAP results were utilized to inform the development of these program actions specific to the Lewis River Subbasin (Table 20). The Sub-Basin plan hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NOAA fisheries approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the Lewis River Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 20. Hatchery program actions to be implemented in the Lewis River Subbasin.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Continue 100 percent mark of hatchery produced steelhead, coho, and spring Chinook released into the lower Lewis River.	*Adipose fin-clip mark hatchery produced coho, spring Chinook and steelhead	Lewis River and Speelyai Hatchery spring chinook and coho. Merwin Hatchery winter and summer steelhead, and Elochoman Hatchery summer steelhead released into the lower Lewis.	Lewis River coho, steelhead, and spring Chinook	Domestication, Diversity, Abundance	In-breeding Harvest	Maintain selective fishery opportunity for hatchery produced spring Chinook, coho and steelhead. Natural produced spring Chinook, coho, and steelhead harvest impacts are indirect and incidental only. Enable visual identification of hatchery and wild returns to provide the means to account for and manage the natural and wild escapement consistent with biological objectives
• Develop a chum brood stock utilizing natural returns to the lower Lewis and East Fork Lewis. Utilize brood stock for supplementation and risk management.	**Lewis River Hatchery complex facilities utilized for supplementation and enhancement of natural chum populations in the lower Lewis and East Fork Lewis.	Hatchery space for chum incubation and rearing.	Lower Lewis and East Fork Lewis chum.	Abundance, Spatial distribution	Low numbers of natural spawners Ecologically appropriate natural brood stock	Development of a late-timed hatchery brood stock would increase diversity similar to the historical populations in the Lewis Basin. Improve abundance and distribution of natural produced coho. Establish an appropriate chum brood stock to supplement and manage risks to extreme low abundance of local populations. Increase abundance and distribution of lower Lewis and EF Lewis chum populations.
• Hatchery produced steelhead, coho, and spring Chinook will be scheduled for release during the time when the maximum numbers of fish are smolted and prepared to emigrate rapidly. • Juvenile rearing strategies will be implemented to provide a fish growth schedule which coincides with an optimum release time for hatchery	*Juvenile release strategies to minimize impacts to natural populations	Lewis Salmon Hatchery spring Chinook and coho. Merwin Trout Hatchery steelhead. Fish First Spring Chinook net pen program.	Lower Lewis fall Chinook, chum, and coho	Predation, Competition	Hatchery smolt residence time in the lower Lewis River.	Minimal residence time of hatchery released juvenile resulting in reduced ecological interactions between hatchery and wild juveniles. Displacement of natural fall Chinook from preferred habitat by larger hatchery smolts will be minimized. Predation of wild zero age chum, coho, and fall Chinook from coho, steelhead, and spring Chinook hatchery

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
production success and to minimize time spent in the Lewis River.						smolts is minimized. Improved survival of wild juvenile Chinook, coho, and chum, resulting in increased productivity and abundance
• Hatchery effluent discharge complies with NPDES permit monitoring requirements. Fish health monitored and treated as per co-managers fish health policy. • Assure stress-relief ponds for upper Lewis reintroduced fish meet water Quality standards.	*Evaluate new License facility operations	All species	Lewis River fall Chinook	Habitat quality,	• water quality,	Hatchery fish disease controlled and water quality standards upheld to avoid impact to habitat quality in the Lewis River downstream of the hatcheries.
• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes • Performance standards developed for each actions with measurable criteria to determine success or failure • Adaptive Management applied to adjust or change actions as necessary	** Monitoring and evaluation, adaptive management	All species	All species	Hatchery production performance, Natural production performance	• All of above	Clear standards for performance and adequate monitoring programs to evaluate actions. Adaptive management strategy reacts to information and provides clear path for adjustment or change to meet performance standard

** Extension or improvement of existing actions-may require additional funding*
*** New action-will likely require additional funding*

5.6 Harvest

Fisheries are both an impact that reduces fish numbers and an objective of recovery. The long-term vision is to restore healthy, harvestable natural salmonid populations in many areas of the lower Columbia basin. The near-term strategy involves reducing fishery impacts on natural populations to ameliorate extinction risks until a combination of actions can restore natural population productivity to levels where increased fishing may resume. The regional strategy for interim reductions in fishery impacts involves: 1) elimination of directed fisheries on natural populations, 2) regulation of mixed stock fisheries for healthy hatchery and natural populations to limit and minimize indirect impacts on natural populations, 3) scaling of allowable indirect impacts for consistency with recovery, 4) annual abundance-based management to provide added protection in years of low abundance, while allowing greater fishing opportunity consistent with recovery in years with much higher abundance, and 5) mass marking of hatchery fish for identification and selective fisheries.

Actions to address harvest impacts are generally focused at a regional level to cover fishery impacts accrued to lower Columbia salmon as they migrate along the Pacific Coast and through the mainstem Columbia River. Fisheries are no longer directed at weak natural populations but incidentally catch these fish while targeting healthy wild and hatchery stocks. Subbasin fisheries affecting natural populations have been largely eliminated. Fishery management has shifted from a focus on maximum sustainable harvest of the strong stocks to ensuring protection of the weak stocks. Weak stock protections often preclude access to large numbers of otherwise harvestable fish in strong stocks.

Fishery impact limits to protect ESA-listed weak populations are generally based on risk assessments that identify points where fisheries do not pose jeopardy to the continued persistence of a listed group of fish. In many cases, these assessments identify the point where additional fishery reductions provide little reduction in extinction risks. A population may continue to be at significant risk of extinction but those risks are no longer substantially affected by the specified fishing levels. Often, no level of fishery reduction will be adequate to meet naturally-spawning population escapement goals related to population viability. The elimination of harvest will not in itself lead to the recovery of a population. However, prudent and careful management of harvest can help close the gap in a coordinated effort to achieve recovery.

Fishery actions specific to the subbasins are addressed through the Washington State Fish and Wildlife sport fishing regulatory process. This public process includes an annual review focused on emergency type regulatory changes and a comprehensive review of sport fishing regulations which occurs every two years. This regulatory process includes development of fishing rules through the Washington Administrative Code (WAC) which are focused on protecting weak stock populations while providing appropriate access to harvestable populations. The actions consider the specific circumstances in each area of each subbasin and respond with rules that fit the relative risk to the weak populations in a given time and area of the subbasin.

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in the the Regional Recovery and Subbasin Plan Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. Harvest actions with significant application to the Lower North Fork Lewis Subbasin populations are summarized in Table 21 and Table 22:

Table 21. Summary of regulatory and protective fishery actions in the lower North Fork Lewis basin

Species	General Fishing Actions	Explanation	Other Protective Fishing Actions	Explanation
Fall Chinook	Open for fall Chinook	Wild fish are healthy and harvestable in most years. Fishery managed to achieve wild escapement goal	Night closures, gear restrictions, and closure in primary spawning area in the fall	Protects fall Chinook in areas of high concentration and while spawning
Spring Chinook	Retain only adipose fin-clipped Chinook	Selective fishery for hatchery Chinook, unmarked wild spring Chinook must be released	Minimum size restrictions and closure near Merwin Dam	Closure protects spring Chinook in areas of high concentration and minimum size protects juveniles
chum	Closed to retention	Protects natural chum. Hatchery chum are not produced for harvest		
coho	Retain only adipose fin-clip marked coho	Selective fishery for hatchery coho, unmarked wild coho must be released	Small Lower Lewis tributaries and Cedar Creek closed to salmon fishing	Protects wild spawners in tributary creeks. Hatchery coho are released in the lower mainstem Lewis
Winter steelhead	Retain only adipose fin-clip marked steelhead	Selective fishery for hatchery steelhead, unmarked wild steelhead must be released	Fishing closures in the spring in Cedar Creek and minimum size restrictions in affect in Lewis and Cedar Creek	Spring closure Protects adult wild steelhead during spawning and minimum size protects juvenile steelhead
Summer Steelhead	Retain only adipose fin-clip marked steelhead	Selective fishery for hatchery steelhead, unmarked wild steelhead released	Spring closures, minimum size restrictions,	Closures and size restrictions protect spawning adults and juveniles

Table 22. Regional harvest actions from Volume I, Chapter 7 with significant application to the North Lewis Subbasin populations.

Action	Description	Responsible Parties	Programs	Comments
**F.A12	Monitor chum handle rate in winter steelhead and late coho tributary sport fisheries.	WDFW	Columbia Compact	State agencies would include chum incidental handle assessments as part of their annual tributary sport fishery sampling plan.
*F.A13	Monitor and evaluate commercial and sport impacts to naturally-spawning steelhead in salmon and hatchery steelhead target fisheries.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Includes monitoring of naturally-spawning steelhead encounter rates in fisheries and refinement of long-term catch and release handling mortality estimates. Would include assessment of the current monitoring programs and determine their adequacy in formulating naturally-spawning steelhead incidental mortality estimates.
*F.A14	Continue to improve gear and regulations to minimize incidental impacts to naturally-spawning steelhead.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Regulatory agencies should continue to refine gear, handle and release methods, and seasonal options to minimize mortality of naturally-spawning steelhead in commercial and sport fisheries.
*F.A20	Maintain selective sport fisheries in ocean, Columbia River, and tributaries and monitor naturally-spawning stock impacts.	WDFW, NOAA, ODFW, USFWS	PFMC, Columbia Compact, BPA Fish and Wildlife Program, WDFW Creel	Mass marking of lower Columbia River spring Chinook, coho and steelhead has enabled successful ocean and freshwater selective fisheries to be implemented since 1998. Marking programs should be continued and fisheries monitored to provide improved estimates of naturally-spawning salmon and steelhead release mortality.
*F.A6	Manage ocean, Columbia River and tributary fisheries to meet the spawning escapement goal for lower Columbia bright fall Chinook.	WDFW, NOAA, ODFW, ADFG, Can DFD	PFMC, PSC, *U.S. v Oregon* (TAC)	Ocean and freshwater fisheries wuld continue to be managed to achieve the Lewis River wild fall Chinook escapement goal. The escapement goal would be assessed by WDFW and NOAA fisheries to assure consistency with biological objectives.
**F.A27	Develop a harvest plan for wild spring Chinook as populations are reestablished.	WDFW, ODFW	Washington Fish and Wildlife Commission, Columbia Compact (TAC)	Adaptively manage harvest to respond to biological objectives for reintroduced Lewis River spring Chinook as they become reestablished in the upper watershed.

* Extension or improvement of existing action
** New action

5.7 Hydropower

The three hydro-electric dams on the Lewis River are considered to be located in the upper Lewis basin. However, lower North Fork Lewis species, in particular fall Chinook, are affected by flow regimes from Lewis River hydro operations which effect spawning and rearing habitat in the lower Lewis. The quantity and quality of fall Chinook habitat in the lower Lewis can be addressed by; maintaining a flow regime, including minimum flow requirements, that enhance the spawning and rearing habitats for natural salmonid populations downstream of the North Lewis hydrosystem. In addition, mainstem Columbia hydro operations and flow regimes affect habitat utilized by lower Lewis species in migration corridors and in the estuary. Key regional strategies applying to the lower North Fork Lewis populations are displayed in the following table.

Table 23. Regional hydropower measure from Volume I, Chapter 7 with significant application to North Lewis Subbasin populations

Measure	Description	Comments
D.M4	Operate the tributary hydrosystems to provide appropriate flows for salmon spawning and rearing habitat in the areas downstream of the hydrosystem.	The quantity and quality of spawning and rearing habitat for salmon, in particular fall Chinook in the North Fork Lewis a, is affected by the water flow discharged at Merwin Dam. The operational plans for the Lewis hydrosystem, in conjunction with fish management plans, should include flow regimes, including minimum flow and ramping rate requirements, which enhance the lower river habitat for fall Chinook.

5.8 Mainstem and Estuary Habitat

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

5.9 Ecological Interactions

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

5.10 Monitoring, Research, & Evaluation

Biological status monitoring quantifies progress toward ESU recovery objectives and also establishes a baseline for evaluating causal relationships between limiting factors and a population response. Status monitoring involves routine and intensive efforts. Routine monitoring of biological data consists of adult spawning escapement estimates, whereas routine monitoring for habitat data consists of a suite of water quality and quantity measurements.

Intensive monitoring supplements routine monitoring for populations and basins requiring additional information. Intensive monitoring for biological data consists of life-cycle population assessments, juvenile and adult abundance estimates and adult run-reconstruction. Intensive monitoring for habitat data includes stream/riparian surveys, and continuous stream flow assessment. The need for additional water quality sampling may be identified. Rather than prescribing one monitoring strategy, three scenarios are proposed ranging in level of effort and cost from high to low (Level 1-3 respectively). Given the fact that routine monitoring is ongoing, only intensive monitoring varies between each level.

An in-depth discussion of the monitoring, research and evaluation (M, R & E) approach for the Lower Columbia Region is presented in the Regional Recovery and Management Plan. It includes site selection rationale, cost considerations and potential funding sources. The following tables summarize the biological and habitat monitoring efforts specific to the lower North Fork Lewis River.

Table 24. Summary of the biological monitoring plan for lower North Fork Lewis River populations.

Lower NF Lewis: Lower Columbia Biological Monitoring Plan						
Monitoring Type	**Fall Chinook**	**Chum**	**Coho**	**Winter Steelhead**	**Summer Steelhead**	**Spring Chinook**
Routine	AA	AA	AA	AA	AA	AA
Intensive						
Level 1	×1/		×2/	×2/		
Level 2	×1/		×2/	×2/		
Level 3	×1/		×2/	×2/		

1/ Mainstem lower NF Lewis
2/ Cedar Creek
AA Annual adult abundance estimates
✓ Adult and juvenile intensive biological monitoring occurs periodically on a rotation schedule (every 9 years for 3-year duration)
× Adult and juvenile intensive biological monitoring occurs annually

Table 25. Summary of the habitat monitoring plan for lower North Fork Lewis River populations.

Lower NF Lewis: Lower Columbia Habitat Monitoring Plan				
Monitoring Type	**Watershed**	**Existing stream / riparian habitat**	**Water quantity[3] (level of coverage)**	**Water quality [2] (level of coverage)**
Routine [1] (level of coverage)	Baseline complete	Poor	Stream Gage-Good IFA-Moderate	WDOE-Poor USGS-Good Temperature-Poor
Intensive				
Level 1		✓		
Level 2				
Level 3				

IFAComprehensive Instream Flow Assessment (i.e. Instream Flow Incremental Methodology)
[1] Routine surveys for habitat data do not imply ongoing monitoring
[2] Intensive monitoring for water quality to be determined
[3] Water quantity monitoring may include stream gauge installation, IFA or low flow surveys

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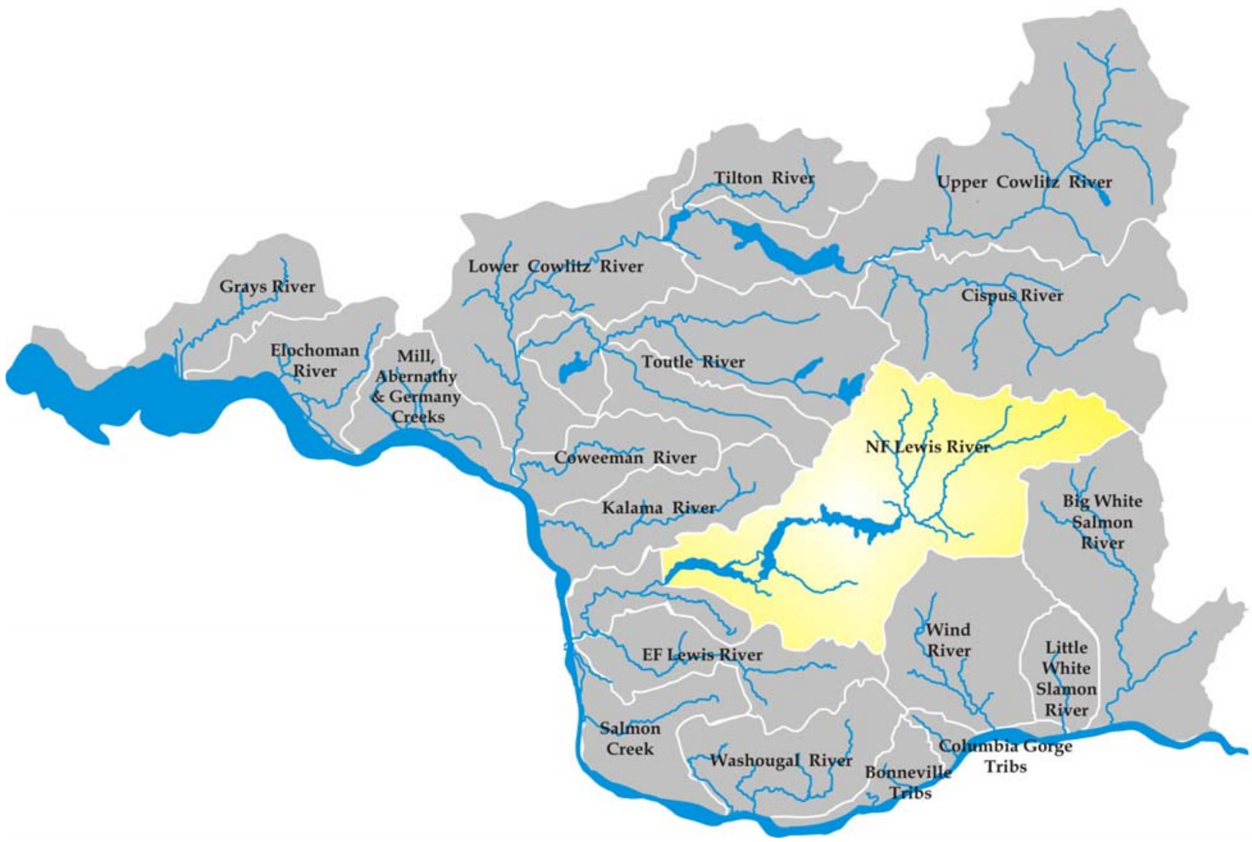
Lewis Subbasin –
Upper North Fork Lewis River



Contents

1.0 Upper North Fork Lewis River – Executive Summary

This plan describes a vision, strategy, and actions for recovery of listed salmon, steelhead, and trout species to healthy and harvestable levels, and mitigation of the effects of the Columbia River hydropower system in Washington Lower Columbia River subbasins. Recovery of listed species and hydropower mitigation is accomplished at a regional scale. This plan for the upper North Fork Lewis River Basin describes implementation of the regional approach within this Basin, as well as assessments of local fish populations, limiting factors, and ongoing activities that underlie local recovery or mitigation actions. The plan was developed in a partnership between the Lower Columbia Fish Recovery Board (Board), Northwest Power and Conservation Council, federal agencies, state agencies, tribal nations, local governments, and others.

The Lewis River is one of eleven major subbasins in the Washington portion of the Lower Columbia Region. The Upper North Fork Lewis comprises the portion of the basin upstream of Merwin Dam at river mile 19.5. The Upper Lewis historically supported thousands of spring Chinook, coho, bull trout and winter steelhead. Today, naturally spawning salmon and steelhead do not have access to the upper Lewis basin as a result of construction of the Lewis River hydrosystem. Chinook and steelhead have been listed as Threatened under the Endangered Species Act and coho is proposed for listing. The lack of passage is the primary reason for decline of upper Lewis salmon and steelhead; however, other reasons limit the potential for recovery once passage is restored as part of current hydropower facility re-licensing agreements. Freshwater habitat quality has been reduced by forestry practices and from the 1980 Mount St. Helens eruption. Key habitats have been inundated by the mainstem reservoirs. Altered habitat conditions have increased the potential for predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has the potential to reduce productivity. Mainstem Columbia hydropower construction and operation has altered flows, habitat, and migration conditions. Degraded conditions in the estuary reduce out-of-basin productivity. Fish are harvested in fresh and saltwater fisheries.

Upper North Fork Lewis River salmon and steelhead will need to be restored to high or medium levels of viability to meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the basin. These enhancements will rely heavily on the effective restoration of access to the upper basin, which is currently being negotiated as part of hydropower re-licensing for the mainstem Lewis hydrosystem.

In recent years, agencies, local governments, and other entities have actively addressed the various threats to salmon and steelhead, but much remains to be done. Although passage is currently the primary limiting factor, once passage is reestablished, all threats and limiting factors will have to be addressed for recovery to be successful. An effective recovery plan must also reflect a realistic balance within physical, technical, social, cultural and economic constraints. The decisions that govern how this balance is attained will shape the region’s future in terms of watershed health, economic vitality, and quality of life.

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact or will potentially impact Upper Lewis River fish populations. Specific strategies, measures, actions and priorities have been developed to address these threats and limiting factors. The specified strategies identify the best long term and short term avenues for achieving fish restoration and mitigation goals. While it is understood that data, models, and theories have their limitations and growing knowledge will certainly spawn new strategies, the Board is confident that by implementation of the recommended actions in this plan, the population goals in the Upper Lewis River Basin can be achieved. Success will depend on implementation of these strategies at the program and project level. It remains uncertain what level of effort will need to be invested in each area of impact to ensure the desired result. The answer to the question of precisely how much is enough is currently beyond our understanding of the species and ecosystems and can only be answered through ongoing monitoring and adaptive management against the backdrop of what is socially possible.

1.1 Key Priorities

Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the Upper Lewis Basin. The following list identifies the most immediate priorities.

1. Provide Upstream and Downstream Passage Through the Lewis River Hydrosystem

The system of dams on the mainstem Lewis River, beginning with Merwin Dam at River Mile 19.5, block all volitional access to the upper basin, consisting of up to approximately 170 miles of potential habitat for anadromous species. The dams also prevent or limit upstream and downstream passage of bull trout, essentially isolating populations in the individual reservoirs. Various passage scenarios are currently being negotiated as part of the hydropower facility re-licensing process. License approval by the Federal Energy Regulatory Commission (FERC) is currently targeted for 2006. Recovery of Upper Lewis salmon and steelhead hinges on the successful re-introduction of fish to the upper basin. It is critical that the new license require a system for providing passage that will allow for the restoration of self-sustaining natural production of ESA-listed salmonids in the Upper North Fork Lewis Basin.

2. Protect Intact Forests in Headwater Basins

The headwaters of the mainstem Lewis watershed originate from federal lands in the Mount Adams Wilderness and the Dark Divide Roadless Area. These headwater basins contain relatively pristine forests that support functioning watershed process conditions. Streams are unaltered, road densities are low, and riparian areas and uplands are characterized by mature forests. Existing legal designations and management policy are expected to continue to offer protection to these lands.

3. Manage Forest Lands to Protect and Restore Watershed Processes

Much of the reservoir tributaries basins and portions of the upper mainstem basin upstream of Swift Reservoir are managed for commercial timber production and have experienced intensive past forest practices activities. Proper forest management in these areas will be critical for fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing sediment, and degrading riparian zones. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Habitat Conservation Plan (State-owned lands), Forest Practices Rules (private lands), and the Northwest Forest Plan (federal lands) are expected to substantially improve conditions by restoring passage, protecting riparian conditions, reducing sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead, spring Chinook, and coho.

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

The human population in the basin is small, with only small rural communities. The upper North Fork Lewis Basin is mostly designated as national forest or national monument and state land. Approximately 19% of the basin is private industrial forest land. Recently, recreational and residential uses have been increasing in the basin. The local economy is also in transition with reduced reliance on forest products. Population growth will primarily occur in lower river valleys and along the major stream corridors. This growth will result in the conversion of forest land to residential uses, with potential impacts to habitat conditions. Land-use changes will provide a variety of risks to terrestrial and aquatic habitats. Careful land-use planning will be necessary to protect and restore natural fish populations and habitats and will also present opportunities to preserve the rural character and local economic base of the basin.

5. Align Hatchery Priorities with Conservation Objectives

Hatcheries throughout the Columbia basin historically focused on producing fish for fisheries as mitigation for hydropower development and widespread habitat degradation. Emphasis of hatchery production without regard for natural populations can pose risks to natural population viability. Hatchery priorities must conserve natural populations, enhance natural fish recovery, and avoid impeding progress toward recovery, while continuing to provide some fishing benefits. The Lewis River hatchery program will produce and/or acclimate spring Chinook, coho, and winter steelhead for use in the Upper Lewis River Basin. Spring Chinook and coho will be used to supplement natural production in appropriate areas of the basin and adjacent tributary streams, develop a local broodstock to reestablish historical diversity and life history characteristics, and also to provide fish enhancement in a manner that does not pose significant risk to natural population rebuilding efforts. The hatchery will also acclimate and releases a temporally-segregated hatchery winter steelhead run for reintroduction into the upper Lewis River Basin.

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

This near-term strategy involves limiting fishery impacts on natural populations to ameliorate extinction risks until a combination of measures can restore fishable natural populations. There is no directed Columbia River or tributary harvest of ESA-listed North Fork Lewis River salmon or steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some Lewis River salmon and steelhead are incidentally taken in mainstem Columbia River and ocean mixed stock fisheries for strong wild and hatchery runs of coho. These fisheries will be managed with strict limits to ensure this incidental take does not threaten the recovery of wild populations from the North Fork Lewis. Steelhead will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Selective fisheries for marked hatchery steelhead and coho will be a critical tool for limiting wild fish impacts. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

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

Upper North Fork Lewis River salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the subbasin. Human impacts include drastic habitat changes in the Columbia River estuary, effects of Columbia Basin hydropower operation on mainstem, estuary, and nearshore ocean conditions, interactions with introduced animal and plant species, and altered natural predation patterns by northern pikeminnow, birds, seals, and sea lions. A variety of restoration and management actions are needed to reduce these out-of-basin effects so that the benefits in-subbasin actions can be realized. To ensure equivalent sharing of the recovery and mitigation burden, impacts in each area of effect (habitat, hydropower, etc.) should be reduced in proportion to their significance to species of interest.

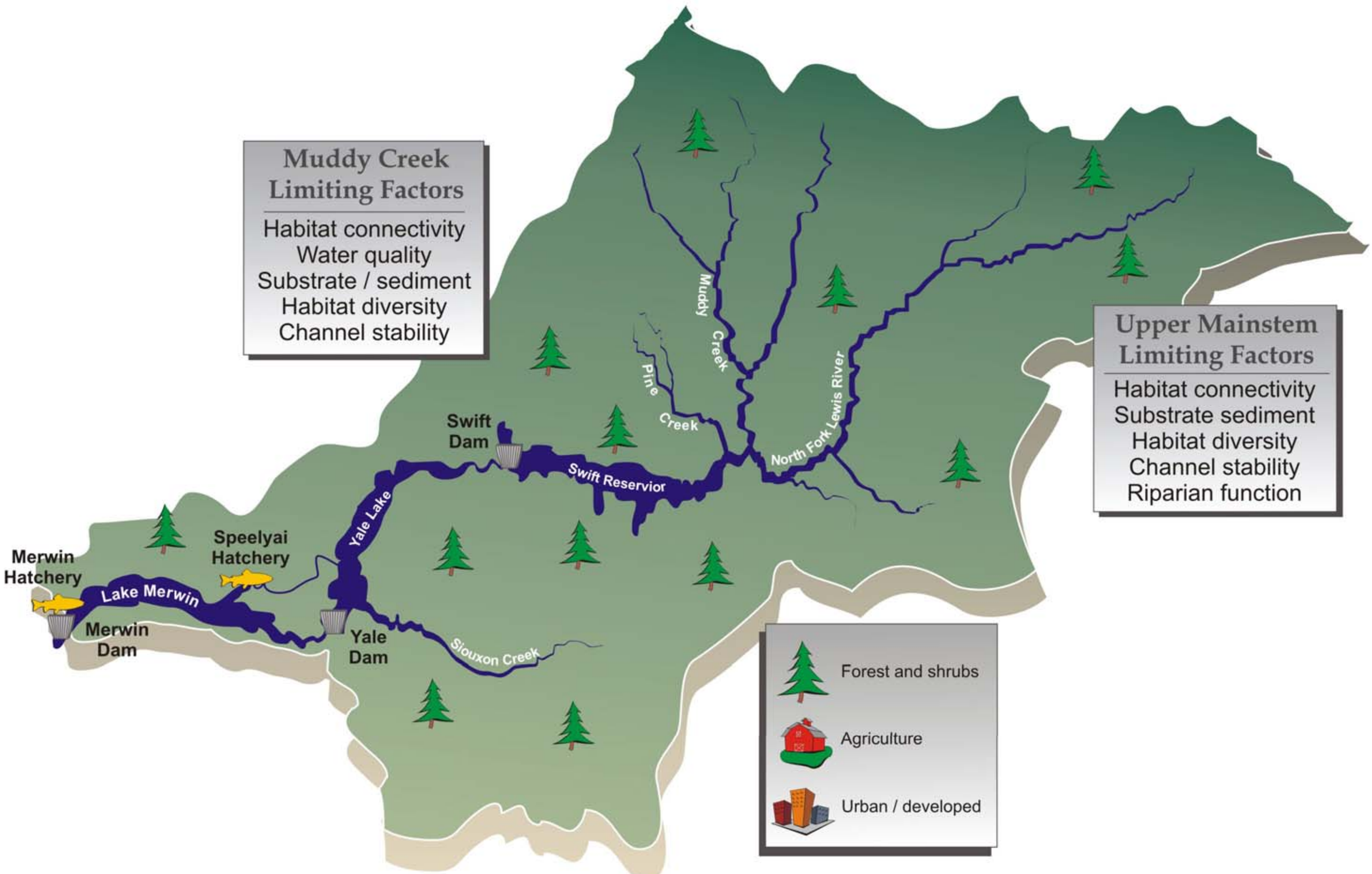


Figure 1. Key features of the Upper North Fork Lewis River subbsin including a summary of limiting fish habitat factors in different areas and the status and relative distribution of focal salmonid species.

2.0 Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's upper North Fork Lewis River Subbasin. The plan addresses subbasin elements of a regional recovery plan for Chinook salmon, chum salmon, coho salmon, steelhead, and bull trout listed or under consideration for listing as Threatened under the federal Endangered Species Act (ESA). The plan also serves as the subbasin plan for the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program to address effects of construction and operation of the Federal Columbia River Power System.

Development of this plan was led and coordinated by the Washington Lower Columbia River Fish Recovery Board (LCFRB). The Board was established by state statue (RCW 77.85.200) in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. It is comprised of representatives from the state legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro project operators, the environmental community, and concerned citizens. A variety of partners representing federal agencies, Tribal Governments, Washington state agencies, regional organizations, and local governments participated in the process through involvement on the LCFRB, a Recovery Planning Steering Committee, planning working groups, public outreach, and other coordinated efforts.

The planning process integrated four interrelated initiatives to produce a single Recovery/Subbasin Plan for Washington subbasins of the lower Columbia:

- Endangered Species Act recovery planning for listed salmon and trout.
- Northwest Power and Conservation Council (NPCC) fish and wildlife subbasin planning for eight full and three partial subbasins.
- Watershed planning pursuant to the Washington Watershed Management Act, RCW 90-82.
- Habitat protection and restoration pursuant to the Washington Salmon Recovery Act, RCW 77.85.

This integrated approach ensures consistency and compatibility of goals, objectives, strategies, priorities and actions; eliminates redundancy in the collection and analysis of data; and establishes the framework for a partnership of federal, state, tribal and local governments under which agencies can effectively and efficiently coordinate planning and implement efforts.

The plan includes an assessment of limiting factors and threats to key fish species, an inventory of related projects and programs, and a management plan to guide actions to address specific factors and threats. The assessment includes a description of the subbasin, focal fish species, current conditions, and evaluations of factors affecting focal fish species inside and outside the subbasin. This assessment forms the scientific and technical foundation for developing a subbasin vision, objectives, strategies, and measures. The inventory summarizes current and planned fish and habitat protection, restoration, and artificial production activities and programs. This inventory illustrates current management direction and existing tools for plan implementation. The management plan details biological objectives, strategies, measures, actions, and expected effects consistent with the planning process goals and the corresponding subbasin vision.

3.0 Assessment

3.1 Subbasin Description

3.1.1 *Topography & Geology*

For the purposes of this assessment, the Upper North Fork Lewis is defined as the watershed area contributing to Merwin Dam, which is located at river mile 19.5 on the mainstem Lewis. The Lewis River has its headwaters in Skamania County and flows generally west/southwest, forming the border of Clark and Cowlitz Counties before reaching Merwin Dam. The drainage area is approximately 468,000 acres (731 mi^2) and reaches as high as 12, 270 feet on the summit of Mt. Adams.

Three reservoirs are situated on the mainstem. These are Swift Reservoir (Swift Dam Number 1, RM 47.9), Yale Lake (Yale Dam, RM 34.2), and Lake Merwin (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 Upper Lewis include Canyon Creek, Speelyai Creek (Lake Merwin tributaries), Siouxon Creek, Cougar Creek (Yale Lake tributaries), Swift Creek (Swift Reservoir tributary), Pine Creek, Muddy Creek, and Rush Creek (upper mainstem tributaries).

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, has given rise to the current landscape. Glaciation has shaped the valleys in upper portions of the basin as recently as 13,000 years ago. 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.

3.1.2 *Climate*

The climate is typified by mild, wet winters and warm, dry summers. Average annual precipitation ranges from 73 inches at Merwin Dam to over 115 inches in the upper basin (WRCC 2003). Much of the precipitation falls as snow in the higher elevations, contributing to streamflow from meltwater in dry summer months.

3.1.3 *Land Use, Ownership, and Cover*

The bulk of the land lies within the Gifford Pinchot National Forest. Approximately 70% of the basin is national forest or national monument land, 11% is state land, and the remainder is private, most of it in private industrial forestland ownership. The State of Washington owns, and the Washington State Department of Natural Resources (DNR) manages the beds of all navigable waters within the subbasin. Any proposed use of those lands must be approved in advance by the DNR. Recreation uses and residential development have increased in recent years. The population of the basin is small, with only small rural communities. The year 2000 population was approximately 14,300 persons (LCFRB 2001). The majority of the basin is heavily forested, except for an area of approximately 30 square miles in the north part of the upper basin that was denuded by the 1980 eruption of Mount St. Helens. 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/use in the North Fork basin is given in Figure 2 and Figure 3.

3.1.4 *Development Trends*

There is very little development in the basin as most of the basin lies within the Gifford Pinchot National Forest. Only the areas surrounding the small communities of Yale, Woodland Park, and Cougar have any residential development or agriculture. The impact from these activities on aquatic and terrestrial habitats is relatively insignificant.

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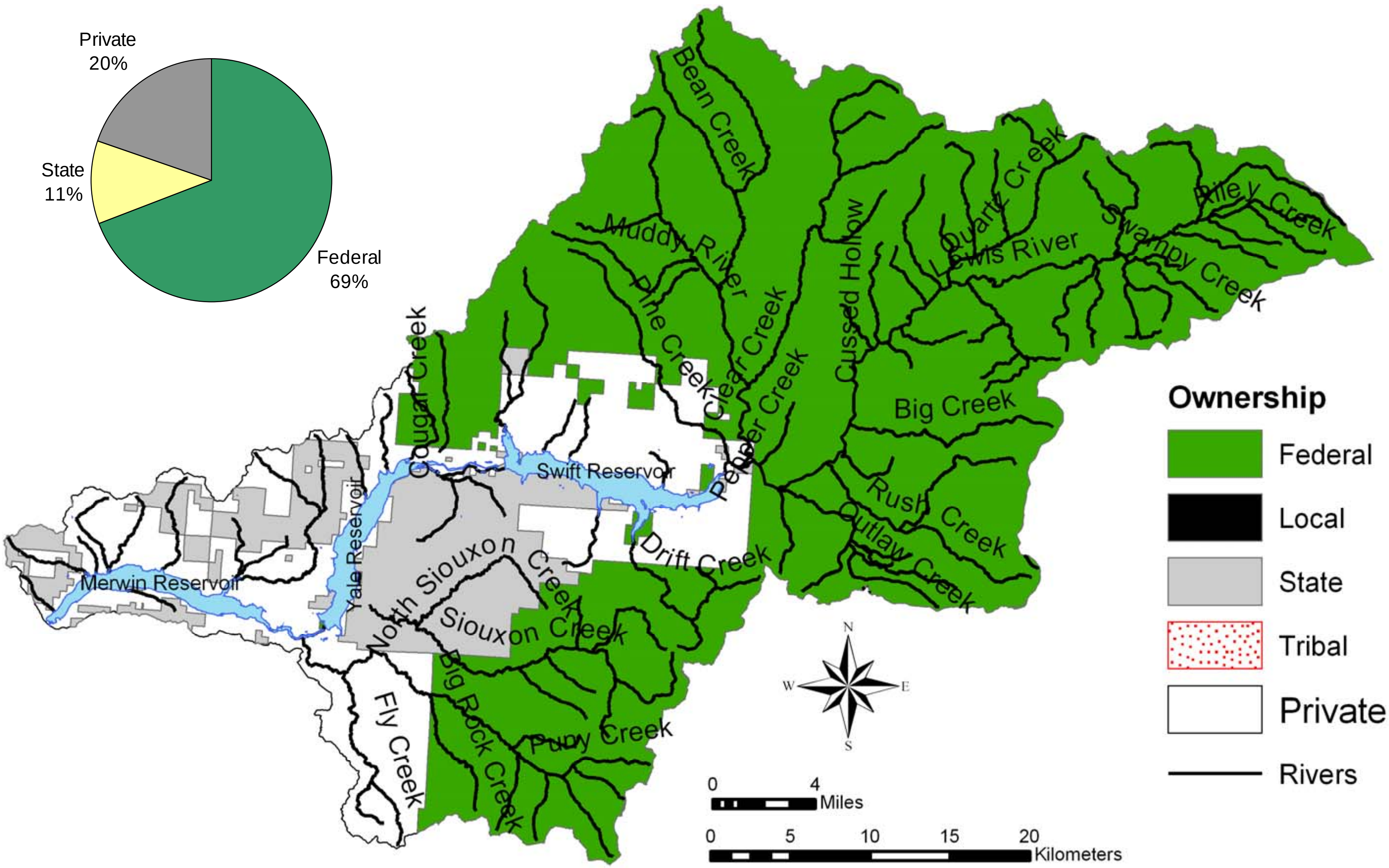


Figure 2. Landownership within the upper North Fork Lewis River basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

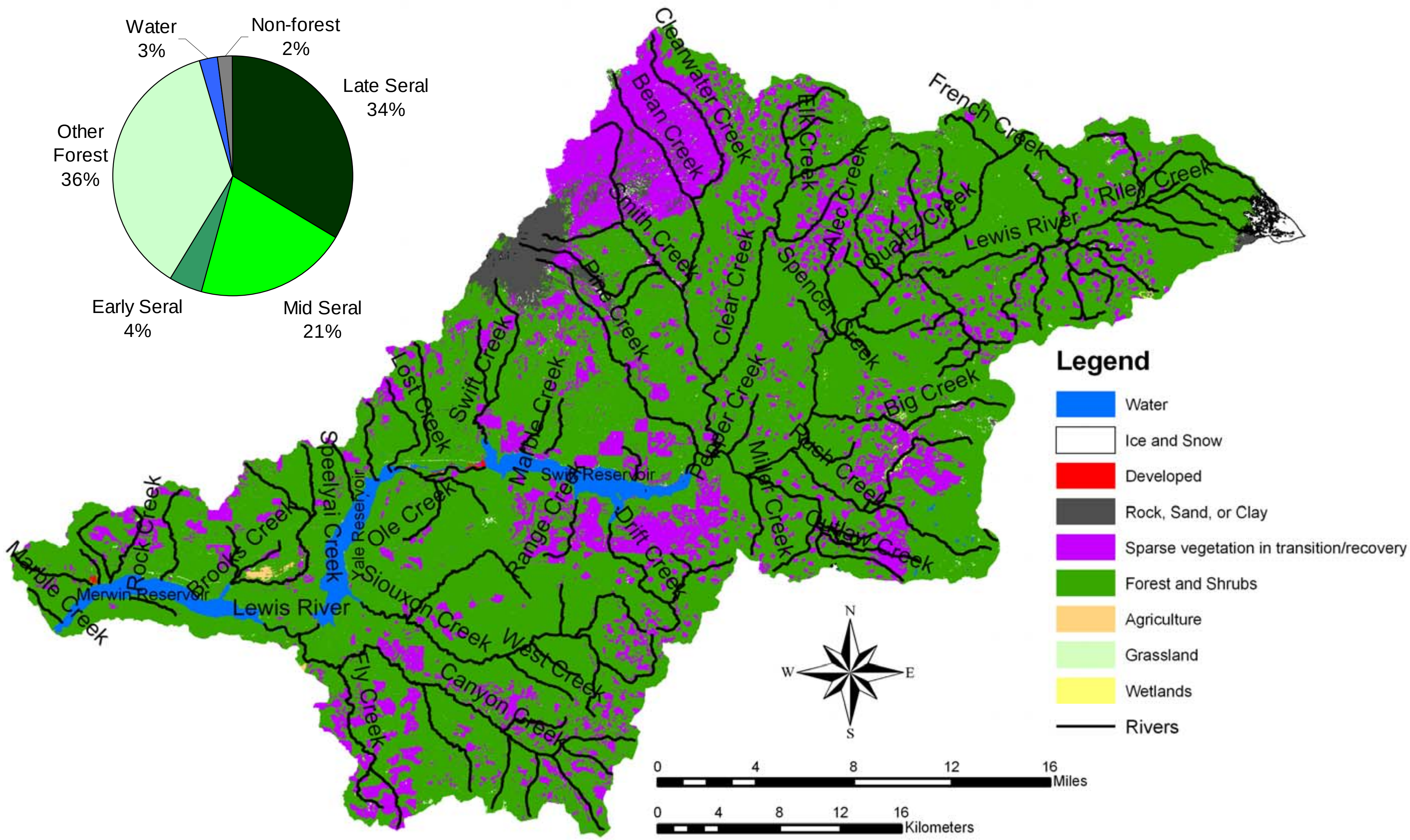


Figure 3. Land cover within the upper North Fork Lewis basin. Vegetation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. (1997). Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the upper North Fork Lewis Subbasin. Other species of interest were also identified as appropriate. Species were selected because they are listed or under consideration for listing under the U.S. Endangered Species Act or because viability or use is significantly affected by the Federal Columbia Hydropower system. Lewis River Hydropower System effects are significant within the upper Lewis River basin. Additionally, anadromous species are subject to mainstem hydrosystem effects in the Columbia River, estuary, and nearshore ocean. The upper Lewis River ecosystem supports and depends on a wide variety of fish and wildlife in addition to designated focal species. A comprehensive ecosystem-based approach to salmon and steelhead recovery will provide significant benefits to other native species through restoration of landscape-level processes and habitat conditions. Other fish and wildlife species not directly addressed by this plan are subject to a variety of other Federal, State, and local planning or management activities.

Focal salmonid species in upper North Fork Lewis River watersheds include spring Chinook, coho, winter steelhead, and bull trout. Lewis River spring Chinook, coho and steelhead numbers have declined to only a fraction of historical levels (Table 1) and are currently restricted to habitats downstream of Merwin Dam until reintroduction efforts occur. Extinction risks are significant for all focal species – the current health or viability of ranges from very low for spring Chinook and coho to low for winter steelhead. Returns of all three anadromous species include both natural and hatchery produced fish.

Table 1. Status of focal salmond, steelhead, and bull trout populations in the upper North Fork Lewis River subbasin.

Focal Species	ESA Status	Hatchery Component[1]	Historical numbers[2]	Recent numbers[3]	Current viability[4]	Extinction risk[5]
Spring Chinook	Threatened	Yes	10,000-50,000	200-1,000	Very Low	60%
Coho	Proposed	Yes	7,500-85,000	Unknown	Very Low	60%
Winter Steelhead	Threatened	Yes	6,000-24,000	Unknown	Low	50%
Bull Trout	Threatened	No	Unknown	200-800	Unknown	Unknown

[1] *Significant numbers of hatchery fish are released in the subbasin.*
[2] *Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations..*
[3] *Approximate current annual range in number of naturally-produced fish returning to the subbasin.*
[4] *Propsects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.*
[5] *Probability of extinction within 100 years corresponding to estimated viability.*
[6] *Historic production for the entire Lewis Basin.*

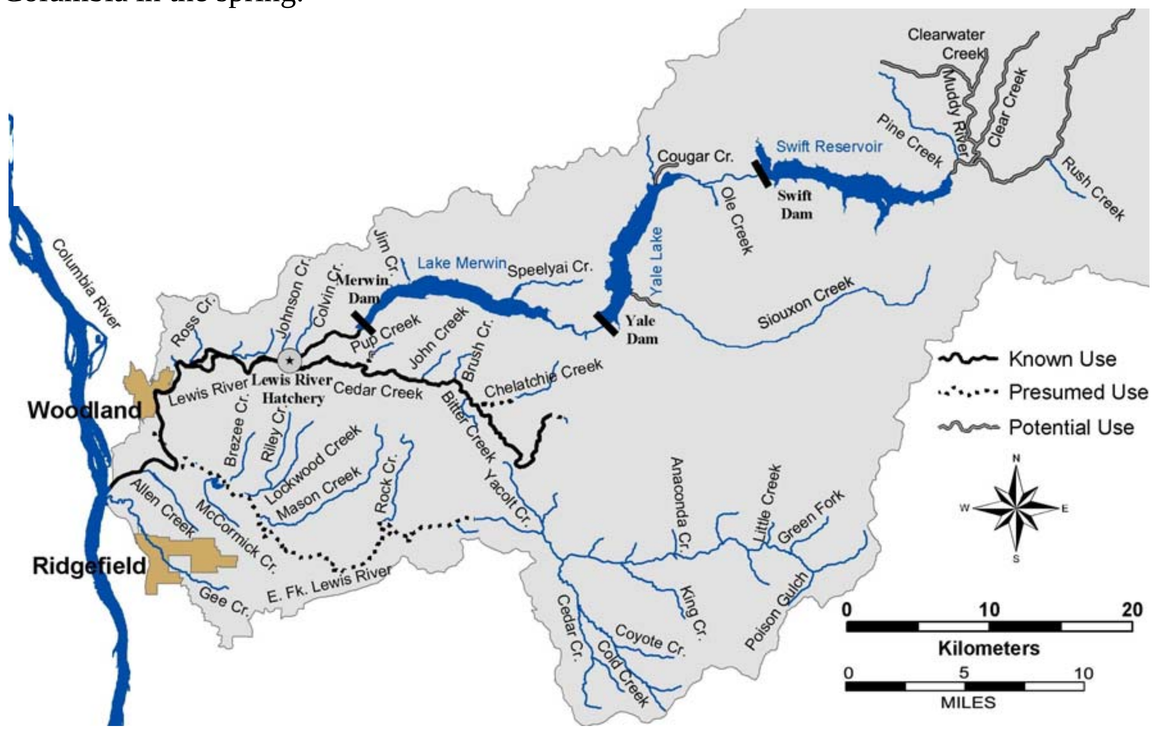
Other species of interest in the upper North Fork Lewis Subbasin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

Brief summaries of the population characteristics and status follow. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

3.2.1 *Spring Chinook—Lewis Subbasin*

ESA: Threatened 1999	**SASSI: Depressed 2002**

The historical North Lewis River adult population estimate is from 10,000-50,000 fish. Current natural spawning returns range from 200-1,000 and are almost entirely hatchery produced fish. Historical spawning was almost entirely in the upper Lewis basin which was blocked by Merwin Dam in 1931. Spring Chinook are expected to be reintroduced above the hydrosystem in the near future. The majority of upper Lewis spawning habitat is above Swift Reservoir in the main North Lewis, the Muddy River, Clearwater Creek, and Clear Creek. Spawning in the lower North Lewis occurs in the first 2 miles below Merwin Dam and in Cedar Creek. Spawning occurs in late August and September. Juveniles rear in the Lewis basin for a full year before migrating to the Columbia in the spring.

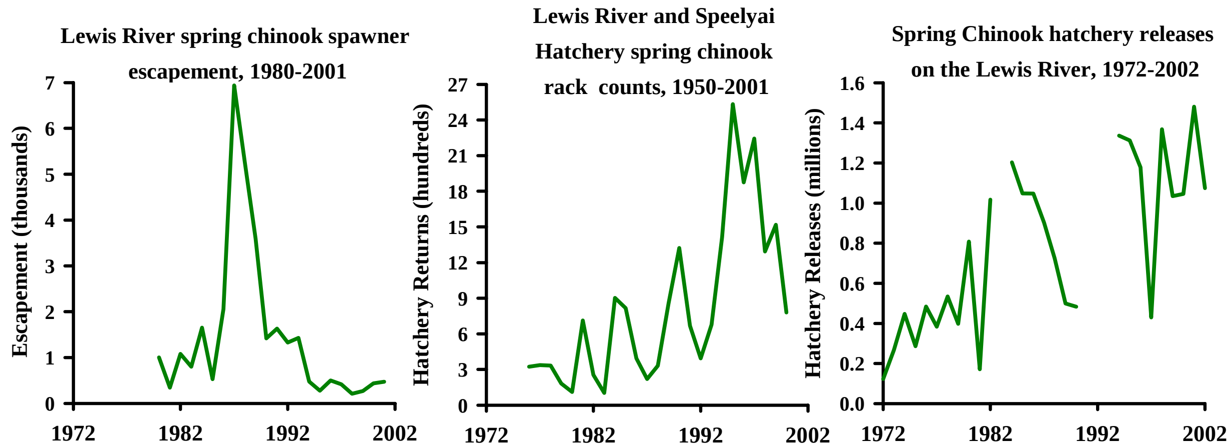


Distribution

- 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 on the mainstem Lewis between Merwin Dam and the Lewis River Hatchery (~4 miles), but is concentrated in the area immediately below Merwin Dam and Cedar Creek

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 on the Lewis, 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
- Lewis River spawning escapements 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 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 produce 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
- The Lewis River Hatchery spring Chinook program will be utilized to reintroduce spring Chinook upstream of the hydrosystem.

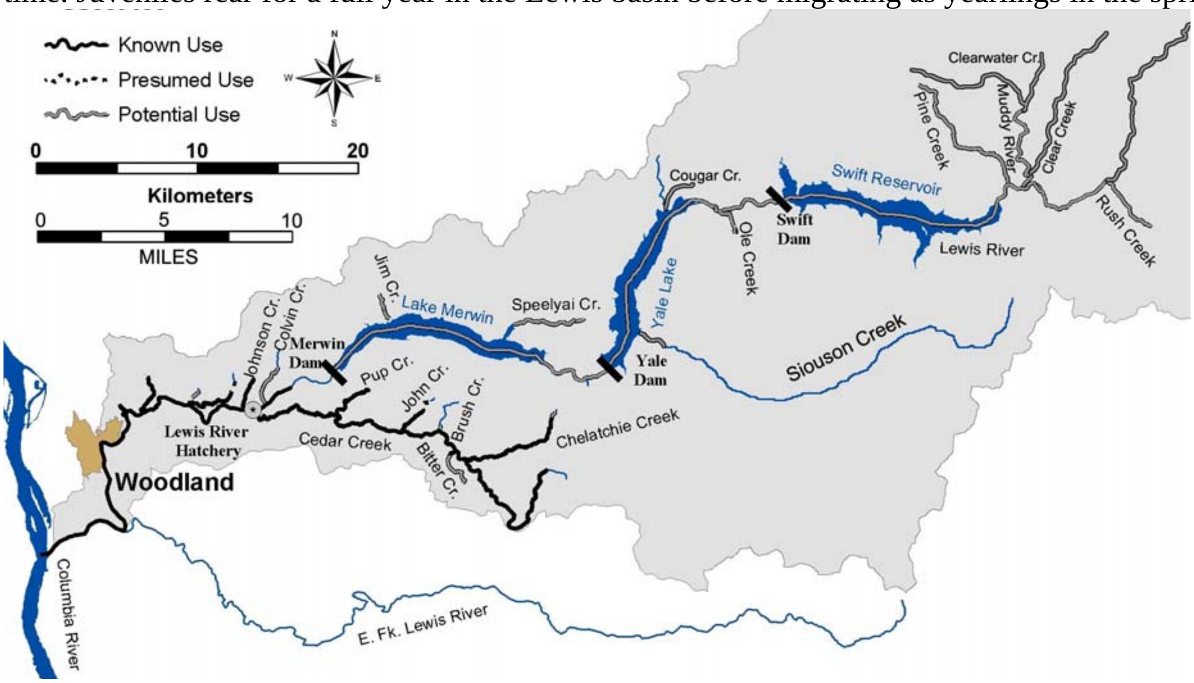
Harvest

- 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 low 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 reduced to 900 averaged during 1995-2002
- Tributary harvest is managed to attain the Lewis hatchery adult broodstock escapement goal
- The tributary sport fishery has been selective for adipose fin clipped hatchery spring Chinook since 2002. Unmarked wild spring Chinook must be released.

3.2.2 *Coho—Lewis Subbasin (North Fork)*

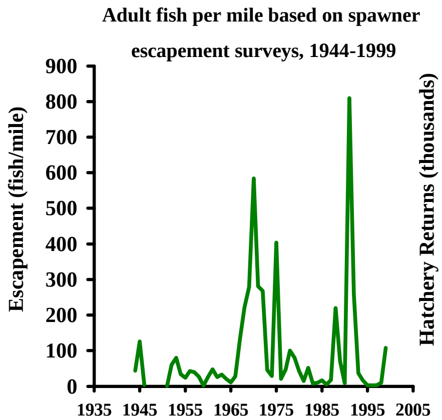
ESA: Candidate 1995 **SASSI: Unknown 2002**

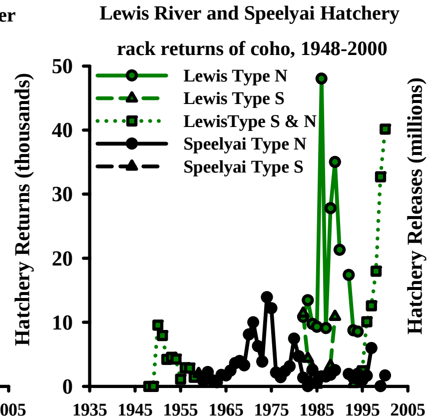
The historical North Lewis River adult population is estimated from 7,500-85,000 fish. Both early and late stocks were present historically, with early stock primarily spawning in the upper Lewis. Current returns are unknown but assumed be low and limited to the habitat downstream of Merwin Dam. Early coho are expected to be reintroduced to the habitat upstream of the hydrosystem in the near future. Coho spawning habitat in the upper Lewis is primarily above Swift Reservoir but is also present in tributaries to Yale and Merwin reservoirs. Early stock coho spawn from late October into November and late stock spawn from late November to March. Juvenile rearing occurs upstream and downstream of spawning areas. Reintroduced juvenile coho are expected to utilize the reservoir habitat to some extent during their freshwater rearing time. Juveniles rear for a full year in the Lewis basin before migrating as yearlings in the spring.

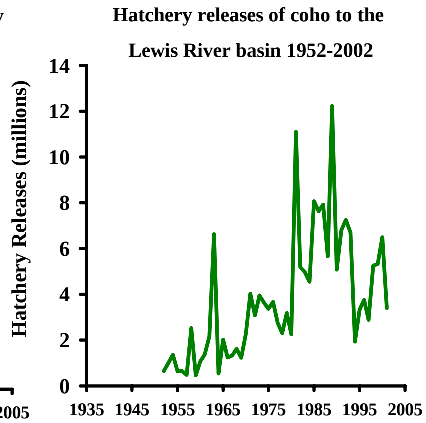


Distribution

- 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
- The Lewis River hatchery program, will be utilized to reintroduce coho to habitats upstream of the hydrosystem

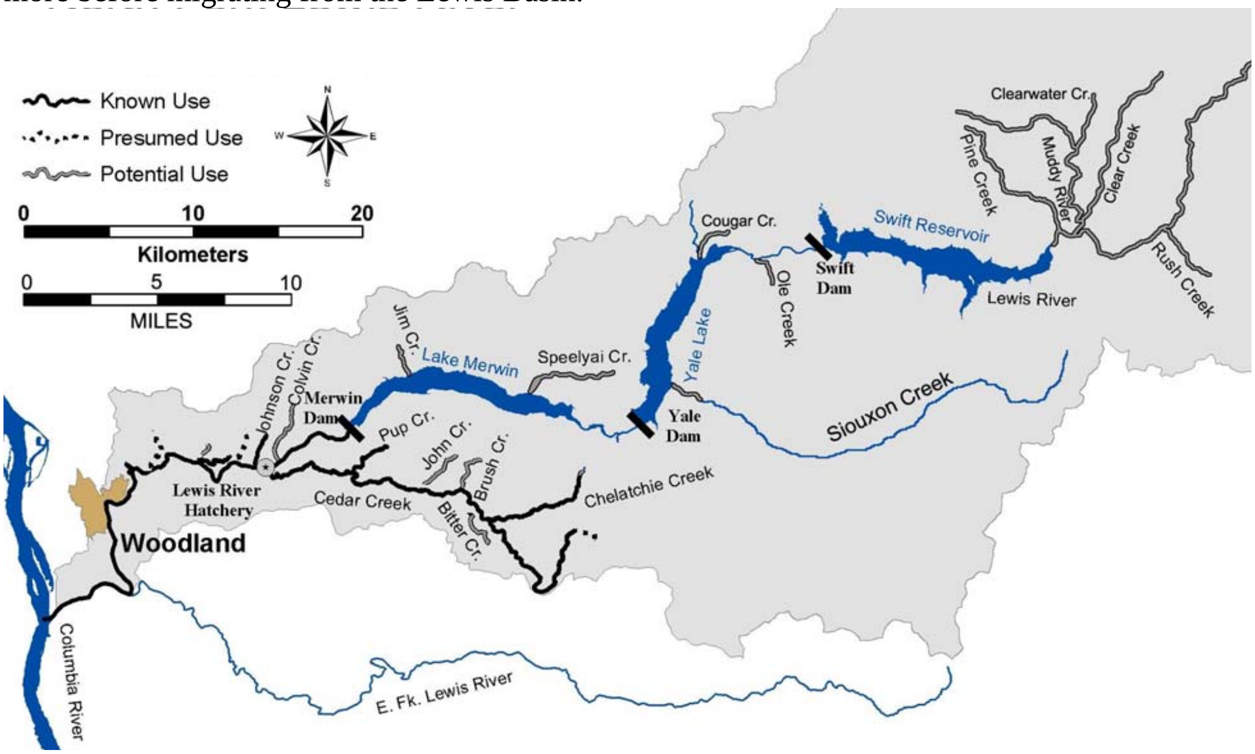
Harvest

- 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

3.2.3 *Winter Steelhead—Lewis Subbasin (North Fork)*

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

The historical North Lewis River adult population is estimated from 6,000-24,000 fish. Current natural spawning returns are presumed to be very low and are limited to habitat below Merwin Dam. Winter steelhead are expected be reintroduced to habitats upstream of the Lewis River hydrosystem in the near future, where the majority of winter steelhead habitat is available. The preferred stock for reintroduction is late-timed wild winter returning to the North Lewis and trapped at Merwin Dam. The majority of habitat in the upper Lewis is in the main North Lewis and tributaries upstream of Swift Dam. Spawning time is March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Lewis Basin.

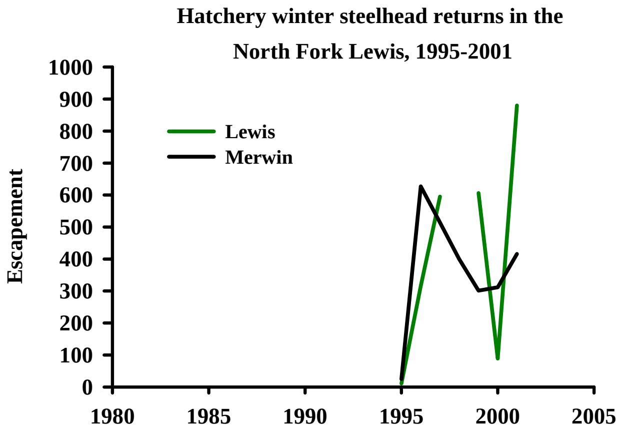


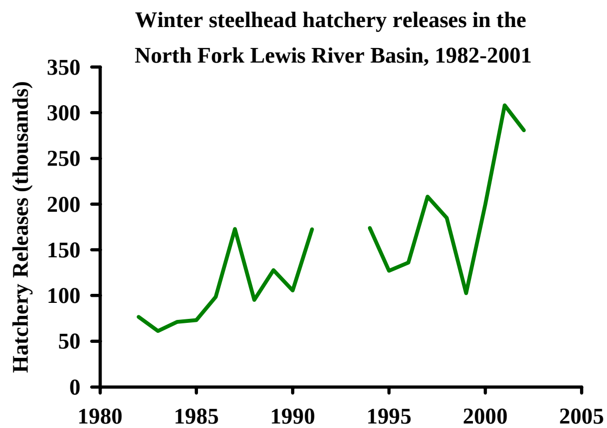
Distribution

- 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 the 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 Lewis are wild fish

Productivity & Persistence

- Winter steelhead natural production is expected to be low and primarily in Cedar Creek
- There are late timed wild winter steelhead trapped annually at Merwin Dam and released downstream

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

- The hatchery program will be used to assist in the reintroduction of winter steelhead into the habitats upstream of the hydrosystem

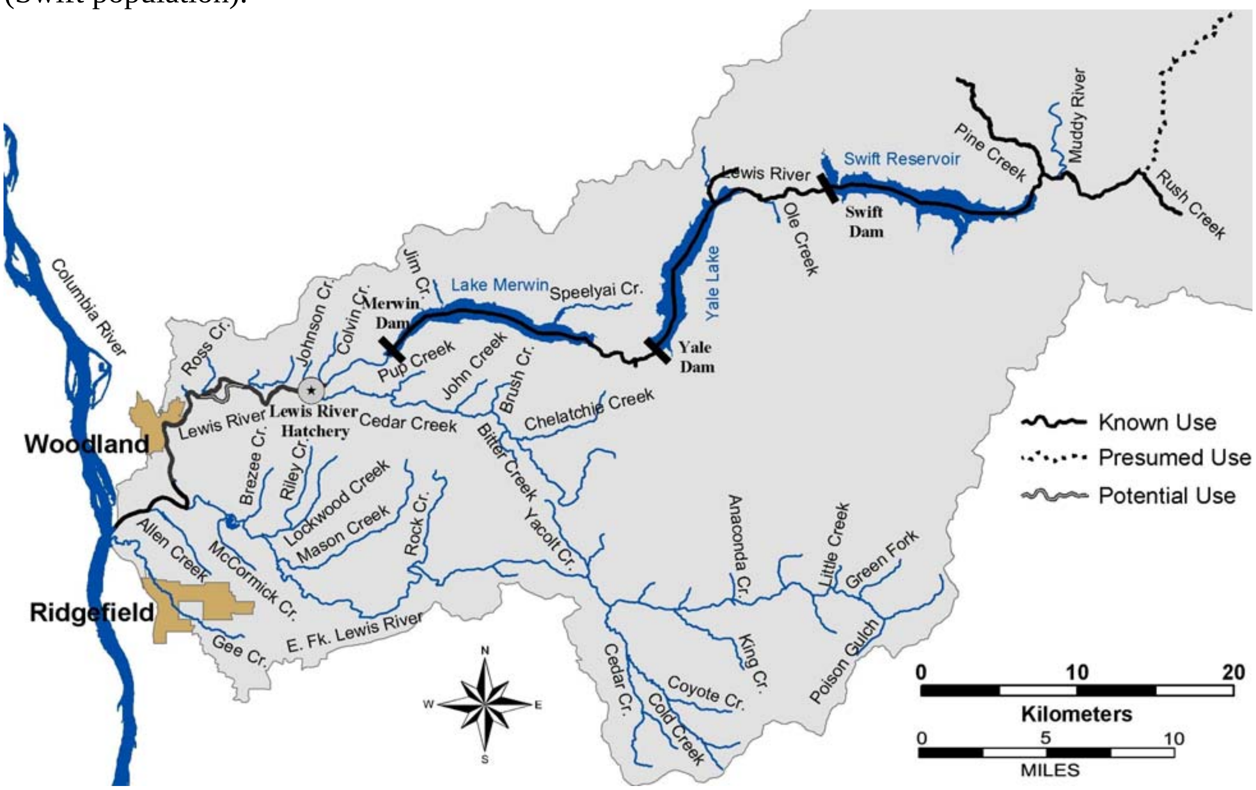
Harvest

- 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,selective fishing regulations limit harvest to hatchery fish only
- ESA limits incidental fishery impact on Lewis River wild winter steelhead

3.2.4 *Bull Trout—Lewis River Subbasin*

ESA: Threatened 1998	**SASSI: Depressed 1998**

There may have been both fluvial, anadromous and resident bull trout populations in the North Lewis River historically. The current bull trout populations in Swift and Yale reservoirs are isolated because there is no upstream passage at the dams. Genetic samples show significant differences between these populations indicating there may have been biological separation prior to construction of Swift Dam in 1958. Current peak counts of spawners in Cougar Creek range from 0-40 fish, and Swift Reservoir spawning population estimates range from 100-900 fish. Spawning occurs primarily in Cougar Creek (Yale population), and in Pine and Rush creeks (Swift population).



Distribution

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

Life History

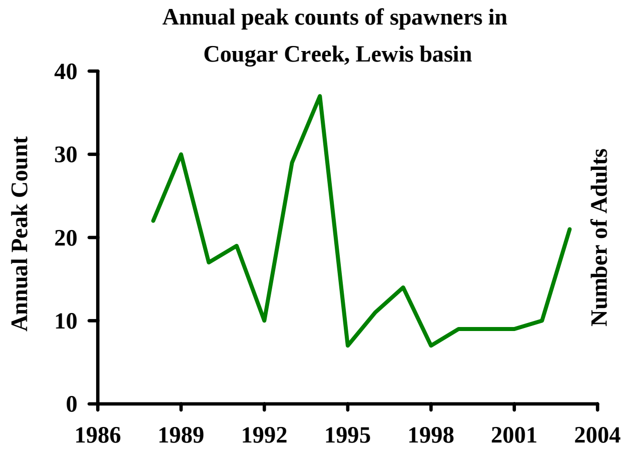
- Prior to dam construction anadromous and fluvial (rivers) forms were likely present

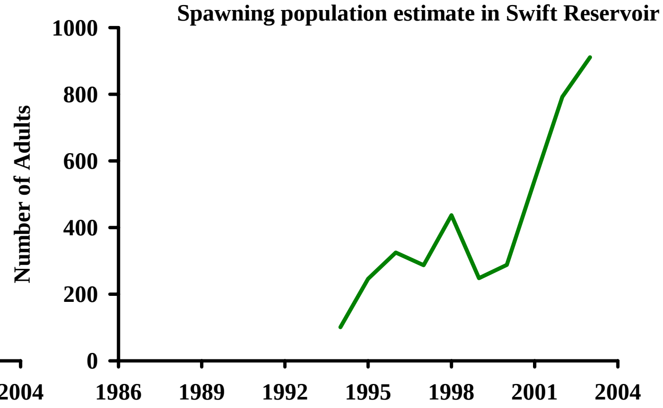
Diversity

- 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

3.2.5 *Cutthroat Trout—Lewis River Subbasin*

ESA: Not Listed	**SASSI: Unknown 2000**

Coastal cutthroat abundance in the North Lewis River has not been quantified but the population is considered depressed. Anadromous cutthroat trout are present in in the North Fork Lewis and tributaries upstream to Merwin Dam, resident forms are present throughout the basin, and adfluvial forms are present in the reservoirs

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

3.2.6 *Other Species*

Pacific lamprey – Information on lamprey abundance is limited and does not exist for the North Lewis River population. Lamprey presence has been documented in Siouxon delta of Yale Reservoir. Lamprey passage is blocked to the upper Lewis Basin.

3.3 Subbasin Habitat Conditions

This section describes the current condition of aquatic and terrestrial habitats within the subbasin. Descriptions are included for habitat features of particular significance to focal salmonid species including watershed hydrology, passage obstructions, water quality, key habitat availability, substrate and sediment, woody debris, channel stability, riparian function, and floodplain function. These descriptions will form the basis for subsequent assessments of the effects of habitat conditions on focal salmonids and opportunities for improvement.

3.3.1 *Watershed Hydrology*

Average annual stream flow measured below Merwin Dam is 4,849 cfs. Flow is dominated by winter rains, though spring and summer flow in the North Fork is augmented by glacier melt. The annual hydrograph indicates peak flows from winter rain and rain-on-snow events as well as peak flows in the spring due to snowmelt (Figure 4). Reservoir levels and flow between reservoirs are largely controlled by releases from the dams.

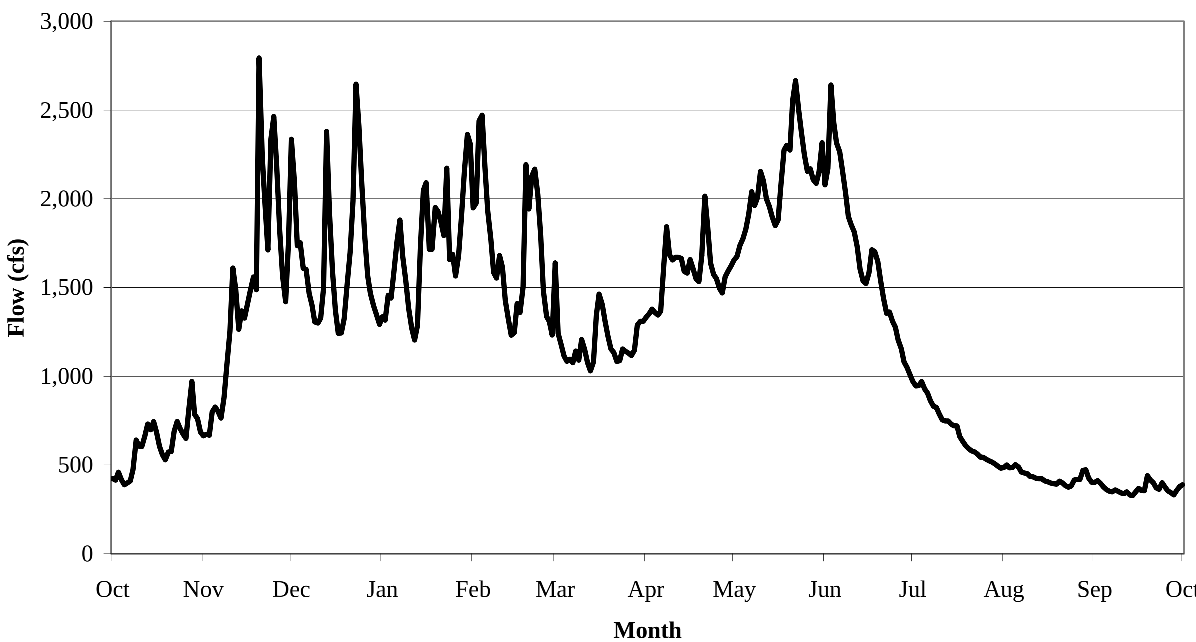


Figure 4. Lewis River flow above reservoirs (Lewis River above Muddy Creek) for water years 1961-1970. These data exhibit the double humped hydrograph typical of a winter rain/rain-on-snow and spring snowmelt flow regime. USGS Gage #14216000; Lewis River above Muddy River near Cougar, Wash.

The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that runoff properties are "impaired" in 10 of the 77 subwatersheds (7^{th} field) in the upper Lewis basin. Seven subwatersheds are "moderately impaired" and the remainder are "functional". Impaired subwatersheds are located primarily in the Canyon Creek drainage (Lake Merwin tributary) and other small Lake Merwin tributaries on the north side of

Lake Merwin close to Merwin Dam. These areas are located mostly in private commercial timberland where forests are in young seral stages and road densities are high. Most of the basin that is within the Gifford Pinchot National Forest is in good condition with regards to runoff properties, however, peak flow analyses by the USFS in 1995 and 1996 indicated potential concerns with increases in the 2-year peak flow in lower and middle Pine Creek and middle Swift Reservoir tributaries due to vegetation conditions (USFS 1995b, USFS 1996). Many streams were also characterized as having extended stream channel networks due to roads and road ditches, which can increase peak flow potential. The channel network of lower Pine Creek has increased 48% due to the presence of roads.

The toe-width method was used to estimate low flow impacts on Upper Lewis River tributaries. The resulting values were compared to stream gauge data and spot flow measurements (Caldwell 1999). Results indicate that in Speelyai Creek, flow may be limiting for juvenile rearing June through November, and may be limiting for fall spawning species in the fall. Flows appear to be adequate for summer steelhead and coho spawning. In Canyon Creek, flows are below optimum for fall spawning, except for coho. Flows for coho spawning approach optimal conditions by mid October. In Cougar Creek, flows are also below optimum for fall spawning, except for coho. Flows for salmonid rearing are adequate.

A 1996 PacifiCorp survey in Panamaker (tributary to Cougar Creek), Ole, Rain, and Dog Creeks indicated that these experienced intermittent fall flow, potentially limiting available habitat (Wade 2000).

Total consumptive water use in the basin, estimated at approximately 672 million gallons per year (mgy) is expected to increase by 573 mgy by 2020, however, the use is minor when compared to stream base flows (LCFRB 2001).

3.3.2 *Passage Obstructions*

The three dams on the mainstem are Merwin Dam (RM 20), Yale Dam (RM 35), and Swift No. 1 (RM 45). Each dam creates its own reservoir with lengths of 14.5, 10.5 and 11.5 miles, respectively. A smaller dam, Swift No. 2, diverts water from the tailrace of Swift No. 1 down a 3.5-mile canal to a power generating facility. On April 21, 2002 the Swift number 2 powerhouse was destroyed by a breach in the power canal. A rebuild of the powerhouse is underway.

All anadromous passage has been blocked by the 240-foot 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, McIsaac 1990). Over 25 miles of stream habitat was directly inundated by the reservoirs (USFS 1995a).

Bull trout populations that were historically fluvial and/or anadromous are now adfluvial populations isolated in the reservoirs, with limited access to spawning habitat. Bull Trout spawning occurs in tributaries to Swift Reservoir and Yale Lake and there is no upstream passage between reservoirs. Bull trout found in Lake Merwin are believed to have spilled over Yale Dam (Wade 2000). Passage issues for bull trout in the upper North Fork basin have been identified in the Bull Trout Recovery Plan (USFWS 2002). Upstream and downstream passage at Yale Dam and Swift Dam (Number 1 and 2) is considered necessary for Lewis River bull trout recovery (USFWS 2002)

3.3.3 *Water Quality*

In the upper Lewis basin, stream water temperatures have exceeded the state standard of 16ºC in Pine, Siouxon, Canyon, and Quartz Creeks. This is of particular concern in Pine Creek due to the presence of bull trout that require very cold water. High temperatures on the portions of Canyon and Siouxon that lie within state and private land are attributed to lack of stream shade. It is suspected that elevated temperatures in Pine Creek are due to channel widening from timber harvest and vegetation removal as a result of the 1980 Mount St. Helens eruption (USFS 1995b, USFS 1996).

High turbidity levels have been documented in some streams. In November 1994 turbidity was measured at 94 NTUs in the Muddy River, 36 NTUs in the upper mainstem Lewis, and 18 NTUs in Pine Creek (USFS 1995b).

A lack of marine derived nutrients from anadromous salmon carcasses may be a limiting factor in the upper watershed but little information exists on this subject (Wade 2000).

3.3.4 *Key Habitat Availability*

The USFS has evaluated pool frequency in the upper watershed. Upper Pine Creek, an important Bull Trout spawning stream, has both poor (</=50% desired frequency) and fair (50-99% desired frequency) pool frequency. Tributaries on the south side of Swift Reservoir received a poor pool frequency rating (USFS 1995). Many tributaries to Canyon Creek and Siouxon creek also have a poor rating, potentially impacting cutthroat trout. In the upper watershed above the Alec Creek confluence, approximately 70% of the surveyed reaches received a poor rating and 26% received a rating of fair for pool frequency (USFS 1995b).

The USFS gauges habitat fragmentation by calculating the amount of road crossings over streams per lineal mile of stream segment. Using this approach, the lower Pine Creek basin is classified as having "extreme" fragmentation (>2.26 road crossings/stream mile) and the upper Pine Creek basin has "high" fragmentation (>1.5 road crossings/stream mile). Cougar Creek was not surveyed (USFS 1995b).

3.3.5 *Substrate & Sediment*

Surface erosion is a particular concern in the northern portion of the upper basin due to highly erodable ash and pumice soils from past eruptions of Mount St. Helens. Mass wasting is also a concern throughout the basin and became particularly evident in the winter 1996 floods that resulted in some large landslides. Portions of the basin have a combination of high road densities, steep slopes, and highly erodable soils that make them especially vulnerable to increased sediment production and transport. These conditions, combined with heavy logging on steep slopes, have increased the potential for sediment production. According to USFS watershed analyses, over 11% of the Pine Creek basin is considered potentially unstable, over 40% of the Cougar Creek basin is considered potentially unstable, and over 27% of the upper watershed (above the Pine Creek confluence) is considered either unstable or potentially unstable (USFS 1995a, USFS 1995b, USFS 1996).

Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results show that the subwatersheds with the greatest sediment supply impairments are tributary basins on the northeastern portion of Swift Reservoir and in lower Canyon Creek. Approximately half of the remaining subwatersheds are rated as moderately impaired and the remainder are rated as functional. The functional subwatersheds are clustered primarily in the upper portion of the basin. Impaired sediment supply conditions are related primarily to high road densities on naturally unstable slopes.

As part of the Interior Columbia Basin Ecosystem Management Project (ICBEMP), investigators found that an increase in road densities is associated with declines in status of bull trout. In areas where bull trout populations were strong, road densities averaged 0.45 mi/ mi^2, whereas areas where populations were depressed or absent, road densities averaged 1.36 mi/ mi^2 and 1.71 mi/ mi^2, respectively (Quigley and Arbelbide 1997). The majority of the subwatersheds contributing to bull trout streams have road densities greater than 2 miles/mi^2.

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

3.3.6 *Woody Debris*

LWD concentrations in Pine Creek are low (<40 pieces per mile). Pine Creek also has low recruitment potential due to logging and effects of the 1980 eruption of Mount St. Helens. Surveys in the upper watershed above the Alec Creek confluence indicate that approximately 53 percent of the surveyed reaches had less than 40 pieces per mile (USFS 1995b).

3.3.7 *Channel Stability*

An aerial photograph analysis conducted by the USFS indicated that reaches of Pine and Swift Creeks have been adjusting to past timber harvest, roading, and the Mount St. Helens eruption. Reaches in Pine Creek increased in width by as much as 210% between 1959 and 1989 and are considered the most sensitive reaches in the area due to highly erodible mudflow deposits. High rates of bank erosion on these streams were also noticed during the analysis (USFS 1996). In 1989, the Upper Lewis mainstem, Quartz Creek, and Pin Creek were still adjusting from past sediment pulses due to 1970s flooding. Several reaches of steams on the south side of the upper mainstem suffer from bank instability and erosion (USFS 1995b).

3.3.8 *Riparian Function*

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, 42 of the 77 subwatersheds in the upper Lewis basin are moderately impaired with regards to riparian function and the remainder are considered functional. Functional riparian areas are located primarily in the upper mainstem subwatersheds above the Muddy Creek confluence and in Siouxon Creek subwatersheds.

The Regional Ecosystem Assessment Project (REAP) report characterized riparian reserves in the upper Lewis basin as having between 50-80% late successional forest. The portion of the basin between upper Yale Lake and just above Pine Creek has only 22% of stream riparian reserves in late successional stages (USFS 1996). The upper basin (above the Alec Creek confluence) has 46% of stream riparian reserves in late successional stages (USFS 1995b).

Timber harvest has occurred on approximately 36%, 77%, and 23% of the riparian reserves in the upper, middle, and lower Pine Creek basins, respectively (USFS 1996). On Rush Creek, 13% of the riparian area in the upper basin and 23% in the lower basin has been harvested (USFS 1995a).

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

3.3.9 *Floodplain Function*

The Upper Lewis system consists of steep slopes with limited floodplains. Any floodplains along the mainstem would have been inundated by the reservoirs. Other floodplain areas are largely intact.

3.4 Stream Habitat Limitations

A systematic link between habitat conditions and salmonid population performance is needed to identify the net effect of habitat changes, specific stream sections where problems occur, and specific habitat conditions that account for the problems in each stream reach. In order to help identify the links between fish and habitat conditions, the Ecosystem Diagnosis and Treatment (EDT) model was applied to upper NF Lewis basin for spring Chinook, coho, and winter steelhead. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Appendix E.

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

3.4.1 *Population Analysis*

Population assessments under different habitat conditions are useful for comparing fish trends and establishing recovery goals. Fish population levels under current and potential habitat conditions were inferred using the EDT model based on habitat characteristics of each stream reach and a synthesis of habitat effects on fish life cycle processes. Habitat-based assessments were completed in the upper NF Lewis basin for spring Chinook, coho, and winter steelhead. There is currently no passage above the dams. Hypothetical survival through the dams and reservoirs was modeled at 100% since the primary objective of the EDT analysis is to assess the relative impact of habitat conditions in the upper basin. This should be taken into consideration when interpreting the numbers presented in the baseline EDT population analysis.

Model results indicate that adult productivity has declined for all species in the upper NF Lewis basin (Table 2). Current productivities are between 21% and 44% of historical levels. Adult abundance levels have also declined sharply for all species (Figure 5). Spring Chinook have seen the greatest decline in adult abundance, with current estimates at only 15% of historical levels. Species diversity (as measured by the diversity index) has decreased from historical estimates for the upper NF Lewis (Table 2). Fall Chinook and spring Chinook diversity is currently at 35% and 30% of historical levels, respectively. Both coho and winter steelhead diversity has declined by 51% and 57%, respectively.

As with adult productivity, smolt productivity has declined for all species in the upper NF Lewis. Current productivity estimates are between 31% and 57% of the historical smolt productivity, depending on species (Table 2). Smolt abundance numbers are similarly low, especially for spring and fall Chinook (Table 2). Current smolt abundance estimates for spring and fall Chinook are at 20% and 30% of historical levels, respectively.

Model results indicate that restoration of PFC conditions would have important benefits in all performance parameters for all species (Table 2). For adult abundance, restoration of PFC conditions would increase current returns from 30% for winter steelhead to 90% for spring Chinook. Similarly, smolt abundance numbers would increase for all species (Table 2). Spring Chinook would see the greatest increase in smolt numbers with a 74% increase.

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

	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
Species	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]
Spring Chinook	1,624	3,079	10,560	4.7	8.0	15.0	0.30	0.44	0.99	66,195	114,944	335,351	176	290	424
Coho	11,526	16,208	23,332	4.7	7.7	21.8	0.48	0.59	0.97	254,912	358,878	345,473	92	150	295
Winter Steelhead	1,952	2,533	4,954	8.0	15.0	24.1	0.42	0.43	0.98	32,330	41,276	73,470	131	240	350

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

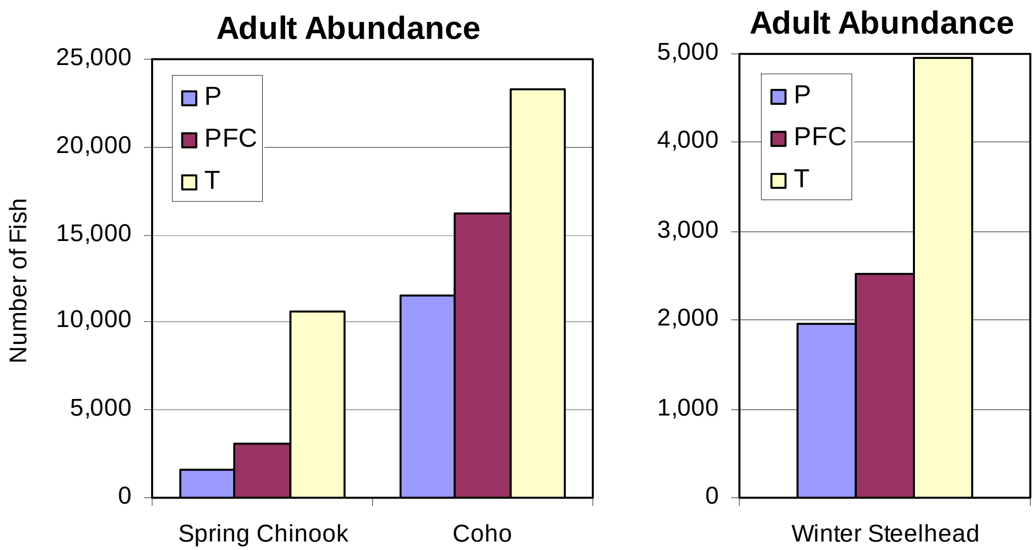


Figure 5. Adult abundance of upper North Fork Lewis River spring Chinook, coho, and winter steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

3.4.2 *Stream Reach Analysis*

Habitat conditions and suitability for fish are better in some portions of a subbasin than in others. The reach analysis of the EDT model uses estimates of the difference in projected population performance between current/patient and historical/template habitat conditions to identify core and degraded fish production areas. Core production areas, where habitat degradation would have a large negative impact on the population, are assigned a high value for preservation. Likewise, currently degraded areas that provide significant potential for restoration are assigned a high value for restoration. Collectively, these values are used to prioritize the reaches within a given subbasin. See Figure 6 for a map of EDT reaches in the upper NF Lewis Basin.

The reach analysis for the upper NF Lewis was conducted for spring Chinook, coho, and winter steelhead. For all species, initial reach analyses showed strong restoration potential in reaches that are now inundated by Merwin, Yale, and Swift Reservoirs. These impoundments flooded approximately 30 stream miles of quality habitat. Due to the impracticality of any restoration measures in the flooded reaches (beside removal of the dams), these reaches were subsequently omitted and analyses run again.

Reaches with a high priority for spring Chinook are located in the upper Lewis mainstem (Lewis 18-20, 22, 25 and 27) (Figure 7). These areas represent important Chinook spawning and rearing habitat and show a combined preservation and restoration habitat recovery emphasis. Lewis 18 appears to be the reach with the highest potential for both preservation and restoration.

Important coho reaches are located in mainstem areas (Lewis 18, 19, 21 and 27) as well as in the tributaries (Diamond Creek, Clearwater Creek, Pepper Creek, and Muddy River among others) (Figure 8). These high priority reaches show a mix of recovery emphases. Reaches Lewis 18 and Muddy R1 appear to have the highest restoration potential of any reach modeled for coho. Similarly, reach Lewis 19 has the highest preservation emphasis of any reach modeled for coho.

For winter steelhead, the high priority reaches are similar to those for spring Chinook, however, winter steelhead utilize tributary habitat to a greater extent (Figure 9). Important mainstem reaches include Lewis 19, 21, and 23-27. Important tributary reaches include areas in Crab Creek, Pine Creek, and Big Creek. The majority of important steelhead reaches show a preservation habitat recovery emphasis, with Lewis 18, Lewis 27, and Crab Creek showing a combined preservation and restoration recovery emphasis.

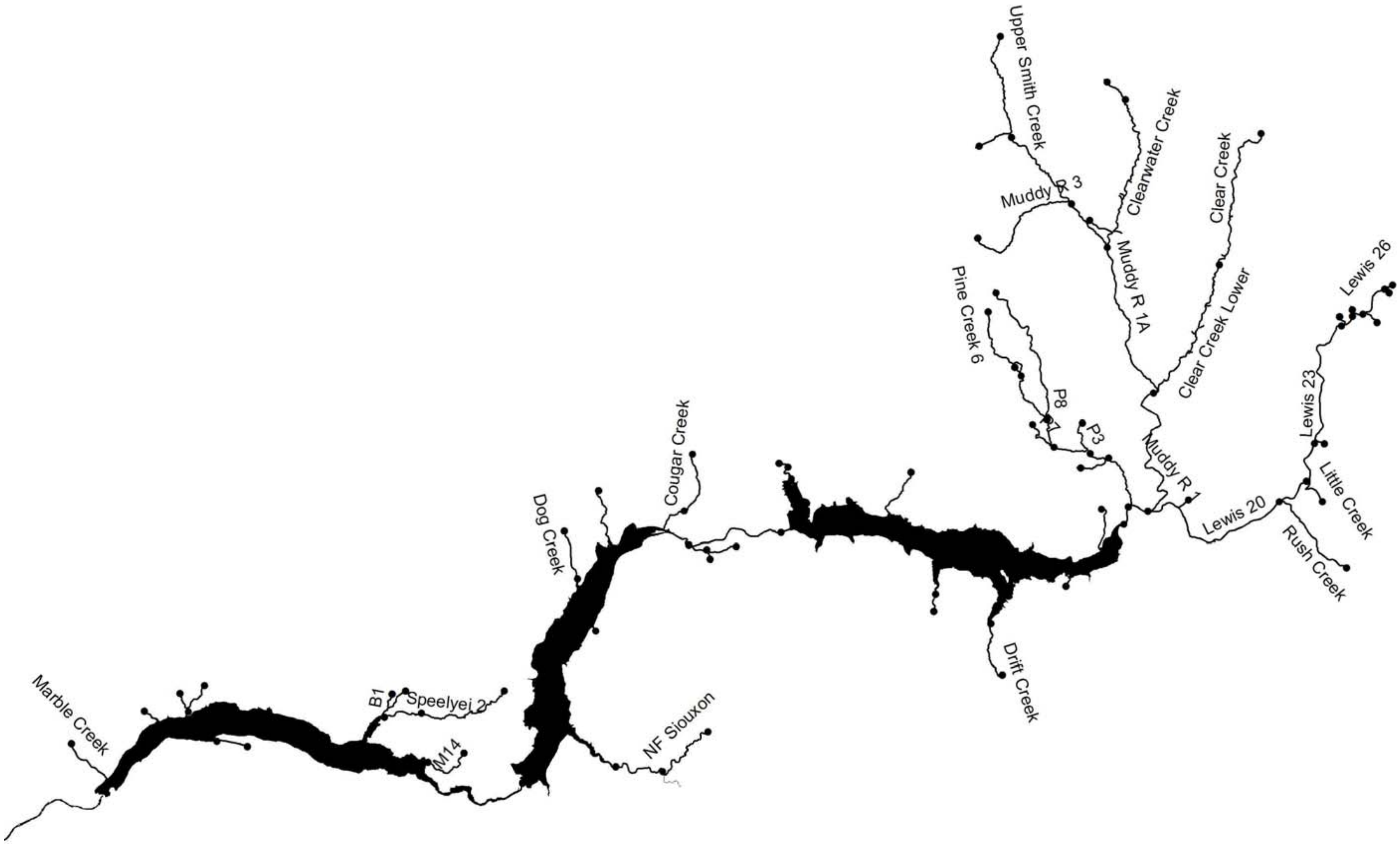


Figure 6. Upper North Fork Lewis River Basin with EDT reaches identified. For readability, not all reaches are labeled.

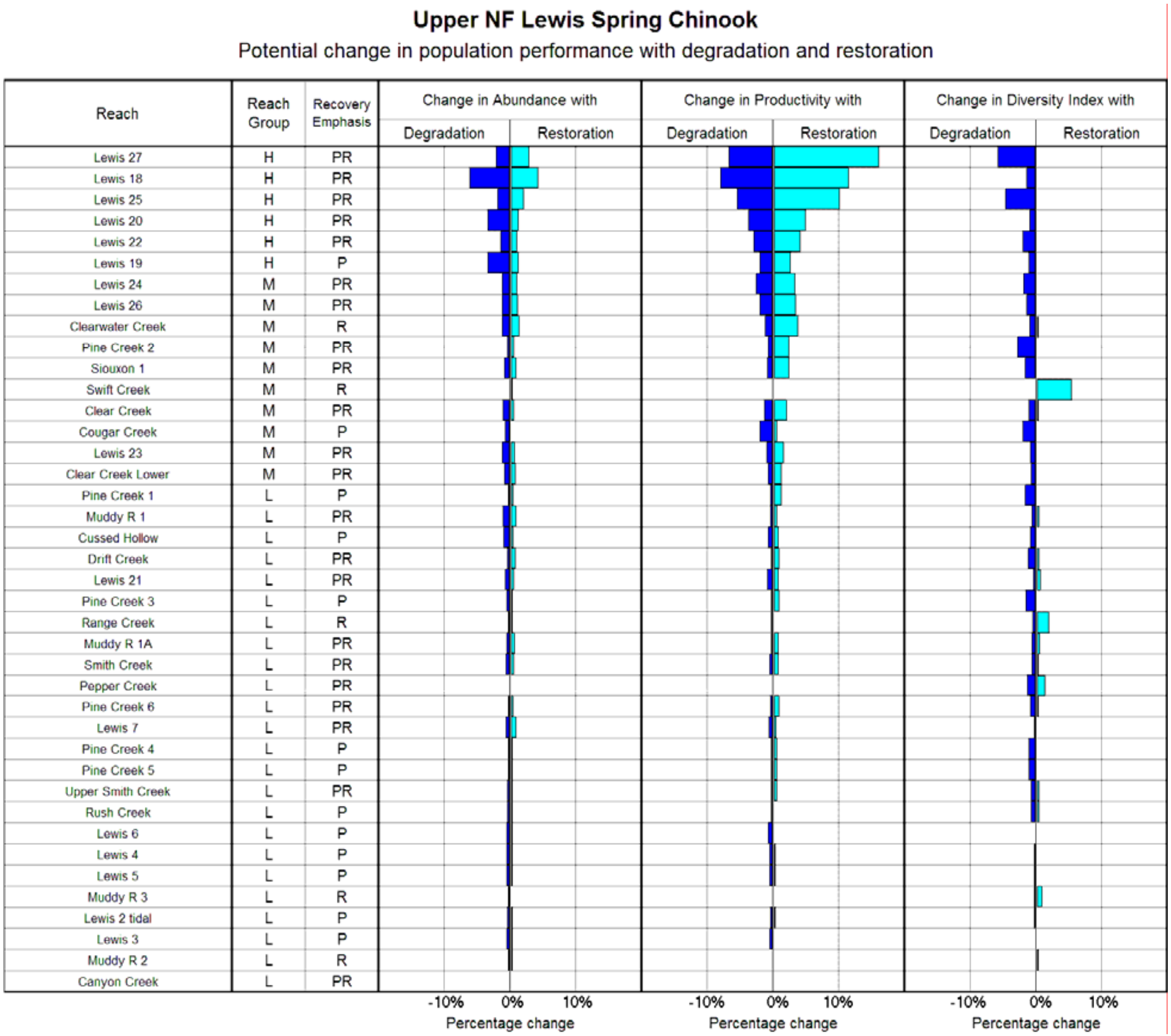


Figure 7. Upper North Fork Lewis River subbasin spring chinookladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Some low priority reaches are not included for display purposes.

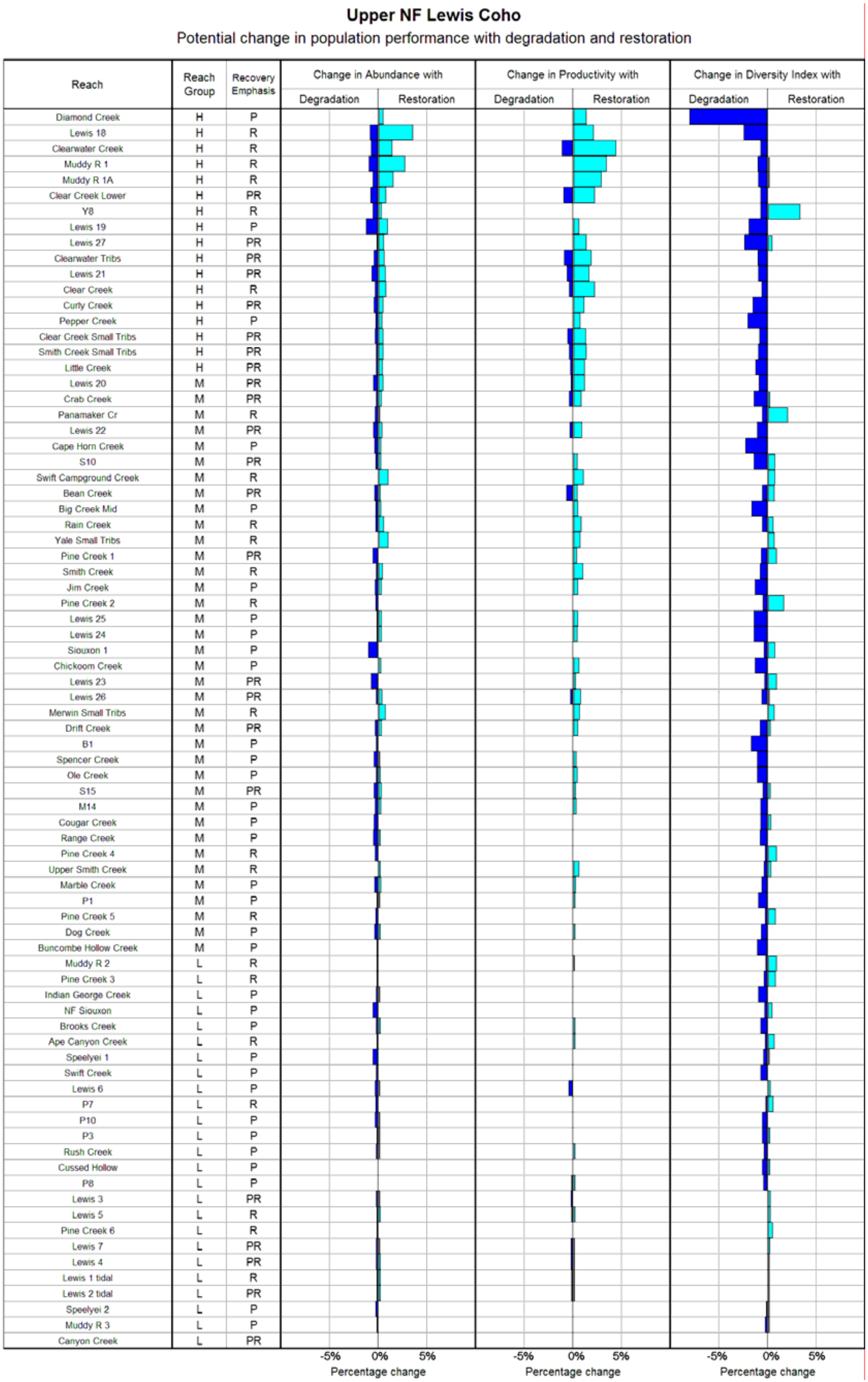


Figure 8. Upper NF Lewis coho ladder diagram.

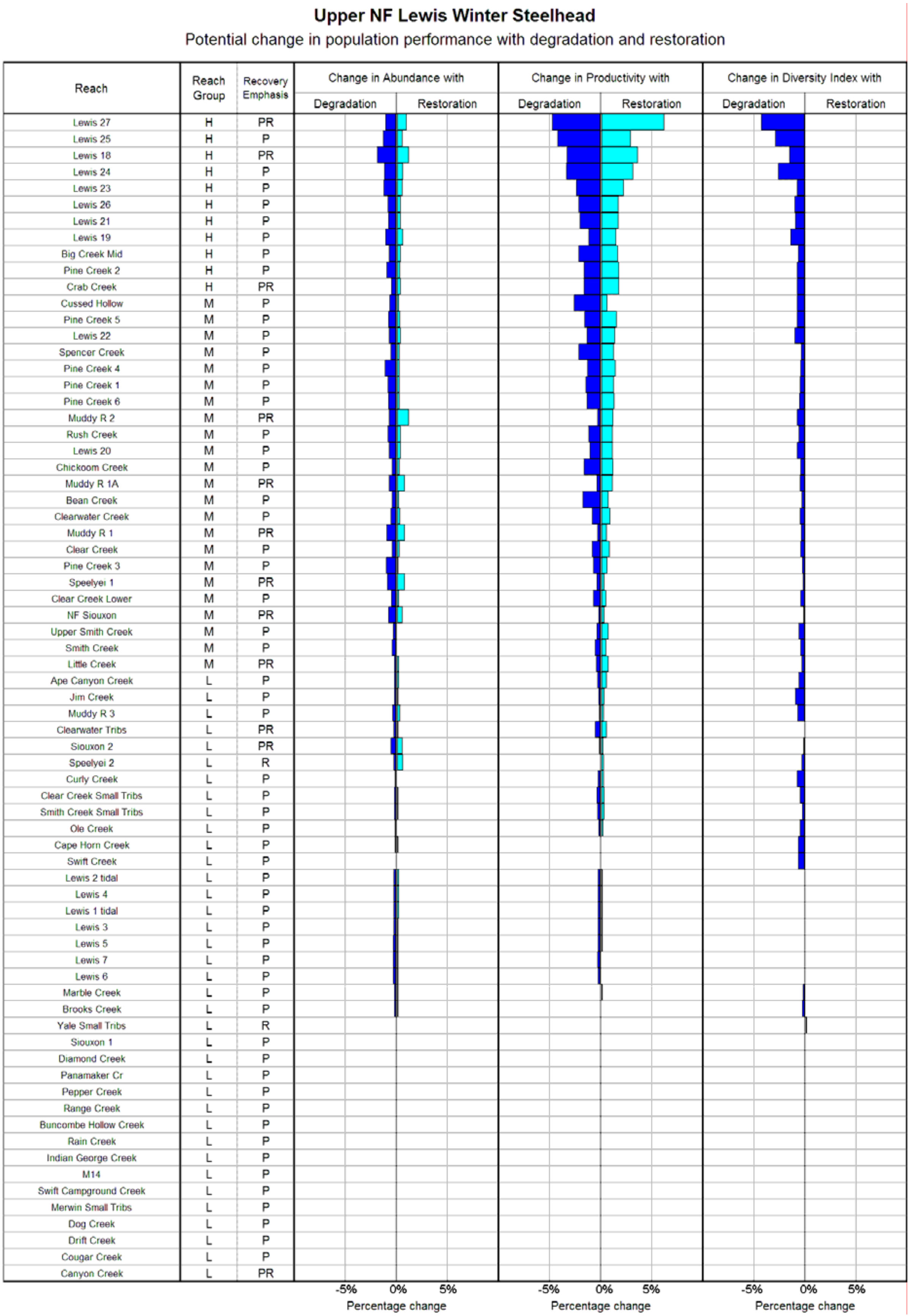


Figure 9. Upper Lewis winter steelhead ladder diagram.

3.4.3 *Habitat Factor Analysis*

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the habitat factor analysis compares current/patient and historical/template habitat conditions. For each reach, EDT generates what is referred to as a “consumer reports diagram”, which identifies the degree to which individual habitat factors are acting to suppress population performance. The effect of each habitat factor is identified for each life stage that occurs in the reach and the relative importance of each life stage is indicated. For additional information and examples of this analysis, see Appendix E. Inclusion of the consumer report diagram for each reach is beyond the scope of this document. A summary of the most critical life stages and the habitat factors affecting them are displayed for each species in Table 3.

Table 3. Summary of the primary limiting factors affecting life stages of focal salmonid species. Results are summarized from EDT Analysis.

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

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

High priority reaches for spring Chinook are located in mainstem areas. These reaches have been negatively impacted primarily by alterations to sediment and key habitat, with lesser impacts related to channel stability, habitat diversity, temperature, competition, predation, and food (Figure 10). High sediment impacts are related to large floods in the 1970s that delivered pulses of sediment that widened channels and contributed to instability (USFS 1995). These channels are still recovering. Predation impacts are primarily due to the potential for bull trout predation on juvenile spring Chinook. Habitat diversity has been reduced due to riparian degradation and low LWD quantities compared to historical levels.

For coho, the high priority reaches appear to be most impacted by sediment, habitat diversity, key habitat, and food (Figure 11). Some of these impacts are related to degraded riparian, channel, and hillslope conditions due to the Mount St. Helens eruption. Other impacts are most likely associated with road construction/condition and riparian harvest, as discussed above for spring Chinook.

As with spring Chinook, high priority winter steelhead reaches are generally located in the mainstem areas. The greatest impacts here are sediment and habitat diversity, with lesser impacts from predation, competition, flow, and food (Figure 12). Once again, lingering conditions from the Mount St. Helens eruption, high road densities, and timber harvest are the primary drivers of these impacts (refer to the discussion above for spring Chinook). Furthermore, these channels are still recovering from large sediment pulses from 1970s floods, which widened channels and created unstable conditions (USFS 1995). The February 1996 flood further exacerbated sediment conditions. Habitat diversity impacts are related to degraded riparian zones (harvest impacts) and low instream LWD levels.

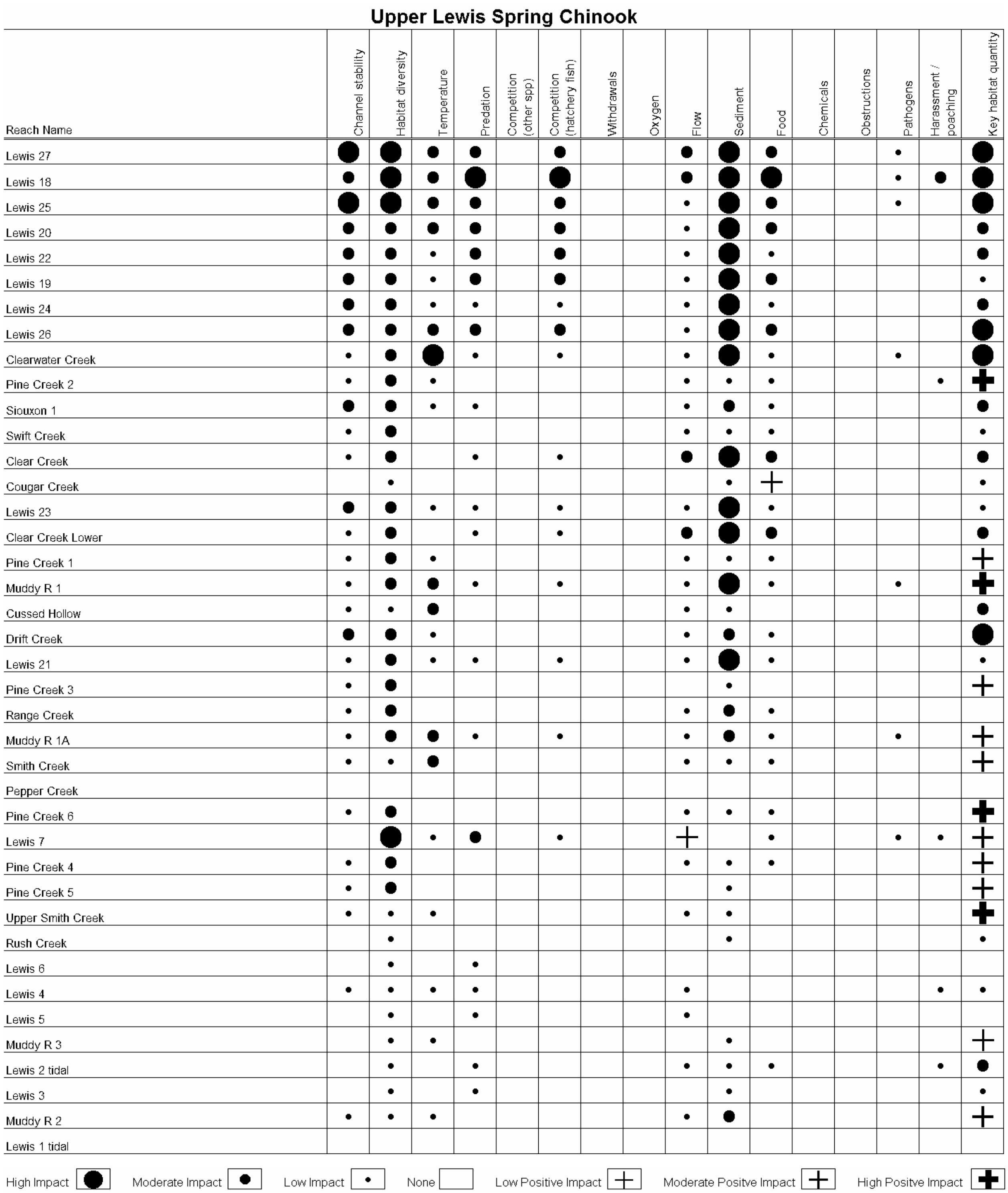


Figure 10. Upper North Fork Lewis River subbasin spring chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

Upper Lewis Coho

ReachName	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
Diamond Creek	M	H		L		L			M	H	L					L
Lewis 18	M	H	L	H		H			M	H	H			M	L	H
Clearwater Creek	M	H	H	L		M			M	H	H			L		H
Muddy R 1	M	H	H	M		H			M	H	H			L	L	+H
Muddy R 1A	M	H	M	M		M			M	H	M			L		+M
Clear Creek Lower	L	H		L		L			M	H	H			L		H
Y8	M	M							L	M	L					L
Lewis 19	M	H	L	M		M			L	H	M			L		L
Lewis 27	M	H		L		L			L	H	L			L		H
Clearwater Tribs	L	H		L		L			M	H	M			L		H
Lewis 21	M	H	L	M		M			L	H	M			L		M
Clear Creek	L	H		L		L			M	H	M			L		H
Curly Creek	M	H		L		L			L	H	M					H
Pepper Creek	M	M	L	L		L			L	H	L					H
Clear Creek Small Tribs	L	M		L		L			M	H	M			L		H
Smith Creek Small Tribs	L	M		L		L			M	H	M			L		H
Little Creek	L	M				L			M	H	L					M
Lewis 20	L	H	L	L		M			L	M	M					L
Crab Creek	L	M	L	L		L			L	H	L					M
Panamaker Cr	L	L							L	L						
Lewis 22	L	M		L		L			L	M	L					L
Cape Horn Creek	L	M	L			L			L	L	L					M
S10	M	M							L	M	L					L
Bean Creek	L	M							L	L	L					M
Big Creek Mid	M	M							L	M						M
Rain Creek	M	M	L	L		L			M	H	M					H
Pine Creek 1																
Smith Creek	L	H	L	L		L			L	L	L			L		+M
Jim Creek	L	M	L	L		L			L	H	M					M
Pine Creek 2																
Lewis 25	M	M		L		L				M	L					M
Lewis 24	L	M		L		L			L	M	L					M
Siouxon 1																
Chickoom Creek	M	M	L						L	M	L					M
Lewis 23																
Lewis 26	L	M		L		L			L	H	L					M
Drift Creek	M	M							L	M	L					M
B1																L
Spencer Creek	L	L							L	L						M
Ole Creek	L	L	L	L		L			L	M	M					M
S15	M	M							L	M	L					L
M14	L	M	L	L		L			L	H	M					M
Cougar Creek		L								L						L
Range Creek	M	L							L	M	L					L
Pine Creek 4																
Upper Smith Creek	L	M	L						L	L	L					+H

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

Figure 11. Upper NF Lewis coho habitat factor analysis diagram. Some low priority reaches are not included for display purposes.

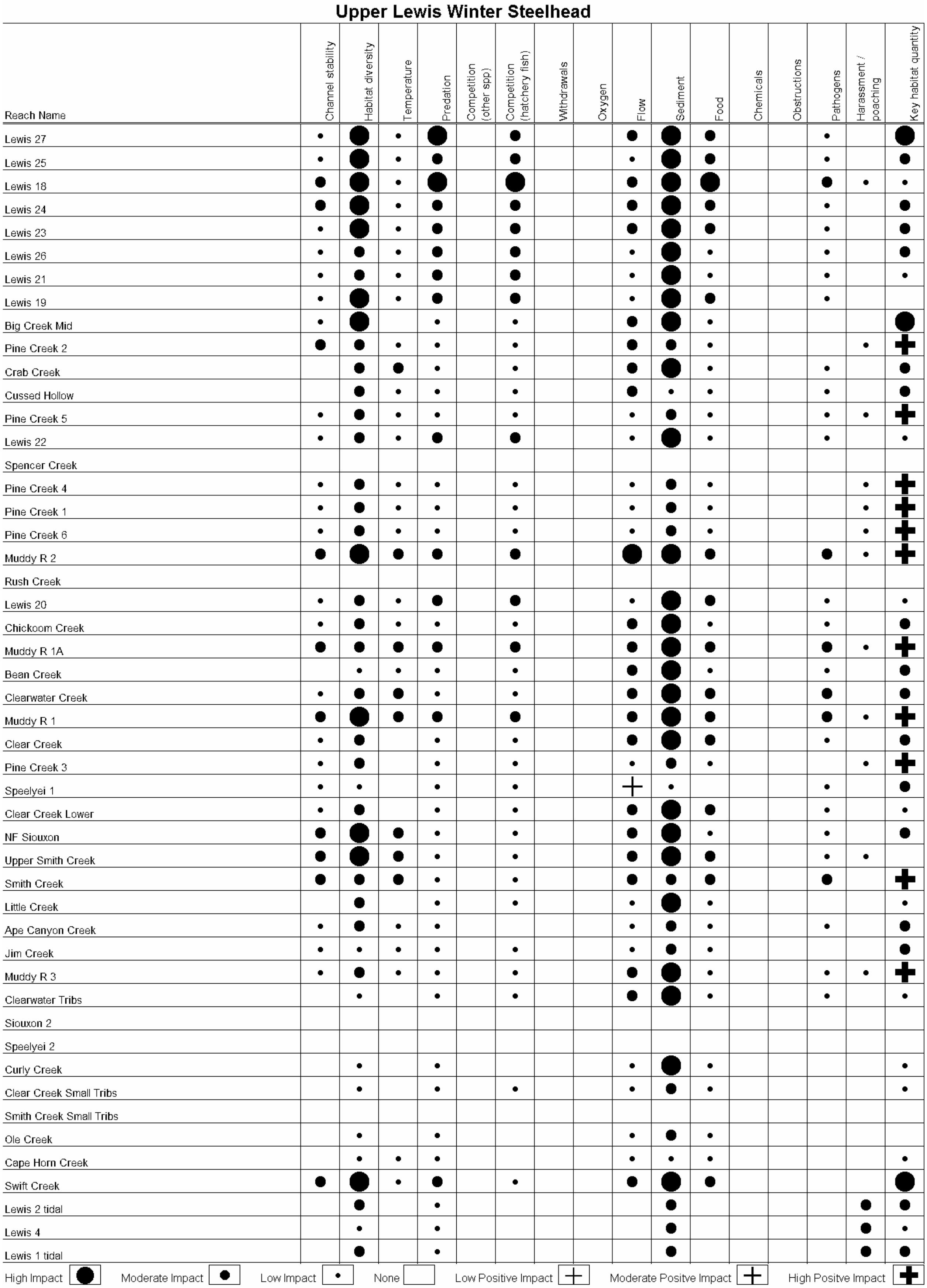


Figure 12. Upper NF Lewis winter steelhead habitat factor analysis diagram.

3.5 Watershed Process Limitations

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

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

For the purpose of recovery planning, the upper NF Lewis (above Merwin Dam) watershed is composed of 77 planning subwatersheds totaling 468,000 acres. IWA results for the upper NF Lewis River watershed are shown in Table 4. A reference map showing the location of each subwatershed in the basin is presented in Figure 13. Maps of the distribution of local and watershed level IWA results are displayed in Figure 14.

3.5.1 *Hydrology*

Current Conditions.— At the local (i.e., within-watershed level) the large majority of subwatersheds in the upper NF Lewis are rated hydrologically functional. Impervious surfaces are nearly absent, as are areas zoned for urban development. Road densities are generally moderate with low densities in the uppermost subwatersheds. Streamside road densities are moderate to high with numerous subwatersheds exceeding 1 mi/stream mi. Thirty-three percent of the watershed is within the rain-on-snow elevation zone, while mature forest covers roughly 54% of the landscape.

Hydrologic conditions are also rated as functional at the watershed level throughout the majority of the watershed. It should be noted, however, that the watershed level IWA hydrologic analysis does not explicitly consider impounded areas as characteristically impaired, but focuses rather on drainage area, land cover, rain-on-snow distribution, etc. It follows that several subwatersheds containing portions of Merwin, Yale and Swift Reservoirs are certainly impaired hydrologically, even if the IWA rating suggests otherwise. The IWA is best used as a descriptor of hydrologic condition as driven by local and watershed level subwatershed process conditions at the subwatershed scale, rather than as a description of instream hydrologic conditions.

In lower portions of the watershed (below the upstream end of Swift Reservoir), public ownership rates are lower but still a relatively robust 60%. Higher levels of hydrologic impairment are in evidence in these lower elevation subwatersheds, on both private and public lands. Seven out of ten hydrologically impaired subwatersheds are located within the Canyon Creek drainage (including Fly Creek), a left-bank tributary to upper Merwin Reservoir that features substantial timber production activities on both public and private lands (60201-205, 60101-103, 60305). The drainage is largely confined with steep banks and numerous smaller tributaries entering through incised hillslopes.

The Siouxon Creek drainage, which empties into Yale Reservoir (series 401xx, 402xx, 403xx), has a high degree of public ownership and currently functional hydrologic conditions. Potentially accessible portions of the Siouxon Creek drainage are thought to have supported substantial numbers of anadromous fish and would likely do so again in the event of anadromous reintroduction into the Yale Reservoir area. In addition, the smaller Ole Creek/Rain Creek drainage (40506) has been identified as a potential site for bull trout restoration for the beleaguered Yale population. This publicly owned subwatershed (WDNR) that drains into the dewatered reach of the mainstem below Swift Dam exhibits functional conditions for all three IWA parameters.

Predicted Future Trends.— Hydrologic conditions in the watershed are generally good, particularly in areas above Swift Reservoir. The three reservoirs of course do not express functional riverine hydrology, but surrounding watershed processes are generally less impaired than areas downstream of Merwin. The overwhelming majority of lands under federal management hold promise for the protection of functional hydrologic conditions and improvement of impaired areas through continually improving forest management practices. In the event of anadromous reintroduction, key areas above Swift reservoir will form the core spawning and rearing areas within the watershed. These upper watersheds (series 20xxx and 10xxx) benefit from greater than 99% public ownership, primarily as federal forest land. While timber harvest is sure to continue, road and riparian management—coupled with other evolving aspects of the federal forest management program—are likely to produce tangible restoration and protection benefits for key areas such as Clear Creek, Clearwater Creek, Smith Creek, Muddy River, Rush Creek and the mainstem NF Lewis River. The predicted trend for hydrologic conditions in these watersheds is stable (i.e., functional), with improvement in the landscape level factors that govern hydrologic conditions.

On the north and south sides of Swift Reservoir, many subwatersheds exhibit functional hydrologic conditions and a mixed distribution of private/public ownership. These subwatersheds (series 30xxx) are key candidates for hydrologic protection measures for lands under private ownership. Pine Creek (30101, 30102), for example, is characterized by mixed public/private ownership and is known to support bull trout. Management practices on private timberlands are also likely to improve under the Timber Fish and Wildlife Agreement. However, the likelihood of higher levels of timber harvest on these lands to offset reduced harvest on public lands suggests a trend towards increasing degradation.

Conditions in most of the Yale Reservoir tributary subwatersheds are functional (Siouxon Creek drainage) or moderaly impaired. These subwatersheds are likely to trend stable, with gradual improvement over time as with other largely publicly owned subwatersheds.

The degraded hydrologic conditions in the Canyon Creek-Fly Creek drainage are likely to persist due to a low percentage of mature vegetation, a high percentage within the rain-on-snow zone, steep slopes, and high road densities. The drainage offers limited potential anadromous habitat due to the presence of impassable natural falls at the base of the drainage.

Table 4. IWA results for the upper NF Lewis River Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
10101	F	M	M	F	M	none
10102	F	F	F	F	F	none
10201	F	F	F	F	F	10101, 10102
10301	F	M	F	F	M	none
10401	F	F	F	F	F	none
10501	F	M	F	F	F	10502, 10401, 10301, 10201, 10101, 10102
10502	F	M	F	F	M	10401, 10301, 10201, 10101, 10102
10601	F	F	F	F	F	none
10701	F	F	F	F	F	none
10702	F	M	F	F	M	10703, 10701
10703	F	M	F	F	M	10701
10801	F	F	F	F	M	10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
10901	F	M	F	F	M	10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
10902	F	F	F	F	F	10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
11001	F	M	F	F	F	11002
11002	F	F	M	F	F	none
11201	F	F	F	F	F	11202
11202	F	F	M	F	F	none
11301	F	M	F	F	F	11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
11302	F	F	F	F	F	11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
11303	F	F	M	F	F	11304
11304	F	F	M	F	F	none
20101	F	F	M	F	F	none

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
20102	F	F	M	F	F	20101
20103	F	M	M	F	F	20102, 20101
20201	F	M	M	F	M	none
20202	F	M	M	F	M	20201
20203	F	F	M	F	F	none
20204	F	F	M	F	M	20203, 20202, 20201
20301	F	M	F	F	M	none
20302	F	M	F	F	M	none
20303	F	F	F	F	M	20302, 20301
20401	F	F	F	F	F	20303, 20302, 20301
20402	F	F	F	F	F	20401, 20303, 20302, 20301
20501	F	M	M	F	M	20103, 20102, 20101, 20204, 20203, 20202, 20201
20502	F	F	M	F	F	20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301
30101	F	F	M	F	F	none
30102	F	M	M	F	M	30101
30201	F	M	F	F	M	30202
30202	F	M	M	F	M	none
30301	F	I	M	F	F	30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
30302	F	M	M	F	F	30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
30401	F	M	M	F	M	30402
30402	F	M	F	F	M	none

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
30501	F	F	M	F	M	30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
30502	F	I	M	F	M	30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
30503	F	M	M	F	M	none
40101	F	M	F	F	M	40102, 40103
40102	M	M	F	M	M	none
40103	M	M	F	M	M	none
40201	F	M	M	F	M	40202, 40101, 40102, 40103
40202	F	F	F	F	M	40101, 40102, 40103
40301	F	M	M	F	M	40302, 40303, 40201, 40202, 40101, 40102, 40103
40302	F	M	F	F	M	40303
40303	F	M	F	F	M	none
40401	M	M	M	M	M	40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
40402	F	M	F	F	M	none
40501	F	M	M	F	M	40301, 40302, 40303, 40201, 40202, 40101, 40102, 40103, 40502, 40401, 40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
40502	F	M	M	M	M	40401, 40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
40503	I	M	M	M	M	40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
40504	M	F	M	M	F	none
40505	M	F	M	M	F	none
40506	F	F	F	F	F	none
60101	M	M	M	M	M	60102
60102	I	M	M	I	M	none
60103	I	M	M	I	M	none
60201	I	I	M	I	M	60203, 60204, 60205, 60202, 60103, 60101, 60102
60202	I	M	F	I	M	60103, 60101, 60102
60203	I	M	M	I	M	60204
60204	I	M	M	I	M	none
60205	M	M	F	M	M	none
60301	I	M	M	M	M	60306, 60302, 60303, 60304, 40505, 60305, 60201, 60203, 60204, 60205, 60202, 60103, 60101, 60102, 40501, 40301, 40302, 40303, 40201, 40202, 40101, 40102, 40103, 40502, 40401, 40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
60302	F	F	M	M	M	60303, 60304, 40505, 60305, 60201, 60203, 60204, 60205, 60202, 60103, 60101, 60102, 40501, 40301, 40302, 40303, 40201, 40202, 40101, 40102, 40103, 40502, 40401, 40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
60303	M	M	M	M	M	none
60304	M	M	M	M	M	40505, 60305, 60201, 60203, 60204, 60205, 60202, 60103, 60101, 60102, 40501, 40301, 40302, 40303, 40201, 40202, 40101, 40102, 40103, 40502, 40401, 40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
60305	I	M	M	F	M	60201, 60203, 60204, 60205, 60202, 60103, 60101, 60102, 40501, 40301, 40302, 40303, 40201, 40202, 40101, 40102, 40103, 40502, 40401, 40503, 40402, 40504, 40506, 30201, 30202, 30501, 30502, 30503, 30401, 30402, 30301, 30302, 30102, 30101, 20502, 20501, 20103, 20102, 20101, 20204, 20203, 20202, 20201, 20402, 20401, 20303, 20302, 20301, 11302, 11201, 11202, 11301, 11303, 11304, 11001, 11002, 10902, 10901, 10801, 10702, 10703, 10701, 10601, 10501, 10502, 10401, 10301, 10201, 10101, 10102
60306	I	F	M	I	F	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.

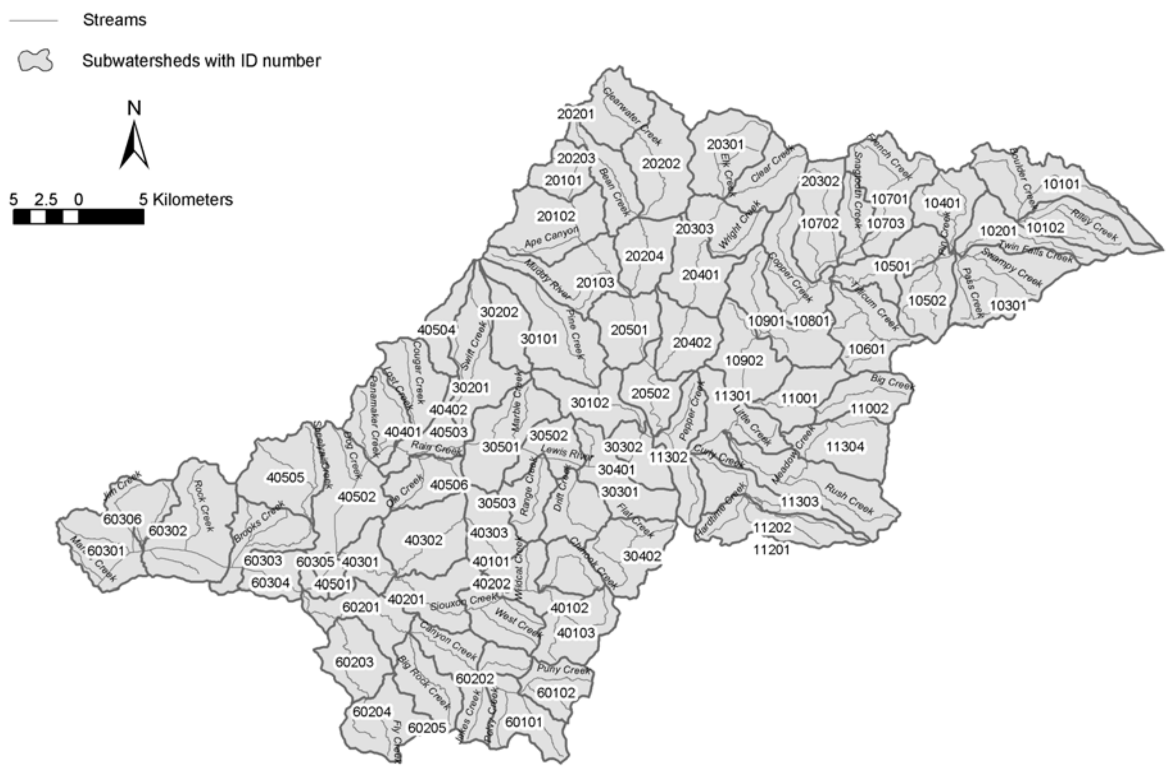


Figure 13. Map of the Upper North Fork Lewis River basin showing the location of the IWA subwatersheds.

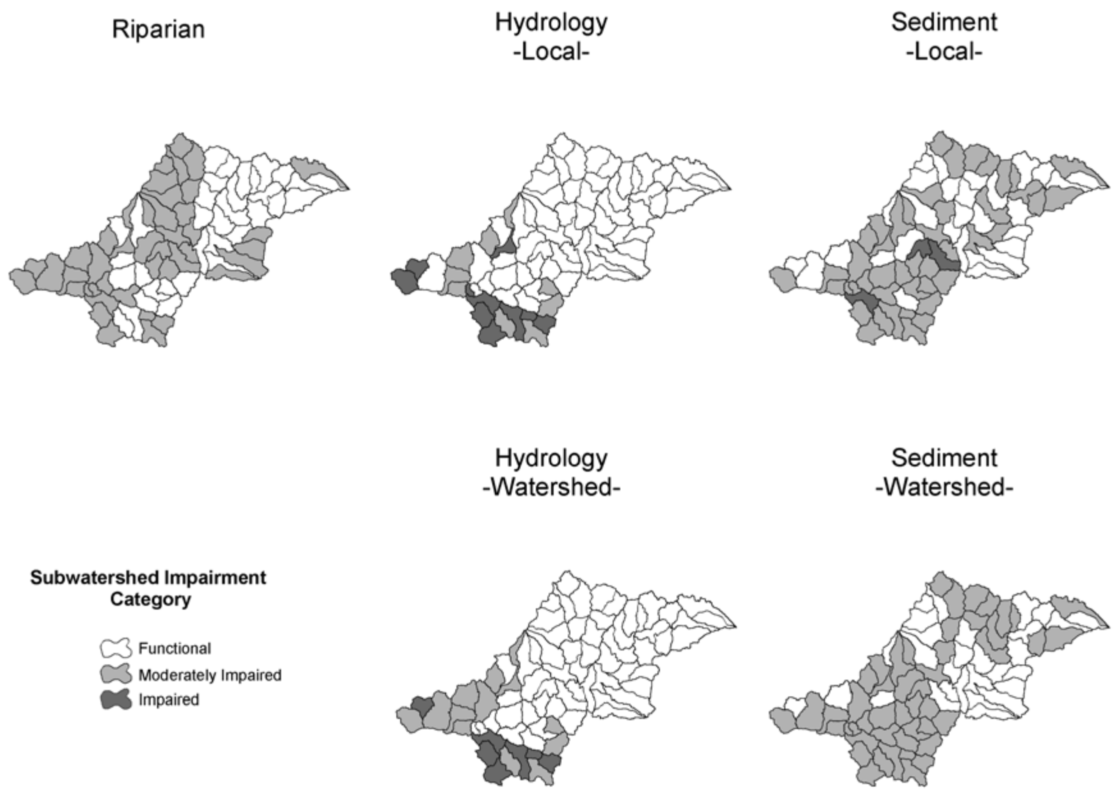


Figure 14. IWA subwatershed impairment ratings by category for the Upper North Fork Lewis River basin.

3.5.2 *Sediment Supply*

Current Conditions.— Moderately impaired sediment and riparian conditions are a reflection of the high levels of timber production within the watershed. Poor road management coupled with clear cutting has exacerbated sediment conditions. In the portions of the watershed flowing from Mt. St. Helens, numerous streams (such as Smith and Pine Creeks) continue to suffer from heavy sediment loads precipitated by the eruption in 1980 (20103, 20501, 20103). Riparian areas throughout these high-elevation reaches were razed by the volcanic debris flow, with the majority of sediment and debris winding up in Swift Reservoir.

The Canyon Creek drainage is largely confined with steep banks and numerous smaller tributaries entering through incised hillslopes. The area has impaired sediment conditions due to human activities, including locally high road densities up to 5 mi/sq mi and stream crossing densities in excess of 5.4 crossings/stream mile in subwatersheds 60201, 60203 and 60204. The proportion of individual Canyon Creek/Fly Creek subwatersheds in the rain-on-snow zone ranges from 15%-93%. Combined with heavily degraded sediment and riparian condition, this area is likely at greatest risk of further degradation within the watershed. However, even in the event of anadromous reintroduction, Canyon Creek would provide limited potential habitat due to impassable, natural falls just upstream of Merwin Reservoir.

Local level sediment conditions in the watershed include 45 subwatersheds with moderately impaired conditions and three with impaired conditions. Impaired and moderately impaired ratings occur throughout the Yale and Merwin portions of the watershed with only isolated pockets of functional conditions. The entire southern half of the watershed (i.e., south of the North Fork reservoirs) from Merwin Dam to the upstream end of Swift Reservoir is rated as impaired or moderately impaired, with the exception of a single subwatershed in the Siouxon drainage (40202), a tributary to Yale Lake, which is rated as functional. This portion of the watershed has experienced high levels of timber harvest, and as a consequence has a higher density of forest roads.

Functional sediment conditions are more prevalent in the upper watershed, upstream of Swift Reservoir. Contiguous concentrations of functional sediment conditions are located along nearly the entire length of Clear Creek (20303, 20401, 20402), Clearwater Creek (20203, 20204), along the mainstem North Fork above Swift (10801, 10902) and in the North Fork headwaters (10201, 10102). Rush Creek, a left bank tributary to the North Fork upstream of Swift Reservoir also has functional sediment conditions. Rush Creek is known for its moderately healthy population of Bull trout.

Predicted Future Trends.— As with hydrologic conditions, sediment conditions in the upper watershed are likely to improve over the next 20 years under federal forest management. These improvements may prove critical to the success of anadromous reintroduction efforts. The northern flank of the upper watershed (Smith Creek, Pine Creek, Clearwater Creek) will continue to process elevated natural sediment loads as a consequence of the Mt. St. Helens eruption. The long-term prognosis for these areas is quite good following natural recovery of riparian conditions.

Sediment conditions in the lower watershed are predicted to trend towards improvement on publicly owned lands as timber harvest levels decline and the impacts of improved forestry management practices are realized. In contrast, moderately impaired or impaired sediment conditions on private timberlands are likely to trend stable over the next 20 years. Improved forestry and road management practices are expected to improve sediment conditions in general, but these gains may be offset by increased timber harvest on private lands.

3.5.3 *Riparian Condition*

Current Conditions.— Moderately impaired riparian conditions occur in 43 of the 77 subwatersheds, with none rated as impaired. The greatest concentration of functional conditions occur in the upper Lewis mainstem, Clear Creek, and Siouxon Creek drainages. Other functional conditions are scattered throughout the basin. Inadequate stream buffers are primarily related to past timber harvests and stream adjacent roadways. The 1980 Mount St. Helens eruption denuded riparian vegetation in portions of the Pine Creek (series 301xx) and Muddy River (series 201xx, 202xx, 205xx) drainages.

Predicted Future Trends.— As a predominantly timber-driven watershed, riparian trends in the future will likely closely mimic sediment trends as described above, with progress on publicly owned lands balanced by stable conditions or slight improvements on privately held timber lands. The predicted trend in riparian conditions on public lands is towards improvement, with the trend on private land towards stability with more gradual improvement over time. Some lower-elevation subwatersheds (e.g. lower Speelyai Creek - 60303) may experience increased degradation due to development pressures.

3.6 Other Factors and Limitations

3.6.1 *Hatcheries*

Hatcheries currently release over 50 million salmon and steelhead per year in Washington lower Columbia River subbasins. Many of these fish are released to mitigate for loss of habitat. Hatcheries can provide valuable mitigation and conservation benefits but may also cause significant adverse impacts if not prudently and properly employed. Risks to wild fish include genetic deterioration, reduced fitness and survival, ecological effects such as competition or predation, facility effects on passage and water quality, mixed stock fishery effects, and confounding the accuracy of wild population status estimates. This section describes hatchery programs in the North Lewis subbasin and discusses their potential effects.

There are three hatcheries operating in the North Lewis Basin: the Lewis River Salmon Hatchery, Speelyai Hatchery, and the Merwin (Ariel) Hatchery. Additionally, Fish First (a volunteer organization) operates spring Chinook net pens at RM 10 in the NF Lewis. The fish first annual production goal is 150,000 spring Chinook smolts, which are obtained from Speelyai Hatchery production. Fish First volunteers also assist in rearing summer steelhead in the Merwin Reservoir net pens, and coho for supplementing Cedar Creek. These hatchery facilities and programs will be used in the near future to facilitate the reintroduction of spring Chinook, coho, and winter steelhead to the habitats in the Upper Lewis Basin.

Lewis River Hatchery

The Lewis River Hatchery (since 1932) produces spring Chinook and coho for harvest as well as a sorting facility for all species trapped at Merwin Dam. The Lewis River Hatchery provides late coho eggs for the Klickitat coho program and in some years spring Chinook pre-smolts for the Deep River program. (Table 5).

The Lewis River Hatchery spring Chinook and late coho programs are primarily derived from Cowlitz stocks, and the early coho program from Toutle stock. The early winter steelhead produced at Merwin Hatchery is a composite Elochoman, Chambers Creek, and Cowlitz steelhead, and the summer steelhead are Skamania stock. The main threats from hatchery released salmon are domestication of wild fish and ecological interactions between hatchery smolts and wild fall Chinook, chum, and coho in the lower river. The main threats from hatchery steelhead are potential domestication of the naturally-produced steelhead as a result of adult interactions or ecological interactions between natural juvenile salmon and hatchery released juvenile steelhead.

Speelyai Hatchery

Speelyai Hatchery (since 1958) is located in Merwin Reservoir and is used for incubation and early rearing of spring Chinook, coho, and steelhead. Speelyai Hatchery also produces kokanee and rainbow trout for reservoir recreational fisheries. Merwin Hatchery (since 1983) produces early-timed winter and summer steelhead and rainbow trout (Table 5).

Table 5 provides information on annual production levels at Speelyai Hatchery. 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 (Figure 15).

Merwin (Ariel) Hatchery

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. Merwin Hatchery also provides summer steelhead for the Elochoman program (Table 5).

Table 5. Current Lewis Basin hatchery production.

Hatchery	Release Location	Spring Chinook	Late Coho	Early Coho	Winter Steelhead	Summer Steelhead	Kokanee	Rainbow
Lewis R.	Lower Lewis	1,050,000	815,000	880,000				
Speelyai	Yale Res.						93,000	
	Swift Res.							400,000
Merwin	Lower Lewis				100,000	175,000		
	Elochoman					35,000		
	Swift Res.							400,000
Fish First net pens	Lower Lewis	150,000				50,000		
	Cedar Creek		15,000					

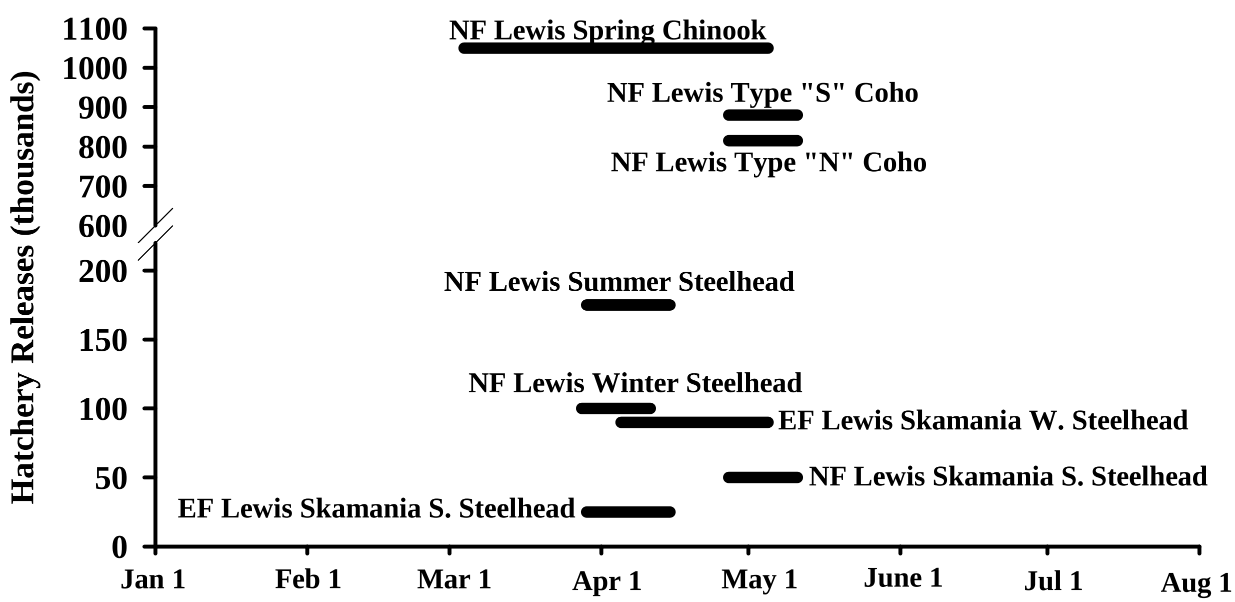


Figure 15. Magnitude and timing of hatchery releases in the Lewis River basins by species, based on 2003 brood production goals.

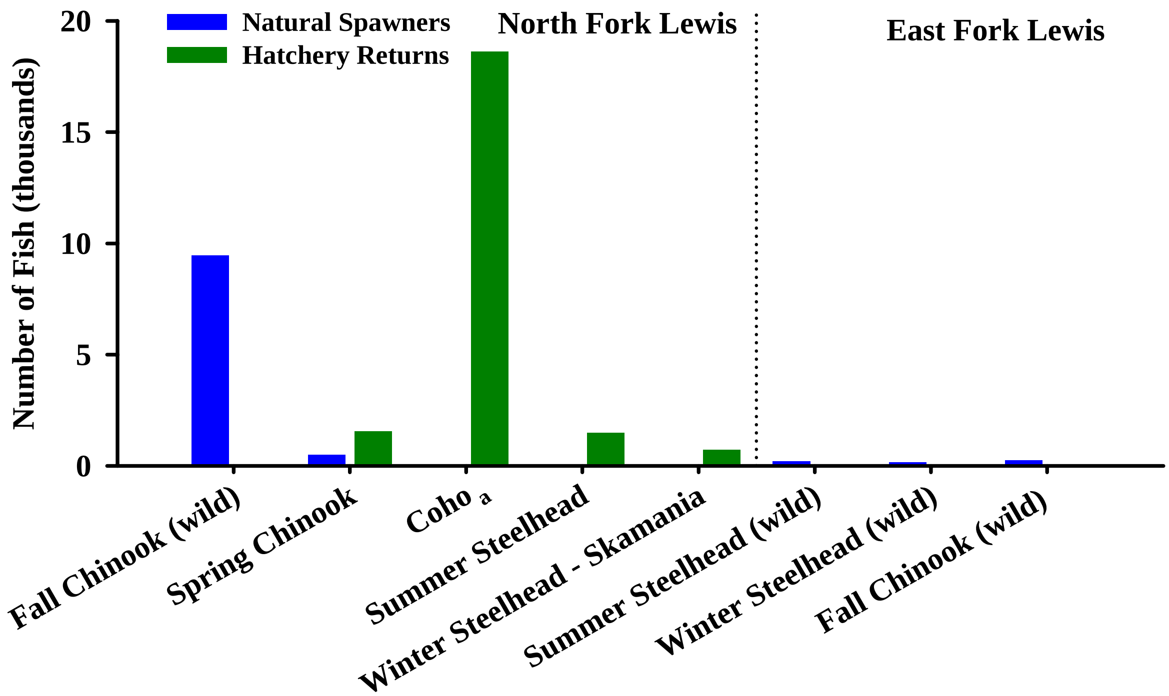


Figure 16. Recent average hatchery returns and estimates of natural spawning escapement in the Lewis River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present. Calculation of each average utilized a minimum of 5 years of data.

Hatchery Effects

Genetics—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.

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.

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.

Biological Risk Assessment

The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC related plans on the Cowlitz River and Lewis River; and 4) the federally mandated Artificial Production Review and Evaluation (APRE) process. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program. WDFW developed the Benefit-Risk Assessment Procedure (BRAP) to provide that framework. The BRAP evaluates hatchery programs in the ecological context of the watershed, with integrated assessment and decisions for hatcheries, harvest, and habitat. The risk assessment procedure consists of five basic steps, grouped into two blocks:

Policy Framework

- Assess population status of wild populations
- Develop risk tolerance profiles for all stock conditions
- Assign risk tolerance profiles to all stocks

Risk Assessment

- Conduct risk assessments for all hatchery programs
- Identify appropriate management actions to reduce risk

Following the identification of risks through the assessment process, a strategy is developed to describe a general approach for addressing those risks. Building upon those strategies, program-specific actions and an adaptive management plan are developed as the final steps in the WDFW framework for hatchery reform.

Table 6 identifies hazards levels associated with risks involved with hatchery programs in the Upper North Fork Lewis River Basin. Table 7 identifies preliminary strategies proposed to address risks identified in the BRAP for the same populations.

The BRAP risk assessments and strategies to reduce risk have been key in providing the biological context to develop the hatchery recovery measures for lower Columbia River sub-basins.

Table 6. Preliminary BRAP for hatchery programs affecting populations in the Upper North Fork Lewis River Basin.

Symbol	Description
○	Risk of hazard consistent with current risk tolerance profile.
?	Magnitude of risk associated with hazard unknown.
●	Risk of hazard exceeds current risk tolerance profile.
(shaded)	Hazard not relevant to population

Upper North Fork Lewis Population	Hatchery Program: Name	Release (millions)	Genetic: Effective Population Size	Genetic: Domestication	Genetic: Diversity	Ecological: Predation	Ecological: Competition	Ecological: Disease	Demographic: Survival Rate	Demographic: Reproductive Success	Facility: Catastrophic Loss	Facility: Passage	Facility: Screening	Facility: Water Quality
Fall Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Late Fall Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Spring Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900	○	○	○	?	?	○	○	?	○	○	○	○
	Fish First Sp. Chinook 1+	0.150	○	○	○	?	?	○	○	?	○	○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Chum	EF Lewis S. Steelhead	0.025				?	○	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	○	○				○	○	○
	Merwin W. Steelhead	0.100				?	○	○				○	○	○
	Lewis Coho Type S	0.880				?	○	○				○	○	○
	Lewis Coho Type N	0.815				?	○	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	○	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	○	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	○	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	○	○				○	○	○
	Merwin S. Steelhead	0.175				?	○	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	○	○				○	○	○
Summer Steelhead	EF Lewis S. Steelhead	0.025	○	○	?	?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050	○	○	?	?	?	○				○	○	○
	Merwin S. Steelhead	0.175	○	○	?	?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Winter Steelhead	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080	○	○	?	?	?	○				○	○	○
	Merwin W. Steelhead	0.100	○	○	?	?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○

Table 7. Preliminary strategies proposed to address risks identified in the BRAP for Upper North Fork Lewis River Basin populations.

	Hatchery Program		Risk Assessment of Hazards														
			Address Genetic Risks					Address Ecological Risks				Address Demographic Risks		Address Facility Risks			
North Fork Lewis Population	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abatemei
Fall Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900						●	●		●						
	Fish First Sp. Chinook 1+	0.150						●	●		●						
	NF Lewis S. Steelhead 1+	0.050						●	●		●				—	—	
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1	0.020						●	●		●						
Late Fall Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900						●	●		●						
	Fish First Sp. Chinook 1+	0.150						●	●		●						
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1	0.020						●	●		●						
Spring Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900		●	●	●		●	●		●		●				
	Fish First Sp. Chinook 1+	0.150		●	●	●		●	●		●		●				
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1	0.020						●	●		●						

Impact Assessment

The potential significance of negative hatchery impacts within the subbasin on natural populations was estimated with a simple index based on: 1) intra-specific effects resulting from depression in wild population productivity that can result from interbreeding with less fit hatchery fish and 2) inter-specific effects resulting from predation of juvenile salmonids of other species. The index reflects only a portion of net hatchery effects but can provide some sense of the magnitude of key hatchery risks relative to other limiting factors. Fitness effects are among the most significant intra-specific hatchery risks and can also be realistically quantified based on hatchery fraction in the natural spawning population and assumed fitness of the hatchery fish relative to the native wild population. Predation is among the most significant inter-specific effects and can be estimated from hatchery release numbers by species. This index assumed that equilibrium conditions have been reached for the hatchery fraction in the wild and for relative fitness of hatchery and wild fish. This simplifying assumption was necessary because more detailed information is lacking on how far the current situation is from equilibrium. The index does not consider the numerical benefits of hatchery spawners to natural population numbers, ecological interactions between hatchery and wild fish other than predation, or out-of-basin interactions, all of which are difficult to quantify. Appendix E contains a detailed description of the method and rationale behind this index.

The indexed potential for negative impacts of hatchery spawners on wild population fitness in the North Fork Lewis Subbasin is quite low (1%) for late fall Chinook where releases were discontinued in 1986. Fitness impact potential is substantially greater for the summer steelhead (65%), spring Chinook (45%), winter steelhead (23%), and coho (21%) fishery enhancement programs in the Lewis River. However, the high incidence of spring Chinook and coho hatchery spawners suggests that the fitness of natural and hatchery fish is now probably quite similar and natural populations might decline substantially without continued hatchery subsidy under current habitat conditions. Fitness impacts of hatchery steelhead are limited by temporal differences between hatchery and wild steelhead. Fitness impacts associated with the upper Lewis basin supplementation and reintroduction program will be a necessary consequence of the effort to restore natural spring Chinook and coho to the upper basin. Hatchery supplementation would likely be reduced or eliminated in the future once natural runs are sustainable. Strategy for reintroduction of winter steelhead to the upper Lewis includes utilization of late returning wild fish which are temporally separated from the earlier spawning hatchery stock and would minimize fitness impacts. Interspecific impacts from predation for the entire Lewis hatchery production are estimated to range from less then 1% for coho to 15% for fall Chinook. A portion of these impacts would be from hatchery production released into the upper Lewis basin in the future.

Table 8. Presumed reductions in wild population fitness as a result of natural hatchery spawners and survival as a result of interactions with other hatchery species for the North Fork Lewis salmon and steelhead populations.

Population	Annual releases[a]	Hatchery fraction[b]	Fitness category[c]	Assumed fitness[d]	Fitness impact[e]	Interacting releases[f]	Interspecies impact[g]
Late Fall Chinook	0[h]	0.13	1	0.9	0.01	3,070,000	0.15
Spring Chinook	1,050,000[i]	0.90	3	0.5	0.45	--	--
Chum	0[j]	0	--	--	0	1,375,000	0.069
Coho	1,695,000[k]	0.69	2	0.7	0.21	3,070,000	0.04
Summer Steelhead	225,000	0.93	4	0.3	0.651	0	0
Winter Steelhead	100,000	0.77	2	0.7	0.231	0	0

[a] Annual release goals.
[b] Proportion of natural spawners that are first generation hatchery fish which are strays from other basins
[c] Broodstock category: 1 = derived from native local stock, 2 = domesticated stock of native local origin, 3 = originates from same ESU but substantial divergence may have occurred, 4 = out-of-ESU origin or origin uncertain
[d] Productivity of naturally-spawning hatchery fish relative to native wild fish prior to significant hatchery influence. Because population-specific fitness estimates are not available for most lower Columbia River populations, we applied hypothetical rates comparable to those reported in the literature and the nature of local hatchery program practices.
[e] Index based on hatchery fraction and assumed fitness.
[f] Number of other hatchery releases with a potential to prey on the species of interest. Includes spring chinook, steelhead and coho for fall Chinook and coho. Includes spring chinook and steelhead for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.
[h] The Lewis River fall Chinook hatchery program was discontinued in 1986. There is no hatchery fall Chinook program in Salmon Creek.
[i] Current releases are in the lower Lewis. Reintroduction into the upper Lewis is also under consideration in the hydroelectric re-licensing process.
[j] There are no records of hatchery chum releases in the basin.
[k] Lewis River Hatchery goals include 880,000 early coho (type S) and 815,000 late coho (type N); fish are released in the lower Lewis River mainstem. Various possible salmonid reintroduction scenarios are currently being evaluated during the re-licensing process for the hydroelectric facilities on the Lewis River; the existing hatchery programs could become an integral part of any successful reintroduction program.

3.6.2 *Harvest*

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

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

Current fishing impact rates on lower Columbia River naturally-spawning salmon populations, which are expected to be reintroduced in the upper North Fork Lewis, ranges from 8.5% for steelhead to 22% for spring Chinook (Table 1). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced spring Chinook, coho, and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

Table 9. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Spring Chinook	13	5	1	1	2	**22**	53	65
Coho	<1	9	6	2	1	**18**	51	85
Steelhead	0	<1	3	0.5	5	**8.5**	70	75

Columbia River spring Chinook are subject to freshwater and ocean fisheries from Alaska to their rivers of origin in fisheries targeting abundant Chinook stocks originating from Alaska, Canada, Washington, Oregon, and California. Columbia River and in-basin fisheries are closed to the retention of unmarked wild Chinook.

Harvest of upper North Fork Lewis coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River as well as recreational fisheries in the upper North Fork basin. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish.

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

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

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

3.6.3 *Mainstem and Estuary Habitat*

Conditions in the Columbia River mainstem, estuary, and plume affect all anadromous salmonid populations within the Columbia Basin. Juvenile and adult salmon may be found in the mainstem and estuary at all times of the year, as different species, life history strategies and size classes continually rear or move through these waters. A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals.

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

3.6.4 *Hydropower Construction and Operation*

Merwin Dam (RM 20), built in 1931, blocks anadromous passage to the upper North Lewis watershed. Merwin Dam, along with Yale Dam (RM 35) and Swift 1 Dam (RM 45) form 39 miles of reservoir in the impounded upper Lewis Basin. Another small dam, Swift 2 diverts water from Swift 1 through a canal to a power generating facility. A program to reintroduce spring Chinook, coho and winter steelhead to the habitats of the upper North Lewis and provide passage for bull trout from Yale Reservoir to Swift Reservoir is likely to occur as part of an agreement for relicensing of the Lewis River hydrosystem. Successful reintroduction of Lewis spring Chinook is especially important for lower Columbia spring Chinook ESU recovery. A significant amount of habitat for North Lewis winter steelhead and coho is also located in the upper North Lewis watershed. The keys to successful reintroduction will be adequate passage of juveniles and adults to and from the upper watershed, hatchery supplementation, and habitat improvements. In addition, Upper Lewis anadromous species are affected by mainstem Columbia hydro operations and flow regimes which affect habitat in migration corridors and in the estuary. These factors are described in further detail in Volume I, Chapter 4. Mainstem hydro factors and threats are addressed by regional strategies and measures identified in Volume I, Chapter 7. Key regional strategies and measures applying to the upper North Lewis populations include.

The hydropower infrastructure and flow regulation affects adult migration, juvenile migration, mainstem spawning success, estuarine rearing, water temperature, water clarity, gas supersaturation, and predation. Dams block or impede passage of anadromous juveniles and adults. Columbia River spring flows are greatly reduced from historical levels as water is stored for power generation and irrigation, while summer and winter flows have increased. These flow changes affect juvenile and adult migration, and have radically altered habitat forming processes. Flow regulation and reservoir construction have increased average water temperature in the Columbia River mainstem and summer temperatures regularly exceed optimums for salmon. Supersaturation of water with atmospheric gases, primarily nitrogen, when water is spilled over high dams causes gas bubble disease. Predation by fish, bird, and marine mammals has been exacerbated by habitat changes. The net effect of these direct and indirect effects is difficult to quantify but is expected to be less significant for populations originating from lower Columbia River subbasins than for upriver salmonid populations. Additional information on hydropower effects can be found in the Regional Recovery and Subbasin Plan Volume I.

3.6.5 *Ecological Interactions*

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

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

3.6.6 *Ocean Conditions*

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

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

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

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

3.7 Summary of Human Impacts on Salmon and Steelhead

Stream habitat, estuary/mainstem habitat, harvest, hatchery and ecological interactions have all contributed to reductions in productivity, numbers, and population viability. Pie charts in Figure 17 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for upper North Fork Lewis Basin salmon and steelhead. Impact values were developed for a base period corresponding to species listing dates. This depiction is useful for identifying which factors are most significant for each species and where improvements might be expected to provide substantial benefits. Larger pie slices indicate greater significance and scope for improvement in an impact for a given species. These numbers also serve as a working hypothesis for factors limiting salmonid numbers and viability.

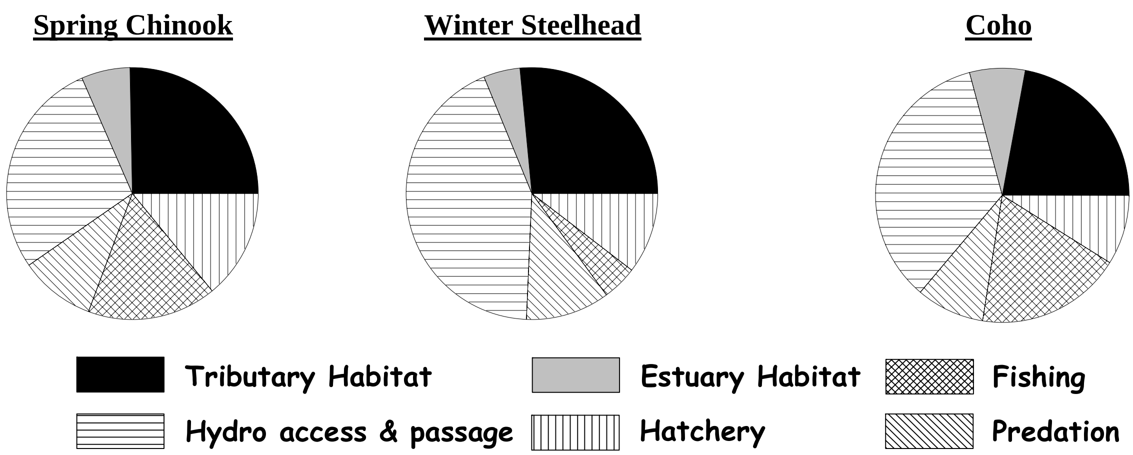


Figure 17. Relative contribution of potentially manageable impacts on upper North Fork Lewis River salmonid populations.

This assessment indicates that current salmonid status is the result of large impacts distributed among several factors. No single factor accounts for a majority of effects on all species. Thus, substantial improvements in salmonid numbers and viability will require significant improvements in several factors. Hydrosystem access and passage impacts are the most influential factor for each of the three upper North Fork Lewis populations. Loss of tributary habitat quality and quantity is an important impact for all species, particularly for spring Chinook and winter steelhead. Harvest has moderate impacts on spring Chinook and coho, but its effects on winter steelhead are minor. Hatchery impacts include domestication of natural populations (most applicable to Chinook and coho) and ecological interactions which can impact all species to variable degrees. Hatcheries moderately impact all three species in the upper North Fork Lewis. Loss of estuary habitat quality and quantity has a moderate impact on all species as does predation.

Impacts were defined as the proportional reduction in average numbers or productivity associated with each effect. Tributary and estuary habitat impacts are the differences between the pre-development historical baseline and current conditions. Hydro impacts identify the percentage of historical habitat blocked by impassable dams and the mortality associated with juvenile and adult passage of other dams. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries. Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in it's relative significance. Methods and data for these analyses are detailed in Appendix E.

Potentially-manageable human impacts were estimated for each factor based on the best available scientific information. Proportions are standardized to a total of 1.0 for plotting purposes. The index is intended to illustrate order-of-magnitude rather than fine-scale differences. Only the subset of factors we can potentially manage were included in this index – natural mortality factors beyond our control (e.g. naturally-occuring ocean mortality) are excluded. Not every factor of interest is included in this index – only readily-quantifiable impacts are included.

4.0 Key Programs and Projects

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

4.1 Federal Programs

4.1.1 *NOAA Fisheries*

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

4.1.2 *US Army Corps of Engineers*

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

4.1.3 *Environmental Protection Agency*

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

4.1.4 *United States Forest Service*

The Unites States Forest Service (USFS) manages federal forest lands within the Gifford Pinchot National Forest (GPNF), Mount Saint Helens National Volcanic Monument, and Wilderness Areas. The GPNF operates under the Gifford Pinchot Forest Plan (GPFP). Management prescriptions within the GPFP have been guided by the 1994 Northwest Forest Plan, which calls for management of forests according to a suite of management designations including Reserves (e.g. late successional forests, riparian forests), Adaptively-Managed Areas, and Matrix Lands. Most timber harvest occurs in Matrix Lands. The GPNF implements a wide range of ecosystem restoration activities. Lands within the Mount St. Helens National Monument and in Wilderness areas are managed for protection and/or passive restoration of ecosystem processes.

4.1.5 *Natural Resources Conservation Service*

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

4.1.6 *Northwest Power and Conservation Council*

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

4.1.7 *Federal Energy Regulatory Commission*

Non-federal hydroelectric projects that meet certain criteria operate under licenses issued by the Federal Energy Regulatory Commission (FERC). A hydroelectric license prescribes operations and safety precautions, as well as environmental protection, mitigation and enhancements. The FERC relicensing process requires years of extensive planning, including environmental studies, agency consensus, and public involvement.

4.2 State Programs

4.2.1 *Washington Department of Natural Resources*

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

4.2.2 *Washington Department of Fish & Wildlife*

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

4.2.3 *Washington Department of Ecology*

The Department of Ecology (DOE) oversees: the Water Resources program to manage water resources to meet current and future needs of the natural environment and Washington's communities; the Water Quality program to restore and protect Washington's water supplies by preventing and reducing pollution; and Shoreline and the Environmental Assistance program for implementing the Shorelines Management Act, the State Environmental Protection Act, the Watershed Planning Act, and 401 Certification of ACOE Permits.

4.2.4 *Washington Department of Transportation*

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

4.2.5 *Interagency Committee for Outdoor Recreation*

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

4.2.6 *Lower Columbia Fish Recovery Board*

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

4.3 Local Government Programs

4.3.1 *Cowlitz County*

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

4.3.2 *Clark County*

Clark County is conducting Comprehensive Planning under the State's Growth Management Act. Clark County manages natural resources under various programs including Critical Areas Ordinance, ESA Program, Road Operations, Parks Operations, Stormwater Management, and the Conservation Futures Program.

4.3.3 *Skamania County*

Skamania County is not planning under the State's Growth Management Act in its Comprehensive Planning process. Skamania County manages natural resources primarily through a Critical Areas Ordinance. Skamania County has adopted special land use and environmental regulations implementing the Columbia River Gorge National Scenic Area Act for some areas within their jurisdiction.

4.3.4 *Cowlitz / Wahkiakum Conservation District*

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

4.3.5 *Clark Conservation District*

Clark Conservation District provides technical assistance, cost-share assistance, and project monitoring in Clark County. Clark CD assists agricultural landowners in the development of farm plans and in the participation in the Conservation Reserve Enhancement Program. Farm plans optimize use, protect sensitive areas, and conserve resources.

4.3.6 *Underwood Conservation District*

The Underwood CD provides technical assistance, cost-share assistance, project and water quality monitoring, community involvement and education, and support of local stakeholder groups within the district. UCD implements a wide variety of programs, including conservation and restoration projects, water quality monitoring, a spring tree sales program, education and outreach activities, and support for local watershed committees.

4.3.7 *Cowlitz County Public Utility District*

Public Utility District No. 1 of Cowlitz County is a municipal corporation of the State of Washington, formed to provide electric service within Cowlitz County. Cowlitz County PUD is a not-for-profit, consumer-owned utility serving 45,500 electric customers and 3,540 water customers in the County. Cowlitz PUD owns the Swift No. 2 hydroelectric project. Cowlitz PUD operates Swift No. 2 according to an agreement that allows PacifiCorp to manage all four hydro projects on the Lewis River in a coordinated manner.

4.4 Non-governmental Programs

4.4.1 *Columbia Land Trust*

The Columbia Land Trust is a private, non-profit organization founded in 1990 to work exclusively with willing landowners to find ways to conserve the scenic and natural values of the land and water. Landowners donate the development rights or full ownership of their land to the Land Trust. CLT manages the land under a stewardship plan and, if necessary, will legally defend its conservation values.

4.4.2 *Lower Columbia Fish Enhancement Group*

The Washington State Legislature created the Regional Fisheries Enhancement Group Program in 1990 to involve local communities, citizen volunteers, and landowners in the state's salmon recovery efforts. RFEGs help lead their communities in successful restoration, education and monitoring projects. Every group is a separate, nonprofit organization led by their own board of directors and operational funding from a portion of commercial and recreational fishing license fees administered by the WDFW, and other sources. The mission of the Lower Columbia

RFEG (LCFEG) is to restore salmon runs in the lower Columbia River region through habitat restoration, education and outreach, and developing regional and local partnerships.

4.4.3 *PacifiCorp*

PacifiCorp is a power company that operates 53 hydropower facilities in Washington, Oregon, Idaho, Utah and Montana. In Washington, Oregon, Wyoming, and California, PacifiCorp operates as Pacific Power. PacifiCorp and the Cowlitz PUD operate hydroelectric facilities on the North Fork Lewis. The projects are currently undergoing relicensing pursuant to the federal Power Act using the Federal Energy Regulatory Commission's alternative licensing approach. Under this approach the utilities are working with federal agencies, local governments, tribes, community interests, and environmental organizations to develop a settlement agreement defining terms for a license.

4.5 NPCC Fish & Wildlife Program Projects

There are no NPCC Fish & Wildlife Program Projects in the Upper North Fork Lewis Basin.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Ac/ Restoration	DuPuis Chelatchie Creek Project	NF Lewis
Ac/ Restoration	Swift-Killian-Sargent Cedar Crk. Project	NF Lewis
Preservation	Doty Habitat Restoration (Cedar Creek)	NF Lewis
Preservation	Eagle Island Acquisition	NF Lewis
Restoration	Cedar Crk Riparian	NF Lewis
Restoration	Cedar Crk @ Amboy Blockage	NF Lewis
Restoration	Chelatichie Creek Restoration/Enhancement	NF Lewis
Restoration	Lockwood Recovery Enhancement	NF Lewis
Restoration	Van Breeman Reparian Restoration	NF Lewis
Restoration	Breeze Creek Culvert Design	NF Lewis
Restoration	Riley Creek Culvert Upgrade	NF Lewis
Restoration	Cedar Cr @ Cedar Creek Rd	NF Lewis
	Carter-Malinowski-Shimano Cedar Creek	NF Lewis

5.0 Management Plan

5.1 Vision

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

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

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

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

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

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

Columbia basin hydropower effects on upper NF Lewis subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Grays River will also be called upon to produce fish to help mitigate for hydropower impacts on upriver stocks where compatible with wild fish recovery.

This plan uses a planning period or horizon of 25 years. The goal is to achieve recovery of the listed salmon species and the biological objectives for other fish and wildlife species of interest within this time period. It is recognized, however, that sufficient restoration of habitat conditions and watershed processes for all species of interest will likely take 75 years or more.

5.2 Biological Objectives

Biological objectives for upper NF Lewis subbasin salmonid populations are based on recovery criteria developed by scientists on the Willamette/Lower Columbia Technical Recovery Team convened by NOAA Fisheries. Criteria involve a hierarchy of ESU, Strata (i.e. ecosystem areas within the ESU – Coast, Cascade, and Gorge), and Population standards. A recovery scenario describing population-scale biological objectives for all species in all three strata in the lower Columbia ESUs was developed through a collaborative process with stakeholders based on biological significance, expected progress as a result of existing programs, the absence of apparent impediments, and the existence of other management opportunities. Under the preferred alternative, individual populations will variously contribute to recovery according to habitat quality and the population's perceived capacity to rebuild. Criteria, objectives, and the regional recovery scenario are described in greater detail in the Regional Recovery and Subbasin Plan Volume I.

Focal populations in the upper NF Lewis subbasin are targeted to improve to a level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels.

The upper NF Lewis subbasin was identified as one of the most significant areas for spring Chinook recovery among lower Columbia populations based on fish population significance. Recovery goals call for restoring winter steelhead and coho to a medium viability level, providing for a 75-95% chance of persistence over the next 100 years. Spring Chinook recovery goals call for a high level of viability. This level will provide for a 95% probability of population survival over 100 years. Cutthroat will benefit from improvements in stream habitat conditions for anadromous species. Lamprey are also expected to benefit from habitat improvements in the estuary, Columbia River mainstem, and upper NF Lewis subbasin although specific spawning and rearing habitat requirements are not well known. The upper North Fork Lewis supports a significant bull trout population.

Table 10. Current viability status of upper North Fork Lewis populations and the biological objective status that is necessary to meet the recovery criteria for the Coastal strata and the lower Columbia ESU.

Species	ESA Status	Hatchery Component	Current Viability	Current Numbers	Objective Viability	Objective Numbers
Spring Chinook	Threatened	Yes	Very Low	200-1,000	High[P]	2,200
Winter steelhead	Threatened	Yes	Low	unknown	Medium[C]	300
Coho	Proposed	Yes	Very Low	unknown	Medium[C]	300

P = primary population in recovery scenario
C = contributing population in recovery scenario
S = stabilizing population in recovery scenario

5.3 Integrated Strategy

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

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

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

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

The following table displays baseline impacts for upper North Fork Lewis salmon and steelhead populations. Productivity improvement targets can be calculated once passage is restored. The hydro passage impact is less than 100% for spring Chinook and steelhead to account for the small percentage of the population downstream of Merwin Dam.

Table 11. Productivity improvements consistent with biological objectives for the upper North Fork Lewis subbasin.

Species	Net increase	Per factor	Baseline impacts					
			Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Spring Chinook	--	--	0.81	0.20	0.90	0.31	0.53	0.45
Coho	na	na	na	na	na	na	na	na
Winter Steelhead	_	_	0.59	0.10	0.95	0.24	0.10	0.23

5.4 Tributary Habitat

Habitat assessment results were synthesized in order to develop specific prioritized measures and actions that are believed to offer the greatest opportunity for species recovery in the subbasin. As a first step toward measure and action development, habitat assessment results were integrated to develop a multi-species view of 1) priority areas, 2) factors limiting recovery, and 3) contributing land-use threats. For the purpose of this assessment, limiting factors are defined as the biological and physical conditions serving to suppress salmonid population performance, whereas threats are the land-use activities contributing to those factors. Limiting Factors refer to local (reach-scale) conditions believed to be directly impacting fish. Threats, on the other hand, may be local or non-local. Non-local threats may impact instream limiting factors in a number of ways, including: 1) through their effects on habitat-forming processes – such as the case of forest road impacts on reach-scale fine sediment loads, 2) due to an impact in a contributing stream reach – such as riparian degradation reducing wood recruitment to a downstream reach, or 3) by blocking fish passage to an upstream reach. It is important to note that in the Upper Lewis Basin, tributary habitat areas and limiting factors were prioritized with the assumption that anadromous fish would have access to the upper basin above the mainstem dams.

Priority areas and limiting factors were determined through the technical assessment, including primarily EDT analysis and the Integrated Watershed Assessment (IWA). As described later in this section, priority areas are also determined by the relative importance of subbasin focal fish populations to regional recovery objectives. This information allows for scaling of subbasin recovery effort in order to best accomplish recovery at the regional scale. Land-use threats were determined from a variety of sources including Washington Conservation Commission Limiting Factors Analyses, the IWA, the State 303(d) list, air photo analysis, the Barrier Assessment, personal knowledge of investigators, or known cause-effect relationships between stream conditions and land-uses.

Priority areas, limiting factors and threats were used to develop a prioritized suite of habitat measures. Measures are based solely on biological and physical conditions. For each measure, the key programs that address the measure are identified and the sufficiency of existing programs to satisfy the measure is discussed. The measures, in conjunction with the program sufficiency considerations, were then used to identify specific actions necessary to fill gaps in measure implementation. Actions differ from measures in that they address program deficiencies as well as biophysical habitat conditions. The process for developing measures and actions is illustrated in Figure 18 and each component is presented in detail in the sections that follow.

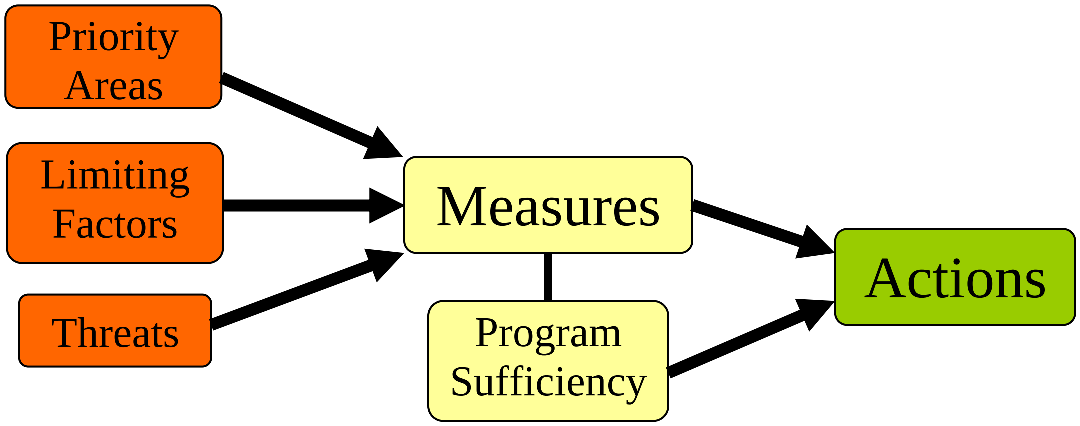


Figure 18. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Areas, Limiting Factors and Threats*

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

Summary

Decades of human activity in the Upper North Fork Lewis River Basin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, stream habitat conditions within the Upper North Fork Lewis Basin have a high impact on the health and viability of salmon and steelhead relative to other limiting factors. The following bullets provide a brief overview of each of the priority areas in the basin. These descriptions are a summary of the reach-scale priorities that are presented in the next section. These descriptions summarize the species most affected, the primary limiting factors, the contributing land-use threats, and the general type of measures that will be necessary for recovery. A tabular summary of the key limiting factors and land-use threats can be found in Table 12. Note that the lack of passage through the hydrosystem is the greatest limiting factor currently affecting all of these priority areas.

- **Upper mainstem** *(reaches Lewis 18-26)* – Most of the potentially productive habitat in the upper Lewis is in the upper mainstem above Swift Reservoir. The contributing basin is almost entirely within the Gifford Pinchot National Forest. The major impacts stem from the effects of forest practices on watershed processes. These reaches have high restoration and preservation value. The most effective recovery measures will be preservation of existing functional conditions and targeted restoration of road impacts and riparian areas
- **Muddy Creek basin** *(reaches Muddy R 1A; Clear Creek lower; Clear Creek; Clearwater Creek)* – The Muddy Creek system includes the large tributaries Clear Creek and Clearwater Creek. This system, particularly the mainstem Muddy and Smith Creek, were heavily impacted by the 1980 Mount St. Helens eruption. Intensive post-eruption timber harvests and road building further impacted these streams. Historically, these reaches were most important for coho but also provided productive winter steelhead and spring Chinook habitat.

- **Pine Creek** *(reaches Pine Creek 1-6)* **–** The recovery emphasis in the Pine Creek system is preservation; therefore no limiting factors and threats are specified. Pine Creek is believed to have historically provided habitat primarily for winter steelhead. This system was impacted by the 1980 Mount St. Helens eruption but has recovered rapidly. Although there has been considerable timber harvest and roading in this system, including some riparian timber harvests, stream conditions are currently good for winter steelhead.

The areas with the greatest current or potential production of bull trout in the upper North Fork Lewis Basin are the following: 1) Pine Creek, 2) Rush Creek, and 3) Cougar Creek (Yale Lake tributary). Bull trout will benefit from many of the same recovery measures identified for anadromous species, especially passage at mainstem dams and restoration/preservation of watershed processes on forested lands. Targeted riparian and stream channel restoration may benefit bull trout in reaches of Cougar, Pine, and Rush creeks.

Table 12. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the upper mainstem (UM) and Muddy Creek and tributaries (MC). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors			Threats		
	UM	MC		UM	MC
Habitat connectivity			***Forest practices***		
Blockages to stream habitats due to structures	✓	✓	Timber harvests –sediment supply impacts	✓	✓
Habitat diversity			Riparian harvests (historical)	✓	✓
Lack of stable instream woody debris	✓	✓	Forest roads – impacts to sediment supply	✓	✓
Altered habitat unit composition		✓	Forest roads – riparian/floodplain impacts	✓	
Channel stability			***Hydropower operations***		
Bed and bank erosion	✓	✓	Passage obstructions (dams)	✓	✓
Mass wasting		✓			
Riparian function					
Reduced bank/soil stability	✓				
Reduced wood recruitment	✓				
Water quality					
Altered stream temperature regime		✓			
Excessive turbidity		✓			
Substrate and sediment					
Excessive fine sediment	✓	✓			

Specific Reach and Subwatershed Priorities

Specific reaches and subwatersheds have been prioritized based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. Reaches have been placed into Tiers (1-4), with Tier 1 reaches representing the areas where recovery measures would yield the greatest benefits towards accomplishing the biological objectives. The reach tiering factors in each fish population's importance relative to regional recovery objectives, as well as the relative importance of reaches within the populations themselves. Reach tiers are most useful for identifying habitat recovery measures in channels, floodplains, and riparian areas. Reach-scale priorities were initially identified within individual populations (species) through the EDT Restoration and Preservation Analysis. This resulted in reaches grouped into categories of high, medium, and low priority for each population (see Stream Habitat Limitations section). Within a subbasin, reach rankings for all of the modeled populations were combined, using population designations as a weighting factor. Population designations for this subbasin are described in the Biological Objectives section. The population designations are 'primary', 'contributing', and 'stabilizing'; reflecting the level of emphasis that needs to be placed on population recovery in order to meet ESA recovery criteria.

Spatial priorities were also identified at the subwatershed scale. Subwatershed-scale priorities were directly determined by reach-scale priorities, such that a Group A subwatershed contains one or more Tier 1 reaches. Scaling up from reaches to the subwatershed level was done in recognition that actions to protect and restore critical reaches might need to occur in adjacent and/or upstream upland areas. For example, high sediment loads in a Tier 1 reach may originate in an upstream contributing subwatershed where sediment supply conditions are impaired because of current land use practices. Subwatershed-scale priorities can be used in conjunction with the IWA to identify watershed process restoration and preservation opportunities. The specific rules for designating reach tiers and subwatershed groups are presented in Table 13. Reach tier designations for this basin are included in

Table 14. Reach tiers and subwatershed groups are displayed on a map in Figure 19. A summary of reach- and- subwatershed-scale limiting factors is included in Table 15.

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

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

Table 14. Reach Tiers in the upper North Fork Lewis

Tier 1	Tier 2	Tier 3	Tier 4
Lewis 18	Big Creek	Bean Creek	Ape Canyon Creek
Lewis 19	Clear Creek	Cape Horn Creek	B1
Lewis 20	Clear Creek Lower	Chickoom Creek	BARRIER RESERVOIR
Lewis 22	Clearwater Creek	Clear Creek Small Tribs	Brooks Creek
Lewis 25	Cougar Creek	Clearwater Tribs	Buncombe Hollow Creek
Lewis 27	Crab Creek	Curly Creek	Canyon Creek
	Cussed Hollow	Little Creek	Dog Creek
	Diamond Creek	Muddy R 2	Drift Creek
	Lewis 21	Panamaker Cr	Indian George Creek
	Lewis 23	Pepper Creek	Jim Creek
	Lewis 24	Rain Creek	Lewis 1 tidal
	Lewis 26	S10	Lewis 2 tidal
	Muddy R 1	Smith Creek Small Tribs	Lewis 3
	Muddy R 1A	Swift Campground Creek	Lewis 4
	Pine Creek 1	Y8	Lewis 5
	Pine Creek 2		Lewis 6
	Pine Creek 4		Lewis 7
	Pine Creek 5		M14
	Pine Creek 6		Marble Creek
	Siouxon 1		Merwin Small Tribs
	Spencer Creek		Muddy R 3
	Swift Creek		NF Siouxon
	Rush Creek		Ole Creek
			P1
			P10
			P3
			P7
			P8
			Pine Creek 3
			Range Creek
			S15
			Siouxon 2
			Smith Creek
			Speelyei 1
			Speelyei 2
			Upper Smith Creek
			Yale Small Tribs

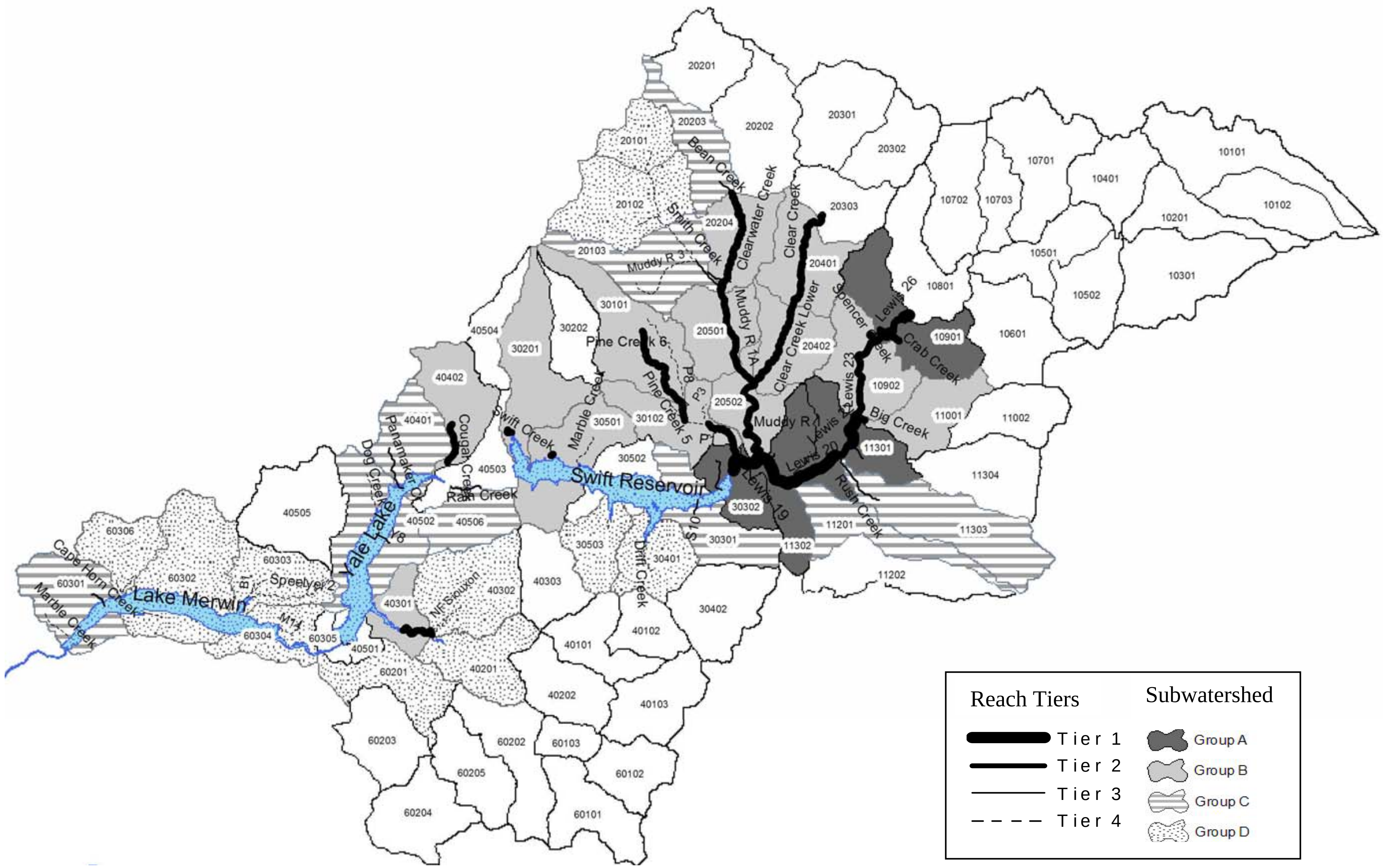


Figure 19. Reach tiers and subwatershed groups in the Upper North Fork Lewis Basin. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities at the reach scale are useful for identifying stream corridor recovery measures. Priorities at the subwatershed scale are useful for identifying watershed process recovery measures. Watershed process recovery measures for stream reaches will need to occur within the surrounding (local) subwatershed as well as in upstream contributing subwatersheds.

Table 15. Reach- and subwatershed-scale limiting factors in priority areas. The table is organized by subwatershed groups, beginning with the highest priority group. Species-specific reach priorities, critical life stages, high impact habitat factors, and recovery emphasis (P=preservation, R=restoration, PR=restoration and preservation) are included. Watershed process impairments: F=functional, M=moderately impaired, I=impaired. Species abbreviations: ChS=spring Chinook, ChF=fall Chinook, StS=summer steelhead, StW=winter steelhead.

Sub-watershed Group	Sub-watersheds	Reaches within subwatershed	Species present	High priority reaches by species	Critical life stages	High impact habitat factors	Restoration or preservation emphasis	Watershed processes (local)			Watershed processes (watershed)	
								Hydrology	Sediment	Riparian	Hydrology	Sediment
A	10901	Chickoom Creek Crab Creek Cussed Hollow Lewis 24 Lewis 25 Lewis 26 Lewis 27	ChS	Lewis 25 Lewis 27	spawning egg incubation fry colonization summer rearing winter rearing adult holding	channel stability habitat diversity sediment key habitat quantity	PR	F	M	F	F	M
			Coho									
			StW	Crab Creek Lewis 24 Lewis 25 Lewis 26 Lewis 27 Cussed Hollow	spawning egg incubation fry colonization summer rearing	habitat diversity predation sediment food key habitat quantity	PR					
	11301	Lewis 20 Lewis 21 Lewis 22 Little Creek	ChS	Lewis 22	egg incubation fry colonization summer rearing	sediment	PR	F	M	F	F	F
			Coho									
			StW	Lewis 21 Lewis 22	egg incubation summer rearing	sediment	P					
	11302	Lewis 20 Pepper Creek	ChS	Lewis 20	egg incubation fry colonization summer rearing	sediment	PR	F	F	F	F	F
			Coho									
			StW									
	30302	Lewis 18 Lewis 19 Swift Campground Cr	ChS	Lewis 18 Lewis 19	egg incubation fry colonization summer rearing	habitat diversity predation competition (hatchery fish) sediment food key habitat quantity	PR	F	M	M	F	F
			Coho	Lewis 18	egg incubation summer rearing winter rearing	habitat diversity predation competition (hatchery fish) sediment food key habitat quantity	R					
			StW	Lewis 18 Lewis 19	summer rearing winter rearing	habitat diversity predation competition (hatchery fish) sediment food	PR					

Sub-watershed Group	Sub-watersheds	Reaches within subwatershed	Species present	High priority reaches by species	Critical life stages	High impact habitat factors	Restoration or preservation emphasis	Watershed processes (local) Hydrology	Watershed processes (local) Sediment	Watershed processes (local) Riparian	Watershed processes (watershed) Hydrology	Watershed processes (watershed) Sediment
B	10902	Spencer Creek Lewis 23	ChS					F	F	F	F	F
			Coho	Lewis 23	spawning	habitat diversity	P					
			StW	Spencer Creek	fry colonization egg incubation summer rearing	sediment						
	11001	Big Creek Mid	Coho					F	M	F	F	F
			StW	Big Creek Mid	spawning egg incubation fry colonization summer rearing winter rearing	habitat diversity sediment key habitat quantity	P					
	20204	Clearwater Creek Clearwater Tribs	ChS					F	F	M	F	M
			Coho	Clearwater Creek	egg incubation fry colonization summer rearing winter rearing	habitat diversity temperature sediment food	R					
			StW									
	20401	Clear Creek Clear Creek Small Tribs	ChS					F	F	F	F	F
			Coho	Clear Creek Small Tribs	egg incubation fry colonization summer rearing winter rearing adult holding	sediment key habitat quantity	PR					
			StW									
	20402	Clear Creek Lower Clear Creek Small Tribs	ChS					F	F	F	F	F
			Coho	Clear Creek Lower	egg incubation summer rearing winter rearing	habitat diversity sediment food key habitat quantity	PR					
			StW									
	20501	Muddy R 1A	ChS					F	M	M	F	M
			Coho	Muddy R 1A	egg incubation summer rearing winter rearing	habitat diversity sediment	R					
			StW									
	20502	Muddy R 1 Muddy R 1A	ChS					F	F	M	F	F
			Coho	Muddy R 1 Muddy R 1A	egg incubation summer rearing winter rearing	habitat diversity temperature competition (hatchery fish) sediment food	R					
			StW									
	30101	P10 P8 Pine Creek 5 Pine Creek 6	ChS					F	F	M	F	F
			Coho									
			StW	Pine Creek 5 Pine Creek 6	spawning egg incubation fry colonization summer rearing winter rearing adult holding		P					
	30102	P1 P3 P7 Pine Creek 1 Pine Creek 2 Pine Creek 3 Pine Creek 4	ChS					F	M	M	F	M
			Coho									
			StW	Pine Creek 1 Pine Creek 2 Pine Creek 4	egg incubation fry colonization summer rearing winter rearing		P					
	30201	Swift Creek	ChS Coho StW					F	M	F	F	M
	30401	Drift Creek	All					F	M	M	F	M
	30501	Diamond Creek Diamond Creek Template Marble Creek	Coho	Diamond Creek	spawning egg incubation fry colonization summer rearing winter rearing adult holding	habitat diversity sediment	P	F	F	M	F	M
			StW									
	40301	Siouxon 1	All					F	M	M	F	M
	40402	Cougar Creek	All					F	M	F	F	M

Sub-watershed Group	Sub-watersheds	Reaches within subwatershed	Species present	High priority reaches by species	Critical life stages	High impact habitat factors	Restoration or preservation emphasis	Watershed processes (local)			Watershed processes (watershed)	
								Hydrology	Sediment	Riparian	Hydrology	Sediment
C	11201	Curly Creek	Coho StW					F	F	F	F	F
	11303	Rush Creek	All					F	F	M	F	F
	20103	Muddy R 2 Muddy R 3 Smith Creek	All					F	M	M	F	F
	20203	Bean Creek	Coho StW					F	F	M	F	F
	30301	S10	Coho					F	I	M	F	F
	40401	Panamaker Cr	Coho StW					M	M	M	M	M
	40502	Dog Creek Dog Creek Template Y8	Coho StW					F	M	M	M	
	40506	Ole Creek Rain Creek	Coho StW					F	F	F	F	F
	60301	Cape Horn Creek Marble Creek Marble Creek Templa	Coho StW					I	M	M	M	M
D	20101	Upper Smith Creek	All					F	F	M	F	F
	20102	Ape Canyon Creek Upper Smith Creek	All					F	F	M	F	F
	30401	Drift Creek	All					F	M	M	F	M
	30503	Range Creek Range Creek Templat	All					F	M	M	F	M
	40201	Siouxon 2	StW					F	M	M	F	M
	40302	NF Siouxon	Coho StW					F	M	F	F	M
	60201	Canyon Creek	All					I	I	M	I	M
	60302	Buncombe Hollow Creek	Coho StW					F	F	M	M	M
	60303	B1 Brooks Creek Speelyei 1 Speelyei 1 Template Speelyei 2	Coho StW					M	M	M	M	M
	60304	M14 M14 Template	Coho StW					M	M	M	M	M
	60306	Indian George Creek Jim Creek	Coho StW					I	F	M	I	F
	60501	Lewis 1 tidal Lewis 2 tidal	All					I	M	I	M	M
	60502	Lewis 3 Lewis 4	All					I	M	M	M	M
	60503	Lewis 5 Lewis 6	All					I	M	M	M	M
	60504	Lewis 7	All					I	M	M	M	M

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the upper NF Lewis subbasin and necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin (Section 3.0) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the Upper Lewis Basin are presented in priority order in Table 16. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the subbasin. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

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

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following priorities for approaches: 1) protect existing functional habitats and the processes that sustain them, 2) allow no further degradation of habitat or supporting processes, 3) re-connect isolated habitat, 4) restore watershed processes (ecosystem function), 5) restore habitat structure, and 6) create new habitat where it is not recoverable. These priorities have been adjusted for the specific circumstances occurring in the Upper Lewis Basin. These priorities are adjusted depending on the results of the technical assessment and on the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

5.4.3 *Habitat Actions*

The prioritized measures and associated gaps are used to develop specific Actions for the subbasin. These are presented in Table 17. Actions are different than the measures in a number of ways: 1) actions have a greater degree of specificity than measures, 2) actions consider existing programs and are therefore not based strictly on biophysical conditions, 3) actions refer to the agency or entity that would be responsible for carrying out the action, and 4) actions are related to an expected outcome with respect to the biological objectives. Actions are not presented in priority order but instead represent the suite of activities that are all necessary for recovery of listed species. The priority for implementation of these actions must consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table 16. Prioritized measures in the Upper North Fork Lewis Basin.

#1 – Restore access through hydropower system

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access above Merwin, Yale, and Swift Dams for anadromous salmonids B. Restore access upstream and downstream through the Dams for Bull Trout and other resident fish	• Blockages to channel habitats	• Lewis hydropower system	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	The system of dams on the mainstem Lewis River, beginning with Merwin Dam at River Mile 19.5, block all volitional access to the upper basin, consisting of up to 170 or more miles of habitat for anadromous species. The dams also prevent or limit upstream and downstream passage of Bull Trout, essentially isolating populations in the individual reservoirs.

Priority Locations

1st- Lewis hydropower system (Merwin, Yale, and Swift Dams and reservoirs)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
PacifiCorp	Lewis River Project (Merwin, Yale, and Swift #1 Dams)		✓
Cowlitz County PUD	Operation of Swift Powerhouse #2		✓
Federal Energy Regulatory Commission (FERC)	Hydropower Project Licensing		✓
NOAA Fisheries	Hydropower Relicensing		✓
WDFW	Hydropower Relicensing		✓
USFWS	Hydropower Relicensing		✓

Program Sufficiency and Gaps

The four Lewis hydropower facilities are owned and operated by PacifiCorp (Merwin Dam, Yale Dam, Swift Dam #1) and Cowlitz County PUD (Swift #2). The project licenses, which expire at different dates between 2001 and 2009, are being combined into a single, collaborative relicensing process to be completed by 2006. The Preliminary Draft Environmental Analysis (PDEA) prepared by PacifiCorp and Cowlitz PUD (2004) proposes a suite of alternatives for management of the hydrosystem with respect to aquatic resources. The preferred alternative includes, but is not limited to, the following measures: 1) trap and haul adult chinook, coho, and steelhead from below Merwin to above Swift Dam, 2) collect juveniles using a surface collector at Swift Dam and transport to below Merwin (seasonally), 3) reduce hatchery production as natural production increases, 4) continually release 50 cfs to the 3 mile bypass reach below Swift Dam to improve habitat for resident fish, 5) improve downstream passage for Bull Trout and other resident fish at Yale Dam, 6) net Bull Trout in Yale tailrace and transport to Cougar Creek (Yale Reservoir tributary), and 7) net Bull Trout at Swift 2 tailrace and transport to a location to be determined by USFWS. More recent re-licensing negotiations have discussed providing anadromous access to and from Merwin and Yale Reservoir Basins in the future and constructing a Bull Trout spawning channel near the Swift #2 tailrace. The negotiations are on-going and requirements will not be finalized until the license is approved by FERC (targeted for 2006).

#2 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	Stream corridors in the Upper NF Lewis Basin in National Forest Lands are generally in good condition except for those in the Muddy and Pine Creek systems that experienced mud and debris flows during the 1980 Mount St. Helens eruption. Stream corridors in private timber lands have, in general, experienced more degradation due to past riparian timber harvest and road building. Streams in and around mixed-use areas (e.g. Speelyai Creek) may be at risk of encroaching residential development. It is crucial that adequate protections are in place in these areas to prevent further habitat degradation. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Tier 1 or 2 reaches with functional riparian conditions according to the IWA
Reaches: Lewis 20-27; Clear Creek Lower & Clear Creek; Big Creek; Cussed Hollow; Crab Creek; Swift Creek; Cougar Creek
2nd- Other Tier 1 or 2 reaches
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NOAA Fisheries	ESA Section 7 and Section 10	✓	
US Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
USFS	Northwest Forest Plan	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Cowlitz County	Comprehensive Planning		✓
Clark County	Comprehensive Planning		✓
Skamania County	Comprehensive Planning		✓
Cowlitz/Wahkiakum Conservation District / Natural Resources Conservation Service (NRCS)	Landowner technical assistance, conservation programs		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation programs		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation programs		✓

Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Education, Enforcement	✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements	✓
Program Sufficiency and Gaps		
Alterations to stream corridor structure that may impact aquatic habitats are regulated through the WDFW Hydraulics Project Approval (HPA) permitting program. Other regulatory protections are provided through USACE permitting, ESA consultations, HCPs, and County regulations. Riparian areas within federal timber lands are protected as part of the Northwest Forest Plan. Riparian areas within private timberlands are protected through the Forest Practices Rules (FPR) administered by WDNR. The FPRs came out of an extensive review process and are believed to adequately protect riparian areas with respect to stream shading, bank stability, and LWD recruitment. The program is new and careful monitoring of the effect of the regulations is necessary. Conversion of land-use from forest to residential use has the potential to increase impairment of aquatic habitat, particularly when residential development is paired with flood control measures. Counties can limit potentially harmful land-use conversions by thoughtfully directing growth through comprehensive planning and tax incentives, by providing consistent protection of critical areas across jurisdictions, and by preventing development in floodplains. In cases where existing programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary.		

#3 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage growth and development to minimize impacts to sediment supply processes, runoff regime, and water quality	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Development – impacts to sediment supply, water quality, and runoff processes	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	Hillslope runoff and sediment delivery processes have been degraded primarily due to past intensive timber harvest and forest road building. Limiting additional degradation will be necessary to prevent further habitat impairment.

Priority Locations

1st- Functional subwatersheds contributing to Tier 1 or 2 reaches (functional for sediment *or* flow according to the IWA – local rating)
Subwatersheds: 40402, 40201, 40301, 40302, 40504, 40101, 40303, 40202, 20201, 20202, 20203, 20301, 20302, 10701, 20101, 10101, 10702, 10401, 10703, 20102, 10801, 10201, 20303, 10102, 20401, 20204, 10501, 20103, 10901, 10301, 10502, 30101, 30201, 10601, 20402, 20501, 10902, 20502, 11001, 11301, 30102, 11002, 30501, 11304, 11302, 11303, 11202, 11201

2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 60302, 60306, 40501, 40502, 40505, 40506, 40102, 40103, 30202, 30502, 30301, 30302, 30503, 30401, 30402

3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 40401, 60303, 60205, 60101, 60304

4th- All remaining subwatersheds

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
USFS	Northwest Forest Plan	✓	
Skamania County	Comprehensive Planning		✓
Cowlitz County	Comprehensive Planning		✓
Clark County	Comprehensive Planning		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, conservation programs		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation programs		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation programs		✓

Program Sufficiency and Gaps

Hillslope processes on federal timber lands are protected through the Northwest Forest Plan. Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. The program is new, however, and careful monitoring of the effect of the regulations is necessary., particularly effects on subwatershed hydrology and sediment delivery. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands, County Comprehensive Planning is the primary nexus for protection of hillslope processes. Counties can control impacts through zoning that protects existing uses,

through stormwater management ordinances, and through tax incentives to prevent lands from becoming developed.

#4- Restore degraded hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Upgrade or remove problem forest roads B. Reforest heavily cut areas not recovering naturally	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest and road building. These processes must be addressed for reach-level habitat recovery to be successful.

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: 20201, 20202, 20301, 20302, 10101, 10702, 10703, 10501, 20103, 10901, 10301, 10502, 30202, 20501, 11001, 11301, 30102

2nd- Moderately impaired or impaired subwatersheds contributing to Tier 2 reaches
Subwatersheds: 40402, 40201, 40301, 40302, 40504, 40101, 40303, 40102, 40103

3rd- Moderately impaired or impaired subwatersheds contributing to other reaches
Subwatersheds: 40401, 60201, 60202, 60203, 60204, 60205, 60301, 60303, 60304, 60305, 60306, 60101, 60102, 60103, 40501, 40502, 40503, 40505, 30201, 30502, 30301, 30302, 30503, 30401, 30402

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Clark County	Stormwater Management		✓
Skamania County	Stormwater Management		✓
Cowlitz County	Stormwater Management		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

Forest management programs including the Northwest Forest Plan (federal timber lands), new Forest Practices Rules (private timber lands), and the WDNR HCP (state timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements for private timber lands are expected to actively address road-related impairments within a 15 year time-frame. While these strategies are believed to be largely adequate to protect watershed processes, the degree of implementation and the effectiveness of the prescriptions will not be fully known for at least another 15 or 20 years. Of particular concern is the capacity of some forest land owners, especially small forest owners, to conduct the necessary road improvements (or removal) in the required timeframe. Additional financial and technical assistance would enable small forest landowners to conduct the necessary improvements in a timeline parallel to large industrial timber land owners. Means of increasing restoration activity

include increasing landowner participation through education and incentive programs, requiring Best Management Practices through permitting and ordinances, and increasing available funding for entities to conduct restoration projects.

#5 - Restore riparian conditions throughout the basin

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore the natural riparian plant community B. Eradicate invasive plant species from riparian areas	• Reduced stream canopy cover • Altered stream temperature regime • Reduced bank/soil stability • Reduced wood recruitment • Lack of stable instream woody debris • Exotic and/or invasive species	• Timber harvest – riparian harvests • Clearing of vegetation due to residential development	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	Riparian areas are in good condition in National Forest Lands with the exception of the Muddy and Pine Creek systems that were affected by mud and debris flows associated with the 1980 Mount St. Helens eruption. Riparian areas are in poorer condition on private forest lands due to past harvests. Riparian conditions are also impaired in the few areas of residential development. The increasing abundance of exotic and invasive species is of particular concern. Riparian restoration has a high potential benefit due to the many limiting factors that are addressed. Riparian restoration projects are relatively inexpensive and are often supported by landowners.

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules, Habitat Projects	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner tech. assistance, conservation programs, habitat projects		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, Control		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring riparian conditions; however, existing programs will afford protections that will allow for the *passive* restoration of riparian forests. These protections are believed to be adequate for riparian areas on forest lands that are subject to Forest Practices Rules or the State forest lands HCP. Other lands receive variable levels of protection and passive restoration through County Comprehensive Plans. Many degraded riparian zones in rural residential or transportation corridor uses will not passively restore with existing regulatory protections and will require active measures. Riparian restoration in these areas may entail tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Increase riparian shading B. Decrease channel width-to-depth ratios	• Altered stream temperature regime	• Timber harvest – riparian harvests • Clearing of vegetation due to rural development	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	There are several areas of temperature concern in the Upper NF Lewis Basin. Impaired riparian canopy cover and increased channel width-to-depth ratios are contributing factors. Mud flows in the Muddy Creek system (Mount St. Helens eruption) and timber harvests along other reaches (Souxon, Canyon Creek) have likely contributed to riparian vegetation impairments.

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 draft list)
Reaches: Clearwater Creek (temperature); Muddy R1A (temperature); Muddy R1 (temperature); Clear Creek Lower (temperature); Lewis 20 & 23 (temperature)
2nd- Other reaches with 303(d) listings
Reaches: Quartz Creek (temperature); Souxon Creek (temperature); Canyon Creek (temperature)
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

The WDOE Water Quality Program manages the State 303(d) list of impaired water bodies. There are several listings in the Upper NF Lewis Basin for temperature (WDOE 2004). A Water Quality Clean-up Plan (TMDL) is required by the WDOE and it is anticipated that the TMDL will adequately set forth strategies to address the temperature impairments. It will be important that the strategies specified in the TMDLs are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin.

#7 – Restore access to habitat blocked by artificial barriers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access to isolated habitats blocked by culverts, dams, or other barriers (not including mainstem dams, which is covered under a separate measure)	• Blockages to channel habitats • Blockages to off-channel habitats	• Dams, culverts, in-stream structures	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	There are many small blockages in the Basin. Many of these are inadequately sized culverts at road crossings. The full extent of these blockages is unknown.

Priority Locations

1st- Tributary streams with blockages

Key Programs

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

Program Sufficiency and Gaps

There has been relatively little emphasis placed on barriers (not including mainstem dams) because of the lack of anadromous access to the basin. Nevertheless, there are on-going programs related to access improvements in the Basin. The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The USFS has identified and repaired blockages as a part of on-going programs. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Additional funding is needed to correct remaining blockages. Further monitoring and assessment is needed to ensure that all potential blockages have been identified and prioritized.

#8 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	Stream structure and stability have been impaired due to past riparian timber harvests and due to mud and in the case of the Muddy River and Pine Creek systems, due to mud and debris flows from the 1980 Mount St. Helens eruption. Large wood installation projects could benefit habitat conditions in many areas although watershed processes contributing to wood deficiencies should be considered and addressed prior to placing wood in streams. Other structural enhancements to stream channels may be warranted in some places.

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
USFS	Northwest Forest Plan, Habitat Projects		✓
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Cowlitz/Wahkiakum Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Clark Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓
Underwood Conservation District / NRCS	Landowner technical assistance, conservation programs, habitat projects		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring channel stability and structure. Passive restoration is expected to slowly occur as a result of protections afforded to riparian areas and hillslope processes. Past projects have largely been opportunistic and have been completed due to the efforts of local NGOs, landowners, and government agencies; such projects are likely to continue in a piecemeal fashion as opportunities arise and only if financing is made available. The lack of LWD in stream channels, and the importance of wood for habitat of listed species, places an emphasis on LWD supplementation projects. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

#9 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve flows in low-flow Summer months	• Water withdrawals	spring Chinook, fall Chinook, winter steelhead, coho, bull trout	Instream flow management strategies for the Upper NF Lewis Basin have been identified as part of Watershed Planning for WRIA 27 (LCFRB 2004). Strategies include water rights closures, setting of minimum flows, and drought management policies. This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WRIA 27/28 Watershed Planning Unit	Watershed Planning	✓	
Washington Department of Ecology	Water Resources Program		✓

Program Sufficiency and Gaps

The Water Resources Program of the WDOE, in cooperation with the WDFW and other entities, manages water rights and instream flow protections. A collaborative process for setting and managing instream flows was launched in 1998 with the Watershed Planning Act (HB 2514), which called for the establishment of local watershed planning groups who's objective was to recommend instream flow guidelines to WDOE through a collaborative process. The current status of this planning effort is to adopt a watershed plan by December 2004. Instream flow management in the Upper NF Lewis Basin will be conducted using the recommendations of the WRIA 27/28 Planning Unit, which is coordinated by the LCFRB. Products of the WRIA 27/28 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the planning unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies.

Table 17. Habitat actions for the Upper North Fork Lewis Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
U-Lew 1. Restore access through the hydropower system for anadromous and resident fish	Expansion of existing program or activity	PacifiCorp, Cowlitz County PUD, FERC, WDFW, NOAA Fisheries	1	High: the system of dams on the Lewis blocks anadromous access to approximately 170 miles of habitat and blocks migrations of adfluvial Bull Trout	High: Increased spawning and rearing capacity due to access to blocked habitat	High
U-Lew 2. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	2, 3, 4, 5, 6 & 7	High: National Forest and National Monument lands in the upper basin	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
U-Lew 3. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	2, 3, 4, 5, 6 & 7	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
U-Lew 4. Expand standards in County Comprehensive Plans to afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Cowlitz County, Clark County, Skamania County	2 & 3	Low: Private lands under County jurisdiction (reservoir tributary basins)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
U-Lew 5. Prevent new floodplain development through County ordinance and with support from the State	New program or activity	Cowlitz County, Clark County, Skamania County, WDOE	2	Low: Private lands under County jurisdiction (reservoir tributary basins)	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
U-Lew 6. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of lands to	Expansion of existing program or activity	Cowlitz County, Clark County, Skamania County	2 & 3	Low: Private lands under County jurisdiction (reservoir tributary basins)	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function,	High

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

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
developed uses through zoning regulations and tax incentives					runoff processes, and sediment supply processes	
U-Lew 7. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit	9	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
U-Lew 8. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, C/WCD, CCD, UCD, LCFEG	4, 5, 6, 7 & 8	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
U-Lew 9. Increase technical support and funding to small forest landowners faced with implementation of Forest Practices Rules to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	2, 3, 4, 5, 6 & 7	Low: Small private timberland owners	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
U-Lew 10. Monitor an notify FERC of significant license violations, enforce terms and conditions of section 7 consultations on FERC relicensing agreements, and encourage implementation of section 7 conservation recommendations on FERC relicensing agreements	Activity is currently in place	NOAA, USFWS	1, 6, 7, 9	High: Entire basin	High: Increased spawning and rearing capacity due to access to blocked habitat, improved conditions related to water quality, adequate instream flows to support life stages of salmonids and other aquatic biota	High
U-Lew 11. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed management	Activity is currently in place	Cowlitz County, Clark County, Skamania County	2, 4, 5, & 6	Low: Applies to public lands under county jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
U-Lew 12. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	2 & 3	Low: Private lands in sensitive areas at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
U-Lew 13. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS,Cowlitz CD, Clark CD, UCD, WDNR, WDFW, LCFEG	2, 3, 4, 5, 6, 7, 8 & 9	Low: Private lands. Applies primarily to lands in rural residential or forestry uses along river corridors	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
U-Lew 14. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive	Expansion of existing program or	WDFW, WDNR, Cowlitz County, Clark County,	7	Medium: There are many minor barriers throughout the Basin.	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is believed to	High

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
habitats (passage obstruction at mainstem dams is considered in a separate action)	activity	Skamania County, WSDOT, LCFEG		The full extent is unknown	be marginal in most cases	
U-Lew 15. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	2, 3, 4, 5, 6 & 7	Low: State timber lands in the U. Lewis Basin (approximately 11% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium
U-Lew 16. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Cowlitz CD, Clark CD, UCD, LCFEG	2 & 5	Low: Greatest risk is in residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
U-Lew 17. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	Expansion of existing program or activity	Cowlitz County, Clark County, Skamania County, Clark CD, Cowlitz CD, UCD	7	Low: Private rural residential lands	Medium: Protection and restoration of water quality (bacteria)	Medium

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the upper NF Lewis River Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery measures in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. This may involve substantial changes in some hatchery programs from their historical focus on production for mitigation. The recovery strategy includes a mixture of conservation programs and mitigation programs for fishery benefits. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the upper NF Lewis River are displayed by species in Table 18. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 18. Summary of natural production and fishery enhancement strategies to be implemented in the upper NF Lewis River Basin.

		Species					
		Fall Chinook	**Spring Chinook**	**Coho**	**Chum**	**Winter Steelhead**	**Summer Steelhead**
Natural Production Enhancement	**Supplementation**		✓	✓		✓	
	Hatch/Nat Conservation [1/]		✓				
	Isolation					✓[2/]	
	Refuge						
Fishery Enhancement	**Hatchery Production**						

1/ Hatchery and natural population management strategy coordinated to meet biological recovery objectives. Strategy may include integration and/or isolation strategy over time. Strategy will be unique to biological and ecological circumstances in each watershed.
[2/] Includes isolation from non-indigenous hatchery steelhead stocks only

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

Natural Refuge Watersheds: In this strategy, certain sub-basins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These regugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish and will be key indicators of natural population status within the ESU. Current strategies do not call for designating refuge areas in the upper NF Lewis Basin.

Hatchery Supplementation: This strategy utilizes hatchery production as a tool to assist in rebuilding depressed natural populations. Supplementation would occur in selected areas that are producing natural fish at levels significantly below current capacity or capacity is expected to increase as a result of immediate benefits of habitat or passage improvements. This is intended to be a temporary measure to jump start critically low populations and to bolster natural fish numbers above critical levels in selected areas until habitat is restored to levels where a population can be self sustaining. This strategy would include spring Chinook, winter steelhead and coho in the upper NF Lewis Basin.

Hatchery/Natural Isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of spring Chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This strategy would be included for winter steelhead in the upper NF Lewis Basin. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations.

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

Not every lower Columbia River hatchery program will be turned into a conservation program. The majority of funding for lower Columbia basin hatchery operations (including Lewis River hatcheries) is for producing salmon and steelhead for harvest to mitigate for lost harvest of natural production due to hydro development and habitat degradation. Programs for fishery enhancement will continue during the recovery period, but will be managed to minimize risks and ensure they do not compromise recovery objectives for natural populations. It is expected that the need to produce compensatory fish for harvest through artificial production will reduce in the future as natural populations recover and become harvestable. There are no fishery enhancement programs for spring Chinook, coho, or steelhead currently in the upper NF Lewis Basin. Rainbow trout and Kokanee fishery enhancement programs occur. Salmon and steelhead fishery enhancement may be considered for the upper Lewis basin in the future if it can occur without compromising restoration of natural populations

The Lewis Hatchery Complex will be operated to include natural production enhancement strategies for Lewis River spring Chinook, chum, coho and winter steelhead as well as support natural spring Chinook enhancement in the Upper North Fork Lewis. The Lewis River Hatchery Complex will continue to support spring Chinook, coho, and steelhead fisheries with hatchery releases in the Lewis River Subbasin. Fall Chinook will not be included as a harvest program in the Lewis River Subbasin. This plan adds seven new conservation programs at the Lewis River Hatchery Complex (Table 19).

Table 19. A summary of conservation and harvest strategies to be implemented through Lewis River Hatchery programs.

		Stock
Natural Production Enhancement	Supplementation	U. Lewis Spring Chinook √
		L. Lewis Chum √
		E Fk. Lewis Chum √
		U. Lewis Winter Steelhead √
		U. Lewis Coho √
	Hatch/Nat Conservation 1/	U. Lewis Spring Chinook √
	Isolation	U. Lewis Winter Steelhead
	Broodstock development	Lewis River Chum √
Fishery Enhancement	In-basin releases	Lewis Early Coho
	(final rearing site)	Lewis Late Coho
		Lewis Spring Chinook
		Merwin Summer Steelhead
		Merwin Winter Steelhead
		Skamania Summer Steelhead
	Out of Basin Releases (final rearing site)	

1/ May include integrated and/or isolated strategy over time.
√ Denotes new program

5.5.2 *Hatchery Measures and Actions*

Hatchery strategies and measures are focused on evaluating and reducing biological risks consistent with the recovery strategies identified for each natural population. Artificial production programs within Lewis River facilities have been evaluated in detail through the WDFW Benefit-Risk Assessment Procedure (BRAP) relative to risks to natural populations. The BRAP results were utilized to inform the development of these program actions specific to the Lewis River Basin (Table 20). These hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NOAA fisheries approval. It is expected that the HGMPs and these recovery actions will be complementary and provide a coordinated strategy for the Lewis River Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 20. Hatchery program actions to be implemented in the Lewis River Basin.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Reintroduction program for spring Chinook would include development of a biologically appropriate relationship and management strategy for hatchery and wild brood stock program over time. • Winter steelhead supplementation into the upper basin would only use late-winter brood stock. Brood stock would be acquired from Merwin Trap with Kalama Hatchery late winter steelhead as a back up if sufficient numbers can not be attained from the Lewis. Late winter brood would be developed at Merwin Hatchery. Early winter and summer stocks will be used for harvest only. • Coho supplementation into the upper Basin would prioritize early stock but may also include some late stock supplementation.	** Conservation management strategy implemented for spring Chinook hatchery production and upper Lewis natural spring Chinook. **Utilize spring Chinook and coho hatchery brood stock to supplement reintroduction of natural production upstream of the hydro system **Develop a late-timed winter steelhead hatchery brood stock to reintroduce natural winter steelhead upstream of the hydro system	Lewis River/ Speelyai Hatchery spring Chinook.	Upper Lewis spring Chinook, upper Lewis coho, upper Lewis winter steelhead (once reestablished).	Domestication, Diversity, abundance	• Non-local genetic traits • No current natural production of spring Chinook, coho, or steelhead in the upper Lewis	• Increased genetic diversity in natural and hatchery spring Chinook populations • Spring Chinook, coho, and steelhead stocks are ecologically adapted to upper Lewis habitat resulting in adequate productivity and abundance. • Self sustaining spring Chinook, winter steelhead, and coho populations are reestablished in the upper Lewis basin • Hatchery brood stock is available and appropriate to continue supplementation as needed.
• Continue 100 percent mark of hatchery produced steelhead, coho, and spring Chinook released into the lower Lewis. • Coded-wire-tag w/o fin-clip fish used for supplementation into Swift reservoir to distinguish from hatchery and natural production. Do not mark or tag (except small experimental groups) natural spring Chinook, coho, or steelhead collected at Swift Dam. Unmarked or tagged adults will be identified as natural production from the upper Lewis basin.	*Adipose fin-clip mark hatchery produced coho, spring Chinook and steelhead released into the lower Lewis ** Blank wire-tag (without exterior mark) hatchery smolts used for supplementation in the upper lewis. **Do not mark or tag natural fish produced upstream of the hydro system, except small experimental groups. Marking program may be	Lewis Salmon Hatchery spring Chinook and coho. Merwin Trout Hatchery steelhead and cutthroat.	upper Lewis spring Chinook, coho, and winter steelhead (once reestablished).	Domestication, Diversity, Abundance	• In-breeding • Harvest	• Maintain selective fishing opportunity for spring Chinook, coho, winter steelhead, and summer steelhead, and only incidental impacts to natural produced fish. • Enable visual identification of hatchery and wild, and supplemented returns to provide the means to account for and manage the hatchery and wild escapement consistent with biological objective • Minimize handling impacts

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
	reevaluated once reintroduction is expanded to include lower reservoirs.					to natural produced juveniles, resulting in increased survival and abundance. The vast majority of unmarked and untagged steelhead, spring Chinook, and coho trapped at Merwin Dam will have been produced from the upper Lewis habitat.
• Hatchery Spring Chinook, steelhead, and coho juveniles released into the upper Lewis should be smolted and prepared to migrate to ensure they continue rapid migration as they are released into the lower river. • Natural produced juveniles from the upper Lewis are evaluated for the proportion of pre-smolt juveniles collected. Large numbers of pre-smolts at critical time periods would need to be addressed by release strategies to minimize impacts to lower Lewis fall Chinook and chum.	**Juvenile release strategies to minimize impacts to wild fish	Reintroduced spring Chinook, coho, and steelhead	Lower lewis fall Chinook and chum	Predation, competition	• Hatchery smolt residence time in lower Lewis. Pre-smolt rearing time in lower Lewis	• Minimal residence time in the Lower River for juveniles released from the stress relief ponds. • Predation on and displacement of fall Chinook and chum as a result of the reintroduction program is minimized. • Current Lewis River fall Chinook juvenile survival is maintained or enhanced in the new license period.
• Juvenile collection facility constructed at Swift Dam to provide passage of juvenile production to the Lower Lewis. Collection facility must trap a high enough percentage of the juveniles to enable the populations to sustain. • Trapping and sorting facilities at Merwin Dam and the Lewis Salmon Hatchery are improved to ensure efficient and low stress handling of adults prior to distribution. • Hatchery trucks are adequate in number and capacity to handle peak periods of juvenile and adult transport without overloading.	*Evaluate facilities and operations for reintroduction of salmon and steelhead	Spring Chinook, steelhead, coho	Spring Chinook, steelhead, and coho	Abundance, spatial distribution	• Juvenile collection efficiency • Adult collection and sorting • Handling, transport, stress relief	• Passage survival of adult and juvenile spring Chinook, coho, and steelhead produced in the upper Cowlitz basin is high enough to enable a self-sustaining population to be developed. • Handling, sorting, and stress relief facilities provide low impact to the natural produced salmon and steelhead from the upper basin. Space and facilities are adequate to provide high survival of

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Stress relief pond is available for juveniles trapped at Swift Dam for short-term relief prior to release into the lower Lewis. • Rearing, spawning, and incubation facilities are adequate to accommodate reintroduction and harvest mitigation.						natural production, supplementation, and harvest mitigation fish
• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes • Performance standards developed for each actions with measurable criteria to determine success or failure • Adaptive Management applied to adjust or change actions as necessary.	** Monitoring and evaluation, adaptive management	All species	All species	Hatchery production performance, Natural production performance, reintroduction facilities performance	• All of above	• Clear standards for performance and adequate monitoring programs to evaluate actions. • Adaptive management strategy reacts to information and provides clear path for adjustment or change to meet performance standard

** Extension or improvement of existing actions-may require additional funding*
*** New action-will likely require additional funding*

5.6 Harvest

Fisheries are both an impact that reduces fish numbers and an objective of recovery. The long-term vision is to restore healthy, harvestable natural salmonid populations in many areas of the lower Columbia basin. The near-term strategy involves reducing fishery impacts on natural populations to ameliorate extinction risks until a combination of measures can restore natural population productivity to levels where increased fishing may resume. The regional strategy for interim reductions in fishery impacts involves: 1) elimination of directed fisheries on weak natural populations, 2) regulation of mixed stock fisheries for healthy hatchery and natural populations to limit and minimize indirect impacts on natural populations, 3) scaling of allowable indirect impacts for consistency with recovery, 4) annual abundance-based management to provide added protection in years of low abundance while allowing greater fishing opportunity consistent with recovery in years with much higher abundance, and 5) mass marking of hatchery fish for identification and selective fisheries.

Actions to address harvest impacts are generally focused at a regional level to cover fishery impacts accrued to lower Columbia salmon as they migrate along the Pacific Coast and through the mainstem Columbia River. Fisheries are no longer directed at weak natural populations but incidentally catch these fish while targeting healthy wild and hatchery stocks. Subbasin fisheries affecting natural populations have been largely eliminated. Fishery management has shifted from a focus on maximum sustainable harvest of the strong stocks to ensuring protection of the weak stocks. Weak stock protections often preclude access to large numbers of otherwise harvestable fish in strong stocks.

Fishery impact limits to protect ESA-listed weak populations are generally based on risk assessments that identify points where fisheries do not pose jeopardy to the continued persistence of a listed group of fish. In many cases, these assessments identify the point where additional fishery reductions provide little reduction in extinction risks. A population may continue to be at significant risk of extinction but those risks are no longer substantially affected by the specified fishing levels. Often, no level of fishery reduction will be adequate to meet naturally-spawning population escapement goals related to population viability. The elimination of harvest will not in itself lead to the recovery of a population. However, prudent and careful management of harvest can help close the gap in a coordinated effort to achieve recovery.

Fishery actions specific to the subbasins are addressed through the Washington State Fish and Wildlife sport fishing regulatory process. This public process includes an annual review focused on emergency type regulatory changes and a comprehensive review of sport fishing regulations which occurs every two years. This regulatory process includes development of fishing rules through the Washington Administrative Code (WAC) which are focused on protecting weak stock populations while providing appropriate access to harvestable populations. The actions consider the specific circumstances in each area of each subbasin and respond with rules that fit the relative risk to the weak populations in a given time and area of the subbasin.

No fishing seasons occur above Merwin Dam for anadromous salmon or steelhead. Fishing for hatchery produced adults may be considered in the future as hatchery supplementation is occurring in the reintroduction program. Current fishing is limited to resident trout, Kokanee, land locked salmon, and other game fish.

Table 21. Regional harvest actions from Volume I, Chapter 7 with significant application to the upper North Lewis Subbasin populations

Action	Description	Responsible Parties	Programs	Comments
*F.A13	Monitor and evaluate commercial and sport impacts to naturally-spawning steelhead in salmon and hatchery steelhead target fisheries.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Includes monitoring of naturally-spawning steelhead encounter rates in fisheries and refinement of long-term catch and release handling mortality estimates. Would include assessment of the current monitoring programs and determine their adequacy in formulating naturally-spawning steelhead incidental mortality estimates.
*F.A14	Continue to improve gear and regulations to minimize incidental impacts to naturally-spawning steelhead.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Regulatory agencies should continue to refine gear, handle and release methods, and seasonal options to minimize mortality of naturally-spawning steelhead in commercial and sport fisheries.
*F.A20	Maintain selective sport fisheries in Ocean, Columbia River, and tributaries and monitor naturally-spawning stock impacts.	WDFW, NOAA, ODFW, USFWS	PFMC, Columbia Compact, BPA Fish and Wildlife Program, WDFW Creel	Mass marking of lower Columbia River spring Chinook, coho and steelhead has enabled successful ocean and freshwater selective fisheries to be implemented since 1998. Marking programs should be continued and fisheries monitored to provide improved estimates of naturally-spawning salmon and steelhead release mortality.
F.A27	Develop a harvest plan for wild spring Chinook as populations are reestablished.	WDFW, ODFW	Washington Fish and Wildlife Commission, Columbia Compact (TAC)	Adaptively manage harvest to respond to biological objectives for reintroduced Lewis River spring Chinook as they become reestablished in the upper watershed.

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in the Regional Recovery and Subbasin Plan Volume I. A number of regional strategies for harvest involve implementation of measures within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. No fishing seasons occur above Merwin Dam for anadromous salmon or steelhead. Fishing for hatchery produced adults may be considered in the future as hatchery supplementation is occurring in the reintroduction program. Current fishing is limited to resident trout, Kokanee, land locked salmon, and other game fish.

5.7 Hydropower

The three hydro-electric dams on the Lewis River are considered to be located in the upper Lewis basin. However, lower North Fork Lewis species, in particular fall Chinook, are affected by flow regimes from Lewis River hydro operations which effect spawning and rearing habitat in the lower Lewis. The quantity and quality of fall Chinook habitat in the lower Lewis can be addressed by; maintaining a flow regime, including minimum flow requirements, that enhance the spawning and rearing habitats for natural salmonid populations downstream of the North Lewis hydrosystem. In addition, mainstem Columbia hydro operations and flow regimes affect habitat utilized by lower Lewis species in migration corridors and in the estuary. Key regional strategies applying to the lower North Fork Lewis populations are displayed in the following table.

Dam construction in the Lewis basin has eliminated access of anadromous fishes to large areas of habitat that historically supportive productive populations and remains suitable for theses species. North Fork Lewis dams have blocked or inundated an estimated 95% of the winter steelhead, 90% of the spring Chinook, 50% of summer steelhead, 50% of fall Chinook, and the majority of coho habitat in the North Lewis River system. Reintroduction of spring Chinook, coho, and winter steelhead to naturally spawning area upstream of the dams is essential to meet recovery objectives, most notably for spring Chinook.

Table 22. Regional hydropower measure from Volume I, Chapter 7 with significant application to North Lewis Subbasin populations

Measure	Description	Comments
D.M1	Evaluate and adaptively implement anadromous fish reintroduction upstream Cowlitz, Lewis, and White Salmon dams and facilities as part of dam relicensing process or requirements.	Experimental evaluations are already underway in the Cowlitz subbasin. Similar efforts are under consideration or planned as part of the Lewis and White Salmon relicensing processes. Substantial uncertainty exists in the feasibility and costs of restoring effective passage through dam and reservoir complexes in the Cowlitz and Lewis systems. Dam heights and reservoir sizes make juvenile passage particularly problematic.
D.M4	Operate the tributary hydrosystems to provide appropriate flows for salmon spawning and rearing habitat in the areas downstream of the hydrosystem.	The quantity and quality of spawning and rearing habitat for salmon, in particular fall Chinook in the North Fork Lewis a, is affected by the water flow discharged at Merwin Dam. The operational plans for the Lewis hydrosystem, in conjunction with fish management plans, should include flow regimes, including minimum flow and ramping rate requirements, which enhance the lower river habitat for fall Chinook.

5.8 Mainstem and Estuary Habitat

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

5.9 Ecological Interactions

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

5.10 Monitoring, Research, & Evaluation

Biological status monitoring quantifies progress toward ESU recovery objectives and also establishes a baseline for evaluating causal relationships between limiting factors and a population response. Status monitoring involves routine and intensive efforts. Routine monitoring of biological data consists of adult spawning escapement estimates, whereas routine monitoring for habitat data consists of a suite of water quality and quantity measurements.

Intensive monitoring supplements routine monitoring for populations and basins requiring additional information. Intensive monitoring for biological data consists of life-cycle population assessments, juvenile and adult abundance estimates and adult run-reconstruction. Intensive monitoring for habitat data includes stream/riparian surveys, and continuous stream flow assessment. The need for additional water quality sampling may be identified. Rather than prescribing one monitoring strategy, three scenarios are proposed ranging in level of effort and cost from high to low (Level 1-3 respectively). Given the fact that routine monitoring is ongoing, only intensive monitoring varies between each level.

An in-depth discussion of the monitoring, research and evaluation (M, R & E) approach for the Lower Columbia Region is presented in the Regional Recovery and Management Plan. It includes site selection rationale, cost considerations and potential funding sources. The following tables summarize the biological and habitat monitoring efforts specific to the upper North Fork Lewis River.

Table 23. Summary of the biological monitoring plan for Upper North Fork Lewis River populations.

Upper NF Lewis: Lower Columbia Biological Monitoring Plan			
Monitoring Type	**Spring Chinook**	**Coho**	**Winter Steelhead**
Routine	AA	AA	AA
Intensive			
Level 1	×	×	×
Level 2	×	×	×
Level 3	×	×	×

AA Annual adult abundance estimates
✓ Adult and juvenile intensive biological monitoring occurs periodically on a rotation schedule (every 9 years for 3-year duration)
× Adult and juvenile intensive biological monitoring occurs annually

Table 24. Summary of the habitat monitoring plan for Upper North Fork Lewis River populations.

Upper Lewis: Lower Columbia Habitat Monitoring Plan				
Monitoring Type	**Watershed**	**Existing stream / riparian habitat**	**Water quantity[3] (level of coverage)**	**Water quality [2] (level of coverage)**
Routine [1] (level of coverage)	Baseline complete	Good	Stream Gage-Moderate IFA-Moderate	WDOE-Poor USGS-Good Temp.-Moderate
Intensive				
Level 1		✓	✓	
Level 2				
Level 3				

IFAComprehensive Instream Flow Assessment (i.e. Instream Flow Incremental Methodology)
[1] Routine surveys for habitat data do not imply ongoing monitoring
[2] Intensive monitoring for water quality to be determined
[3] Water quantity monitoring may include stream gauge installation, IFA or low flow surveys

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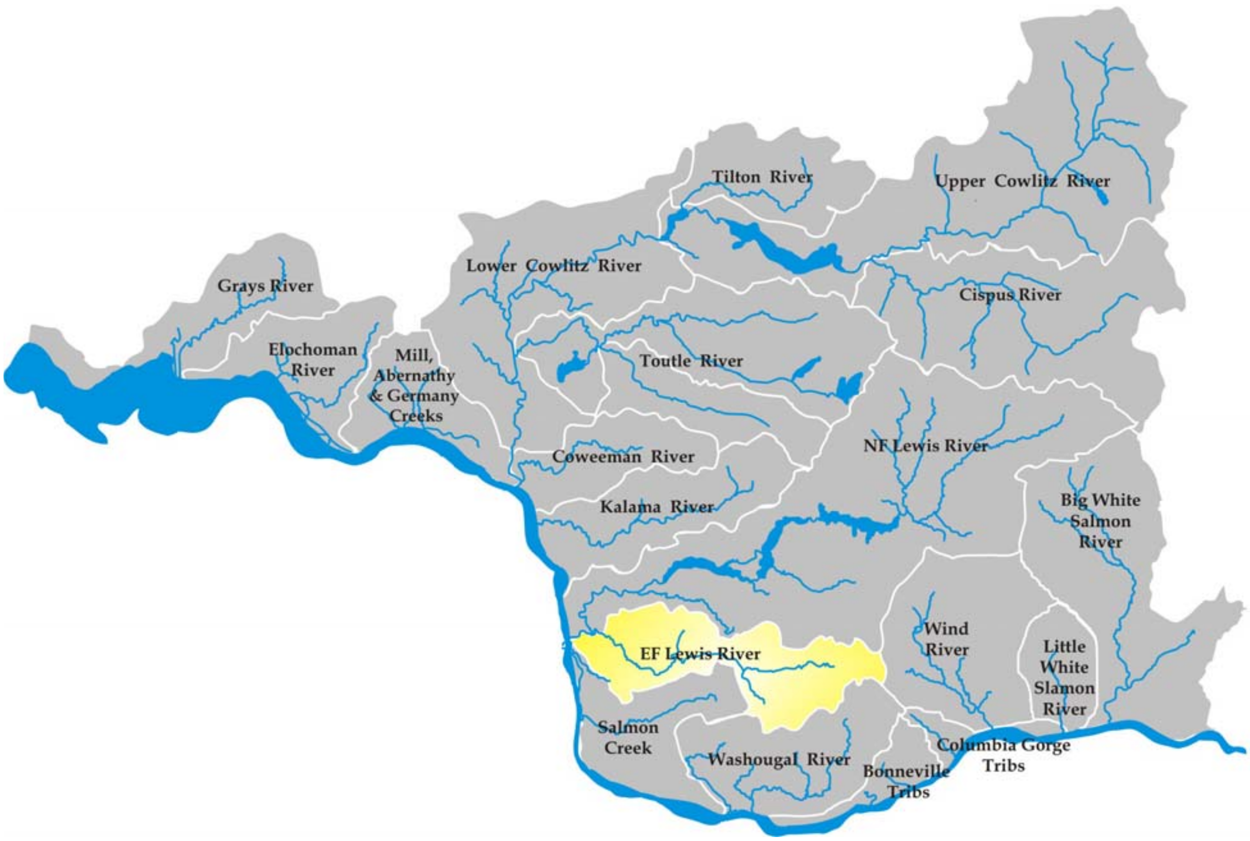
Subbasin Plan Vol. II.G.
Lewis Subbasin –
East Fork Lewis River



Contents

1.0 East Fork Lewis River – Executive Summary

This plan describes a vision, strategy, and actions for recovery of listed salmon, steelhead, and trout species to healthy and harvestable levels, and mitigation of the effects of the Columbia River Hydro system in Washington lower Columbia River subbasins. Recovery of listed species and hydropower mitigation is accomplished at a regional scale. This plan for the East Fork Lewis River Subbasin describes implementation of the regional approach within this subbasin, as well as assessments of local fish populations, limiting factors, and ongoing activities that underlie local recovery or mitigation actions. The plan was developed in a partnership between the Lower Columbia Fish Recovery Board (Board), Northwest Power and Conservation Council, federal agencies, state agencies, tribal nations, local governments, and others.

The East Fork Lewis River Basin is part of the Lewis River Subbasin, one of eleven major subbasins in the Washington portion of the Lower Columbia Region. The East Fork Lewis Basin historically supported thousands of fall Chinook, chum, coho, and winter and summer steelhead. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook and chum have been listed as Threatened under the Endangered Species Act and coho is proposed for listing. The decline has occurred over decades and the reasons are many. Freshwater and estuary habitat quality has been reduced by agricultural, mining, and forestry practices. Key habitats have been isolated or eliminated by dredging and channel modifications and diking, filling, or draining floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or non-local hatchery fish has reduced productivity. Hydropower operations on the Lewis and Columbia Rivers have altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

All East Fork Lewis River salmon and steelhead will need to be restored to a high level of viability to meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the subbasin. Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the East Fork Lewis subbasin.

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

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact East Fork Lewis River fish populations. Specific strategies, measures, actions and priorities have been developed to address these threats and limiting factors. The specified strategies identify the best long term and short term avenues for achieving fish restoration and mitigation goals. While it is understood that data, models, and theories have their limitations and growing knowledge will certainly spawn new strategies, the Board is confident that by implementation of the recommended actions in this plan, the population goals in the East Fork Lewis River Basin can be achieved. Success will depend on implementation of these strategies at the program and project level. It remains uncertain what level of effort will need to be invested in each area of impact to ensure the desired result. The answer to the question of precisely how much is enough is currently beyond our understanding of the species and ecosystems and can only be answered through ongoing monitoring and adaptive management against the backdrop of what is socially possible.

1.1 Key Priorities

Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the East Fork Lewis Basin. The following list identifies the most immediate priorities.

1. Protect Intact Forests in Headwater Basins

Headwater tributaries of the upper mainstem and upper Rock Creek basins, which are dominated by state and federal timber lands, are heavily forested with relatively intact landscape conditions that support functioning watershed processes. Streams are relatively unaltered, road densities are low, and riparian areas and uplands are characterized by mature forests. Much of this area is still recovering from large fires in the early 1900s. Protection of intact landscape conditions will be necessary to allow continued ecosystem recovery and to support healthy downstream habitat. Existing legal designations and management policy are expected to continue to offer protection to these lands.

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

The lower mainstem Lewis below Lewisville Park (river mile 14), and especially below Daybreak Park (river mile 10), flows through a broad, alluvial valley that historically was an active floodplain and channel migration zone (CMZ) with diverse riparian forests. Channel modifications over the years have dramatically altered natural channel migration and floodplain processes in order to facilitate and protect rural residential development, agricultural land, and gravel mining operations. Levee construction, bank stabilization, and riparian vegetation removal have heavily impacted fish habitat in these areas. Streamside gravel mining operations have had a particularly high impact on the mainstem valley below Daybreak Park, where the stream has avulsed into gravel ponds, abandoning once productive spawning habitat. There are current plans to expand gravel mining and processing operations in the historical floodplain, activities that are being managed through the NOAA Fisheries Habitat Conservation Planning process. Throughout the lower river, removing or modifying channel control and containment structures to reconnect the stream and its floodplain/CMZ, where this is feasible and can be done without increasing risks of substantial flood damage, will restore normal habitat-forming processes to reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing. These improvements will be particularly beneficial to chum, fall Chinook, and coho. Partially restoring normal floodplain function will also help control downstream flooding and provide wetland and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain function and riparian habitats will be protected through local land use ordinances, partnerships with landowners, and the acquisition of land, where appropriate. Restoration will be achieved by working with willing landowners, non-governmental organizations, conservation districts, and state and federal agencies.

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

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

4. Manage Forest Lands to Protect and Restore Watershed Processes

Much of the middle and upper basin is managed for commercial timber production and has experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing fine sediment, and degrading riparian zones. In addition, forest road culverts have blocked fish passage in some tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Habitat Conservation Plan (state-owned lands), Forest Practices Rules (private lands), and the Northwest Forest Plan (federal lands) are expected to substantially improve conditions by restoring passage, protecting riparian conditions, reducing fine sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly steelhead and coho.

5. Restore Passage at Culverts and Other Barriers

There are several culverts and other barriers that limit fish passage in the East Fork Lewis Basin. Many of these barriers occur on rural residential and agricultural land on mainstem tributaries in the lower basin and a few potential barriers are located on upper basin forest lands. Although no single barrier accounts for a significant percentage of blocked habitat, correction of passage obstructions could provide access to as many as 30 miles of stream. Further assessment and prioritization of passage barriers is needed.

6. Address Immediate Risks with Short-term Habitat Fixes

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

7. Align Hatchery Priorities with Conservation Objectives

Hatcheries throughout the Columbia basin historically focused on producing fish for fisheries as mitigation for hydropower development and widespread habitat degradation. Emphasis of hatchery production without regard for natural populations can pose risks to natural population viability. Hatchery priorities must be aligned to conserve natural populations, enhance natural fish recovery, and avoid impeding progress toward recovery while continuing to provide some fishery mitigation benefits. There are no hatcheries operating in the East Fork Lewis Basin. Skamania hatchery winter and summer steelhead are released in to the East Fork Lewis to provide harvest opportunity.

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

This near-term strategy involves limiting fishery impacts on natural populations to ameliorate extinction risks until a combination of measures can restore fishable natural populations. There is no directed Columbia River or tributary harvest of ESA-listed East Fork Lewis River salmon and steelhead. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some East Fork Lewis River salmon and steelhead are incidentally taken in mainstem Columbia River and ocean mixed stock fisheries for strong wild and hatchery runs of fall Chinook and coho. These fisheries will be managed with strict limits to ensure this incidental take does not threaten the recovery of wild populations including those from the East Fork Lewis. Steelhead and chum will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Selective fisheries for marked hatchery steelhead and coho (and fall Chinook after mass marking occurs) will be a critical tool for limiting wild fish impacts. State and federal legislative bodies will be encouraged to develop funding necessary to implement mass-marking of fall Chinook, thus enabling a selective fishery with lower impacts on wild fish. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

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

East Fork Lewis River salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the subbasin. Human impacts include drastic habitat changes in the Columbia River estuary, effects of Columbia Basin hydropower operation on mainstem, estuary, and nearshore ocean conditions, interactions with introduced animal and plant species, and altered natural predation patterns by northern pikeminnow, birds, seals, and sea lions. A variety of restoration and management actions are needed to reduce these out-of-basin effects so that the benefits in-subbasin actions can be realized. To ensure equivalent sharing of the recovery and mitigation burden, impacts in each area of effect (habitat, hydropower, etc.) should be reduced in proportion to their significance to species of interest.

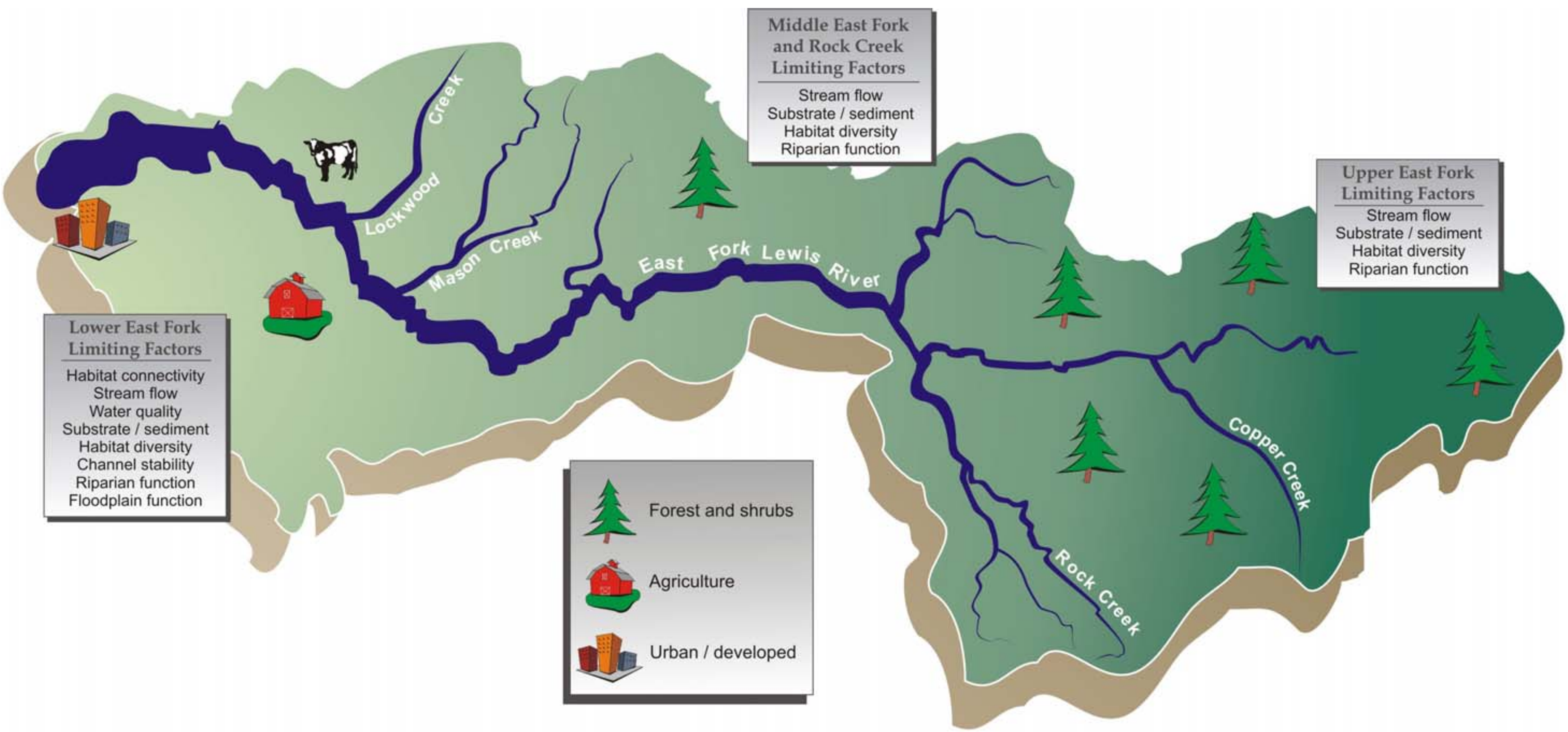


Figure 1. Key features of the East Fork Lewis River subbsin including a summary of limiting fish habitat factors in different areas and the status and relative distribution of focal salmonid species.

2.0 Background

This plan describes a vision and framework for rebuilding salmon and steelhead populations in Washington's East Fork Lewis River Subbasin. The plan addresses subbasin elements of a regional recovery plan for Chinook salmon, chum salmon, coho salmon, and steelhead listed or under consideration for listing as Threatened under the federal Endangered Species Act (ESA). The plan also serves as the subbasin plan for the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program to address effects of construction and operation of the Federal Columbia River Power System.

Development of this plan was led and coordinated by the Washington Lower Columbia River Fish Recovery Board (LCFRB). The Board was established by state statue (RCW 77.85.200) in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. It is comprised of representatives from the state legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro project operators, the environmental community, and concerned citizens. A variety of partners representing federal agencies, Tribal Governments, Washington state agencies, regional organizations, and local governments participated in the process through involvement on the LCFRB, a Recovery Planning Steering Committee, planning working groups, public outreach, and other coordinated efforts.

The planning process integrated four interrelated initiatives to produce a single Recovery/Subbasin Plan for Washington subbasins of the lower Columbia:

- Endangered Species Act recovery planning for listed salmon and trout.
- Northwest Power and Conservation Council (NPCC) fish and wildlife subbasin planning for eight full and three partial subbasins.
- Watershed planning pursuant to the Washington Watershed Management Act, RCW 90-82.
- Habitat protection and restoration pursuant to the Washington Salmon Recovery Act, RCW 77.85.

This integrated approach ensures consistency and compatibility of goals, objectives, strategies, priorities and actions; eliminates redundancy in the collection and analysis of data; and establishes the framework for a partnership of federal, state, tribal and local governments under which agencies can effectively and efficiently coordinate planning and implement efforts.

The plan includes an assessment of limiting factors and threats to key fish species, an inventory of related projects and programs, and a management plan to guide actions to address specific factors and threats. The assessment includes a description of the subbasin, focal fish species, current conditions, and evaluations of factors affecting focal fish species inside and outside the subbasin. This assessment forms the scientific and technical foundation for developing a subbasin vision, objectives, strategies, and measures. The inventory summarizes current and planned fish and habitat protection, restoration, and artificial production activities and programs. This inventory illustrates current management direction and existing tools for plan implementation. The management plan details biological objectives, strategies, measures, actions, and expected effects consistent with the planning process goals and the corresponding subbasin vision.

3.0 Assessment

3.1 Subbasin Description

3.1.1 *Topography & Geology*

The East Fork Lewis River has its headwaters in Skamania County and flows generally west, with most of the basin lying within Clark County. It enters the mainstem (North Fork) Lewis at approximately river mile 3.5, about 4,000 feet downstream of the I-5 Bridge. The basin covers an area of approximately 150,635 acres (235 mi^2). The East Fork has its source near Green Lookout Mountain in the Gifford Pinchot National Forest. Elevation ranges from near sea level at the mouth to 4,442 feet. The headwaters are very steep, with narrow valleys, and are dominated by bedrock and boulder substrates. Copper Creek and upper Rock Creek are the two largest tributaries in the upper basin. Lucia Falls at RM 21.3 blocks passage of anadromous fish except steelhead and an occasional chinook and coho. Upstream migration for steelhead was essentially blocked at Sunset Falls (RM 32.7) until 1982 when the falls were notched, lowering the falls from 13.5 to 8 feet; approximately 12% of the steelhead run now spawns above Sunset Falls. Below Lucia Falls, the river flows through a narrow valley, forming a canyon in places, until it opens up around RM 14 into a broad alluvial valley. Stream gradient dramatically drops off within this reach causing large sediment aggradations. Extensive meandering, braiding, and channel shifting occurs in the lower river, particularly between RM 6 and RM 10. Backwater effects from the Columbia extend up to RM 6.

The East Fork Lewis basin has developed from volcanic, glacial, and erosional processes. Glaciation has shaped the valleys in upper portions of the basin as recently as 13,000 years ago. 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.

3.1.2 *Climate*

The climate is typified by mild, wet winters and warm, dry summers. Mean annual precipitation is 52 inches at Battle Ground, which is along the lower river (WRCC 2003). Precipitation in the upper basin is considerably greater. Although most of the basin is rainfall dominated, much of the upper basin receives abundant snowfall, with a significant portion of the upper basin in the rain-on-snow zone. The basin is subject to winter freshets and flooding.

3.1.3 *Land Use, Ownership, and Cover*

The bulk of the land is forested and a large percentage is managed as commercial forest. Agricultural and residential activities are found in valley bottom areas. Recreation uses and residential development have increased in recent years. The population in the basin was approximately 24,400 persons in 2000 (LCFRB 2001). Most of the land is private (63%), with about 20% of the basin area lying within the Gifford Pinchot National Forest. 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 fires 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. The State of Washington owns, and the Washington State Department of Natural Resources (DNR) manages the beds of all navigable waters within the subbasin. Any proposed use of those lands must be approved in advance by the DNR. A breakdown of land ownership and land cover/land use in the EF Lewis basin is presented in Figure 3 and Figure 5.

3.1.4 *Development Trends*

Rural residential development is widespread in the lower portion of the basin and is expected to increase. The population in the basin was approximately 24,400 persons in 2000 (LCFRB 2001). The population of the basin is expected to more than double by 2020. Continued population growth will increase pressures for conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions.

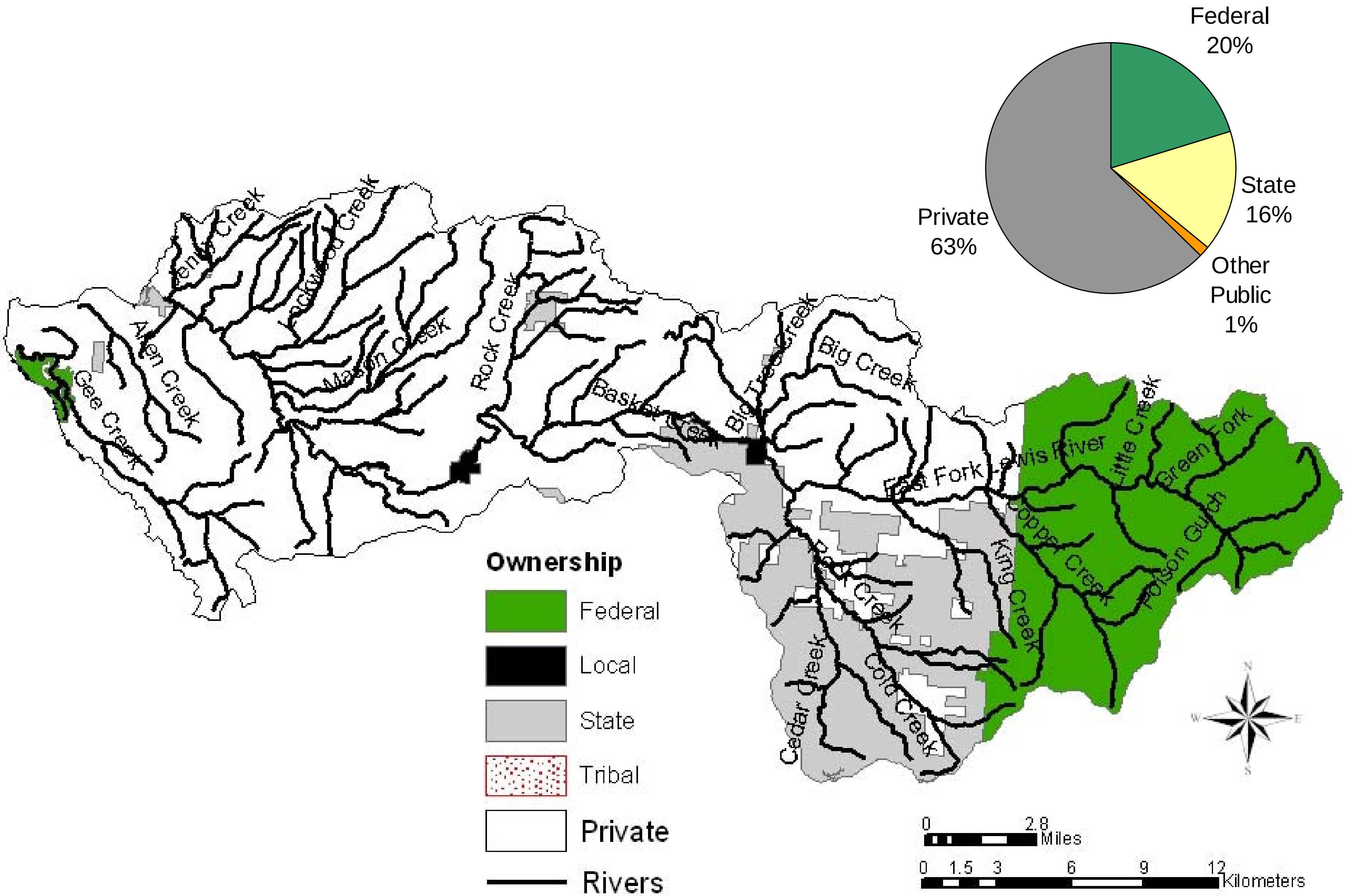


Figure 2. Landownership within the East Fork Lewis River basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

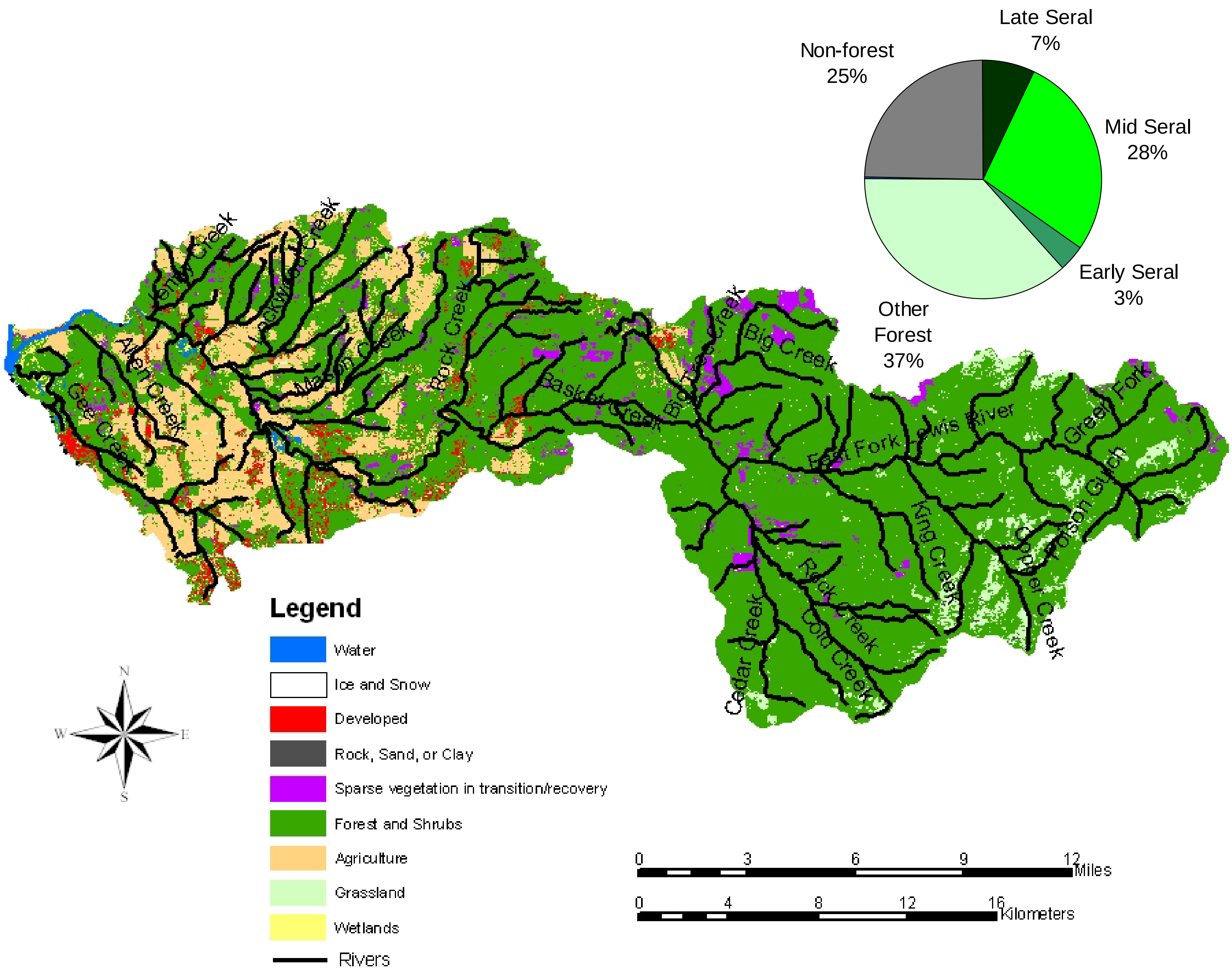


Figure 3.Land cover within the East Fork Lewis basin. Vegitation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. 1997. Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the East Fork Lewis Subbasin. Other species of interest were also identified as appropriate. Species were selected because they are listed or under consideration for listing under the U.S. Endangered Species Act or because viability or use is significantly affected by the Federal Columbia Hydropower system. Federal hydropower system effects are not significant within the East Fork Lewis River basin although anadromous species are subject to effects in the Columbia River, estuary, and nearshore ocean. The East Fork Lewis ecosystem supports and depends on a wide variety of fish and wildlife in addition to designated species. A comprehensive ecosystem-based approach to salmon and steelhead recovery will provide significant benefits to other native species through restoration of landscape-level processes and habitat conditions. Other fish and wildlife species not directly addressed by this plan are subject to a variety of other Federal, State, and local planning or management activities.

Focal salmonid species in East Fork Lewis River watersheds include fall Chinook, chum, coho, and summer and winter steelhead. Bull trout do not occur in the subbasin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table 1). Extinction risks are significant for all focal species – the current health or viability of ranges from very low for chum to medium for fall Chinook. Returns of summer and winter steelhead include both natural and hatchery produced fish. The East Fork Lewis chum population is a subset of the Lewis Basin chum population which includes the North Fork and East Fork combined populations.

Table 1. Status of focal salmon and steelhead populations in the East Fork Lewis River subbasin.

Focal Species	ESA Status	Hatchery Component[1]	Historical numbers[2]	Recent numbers[3]	Current viability[4]	Extinction risk[5]
Fall Chinook	Threatened	No	4,000-30,000	100-700	Medium	20%
Chum (a)	Threatened	No	120,000-300,000[6]	<100	Very Low	70%
Coho	Proposed	No	5,000-40,000	Unknown	Low	70%
Summer Steelhead	Threatened	Yes	1,000-9,000	100	Low+	30%
Winter Steelhead	Threatened	Yes	3,000-10,000	100-300	Low+	40%

(a) Includes combined East Fork and North Fork Lewis populations

[1] *Significant numbers of hatchery fish are released in the subbasin.*
[2] *Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations..*
[3] *Approximate current annual range in number of naturally-produced fish returning to the subbasin.*
[4] *Propsects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.*
[5] *Probability of extinction within 100 years corresponding to estimated viability.*
[6] *Historic production for the entire Lewis Basin.*

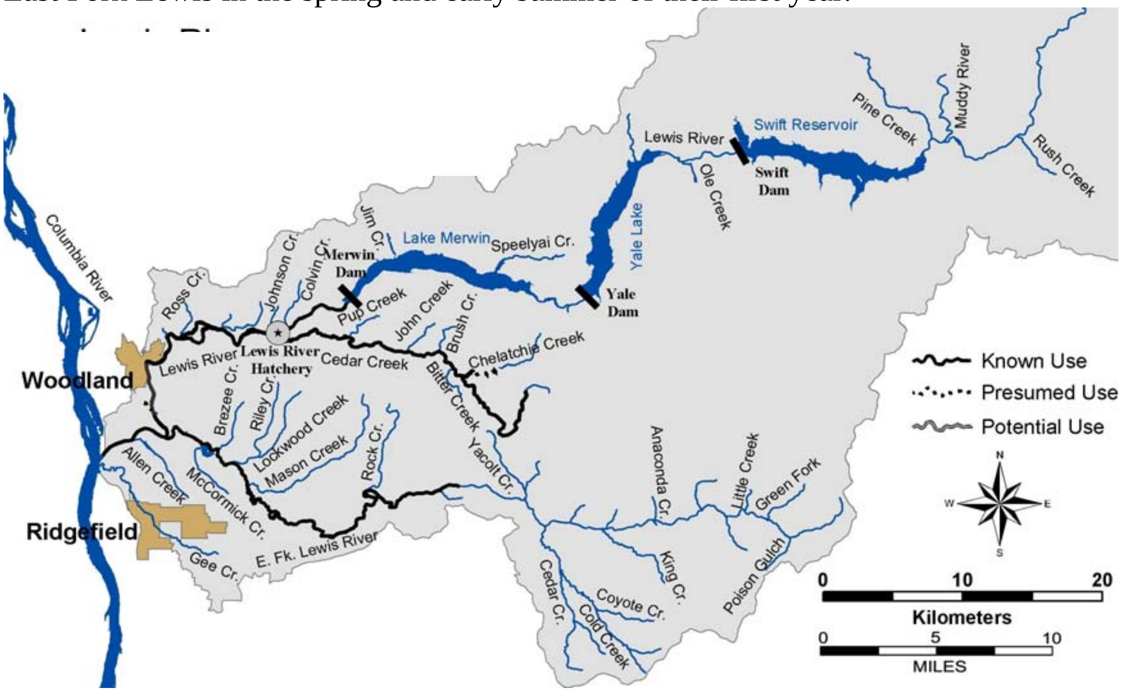
Other species of interest in the East Fork Lewis Subbasin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

Brief summaries of the population characteristics and status follow. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

3.2.1 *Fall Chinook—Lewis Subbasin (East Fork)*

ESA: Threatened 1999	**SASSI: Depressed 2002**

The historical East Fork Lewis River adult population is estimated from 4,000-30,000 fish. The current natural spawning number for tule fall Chinook ranges from 100-700 fish. There is no hatchery fall Chinook production. Natural spawning occurs primarily in six miles of the mainstem from Lewisville Park downstream to Daybreak Park. Spawning occurs primarily in October for the tule population, a later timed fall Chinook run spawns in November to January. Juvenile rearing occurs near and downstream of the spawning areas. Juveniles migrate from the East Fork Lewis in the spring and early summer of their first year.

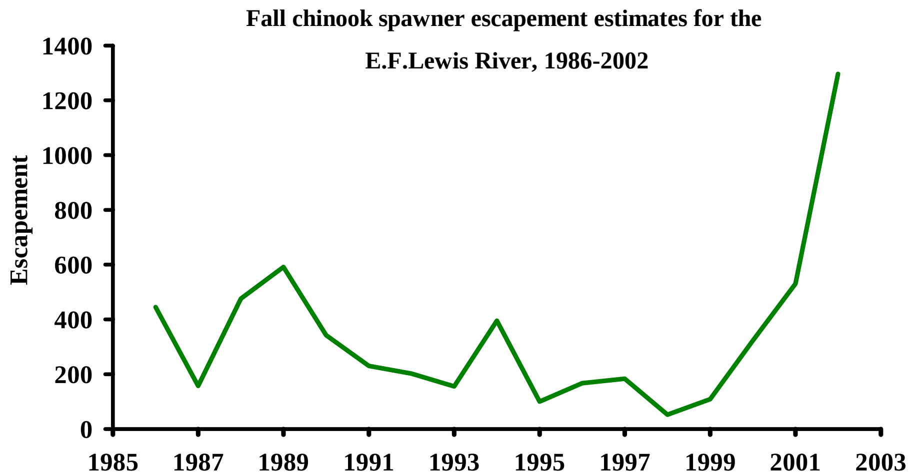


Diversity

- Late spawners in the North Fork and EF Lewis are considered a lower river wild stock within the lower Columbia River ESU
- Early spawners in the EF Lewis are considered lower Columbia tules
- The EF Lewis River fall chinook stock designated based on distinct spawning distribution and timing
- Genetic analysis of EF Lewis River fall chinook indicated they were genetically distinct from other lower Columbia River chinook stocks, except North Lewis River fall chinook

Life History

- Fall chinook enter the Lewis River from August to November, depending on early fall rain
- Natural spawning in the EF Lewis River occurs in two distinct segments: the early segment in October and the late segment from November through January
- Age ranges from 2-year-old jacks to 6-year-old adults, with dominant adult ages of 3, 4, and 5 (averages are 20.5%, 48.5%, and 22.7%, respectively)
- Fry emerge from March to August (peak usually in April), depending on time of egg deposition and water temperature; fall chinook fry spend the spring in fresh water, and emigrate in the summer as sub-yearlings



Distribution

- Spawning occurs primarily from Lewisville Park downstream to Daybreak Feeders (approx. 6 miles); the late spawning segment also spawns in areas upstream of Lewisville Park
- The EF Lewis late spawning fall chinook along with North Lewis and Sandy River late spawning fall chinook comprise the lower Columbia River wild management unit

Abundance

- Fall chinook escapement estimates by WDFW (1951) were about 4,000 into the EF Lewis River
- EF Lewis River spawning escapement from 1986-2001 ranged from 52 to 591 (average 279)

Productivity & Persistence

- NMFS Status Assessment for the EF Lewis River fall chinook indicated a 0.0 risk of 90% decline in 25 years, a 0.06 risk of 90% decline in 50 years, and a 0.0 risk of extinction in 50 years
- The EF Lewis early and late components of natural produced fall chinook have been sustained at low levels with minimal influence from hatchery fish

Hatchery

- There are no hatcheries on the EF Lewis River
- Hatchery fish have never been released into the East Fork; hatchery releases of fall chinook in the North Lewis began as early as 1909 and continued through 1985; there may have been some straying of North Lewis hatchery fish to the EF Lewis in past years

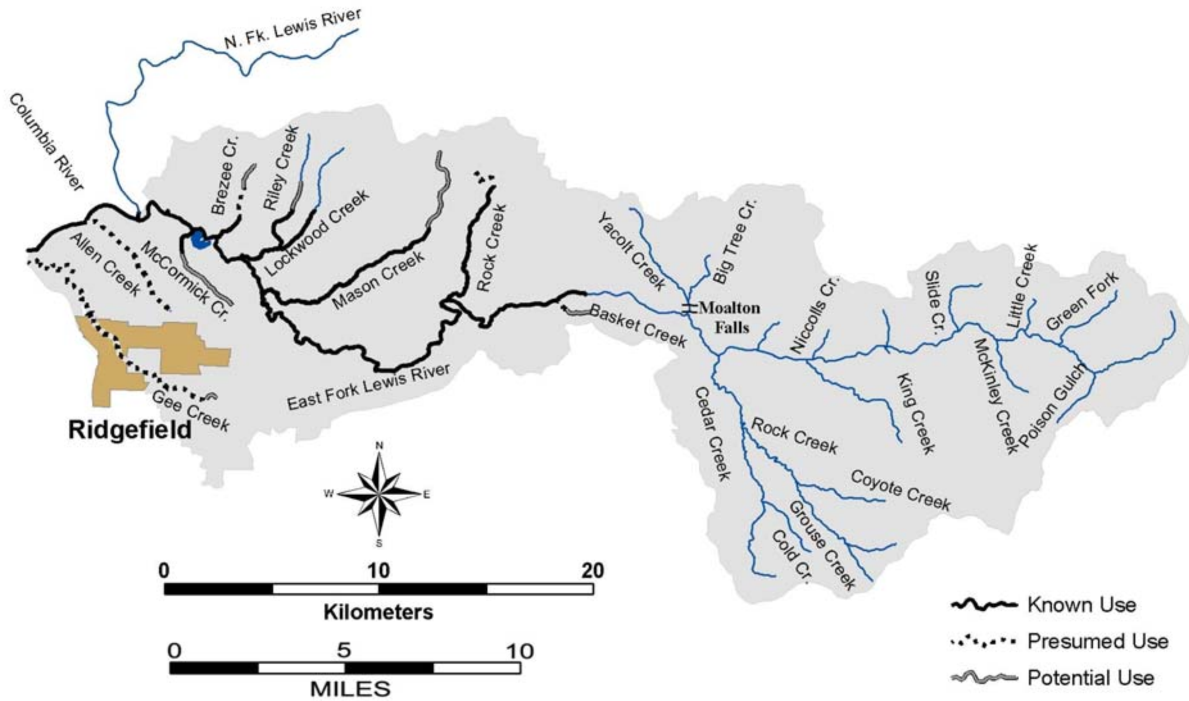
Harvest

- East Fork Lewis wild fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, and in Columbia River commercial and sport fisheries
- East Fork Lewis late spawning fall chinook migration patterns are likely similar to North Lewis fall chinook and more northerly distributed than other lower Columbia chinook populations, primarily along the coasts of British Columbia and Alaska
- East Fork Lewis early spawning fall chinook migration patterns are likely similar to lower Columbia tule populations, primarily along the coasts of Washington and Southern British Columbia
- Columbia River commercial and sport harvest of late East Fork Lewis fall chinook is constrained by ESA limits on Snake and Coweeman wild fall chinook and the North Lewis spawning escapement goal
- Using North Lewis wild fall chinook as a surrogate for late spawning East Fork Lewis chinook suggests a harvest rate of 49% in the 1980s to early 1990s and a reduced harvest rate of 28% in the mid to late 1990s
- The EF Lewis River is closed to sport fishing for fall chinook

3.2.2 *Coho—Lewis Subbasin (East Fork)*

ESA: Candidate 1995	**SASSI: Unknown 2002**

The historical East Fork Lewis adult population is estimated from 5,000-40,000, with the majority of returns late stock which spawn from late November to March. Some early stock coho were also historically present with spawning occurring primarily in early to mid- November. Current returns are unknown but assumed to be low. There is currently no hatchery coho released into the East Fork Lewis. Natural spawning occurs downstream of Lucia Falls (RM 21), particularly in Lockwood, Mason, and Rock creeks. Juveniles rear for a full year in the Lewis Basin before migrating as yearlings in the spring.

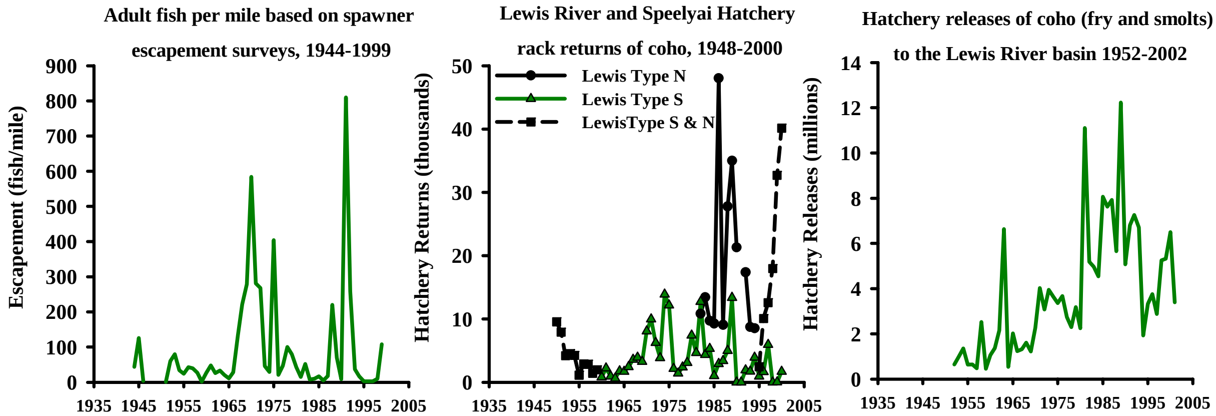


Distribution

- 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
- On the East Fork, spawning occurs primarily below Lucia Falls (RM 21); Lockwood, Mason, and Rock Creeks are extensively used

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 and 1,166 coho in the East Fork
- In 1951, WDF estimated coho escapement to the basin was 15,000 fish; 10,000 in the North Fork (primarily early run) and 5,000 in the East Fork (primarily late run)

Productivity & Persistence

- Natural coho production is presumed to be generally low in most tributaries
- Juvenile sampling in Lockwood Creek in 1994-95 found a low level of coho
- 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 coho adults released above Swift Reservoir successfully spawned in upper basin tributaries

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
- There are no hatcheries in the East Fork Lewis, although coho fry were periodically released from the Lewis River Hatchery in past years.

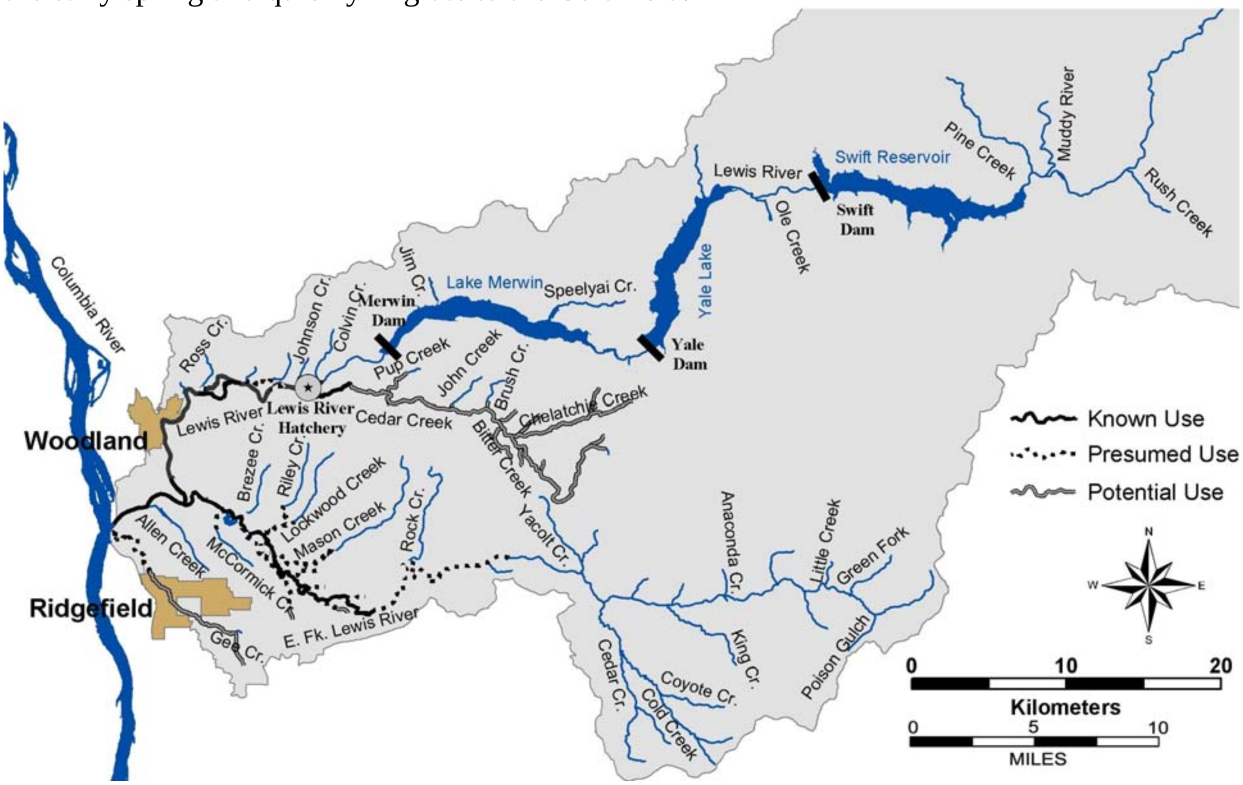
Harvest

- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% 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
- An average of 40 coho (1982-1989) were harvested annually in the EF Lewis sport fishery
- The East Fork Lewis is now closed to fishing for coho
- 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

3.2.3 *Chum—Lewis Subbasin*

ESA: Threatened 1999	**SASSI: NA**

Historical adult populations produced from the Lewis Basin (including the mainstem, North, and East Lewis) are estimated from 120,000-300,000. Current natural spawning is estimated at less than 100 fish. Spawning occurs in the lower reaches of the mainstem, North Fork, East Fork, and in Cedar Creek. Natural spawning chum in the Lewis Basin are all naturally produced as no hatchery chum are released in the area. Juveniles rear in the lower reaches for a short period in the early spring and quickly migrate to the Columbia.



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
- In 2002, WDFW estimated a chum spawning escapement of 28 in the North Fork Lewis and 3 in the East Fork Lewis

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

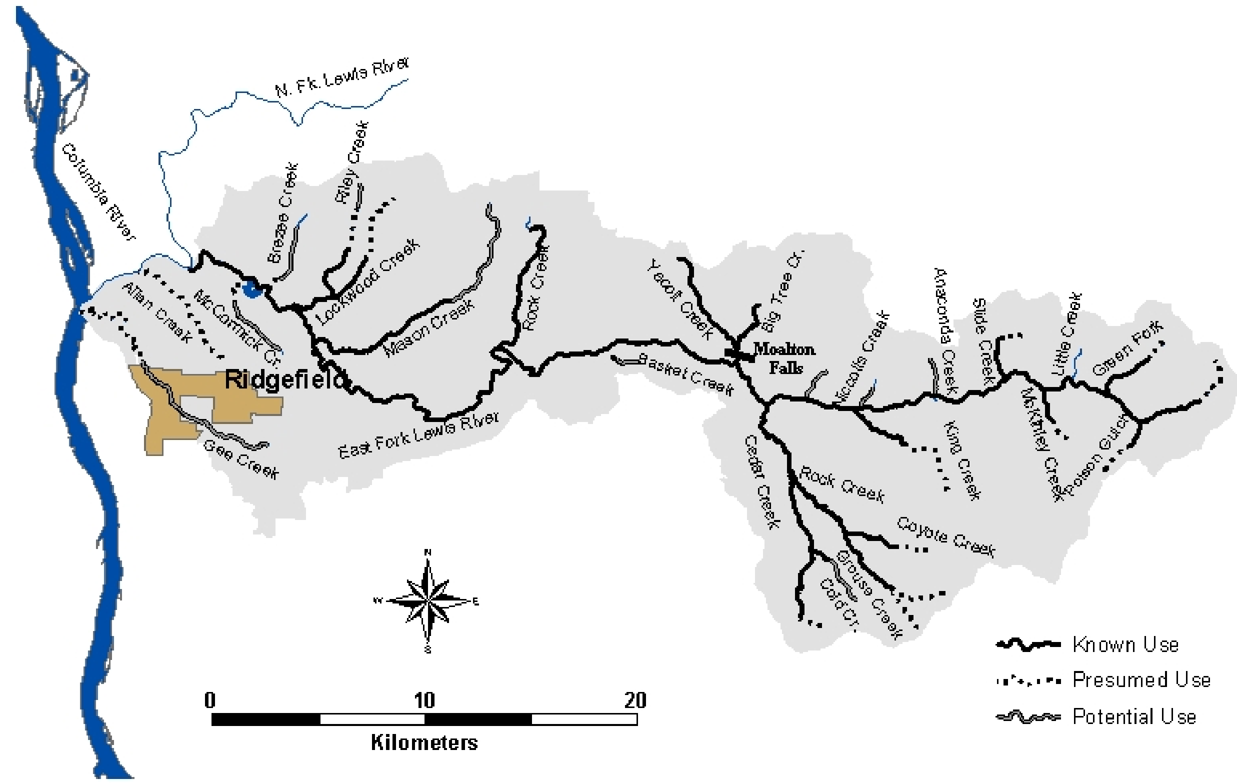
Harvest

- 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

3.2.4 *Summer Steelhead—Lewis Subbasin (East Fork)*

ESA: Threatened 1998	SASSI: Unknown 2002

The historical East Fork Lewis adult population is estimated from 1,000-9,000 fish. Current natural spawning returns average about 100 fish. In-breeding with Skamania Hatchery produced steelhead is thought to be low because of differences in spawn timing and distribution. Spawning occurs throughout the basin, extending to the mainstem East Fork Lewis and tributaries upstream of Moulton Falls. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Lewis.

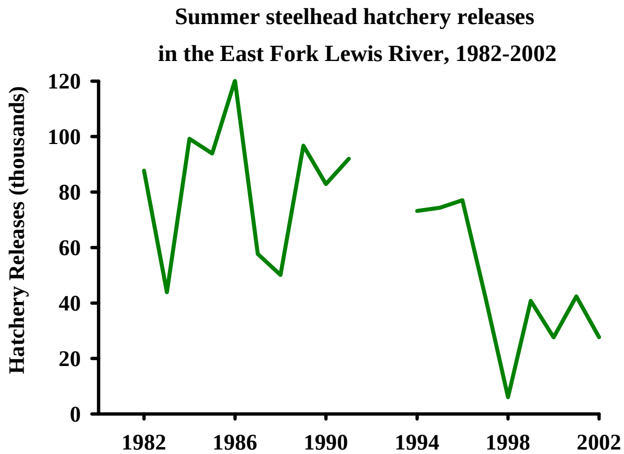


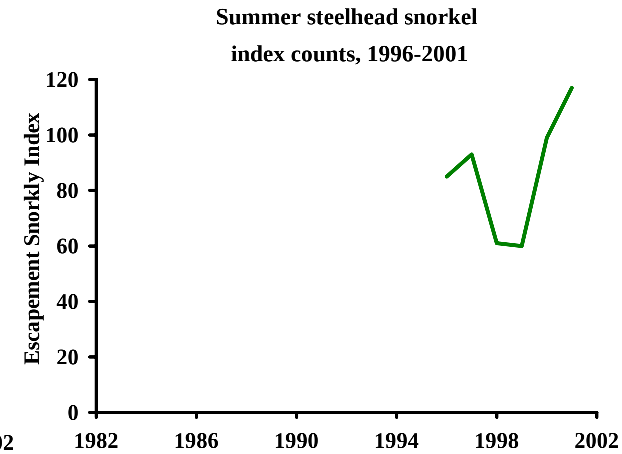
Distribution

- Spawning occurs in the EF Lewis River as well as Rock Creek and other tributaries; rearing habitat is available throughout most of the basin
- Upstream migration was essentially blocked at Sunset Falls until 1982 when the falls were “notched”, lowering the falls from 13.5 to 8 feet; approximately 12% of the run now spawns above Sunset Falls

Life History

- Adult migration timing for EF Lewis River summer steelhead is from May through November
- Spawning timing on the EF Lewis River is generally from early March through early June
- Age composition data are not available for EF 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 early 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 stocks
- Genetic analysis in 1996 provided little information in determining stock distinctiveness

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 EF Lewis River was estimated at 600 fish in 1984
- Average wild summer steelhead escapement to the EF Lewis River from 1991-1996 was 851
- Snorkel index escapement surveys have been conducted since 1996
- The escapement goal for the EF Lewis River is 814 wild adults

Productivity & Persistence

- Wild fish production is believed to be moderate

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
- 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 available from 1982-2002; current annual stocking levels in the East Fork are around 40,000 smolts
- The portion of wild summer steelhead in the run at Lucia Falls averaged 27% from 1974-1983
- Recent snorkel surveys indicate hatchery summer steelhead comprise about 70% of the spawning escapement on the EF Lewis River

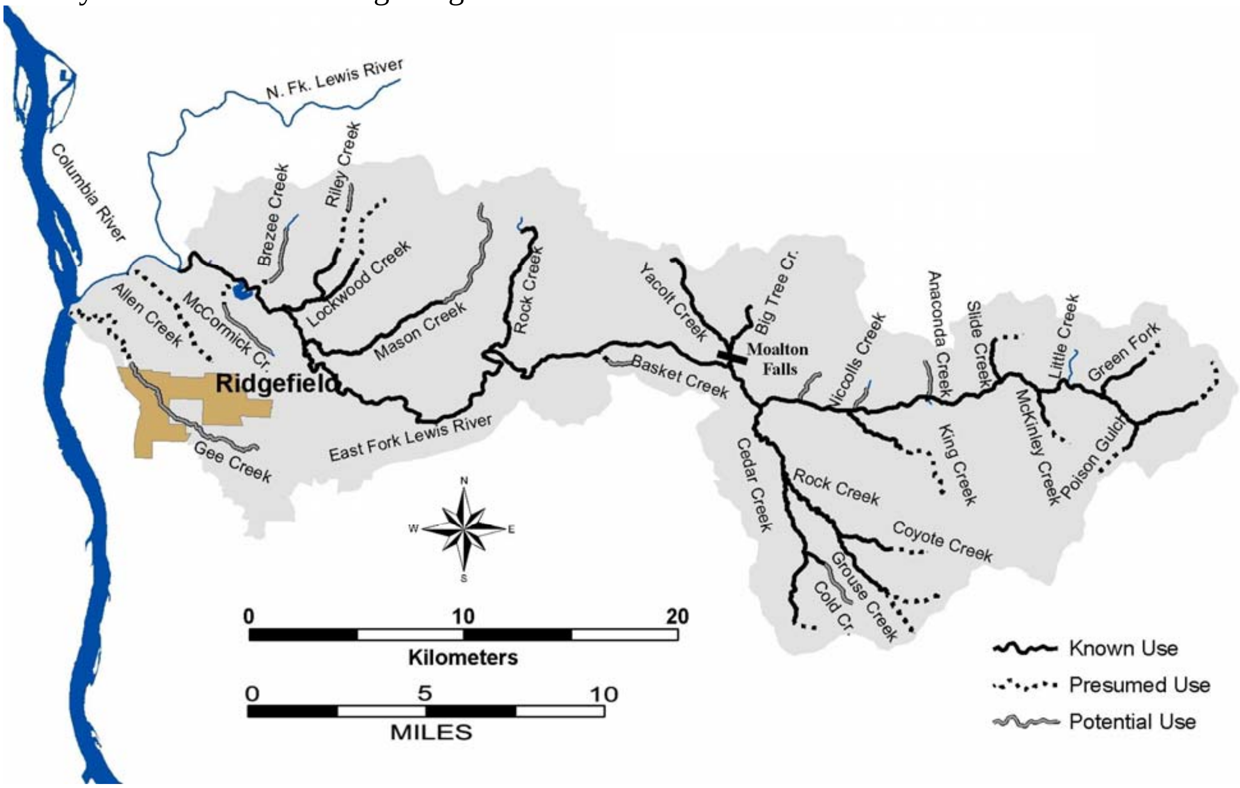
Harvest

- No directed fisheries target EF Lewis River summer steelhead; incidental mortality currently occurs during the Columbia River fall commercial fisheries 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 East Fork harvest; since 1986, regulations limit harvest to hatchery fish only
- ESA limits fishery impact on wild EF Lewis summer steelhead in the mainstem Columbia River and in the EF Lewis River

3.2.5 *Winter Steelhead—Lewis Subbasin (East Fork)*

ESA: Threatened 1998	SASSI: Depressed 2002

The historical East Fork Lewis adult population is estimated from 3,000-10,000 fish. Current natural spawning returns range from 100-300. In-breeding with Skamania Hatchery produced steelhead is possible, but likely low because of differences in spawn timing. Spawning occurs in the mainstem East Fork Lewis and tributaries. Access upstream of Sunset Falls was blocked until 1982 when the falls were "notched". Spawning time is generally from early March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the East Fork Lewis.

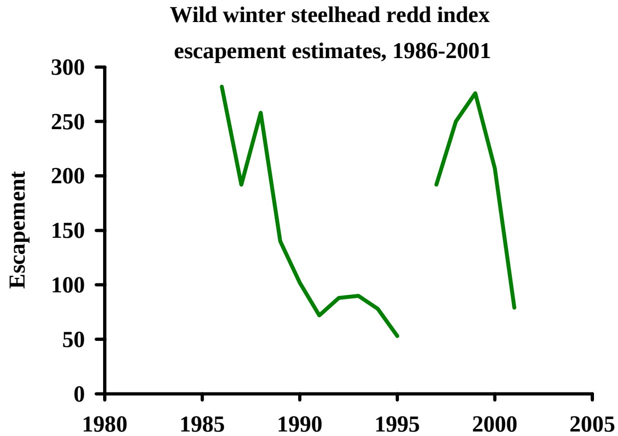


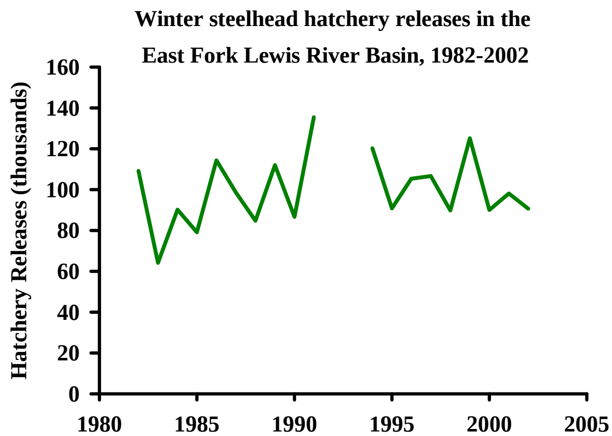
Distribution

- Spawning occurs in the EF Lewis River as well as Rock Creek and other tributaries; rearing habitat is available throughout most of the basin
- Upstream migration was essentially blocked at Sunset Falls until 1982 when the falls were "notched", lowering the falls from 13.5 to 8 feet; approximately 12% of the run now spawns above Sunset Falls

Life History

- Adult migration timing for EF Lewis winter steelhead is from December through April
- Spawning timing on the EF 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

- EF Lewis winter steelhead stock designated based on distinct spawning distribution and late 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 EF Lewis winter steelhead in 1996 was unable to determine the distinctiveness of the stock compared to other lower Columbia River steelhead stocks

Abundance

- In 1936, steelhead were reported in the Lewis River during escapement surveys
- Historical winter steelhead annual escapement in the Lewis River ranged from 1,000 to 11,000 fish
- Redd index escapement counts from 1986-2001 ranged from 53 to 282 (average 157); a new escapement index was instituted in 1997 and the relationship to the previous index is unknown
- Escapement goal for the EF Lewis River is 875 wild adult steelhead
- The portion of wild winter steelhead at Lucia Falls found in the creel ranged from 35% to 74% from 1974-1983
- Recent data suggests that 51% of spawning steelhead in the East Fork are of hatchery origin

Productivity & Persistence

- NMFS Status Assessment for the EF Lewis River winter steelhead predicted a risk of 1.0 for the risk of 90% decline in both 25 and 50 years; the risk of extinction in 50 years was not applicable
- Winter steelhead natural production is unknown

Hatchery

- There are no hatcheries on the EF Lewis River
- The Ariel (Merwin) Hatchery is located below Merwin Dam the NF Lewis River; the hatchery has been releasing winter steelhead in the Lewis basin since the early 1990s, but does not release steelhead in the EF Lewis

- Annual winter steelhead hatchery smolt releases into the EF Lewis during 1982-2002 have ranged from about 60,000—140,000
- Currently program releases about 90,000 winter steelhead smolts from Skamania Hatchery into the EF Lewis. Hatchery program has changed acclimation sites to the lower East Fork to reduce hatchery/wild interactions in the upper watershed

Harvest

- No directed commercial or tribal fisheries target EF 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 Lewis River from 1980-1990 ranged from 2,245 to 6,766 (average 4,385); the portion of this harvest from the East Fork is unknown; 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 EF Lewis River

3.2.6 *Other Species*

Pacific lamprey – Information on lamprey abundance is limited and does not exist for the East Fork Lewis population. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have declined in the East Fork Lewis basin also. Adult lamprey return from the ocean to spawn in the spring and summer. Spawning likely occurs in the small to mid-size streams of the East Fork basin. Juveniles rear in freshwater up to six years before migrating to the ocean.

3.3 Subbasin Habitat Conditions

This section describes the current condition of aquatic and terrestrial habitats within the subbasin. Descriptions are included for habitat features of particular significance to focal salmonid species including watershed hydrology, passage obstructions, water quality, key habitat availability, substrate and sediment, woody debris, channel stability, riparian function, and floodplain function. These descriptions will form the basis for subsequent assessments of the effects of habitat conditions on focal salmonids and opportunities for improvement.

3.3.1 *Watershed Hydrology*

The EF Lewis River watershed is primarily a low to mid-elevation, rain dominated system with extensive rain-on-snow conditions present in the upper reaches. Peak stream flows are generated by fall, winter, and spring rains with flows augmented by snowmelt in the spring and early summer (Figure 4).

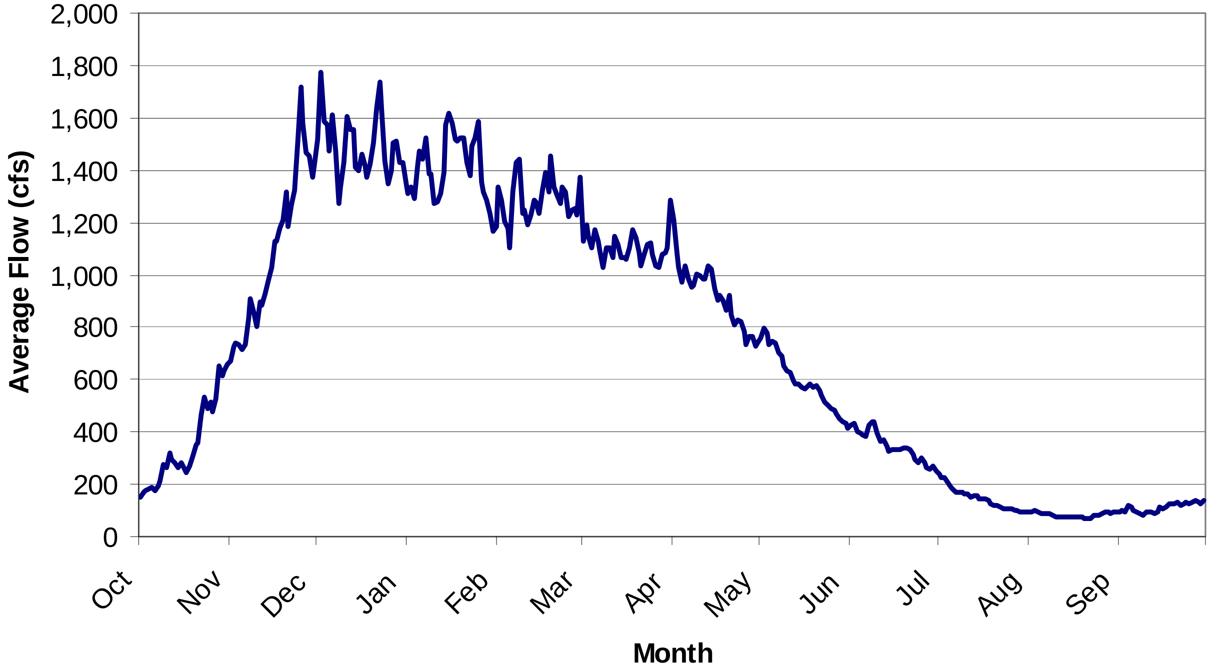


Figure 4. Daily average stream flow for the period 1929-2002. USGS Gage #14222500; East Fork Lewis River Near Heisson, WA

The potential exists for impaired runoff conditions in certain areas due to past fires, the presence of young forest stands, high road densities, and impervious surfaces. The Integrated Watershed Assessment (IWA), which is presented in greater detail later in this chapter, indicates that 18 of the 36 subwatersheds (7^{th} field) in the basin are "impaired" with respect to landscape conditions influencing runoff; 14 are rated as "moderately impaired"; and only 4 are considered "functional". The greatest impairments are located in the lower and middle elevation subwatersheds. These subwatersheds are primarily private agricultural, residential, or commercial forest. Runoff conditions improve in the upper watershed, which is predominantly composed of public forest land. In the uppermost, federally managed, portion of the basin, the USFS conducted a peak flow analysis that modeled the effect of vegetation removal on the 2-year peak flow. The Slide Creek, Rock Creek (upper), and Copper Creek basins show susceptibility to flow increases of greater than 10%. These basins show "moderately impaired" conditions according to the IWA. The USFS assessment also indicated that many basins have a significant increase in the length of the channel network due to roads and road ditches, which can also increase peak flows (USFS 1995).

DOE conducted an instream flow study on the EF Lewis and 13 tributaries. The Instream Flow Incremental Methodology (IFIM) was used to model flow-habitat conditions on the mainstem while the toe-width method was used to assess flow-habitat conditions on tributaries. The IFIM results revealed that flows at certain times of the year may be below optimal for fish at various life history stages. Flows for Chinook spawning, which starts in October, were only 25% of the optimal flow in October but reached 80% of the optimal flow by November 1. Flows necessary for Chinook and steelhead juvenile rearing were only about 30% of optimum in August and September (Caldwell 1999).

Comparing spot flow measurements with flow requirements determined from the Toe-Width method revealed that spawning and rearing habitat was limited for most species in McCormick, Brezee, Lockwood, Mason, and Yacolt Creeks during the fall of 1998. The results in Rock creek suggested insufficient flows for fall spawning but optimum fall rearing conditions (Caldwell 1999).

Based on predictions of future population growth in the basin, total water use is estimated to increase from 10% (2000) to 20% (2020) of late summer flow, assuming full hydraulic continuity between ground water and stream flow. The watershed is near closure for surface water rights and for some existing surface water rights, low flow restrictions are in place in order to protect aquatic biota (LCFRB 2001). The potential for ground and/or surface water withdrawal impacts to salmonids needs further investigation.

3.3.2 *Passage Obstructions*

No artificial barriers exist on the mainstem of the East Fork Lewis. Lucia Falls at RM 21.3 is believed to block access to anadromous species except for steelhead and an occasional coho. Sunset Falls at RM 32.7 was notched in 1982, allowing for easier passage of this natural feature. Artificial passage obstructions within the watershed include culverts, road crossings, and small dams. More than 10 miles of habitat are believed to be blocked by these obstructions (see Wade 2000 for more details).

3.3.3 *Water Quality*

The mainstem from the mouth to RM 24.6 was listed on the 1998 WA state 303(d) list of impaired waterbodies due to exceedance of temperature and fecal coliform standards (WDOE 1998). Stream temperatures in the mainstem East Fork commonly exceed the 64°F (18°C) state standard, and occasionally exceed 73.4ºF (23ºC), at locations from Daybreak Park down. In the Ridgefield gravel pits (RM 8), which the stream avulsed into in 1996, temperatures may be warming as a result of large water surface areas within the former gravel pits. Temperature effects in this reach are of particular concern for salmonids (Sweet et al. 2003). USFS monitoring has showed exceedances of the 60.8ºF (16ºC) standard on the mainstem East Fork above and below Sunset Falls as well as on the Green Fork (Wade 2000).

Stream temperatures are also a concern in McCormick Creek, Lockwood Creek and lower Dean Creek. Temperatures in excess of 82.4ºF (28ºC) in lower Dean Creek have been recorded near the outlet of the J.L. Storedahl & Sons - Daybreak gravel mining pits, and conditions are believed to be generally unsuitable for salmonids during the summer (Sweet et al. 2003).

Turbidity is also a concern in portions of the basin. In lower Dean Creek, turbid water has been discharged from the gravel processing ponds owned by J. L. Storedahl and Sons. Measurements associated with the evaluation of a new effluent treatment system, which was implemented in 1999, showed considerable improvements in turbidity levels from pre-project measurements. Recent data from the mainstem East Fork Lewis shows no significant difference in fines between the first riffle above and the first riffle below the Dean Creek confluence (Sweet et al. 2003). Limiting Factors Analysis TAG members noticed turbidity problems in Cedar Creek, potentially from wastewater releases from Larch Mountain Corrections Facility and roads leading to the facility (Wade 2000). An unnamed tributary to the East Fork Lewis, sometimes referred to as Manley Road Creek, has turbidity problems resulting from Teboe processing/mining operations (Donna Hale, personal communication).

Turbidity measurements in lower Rock Creek exceeded state standards in 30% of the samples. Fecal coliform standards were exceeded in 55% of samples and D.O. standards were exceeded 10% of the time. These water quality problems may be due to farming operations (Hutton 1995 as cited in Wade 2000).

Low nutrient levels are assumed to exist in the East Fork Lewis basin due to the lack of sufficient salmonid carcasses as a result of low escapement numbers for most species. However, nutrient enhancement projects have planted numerous carcasses into tributary streams over the past several years (Wade 2000)

3.3.4 *Key Habitat Availability*

In the lower mainstem, pool abundance and quality are concerns between RM 6 and RM 16.2, partly as a result of the 1996 avulsion of the mainstem into the Ridgfield Pits near RM 8. This avulsion resulted in the abandonment of approximately 3,200 lineal feet of riffle habitat (used primarily for spawning) in exchange for low velocity pool habitat (used primarily for rearing). Portions of the upstream end of the avulsed reach are slowly converting to riffle habitat as the pools fill with coarse sediments (Sweet et al. 2003).

As part of the 2000 Limiting Factors Analysis, the TAG expressed concerns with the availability of suitable pool habitat on the mainstem between lower Rock Creek (RM 16.2) and Sunset Falls (RM 32.7).

USFS surveys in the upper basin, conducted as part of the 1995 watershed analysis, identified substandard pool frequency in approximately 58% of surveyed streams (USFS 1995). Pools suitable for summer steelhead holding exist on the upper mainstem below the Green Fork confluence, though many of these lack adequate cover. Good holding pools are rare on Slide, Green Fork, and the mainstem above Green Fork (USFS 1999).

Historically available side channel habitat has been reduced in the lower river due to draining of wetlands for agricultural uses and conversion to a single thread channel as a result of channel confinement projects (Sweet et al. 2003). Off-channel habitat in the upper basin is sparse and is only accessible during the highest flows (USFS 1999).

3.3.5 *Substrate & Sediment*

A large portion of sediment delivery in the lower river is from in-channel bed and bank erosion related to channel migration and avulsions. Analysis of historical aerial photos indicates that movement of the channel is a natural process in the lower mainstem alluvial reaches; however, between RM 7 and RM 10, natural rates of channel adjustment have been influenced by the presence of stream-adjacent gravel pits, which have captured the mainstem in a few locations within the past 10 years. These avulsions have altered rates of sediment generation and accumulation. The most notable avulsion occurred near RM 8 in November, 1996, when the mainstem was captured by the abandoned gravel ponds known as the Ridgefield Pits. This avulsion alone abandoned approximately 3,200 feet of riffle habitat. The previous riffle habitat was replaced by pools that are rapidly filling with sediment. In the Ridgefield Pit reach, the former gravel ponds have been filling with fine sediments that are believed to originate primarily from a high sandy bank just upstream of the avulsed reach. In some areas, riffle habitat suitable for spawning is being re-created as the pools fill. Sediment sampling downstream of the Ridgefield Pits in 2001 indicated that fine sediment volumes were less than 10% (Sweet et al. 2003).

Basin-wide sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. The results indicate that 28 out of the 36 subwatersheds in the basin are "moderately impaired" with respect to conditions that influence sediment supply. The remainder of the basin was rated as "functional" with respect to sediment supply. Most of the functional subwatersheds were concentrated in the Rock Creek basin (Upper). Sediment supply impairment is related to a number of factors, including primarily naturally unstable slopes and high road densities. The total road density in the basin is 4.13 mi/mi2 (greater then 3 mi/mi2 is considered high by most standards). The upper watershed, dominated by National Forest lands, has a relatively low overall road density of 1.79 mi/mi2. The USFS Watershed Analysis reports an estimated sediment yield due to roads of 400 tons/mi2/year, with 3 out of 23 of the subbasins in the upper watershed (portion primarily in National Forest) having high rates of surface erosion from roads (USFS 1995).

Despite the effects of roads, the Pacific Watershed Institute completed a sediment budget for the upper watershed and determined that the sediment supply is limited, primarily due to most available material having already eroded following early 20th century fires. The lack of supply of gravels may limit spawning habitat in the upper basin. Furthermore, low large woody debris (LWD) concentrations combined with the steep gradient and confinement of most upper basin channels probably results in transport of most gravels out of the upper basin (USFS 1999).

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

3.3.6 *Woody Debris*

LWD recruitment potential is of concern throughout the basin due to past forest fire impacts and harvest of riparian areas. A 1995 aerial photo analysis conducted by the USFS noted that 87% of riparian stands in the upper basin had either young, sparse hardwood stands or were burned in the early part of the century and now contained mature, dense hardwoods, with low to moderate potential for LWD recruitment (USFS 1995). In-stream LWD levels are very low also as a result of salvage logging following large fires in the early 20th century and from removal of log jams in the 1980s that were incorrectly assumed to be fish passage barriers (USFS 1999).

USFS stream surveys in the 1990s found that 92% of the surveyed streams had less than 40 pieces per mile (a poor rating), and at least 98% of the streams surveyed had concentrations of LWD less than 80 pieces per mile (USFS 1995). Limiting Factors Analysis TAG members felt that overall, LWD concentrations in the lower basin were low (Wade 2000).

3.3.7 *Channel Stability*

Bank stability is a major concern along portions of the lower 14 miles of the mainstem, particularly in areas that have received extensive alteration due to agricultural, residential, and mining development. In the broad alluvial valley between RM 7 and RM 10, dramatic channel adjustments including avulsions and lateral meander migration have occurred since 1858 (Sweet et al. 2003). Current rates of channel adjustment may be altered from their historical condition due to confinement of the river by levees and removal of riparian forests. Recent avulsions into stream-adjacent gravel pits occurred near RM 9 in 1995 and near RM 8 (Ridgefield Pits) in 1996. These adjustments abandoned a combined total of 4,900 feet of spawning habitat and have altered sediment transport dynamics in the lower river. A comprehensive evaluation of the effects of these events can be found in Sweet et al. (2003).

Reconnaisance surveys in 1999 indicated that high stream-adjacent bluffs near Daybreak Park may be contributing large amounts of fine sediment to the river, much of which is collecting in the Ridgefield Pits (Sweet et al. 2003). There are other areas of bank instability near RM 10.5 and RM 11.3. All of these conditions have dramatically altered channel stability and rates of sediment supply in the lower river. In particular, aggradation of sediments in some areas is believed to be causing erosion of lateral banks, therefore increasing width-to-depth ratios.

Bank stability problems in East Fork tributaries include streambank erosion along a segment of Mason Creek, cattle impacts on Rock Creek, and chronic mass wasting sites on upper Rock Creek and upper Lockwood Creek (Wade 2000).

3.3.8 *Riparian Function*

Riparian conditions in the lower river below RM 10 have been substantially impacted by residential, agricultural, and mining development. This area is believed to have been a gallery-type forest consisting of multiple age classes of willow, alder, ash, and cottonwood, but now consists only of widely dispersed cottonwoods, willow, and ash, with abundant reed canary grass, Himalayan blackberry, and Scotch broom in the disturbed areas. Substantial restoration efforts have involved the planting of thousands of native trees and shrubs in the past few years (Wade 2000).

An analysis of 1996 aerial photos indicated that the majority of the mainstem has lost substantial portions of riparian forest, many having been replaced by lawns. Most of the tributaries also have poor riparian conditions (Wade 2000). Riparian forests in the upper watershed have been altered by fire history, with only 4% of riparian reserves in late-successional stages and a total riparian hardwood composition of 23%. Large segments of the upper mainstem and Copper Creek have canopies that cover less than 50% of the stream channel (USFS 1995).

According to IWA watershed process modeling, which is presented in greater detail later in this chapter, 8 of the 36 subwatersheds in the basin are "impaired" with respect to riparian function. The remainder fall primarily in the "moderately impaired" category, with only 4 subwatersheds rated as "functional". The greatest impairments are in the low elevation portions of the basin, which have received the greatest impacts to riparian areas due to agricultural and residential development. Fully functional conditions exist only in a handful of headwaters subwatersheds.

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

3.3.9 *Floodplain Function*

The lower river flows through a broad alluvial valley that has been extensively diked to protect agricultural, residential, and mining activities. Historically, nearly the entire lower river valley bottom was wetlands, with extensive channel braiding from RM 7 to RM 10. By 1937, the mainstem was mostly a single-thread channel with ephemeral floodplain sloughs where the braids once were. This simplification of the channel has reduced a substantial amount of side channel and backwater habitat that was historically used for chum spawning and could provide important overwintering habitat for juvenile coho. Limiting Factors Analysis TAG members estimated that over 50% of the off-channel habitat and wetlands in the historical lower river floodplain have been disconnected from the river (Wade 2000).

3.4 Stream Habitat Limitations

A systematic link between habitat conditions and salmonid population performance is needed to identify the net effect of habitat changes, specific stream sections where problems occur, and specific habitat conditions that account for the problems in each stream reach. In order to help identify the links between fish and habitat conditions, the Ecosystem Diagnosis and Treatment (EDT) model was applied to East Fork Lewis River winter steelhead, summer steelhead, fall Chinook, chum, and coho.. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Appendix E.

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

3.4.1 *Population Analysis*

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

Habitat-based assessments were completed in the EF Lewis basin for summer steelhead, winter steelhead, fall Chinook, chum and coho. Model results indicate an estimated 61- 88% decline in adult productivity for all species compared to historical estimates (Table 2). Estimated historical-to-current trends in adult abundance show a decline of 49-90% for all species (Figure 5). Fall Chinook adult abundance has declined the least, to an estimated 51% of historical levels. Adult abundance of coho, winter and summer steelhead has declined by 75%, 75%, and 79%, respectively. Chum abundance has witnessed the most severe decline. Current estimates of chum abundance are at only 10% of historical levels. Diversity (as measured by the diversity index) has remained relatively constant for fall Chinook, chum and summer steelhead (Table 2). However, coho and winter steelhead diversity has declined by 29% and 23%, respectively.

Smolt productivity has also declined from historical levels for each species in the EF Lewis basin (Table 2). For fall Chinook and chum, smolt productivity has decreased by 58% and 43% respectively. For both coho and winter steelhead the decrease was estimated as approximately 80%. Summer steelhead smolt productivity has declined by 72%. Smolt abundance in the EF Lewis has declined most dramatically for chum and coho, with respective 79% and 80% changes from historical levels (Table 2). Current fall Chinook, winter steelhead, and summer steelhead smolt abundance levels are modeled at approximately half of their historical numbers (Table 2).

Model results indicate that restoration of properly functioning habitat conditions (PFC) would achieve significant benefits for all species (Table 2). Adult abundance of both chum and coho would increase by more than 200%. Adult returns of fall Chinook, winter steelhead, and summer steelhead would increase by more than 60%. Smolt numbers are also estimated to increase dramatically for all species, especially for coho, which shows a 287% increase in smolt abundance with restoration of PFC.

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

Species	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]
Fall Chinook	1,380	2,223	2,690	3.5	7.0	8.8	0.96	1.00	1.00	194,805	323,012	411,593	384	725	913
Chum	4,652	16,540	45,517	2.0	6.7	10.4	0.97	1.00	1.00	2,200,608	6,194,596	10,474,620	641	960	1,122
Coho	1,066	3,306	4,280	2.6	8.8	12.6	0.71	1.00	1.00	20,097	77,730	102,601	56	206	294
Winter Steelhead	631	1,109	2,517	3.7	10.4	29.9	0.77	0.84	1.00	10,560	18,414	22,539	69	188	292
Summer Steelhead	187	338	893	2.6	5.3	17.4	0.94	1.00	1.00	3,500	6,247	8,797	48	97	170

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

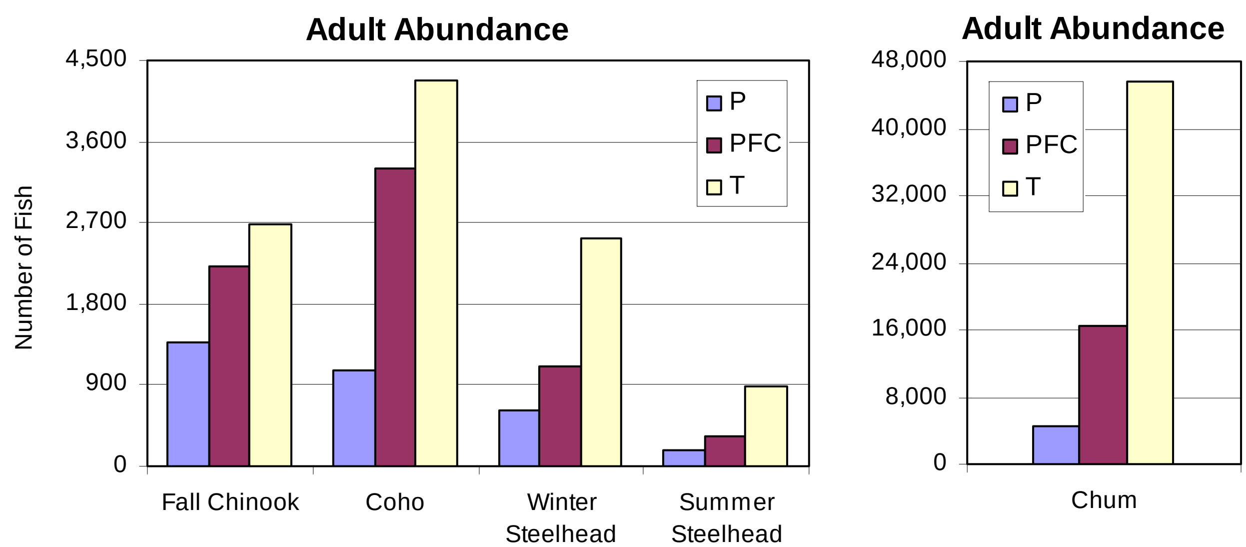


Figure 5. Adult abundance of East Fork Lewis River fall chinook, coho, winter steelhead and chum based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

3.4.2 *Stream Reach Analysis*

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

Summer steelhead, which are able to ascend Sunset Falls at RM 32.7, ascend the furthest up the EF Lewis. Winter steelhead, whose distribution stops at Sunset Falls, make greater use of mainstem tributary habitats. Fall Chinook distribution ends at Lucia Falls (RM 21.3) and chum distribution ends approximately at lower Rock Creek. See Figure 6 for a map of EDT reaches within the EF Lewis basin.

For both fall Chinook and chum, the high priority reaches are located lower in the basin. High priority reaches for fall Chinook include lower and middle mainstem reaches (EF Lewis 5-7 and 9) (Figure 7). Reaches EF Lewis 5-7 show a combined preservation and restoration emphasis, while EF Lewis 9 only has a preservation emphasis. For chum, the high priority reaches are EF Lewis 4-8 (Figure 8). All of these reaches, except for EF Lewis 4, have a combined preservation and restoration emphasis.

High priority reaches for coho in the EF Lewis are similar to those for fall Chinook. Coho high priority reaches include EF Lewis 5-8 and EF Lewis 10 (Figure 9). For coho, all of these reaches have a restoration emphasis, suggesting degradation to key coho habitat in these areas.

The high priority reaches for winter steelhead are the mainstem reaches (EF Lewis 12 and 13) and reaches in the Rock Creek basin (Rock 1-4) (Figure 11). These reaches represent the primary spawning and rearing areas for this population. As such, all of these reaches, except Rock Creek 4, show a preservation emphasis. High priority reaches for summer steelhead are also located in the most productive spawning and rearing reaches of the headwaters (EF Lewis 17-19) and the upper mainstem (EF Lewis 15) (Figure 10). These reaches, with the exception of EF Lewis 15, all show a combined preservation and restoration recovery emphasis.

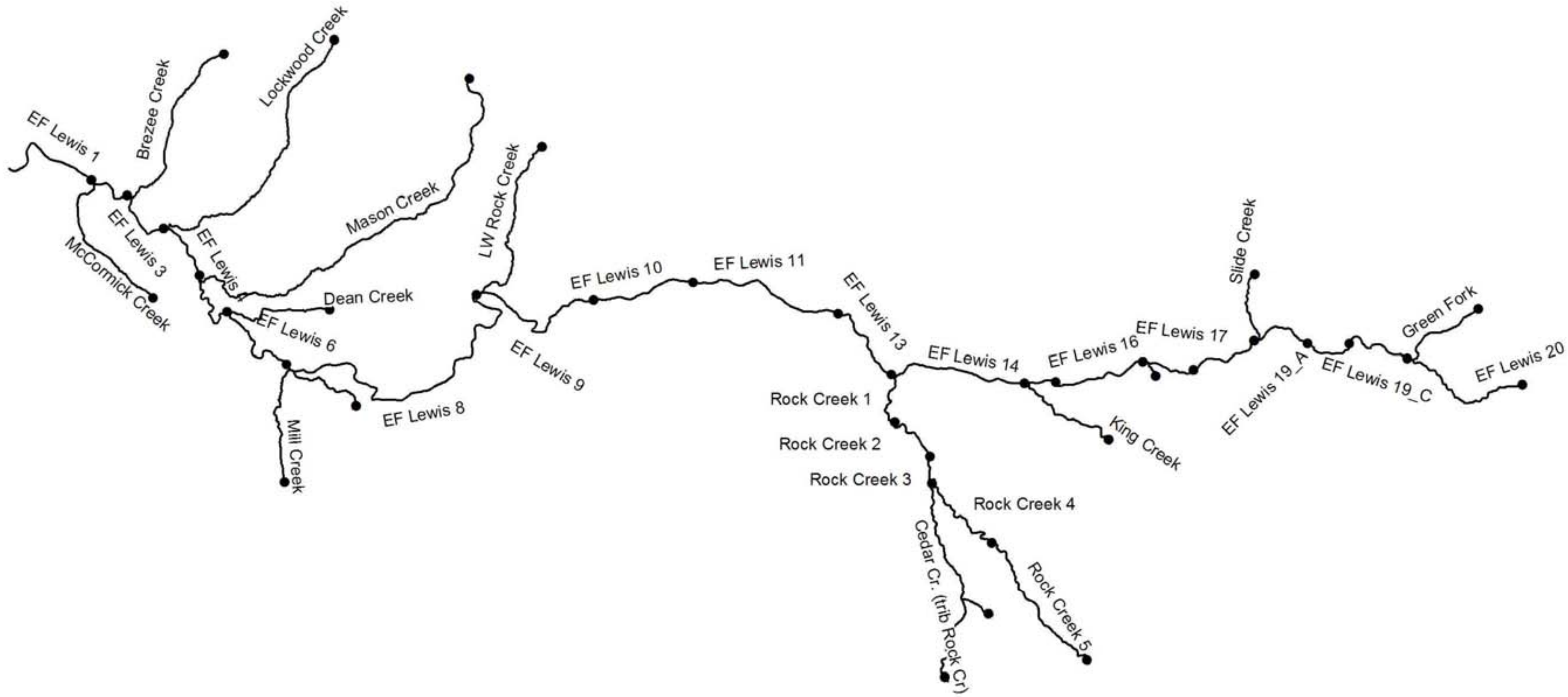


Figure 6. East Fork Lewis River subbasin with EDT reaches identified. For readability, not all reaches are labeled.

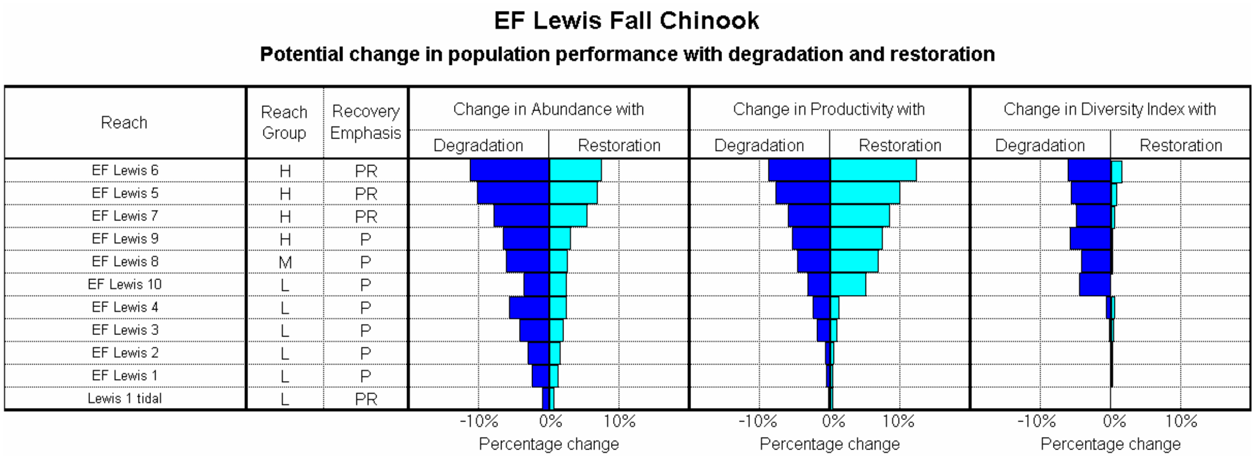


Figure 7. East Fork Lewis fall chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E Chapter 6 for more information on EDT ladder diagrams. Some low priority reaches are not included for display purposes.

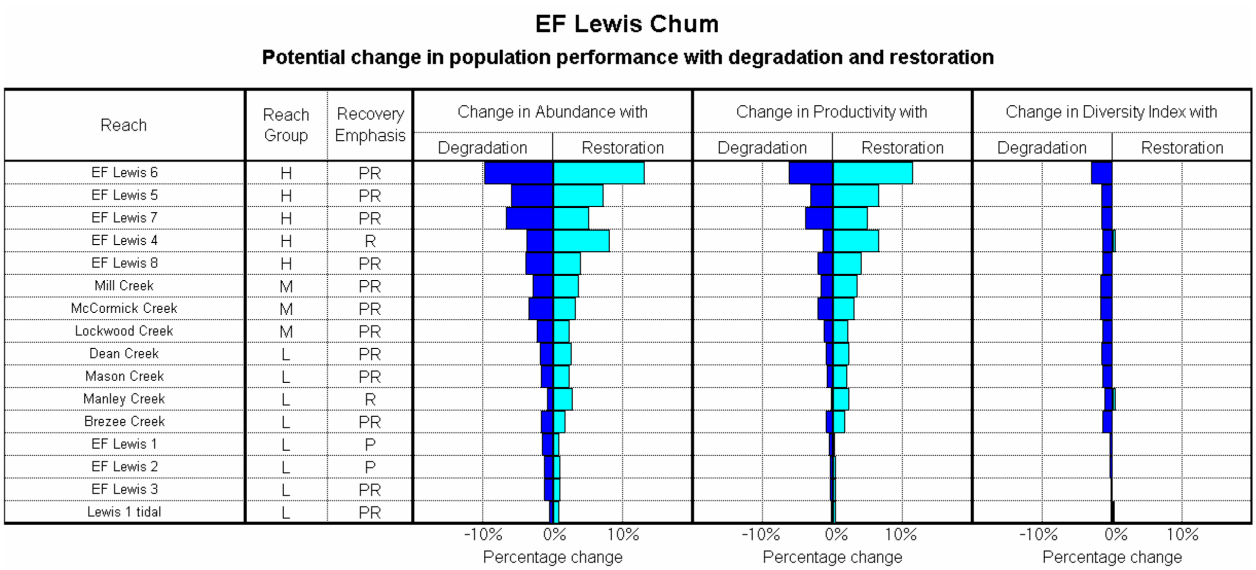


Figure 8. East Fork Lewis chum ladder diagram.

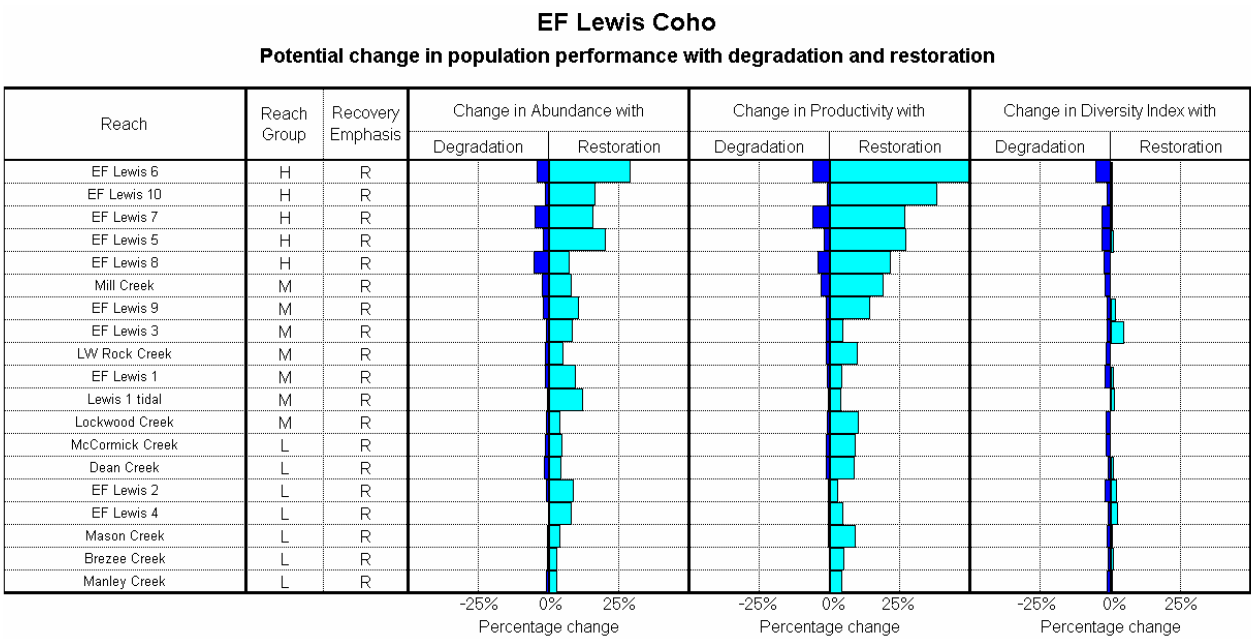


Figure 9. East Fork Lewis coho ladder diagram.

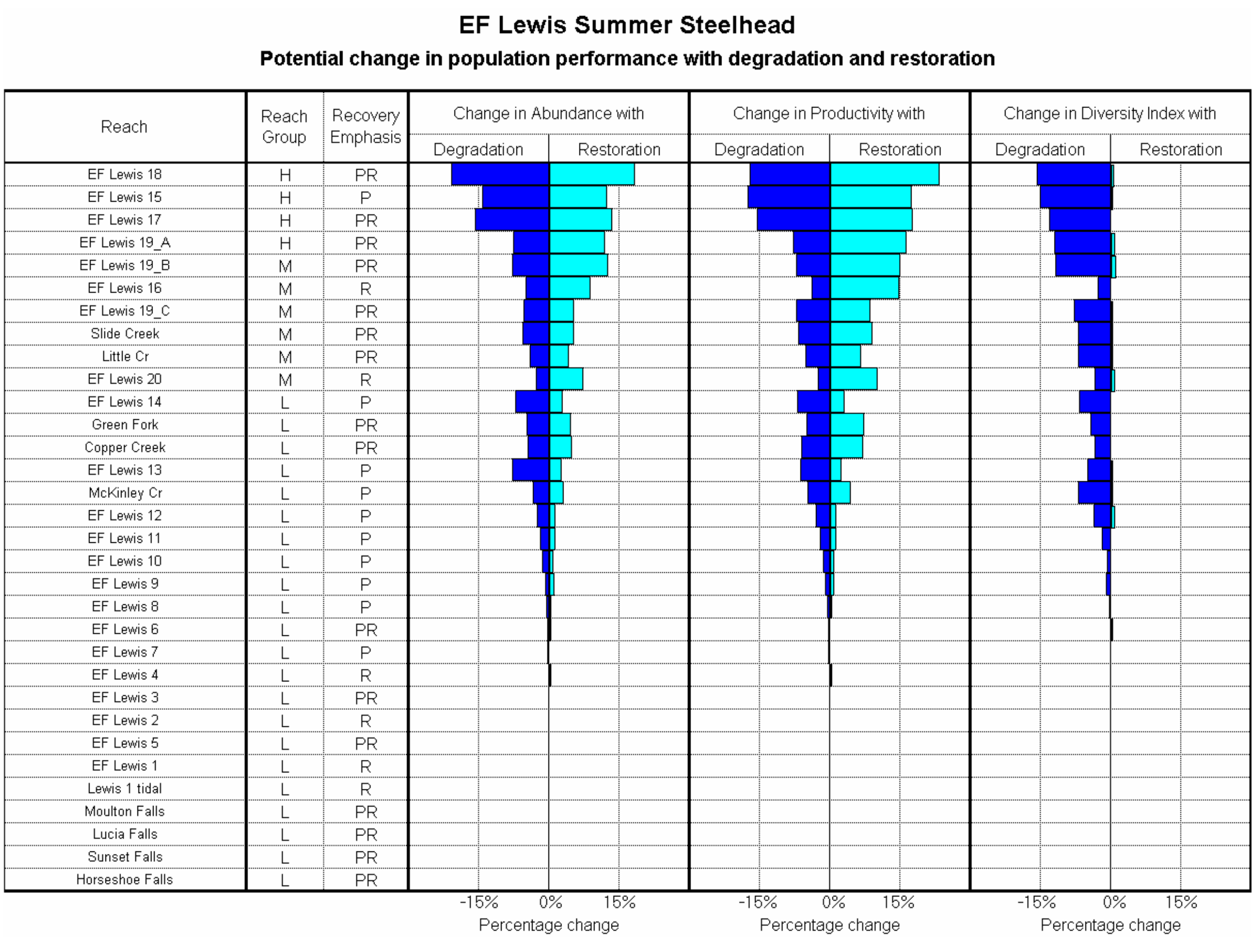


Figure 10. East Fork Lewis summer steelhead ladder diagram.

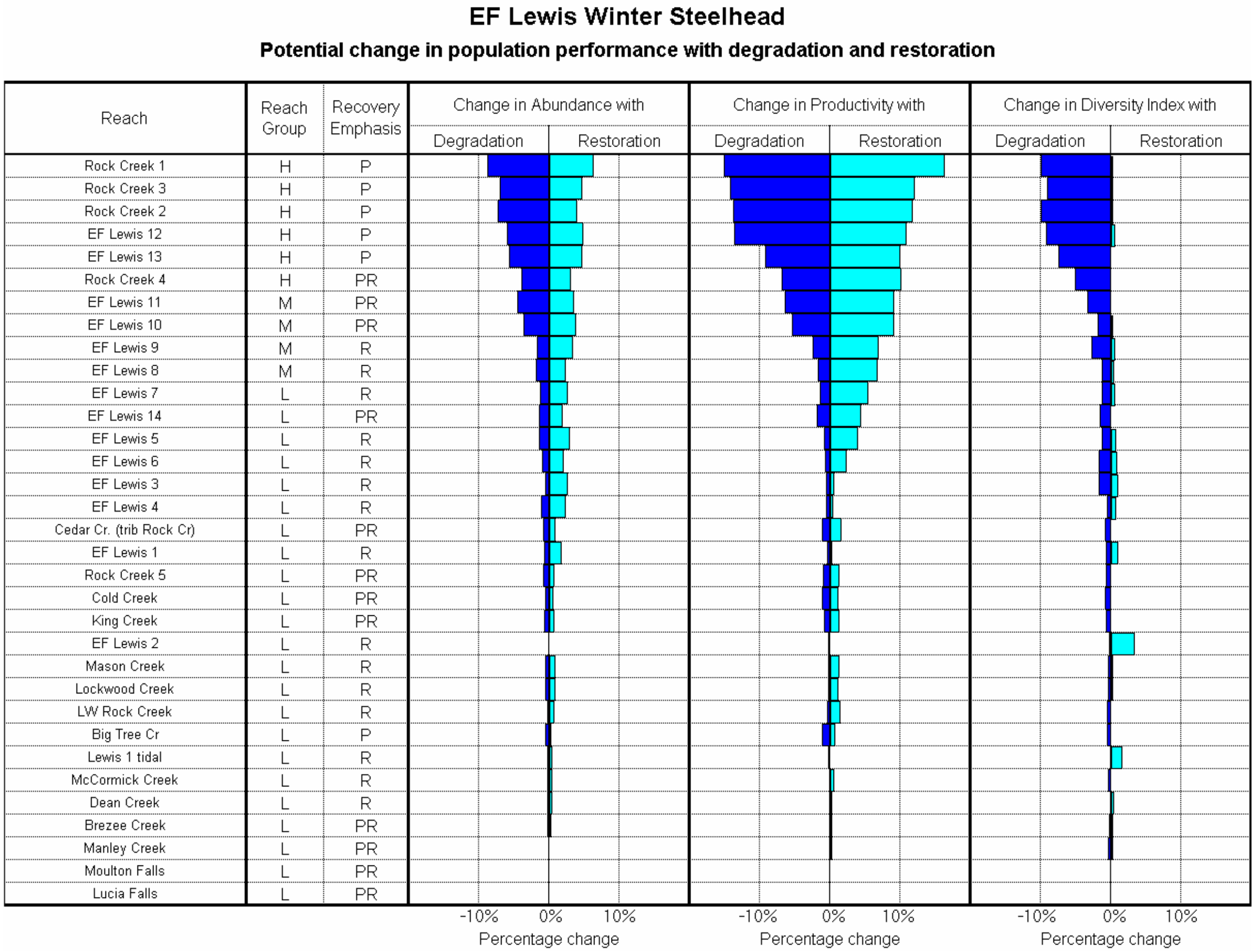


Figure 11. East Fork Lewis River subbasin winter steelhead ladder diagram.

3.4.3 *Habitat Factor Analysis*

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the habitat factor analysis compares current/patient and historical/template habitat conditions. For each reach, EDT generates what is referred to as a “consumer reports diagram”, which identifies the degree to which individual habitat factors are acting to suppress population performance. The effect of each habitat factor is identified for each life stage that occurs in the reach and the relative importance of each life stage is indicated. For additional information and examples of this analysis, see Appendix E. Inclusion of the consumer report diagram for each reach is beyond the scope of this document. A summary of the most critical life stages and the habitat factors affecting them are displayed for each species in Table 3.

Table 3. Summary of the primary limiting factors affecting life stages of focal salmonid species. Results are summarized from EDT Analysis.

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

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

Important fall Chinook reaches are located in the lower mainstem. The greatest impact here is sediment, key habitat, and temperature (Figure 12). There is a large influx of sediment from channel sources due to rapid channel migration rates and avulsions into streamside gravel pits. These conditions have served to decrease overall channel stability, increasing bank erosion and downcutting. Low LWD levels, channelization, and degraded riparian forests have contributed to a lack of habitat diversity. Key habitat has been lost due to channelization and channel avulsions. Temperature is impacted by low canopy cover levels. Flow and sediment impacts are related to upper basin forest and road conditions, with some effects still lingering from large fires and floods in the 1920s and 30s.

The high priority areas for chum are similar to those for fall Chinook. These reaches suffer from similar sediment problems and loss of key habitat (Figure 13). However, an additional impact to chum in these areas comes from lack of habitat diversity. These reaches have experienced heavy channelization (diking) and riparian zone degradation. LWD levels are low in these streams. Residential development and agriculture have altered sediment and flow regimes. Furthermore, the high density of people in the area increases the risk of harassment impacts from anglers and recreationalists.

Key restoration areas for coho in the EF Lewis are generally located in middle and lower mainstem sections. In these areas, habitat impacts to coho come from sediment, loss of both key habitat and habitat diversity, and poor channel stability (Figure 14). The causes of impacts are similar to those discussed for fall Chinook and chum.

High priority reaches for summer steelhead are located in upper mainstem reaches that are affected mostly by degraded habitat diversity and flow (Figure 15). Sediment, loss of key habitat, and channel stability have also had negative impacts (Figure 15). Habitat diversity is low due to degraded riparian zones and low LWD levels. Flow and sediment impacts are related to upper basin forest and road conditions, with some effects still lingering from large fires and floods in the 1920s and 30s. The 1995 USFS watershed analysis (USFS 1995) rated nearly all of the headwater reaches occupied by summer steelhead (except for the Green Fork) as having poor (<40 pieces per mile) LWD abundance. The bulk of these reaches also have riparian canopy openings of greater than 50%. Sediment impacts in the channel below Sunset Falls (EF Lewis 17) and in Green Fork Creek stem largely from past fires and floods (USFS 1995). Flow is affected by hillslope vegetation and road conditions. The 1995 watershed analysis rated 14 of 23 upper basin subwatersheds as being impaired with regards to peak flows.

As described in the reach analysis section, the high priority reaches for winter steelhead are in the middle mainstem (EF Lewis 12 and 13) and reaches in the Rock Creek basin (Rock 1-4). In these areas, habitat diversity, sediment, flow, and temperature have had a negative impact on the population (Figure 16). Loss of key habitat and channel stability are also important factors. Key habitat has been lost due to recent channel avulsions into streamside gravel pits in the lower and middle mainstem. Sediment impacts are mostly from upriver sources. Habitat diversity impacts stem from degraded riparian zones and low LWD levels.

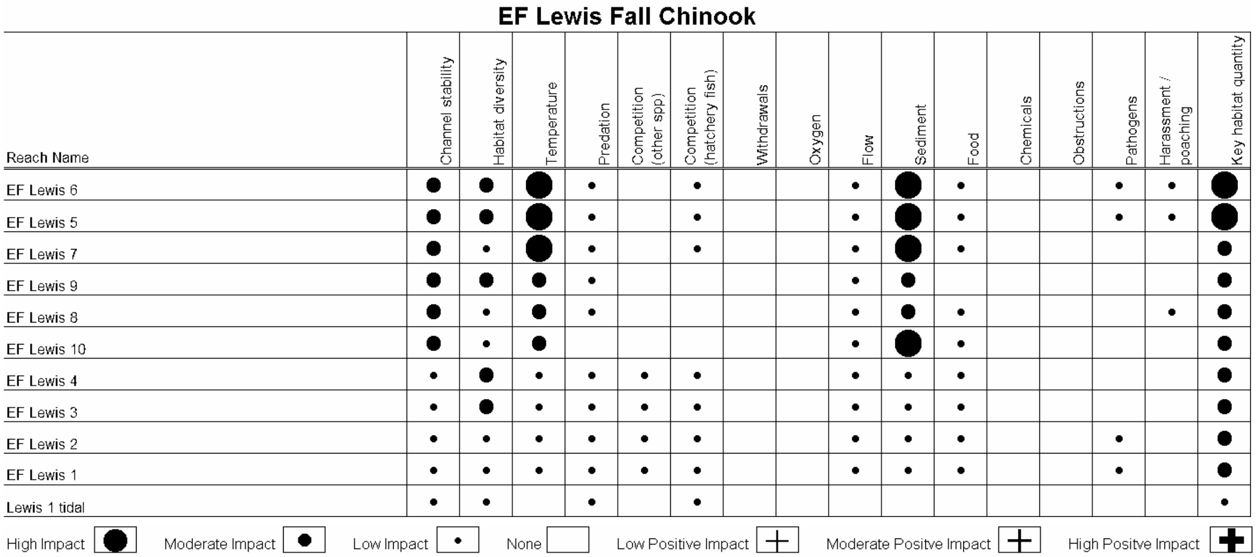


Figure 12. East Fork Lewis fall Chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Appendix E Chapter 6 for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.

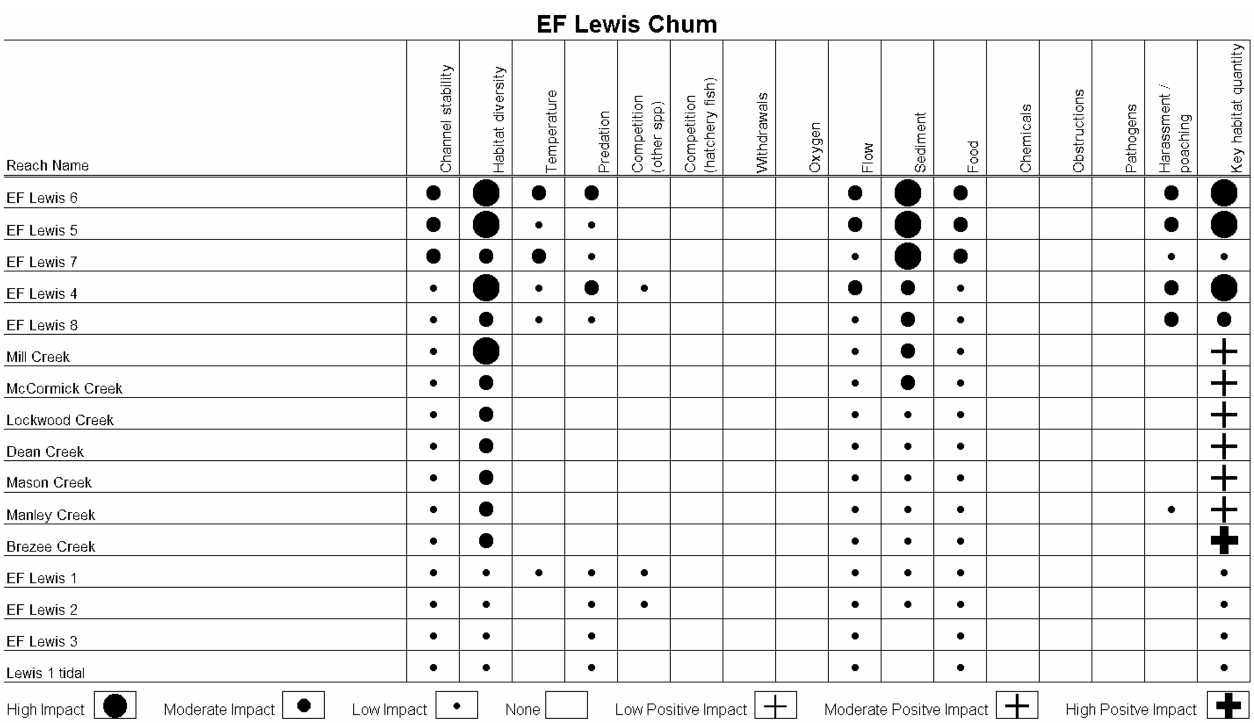


Figure 13. East Fork Lewis chum habitat factor analysis diagram.

EF 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
EF Lewis 6	⬤	⬤	●	●		●			•	⬤	●			•		⬤
EF Lewis 10	●	⬤	●	•		•			•	●	•			•		⬤
EF Lewis 7	●	●	●	●		•			•	⬤	•			•		⬤
EF Lewis 5	●	●	●	●		•			•	●	●			•		⬤
EF Lewis 8	●	●	●	•		•			•	●	•			•		⬤
Mill Creek	●	●	•	•		•			•	⬤	•					●
EF Lewis 9	●	●	•	•		•			•	●						•
EF Lewis 3	•	●	•	•		•			•		•			•		⬤
LW Rock Creek	•	●	•						•	●	•					●
EF Lewis 1	•	●	●	●	•	•			•	•	•			•		⬤
Lewis 1 tidal	•	⬤	+	●		•			•	•	•			•		⬤
Lockwood Creek	•	●	•						•	●	•					●
McCormick Creek	•	●	•						•	●	•					●
Dean Creek	•	●	•						•	●	•					●
EF Lewis 2	•	●	•	●	•	•			•	•	•			•		⬤
EF Lewis 4	•	●	•	•		•			•	•	•			•		⬤
Mason Creek	•	●	•						•	•	•					●
Brezee Creek	•	●	•						•	•	•					•
Manley Creek	•	•	•						•	•	•					•

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

Figure 14. East Fork Lewis coho habitat factor analysis diagram.

EF Lewis Summer Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
EF Lewis 18	Moderate	High	Moderate	Low		Low			High	Moderate	Low			Low		High
EF Lewis 15	Moderate	High	Moderate	Low		Low			High	Moderate	Low			Low		Low
EF Lewis 17	Moderate	High	Moderate	Low		Low			High	Moderate	Low			Low		Moderate
EF Lewis 19_A	Moderate	High				Low			High	Moderate	Low					Moderate
EF Lewis 19_B	Moderate	High				Low			High	Moderate	Low					Moderate
EF Lewis 16	Moderate	High	Low	Low		Low			Moderate	High	Low			Low		High
EF Lewis 19_C	Moderate	Moderate	Low	Low		Low			Moderate	Moderate	Moderate					Low
Slide Creek	Moderate	Moderate				Low			Moderate	High	Low					High
Little Cr	Moderate	Moderate				Low			Moderate	High	Low					High
EF Lewis 20	Moderate	High	Low			Low			Moderate		Low					High
EF Lewis 14	Low	Moderate	Low	Low		Low			Moderate					Low		Low
Green Fork	Low	Moderate				Low			Moderate	High	Low					Moderate
Copper Creek	Low	Moderate	Low						Moderate	High						High
EF Lewis 13	Low	Moderate	Low						Low							Moderate
McKinley Cr	Moderate	Moderate							Moderate	High	Low					High
EF Lewis 12	Low	Moderate	Low						Low							
EF Lewis 11	Low	Moderate	Low						Low							
EF Lewis 10	Low	Low	Low						Low							
EF Lewis 9	Low	Low	Low	Low					Low							
EF Lewis 8			Low	Low												
EF Lewis 6			Low	Low												Low
EF Lewis 7			Low													
EF Lewis 4			Low	Low												Low
EF Lewis 3				Low												
EF Lewis 2		Low		Low												
EF Lewis 5																
EF Lewis 1				Low												
Lewis 1 tidal		Low														
Moulton Falls																
Lucia Falls																
Sunset Falls																
Horseshoe Falls																

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

Figure 15. East Fork Lewis summer steelhead habitat factor analysis diagram.

EF Lewis Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Rock Creek 1	M	H	M	L		L			H	H	L			L		+M
Rock Creek 3	L	H	L			L			M	H	L					L
Rock Creek 2	L	H	M	L		L			M	M	L			L		M
EF Lewis 12	M	H	M	L		L			M	M	L			L		L
EF Lewis 13	M	H	M	L		L			M	M	L			L		M
Rock Creek 4	L	H	L			L			M	H	L					H
EF Lewis 11	M	H	M	L		L			M	M	L			L		L
EF Lewis 10	M	M	M	L		L			M	M	L			L		L
EF Lewis 9	L	H	M	L		L			M	M				L		L
EF Lewis 8	L	L	M	M		L			L	M	L			L		M
EF Lewis 7	L	L	M	M		L			L	M	L			L		H
EF Lewis 14	L	M	L	L		L			M	M	L			L		H
EF Lewis 5	L	M	M	M		L			L	M	L			L		H
EF Lewis 6	L	M	M	M		L			L	M	L			L		H
EF Lewis 3	L	M	M	M	L	L			M	L	L			L		H
EF Lewis 4	L	M	M	M	L	L			L	M	L			L		H
Cedar Cr. (trib Rock Cr)	L	M							L	M						M
EF Lewis 1	L	M	L	M	L	L			L	M	L			L		H
Rock Creek 5	L	M							L	M						M
Cold Creek	L	L							L	M						L
King Creek	L	M							L	M						M
EF Lewis 2																
Mason Creek	L	L	L	L					L	M	L			L		+H
Lockwood Creek	L	L	L	L					L	M	L			L		+H
LW Rock Creek	L	L	L	L					L	M	L					+H
Big Tree Cr		L	L						L	H	L					+L
Lewis 1 tidal		M		L						L						H
McCormick Creek		L	L						L	L	L					+L
Dean Creek		L	L						L	L				L		+H
Brezee Creek		L	L						L	L						+L
Manley Creek		L								L						+L
Moulton Falls																
Lucia Falls																

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

Figure 16. East Fork Lewis River subbasin winter steelhead habitat factor analysis diagram.

3.5 Watershed Process Limitations

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

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

The East Fork Lewis River is composed of 34 subwatersheds within the East Fork proper, and two independent tributaries, Gee Creek and Allen Canyon Creek. Gee Creek discharges into the Columbia at the Lewis River confluence, whereas Allen Canyon Creek enters the lower Lewis between the East Fork/North Fork split and the Columbia. IWA results for the East Fork Lewis River watershed are shown in Table 4. A reference map showing the location of each subwatershed in the basin is presented in Figure 17. Maps of the distribution of local and watershed level IWA results are displayed in Figure 18.

3.5.1 *Hydrology*

Current Conditions.— There is a dramatic difference in hydrologic conditions between the upper and lower watershed. In the lower watershed, local hydrologic conditions are uniformly impaired, with the exception of the independent tributaries (Gee and Allen Canyon Creeks) as well as the mainstem subwatershed furthest downstream (50602).

Subwatersheds above Lucia Falls are for the most part rated moderately impaired at the local level, with the exception of three subwatersheds with more substantial impairment (50202 Anaconda Creek, 50507 Roger Creek, and 50505 Yacolt Creek), and four non-contiguous subwatersheds in the upper basin with functional conditions, including the headwaters of the mainstem (50101), Coyote Creek (50403, a tributary to upper Rock Creek), lower Copper Creek (50301), and Cedar Creek (50402, a tributary to Rock Creek).

Analysis of hydrologic conditions at the watershed scale produces a small number of changes in IWA ratings. For example, two upper mainstem subwatersheds (50201, 50203) earn a functional rating due to the influence of upstream functional conditions.

Predicted Future Trends.— In the lower portion of the basin, low levels of public ownership, low levels of mature forest cover, high road densities, and intense development pressure are likely to lead to downward trends in hydrologic conditions. More than 75% of areas zoned for development remain vacant, meaning this area may develop extensively over the next

20 years. As a result, impervious surfaces, road density, and stream crossing density will likely increase.

These trends will apply in low-elevation tributaries, which generally have low forest cover and increasing development. The tributaries to the East Fork—including Brezee, Lockwood, Mason and Mill Creeks, in addition to non-key subwatersheds—likely will become increasingly ‘flashy’, featuring higher, short-duration flows during the rainy season, while also suffering lower base flows during late summer months due to loss of riparian cover, increased watershed imperviousness, higher rates of surface water withdrawal, and depletion of groundwater resources due to withdrawal and reduced infiltration.

Mainstem subwatersheds in the lower East Fork may suffer similar consequences due to development pressure, but hydrologic effects will be substantially governed by conditions further upstream in the upper watershed. Hydrologic continuity has been substantially degraded by the loss of wetlands, gravel mining, and construction of levees. The East Fork avulsion through abandoned gravel pits in the lower river impacted spawning and rearing habitat.

Upper watershed hydrologic conditions are likely to maintain current conditions or gradually improve due to the high percentage of public ownership and low levels of anticipated development. Predicted improvements are based on improved forest management practices on both federal (GPNF) and state (WDNR) lands. Road and road-crossing removal as well as riparian restoration are likely to provide substantial hydrologic benefits.

Table 4. IWA results for the East Fork Lewis River Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
50601	M	M	I	M	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502, 50501, 50616, 50605, 50604, 50615, 50614, 50613, 50604, 50603, 50612, 50611, 50608, 50602, 50609, 50607, 50606, 50610
50610	M	M	M	M	M	none
50606	M	M	M	M	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502, 50501, 50616, 50605, 50604, 50615, 50614, 50613, 50604, 50603, 50612, 50611, 50608, 50602, 50609, 50607
50607	M	M	M	M	M	none
50609	I	M	I	I	M	none
50602	M	M	M	I	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502, 50501, 50616, 50605, 50604, 50615, 50614, 50613, 50604, 50603, 50612, 50611, 50608, 50609, 50607
50608	I	M	I	I	M	none
50611	M	M	M	M	M	none
50612	I	F	M	I	M	50611
50603	I	M	I	I	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502, 50501, 50616, 50605, 50604, 50615, 50614, 50613, 50604, 50612, 50611
50613	I	M	M	I	M	none
50614	I	M	I	I	M	none
50615	I	M	M	I	M	none

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
50604	I	M	M	I	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502, 50501, 50616, 50605, 50615
50605	I	M	I	I	M	none
50616	I	M	M	M	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502, 50501
50501	I	M	M	M	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505, 50502
50505	I	M	I	I	M	None
50504	I	M	I	I	M	50506
50506	I	M	M	I	M	none
50401	M	F	M	F	F	50405, 50404, 50403, 50402
50402	F	F	M	M	F	50404
50403	I	F	M	I	F	none
50404	M	M	F	M	M	
50405	M	F	M	M	F	
50507	I	M	M	I	M	
50502	M	F	M	M	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505
	M	F	M	M	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509, 50503, 50502, 50507, 50405, 50404, 50403, 50402, 50401, 50506, 50504, 50505
50503	M	M	M	F	M	50101, 50203, 50201, 50202, 50302, 50301, 50508, 50509
50509	M	M	M	M	M	none

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
50508	I	M	M	I	M	none
50301	F	M	M	M	M	50302
50302	I	F	M	I	F	none
50202	F	F	F	F	F	none
50201	M	M	M	F	M	50203, 50101
50203	M	M	F	F	M	50101
50101	F	M	F	F	M	none

Notes:

a LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800030#####.
b IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:
F: Functional
M:Moderately impaired
I:Impaired
c IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.
d Subwatersheds upstream from this subwatershed.

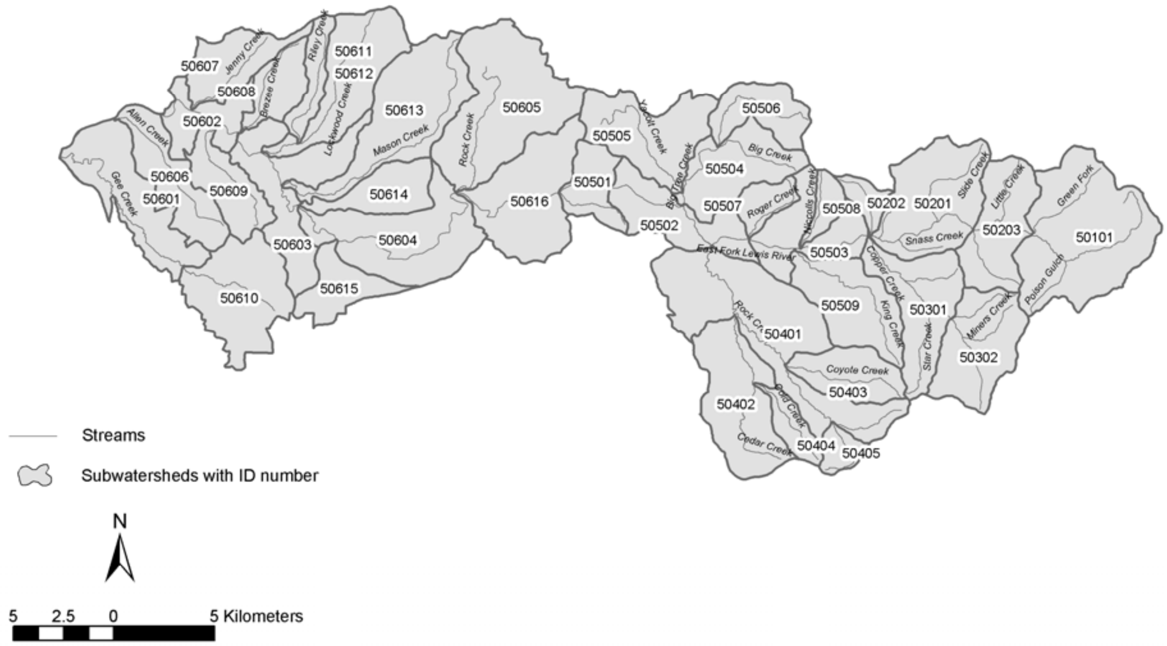


Figure 17. Map of the East Fork Lewis River basin showing the location of the IWA subwatersheds.

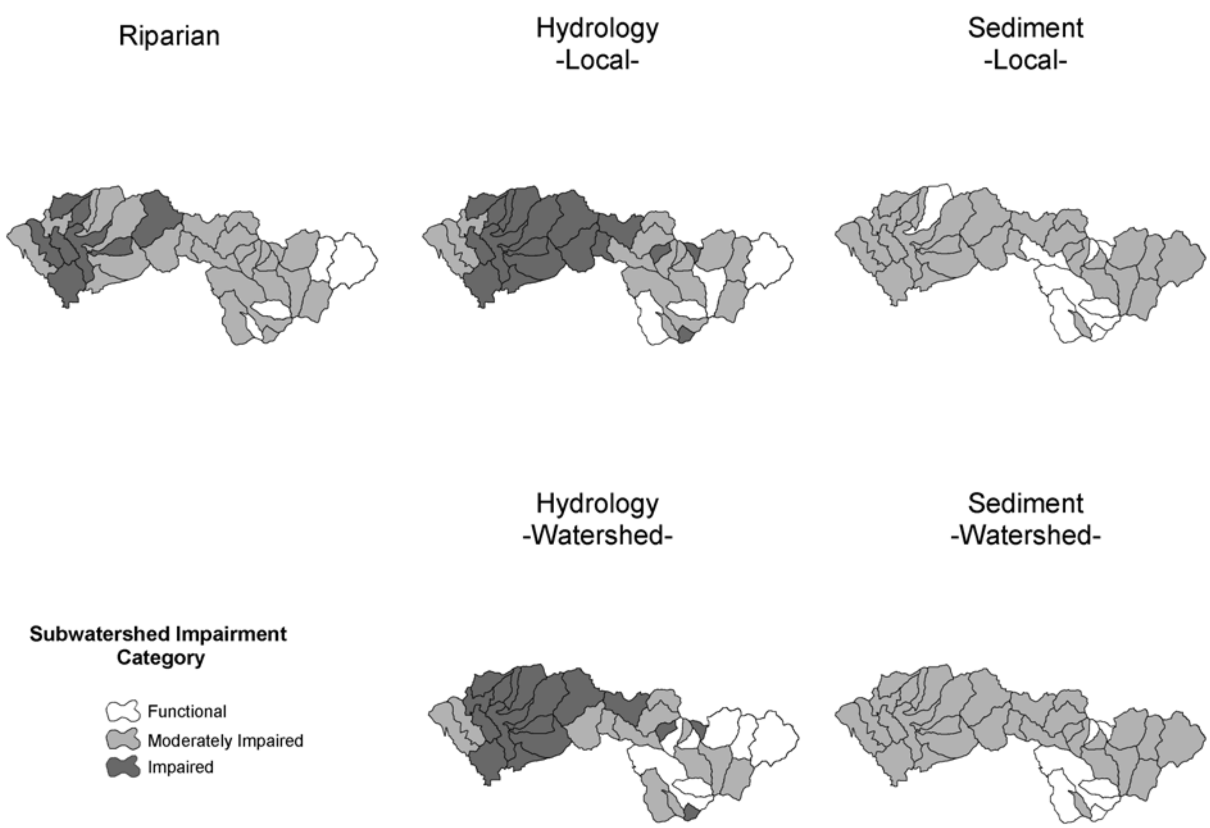


Figure 18. IWA subwatershed impairment ratings by category for the East Fork Lewis River basin

3.5.2 *Sediment Supply*

Current Conditions.— Local sediment conditions fall primarily into the moderately impaired category, with no cases of impaired sediment condition and with nearly all functional subwatersheds occurring in the upper basin. Local sediment conditions are moderately impaired throughout the lower watershed, including the mainstem and tributaries Brezee Creek (50611), Lockwood Creek (50602) and Mason Creek (50613).

The change between natural and current erodability is similar for both the upper and lower portions of the basin, and therefore subwatersheds in these areas are rated similarly. However, on an absolute scale, erodability indices are much greater in the lower basin. This is an important distinction: while the IWA method rates sediment conditions as similarly degraded throughout the watershed due to the relative difference between natural and current conditions, the absolute levels remain very low throughout the upper watershed while the lower watershed is in the moderate to high category. Impaired conditions in the lower watershed are not surprising given the extremely low percentage of public ownership, mature forest cover of only 9%, very high road densities ranging from 4.8-7.7 mi/sq mi, and erodable soils.

Whereas rain-on-snow conditions are prevalent in most of the upper watershed, they are generally absent downstream of Lucia Falls. However, due to the stability of soils and much higher level of mature forest cover (57%), rain-on-snow events have less adverse impacts on upper subwatersheds. Road densities in the upper watershed range from 1.9-5.6 mi/sq mi, while stream crossing densities are moderately high.

Watershed level analysis results in few changes to local sediment condition ratings as all but one functional subwatershed are located in terminal areas (i.e., without effects from upstream subwatersheds).

Predicted Future Trends.— As with hydrologic trends, the lower watershed is not likely to experience substantial improvements in sediment conditions in the next 20 years due to development pressures. Furthermore, natural erodability is moderately high (due to geologic conditions) and road densities are unlikely to decrease.

Even with moderate impairment, geology in the upper watershed naturally limits the extent of deleterious, episodic sediment erosion. Sediment processes are likely to improve based on a trend towards improved forest and road management on public lands. Natural regeneration of previously harvested and burned areas will also yield improved sediment supply conditions.

3.5.3 *Riparian Condition*

Current Conditions.— Riparian conditions are evenly divided in the lower watershed between impaired and moderately impaired categories. Riparian conditions in the upper watershed are for the most part moderately impaired, with localized areas of functional conditions in headwater areas. Riparian impairment in the upper basin is primarily the result of timber harvest and historical stand replacing fires. In the lower watershed, riparian impairment can be attributed to timber harvest, residential development, roadways, and agricultural uses.

Predicted Future Trends.— Upper watershed riparian conditions are represented by a patchwork of functional and moderately impaired subwatersheds. Currently, functional riparian areas are found in only four subwatersheds in the entire basin, all located in the upper reaches of the watershed on publicly owned lands. Forest management by WDNR and the USFS are expected to result in improved riparian conditions.

Moderately impaired to impaired riparian condition ratings are most prevalent along the lower mainstem and tributaries. Historical riparian forests within the mainstem floodplain have been almost entirely removed, limiting LWD recruitment while also reducing channel roughness and stability, which results in higher rates of bank erosion during high flows. Absent restorative measures, episodic levee avulsion and bank erosion events may accelerate in the future. In the lower mainstem and tributary subwatersheds, currently degraded conditions are expected to persist due to existing road densities, channelization, and current land uses.

3.6 Other Factors and Limitations

3.6.1 *Hatcheries*

Hatcheries currently release over 50 million salmon and steelhead per year in Washington lower Columbia River subbasins. Many of these fish are released to mitigate for loss of habitat. Hatcheries can provide valuable mitigation and conservation benefits but may also cause significant adverse impacts if not prudently and properly employed. Risks to wild fish include genetic deterioration, reduced fitness and survival, ecological effects such as competition or predation, facility effects on passage and water quality, mixed stock fishery effects, and confounding the accuracy of wild population status estimates. This section describes hatchery programs in the East Fork Lewis Subbasin and discusses their potential effects.

There are no hatcheries operating in the East Fork Lewis Basin. Skamania Hatchery winter and summer steelhead are released into the East Fork Lewis to provide harvest opportunity. Skamania Hatchery steelhead are a composite stock and are genetically different from the naturally-produced steelhead in the East Fork Lewis River. The main threats from hatchery steelhead are potential domestication of the naturally-produced steelhead as a result of adult interactions or ecological interactions between natural juvenile salmon and hatchery released juvenile steelhead.

Table 5. East Fork Lewis Hatchery Production.

Hatchery	Release Location	Winter Steelhead	Summer Steelhead
Skamanaia	East Fork Lewis	90,000	30,000

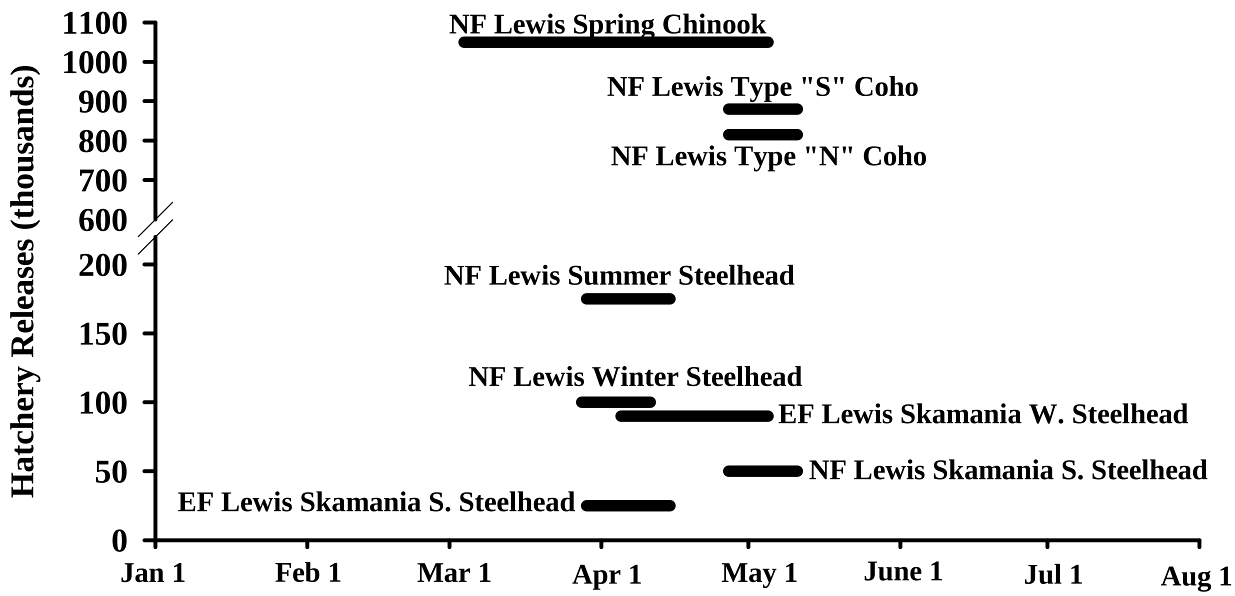


Figure 19. Magnitude and timing of hatchery releases in the Lewis River basins by species, based on 2003 brood production goals.

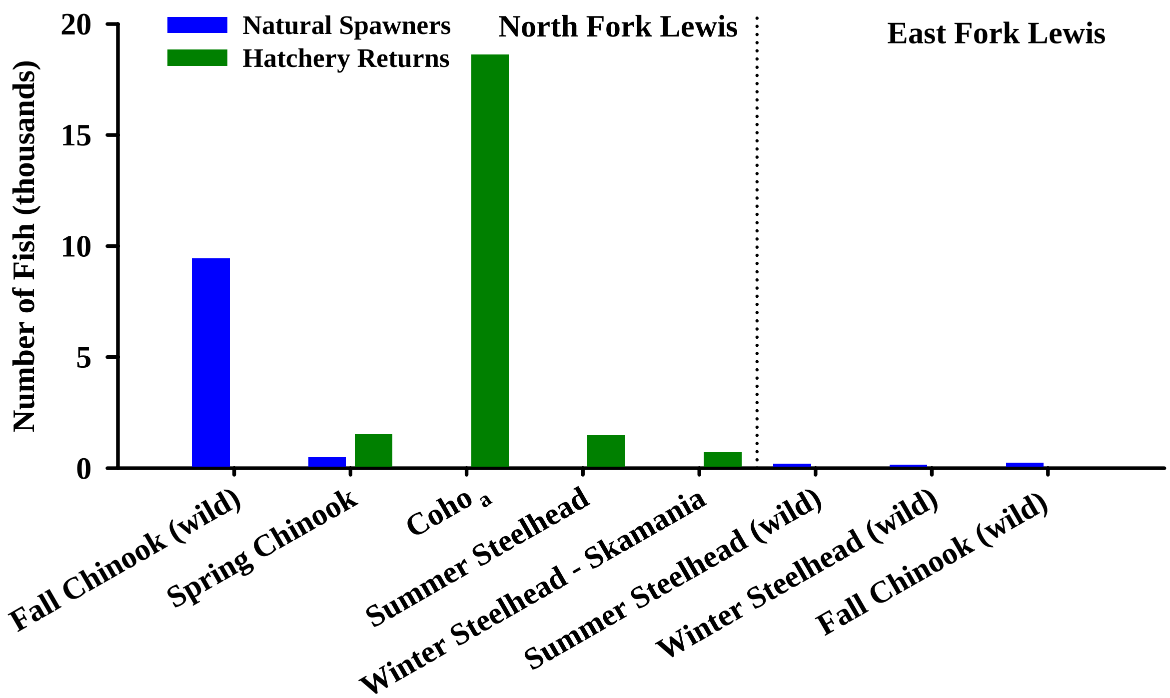


Figure 20. Recent average hatchery returns and estimates of natural spawning escapement in the Lewis River basin by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present. Calculation of each average utilized a minimum of 5 years of data.

Hatchery Effects

Genetics—Broodstock for the former fall Chinook hatchery program on the NF Lewis 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. There is no hatchery fall chinook production in the EF Lewis

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. There is no coho hatchery program on the EF Lewis, although there has been coho fry planted into tributary streams historically.

Broodstock for the NF Lewis 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. The hatchery winter steelhead released in the EF Lewis are Skamania Hatchery stock.

Broodstock for the NF Lewis 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. The hatchery steelhead released into the EF Lewis are Skamania Hatchery stock.

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.

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.

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Biological Risk Assessment

The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC releated plans on the Cowlitz River and Lewis River; and 4) the federally mandated Artificial Production Review and Evaluation (APRE) process. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program. WDFW developed the Benefit-Risk Assessment Procedure (BRAP) to provide that framework. The BRAP evaluates hatchery programs in the ecological context of the watershed, with integrated assessment and decisions for hatcheries, harvest, and habitat. The risk assessment procedure consists of five basic steps, grouped into two blocks:

Policy Framework

- Assess population status of wild populations
- Develop risk tolerance profiles for all stock conditions
- Assign risk tolerance profiles to all stocks

Risk Assessment

- Conduct risk assessments for all hatchery programs
- Identify appropriate management actions to reduce risk

Following the identification of risks through the assessment process, a strategy is developed to describe a general approach for addressing those risks. Building upon those strategies, program-specific actions and an adaptive management plan are developed as the final steps in the WDFW framework for hatchery reform.

Table 6 identifies hazards levels associated with risks involved with hatchery programs in the East Fork Lewis River Basin. Table 7 identifies preliminary strategies proposed to address risks identified in the BRAP for the same populations.

The BRAP risk assessments and strategies to reduce risk have been key in providing the biological context to develop the hatchery recovery measures for lower Columbia River sub-basins.

Table 6. Preliminary BRAP for hatchery programs affecting populations in the East Fork Lewis River Basin.

Symbol	Description
○	Risk of hazard consistent with current risk tolerance profile.
?	Magnitude of risk associated with hazard unknown.
●	Risk of hazard exceeds current risk tolerance profile.
(grey)	Hazard not relevant to population

East Fork Lewis Population	Hatchery Program: Name	Release (millions)	Genetic: Effective Population Size	Genetic: Domestication	Genetic: Diversity	Ecological: Predation	Ecological: Competition	Ecological: Disease	Demographic: Survival Rate	Demographic: Reproductive Success	Catastrophic Loss	Facility: Passage	Facility: Screening	Facility: Water Quality
Fall Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Late Fall Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Spring Chinook	EF Lewis S. Steelhead	0.025				?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900	○	○	○	?	?	○	○	?	○	○	○	○
	Fish First Sp. Chinook 1+	0.150	○	○	○	?	?	○	○	?	○	○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175				?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	?	○				○	○	○
Chum	EF Lewis S. Steelhead	0.025				?	○	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	○	○				○	○	○
	Merwin W. Steelhead	0.100				?	○	○				○	○	○
	Lewis Coho Type S	0.880				?	○	○				○	○	○
	Lewis Coho Type N	0.815				?	○	○				○	○	○
	Lewis Coho Type N Eggs	0.860				?	○	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	○	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	○	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	○	○				○	○	○
	Merwin S. Steelhead	0.175				?	○	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060				?	○	○				○	○	○
Summer Steelhead	EF Lewis S. Steelhead	0.025	○	○	?	?	?	○				○	○	○
	EF Lewis W. Steelhead	0.080				?	?	○				○	○	○
	Merwin W. Steelhead	0.100				?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○
	Lewis Sp. Chinook 1+	0.900				?	?	○				○	○	○
	Fish First Sp. Chinook 1+	0.150				?	?	○				○	○	○
	NF Lewis River S. Steelhead	0.050				?	?	○				○	○	○
	Merwin S. Steelhead	0.175	○	○	?	?	?	○				○	○	○
	Speelyai Net Pens S. Steelhead	0.060	○	○	?	?	?	○				○	○	○
	Klineline(Salmon Ck) W. Steelhea	0.020				?	?	○				○	○	○
Winter Steelhead	EF Lewis S. Steelhead	0.025				?	?	○						
	EF Lewis W. Steelhead	0.080	○	○	?	?	?	○				○	○	○
	Merwin W. Steelhead	0.100	○	○	?	?	?	○				○	○	○
	Lewis Coho Type S	0.880				?	?	○				○	○	○
	Lewis Coho Type N	0.815				?	?	○				○	○	○

Table 7. Preliminary strategies proposed to address risks identified in the BRAP for East Fork Lewis River Basin populations.

East Fork Lewis Population	Hatchery Program Name	Release (millions)	Risk Assessment of Hazards: Address Genetic Risks: Mating Procedure	Address Genetic Risks: Integrated Program	Address Genetic Risks: Segregated Program	Address Genetic Risks: Research/ Monitoring	Address Genetic Risks: Broodstock Source	Address Ecological Risks: Number Released	Address Ecological Risks: Release Procedure	Address Ecological Risks: Disease Containment	Address Ecological Risks: Research/ Monitoring	Address Demographic Risks: Culture Procedure	Address Demographic Risks: Research/ Monitoring	Address Facility Risks: Reliability	Address Facility Risks: Improve Passage	Address Facility Risks: Improve Screening	Address Facility Risks: Pollution Abatement
Fall Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900						●	●		●						
	Fish First Sp. Chinook 1+	0.150						●	●		●						
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1+	0.020						●	●		●						
Late Fall Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900						●	●		●						
	Fish First Sp. Chinook 1+	0.150						●	●		●						
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1+	0.020						●	●		●						
Spring Chinook	EF Lewis S. Steelhead 1+	0.025						●	●		●						
	EF Lewis W. Steelhead 1+	0.080						●	●		●						
	Merwin W. Steelhead	0.100						●	●		●						
	Lewis Coho Type S	0.880						●	●		●						
	Lewis Coho Type N	0.815						●	●		●						
	Lewis Sp. Chinook 1+	0.900		●	●	●		●	●		●		●				
	Fish First Sp. Chinook 1+	0.150		●	●	●		●	●		●		●				
	NF Lewis S. Steelhead 1+	0.050						●	●		●						
	Merwin S. Steelhead 1+	0.175						●	●		●						
	Speelyai Net Pens S. Steelhead 1+	0.060						●	●		●						
	Klineline (Salmon Ck) W. Steelhead 1+	0.020						●	●		●						

Impact Assessment

The potential significance of negative hatchery impacts within the subbasin on natural populations was estimated with a simple index based on: 1) intra-specific effects resulting from depression in wild population productivity that can result from interbreeding with less fit hatchery fish and 2) inter-specific effects resulting from predation of juvenile salmonids of other species. The index reflects only a portion of net hatchery effects but can provide some sense of the magnitude of key hatchery risks relative to other limiting factors. Fitness effects are among the most significant intra-specific hatchery risks and can also be realistically quantified based on hatchery fraction in the natural spawning population and assumed fitness of the hatchery fish relative to the native wild population. Predation is among the most significant inter-specific effects and can be estimated from hatchery release numbers by species. This index assumed that equilibrium conditions have been reached for the hatchery fraction in the wild and for relative fitness of hatchery and wild fish. This simplifying assumption was necessary because more detailed information is lacking on how far the current situation is from equilibrium. The index does not consider the numerical benefits of hatchery spawners to natural population numbers, ecological interactions between hatchery and wild fish other than predation, or out-of-basin interactions, all of which are difficult to quantify. Appendix E contains a detailed description of the method and rationale behind this index.

The indexed potential for negative impacts of hatchery spawners on wild population fitness in the East Fork Lewis River subbasin is 23% for coho. Though hatchery coho salmon are no longer released in the basin; hatchery fish in these basins appear to be strays from other programs. However, the incidence of coho hatchery spawners suggests that the fitness of natural and hatchery fish is now probably quite similar and natural populations might decline substantially without continued hatchery subsidy under current habitat conditions. Summer steelhead have a fitness impact of approximately 19%. The fitness impact for winter steelhead where hatchery and wild fish are segregated by differences in spawn timing (competition effects are not assessed. Interspecific impacts from predation appear to be less than 1% for all species.

Table 8. Presumed reductions in wild population fitness as a result of natural hatchery spawners and survival as a result of interactions with other hatchery species for East Fork Lewis salmon and steelhead populations.

Population	Annual releases[a]	Hatchery fraction[b]	Fitness category[c]	Assumed fitness[d]	Fitness impact[e]	Interacting releases[f]	Interspecies impact[g]
Fall Chinook	0	0.00	0	--	0.00	115,000	0.01
Chum	0[j]	0	--	--	0	0	0.000
Coho	0[k]	0.78	2	0.7	0.23	115,000	0.001
Summer Steelhead	25,000	0.27	4	0.3	0.189	0	0
Winter Steelhead	90,000	0	--	--	0	0	0

[a] Annual release goals.
[b] Proportion of natural spawners that are first generation hatchery fish.
[c] Broodstock category: 1 = derived from native local stock, 2 = domesticated stock of native local origin, 3 = originates from same ESU but substantial divergence may have occurred, 4 = out-of-ESU origin or origin uncertain
[d] Productivity of naturally-spawning hatchery fish relative to native wild fish prior to significant hatchery influence. Because population-specific fitness estimates are not available for most lower Columbia River populations, we applied hypothetical rates comparable to those reported in the literature and the nature of local hatchery program practices.
[e] Index based on hatchery fraction and assumed fitness.
[f] Number of other hatchery releases with a potential to prey on the species of interest. Includes steelhead and coho for fall chinook and coho. Includes steelhead for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.
[h] The Lewis River fall chinook hatchery program was discontinued in 1986. There is no hatchery fall chinook program in Salmon Creek.
[i] Current releases are in the lower Lewis. Reintroduction into the upper Lewis is also under consideration in the hydroelectric re-licensing process.
[j] There are no records of hatchery chum releases in the basin.
[k] Hatchery coho salmon are no longer released in the basin; hatchery fish in these basins appear to be strays from other programs.

3.6.2 *Harvest*

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

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

Current fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table 9). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced coho, and steelhead are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon and steelhead under current harvest management plans.

Table 9. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60
Coho	<1	9	6	2	1	**18**	51	85
Steelhead	0	<1	3	0.5	5	**8.5**	70	75

Columbia River fall Chinook are subject to freshwater and ocean fisheries from Alaska to their rivers of origin in fisheries targeting abundant Chinook stocks originating from Alaska, Canada, Washington, Oregon, and California. Columbia tule fall Chinook harvest is constrained by a Recovery Exploitation Rate (RER) developed by NOAA Fisheries for management of Coweeman naturally-spawning fall Chinook. Some in-basin sport fisheries (like the East Fork Lewis) are closed to the retention of Chinook to protect naturally spawning populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

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

Harvest of East Fork Lewis coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River. Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish. The East Fork Lewis sport fishery is closed to salmon.

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

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

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

3.6.3 *Mainstem and Estuary Habitat*

Conditions in the Columbia River mainstem, estuary, and plume affect all anadromous salmonid populations within the Columbia Basin. Juvenile and adult salmon may be found in the mainstem and estuary at all times of the year, as different species, life history strategies and size classes continually rear or move through these waters. A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals.

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

3.6.4 *Hydropower Construction and Operation*

There are no hydro-electric dams in the East Fork Lewis River Basin. However, East Fork Lewis species are affected by changes in Columbia River mainstem and estuary related to Columbia basin hydropower development and operation. The mainstem Columbia River and estuary provide important habitats for anadromous species during juvenile and adult migrations between spawning and rearing streams and the ocean where they grow and mature. These habitats are particularly important for fall Chinook and chum which rear extensively in the Columbia mainstem and estuary. Aquatic habitats have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control.

The hydropower infrastructure and flow regulation affects adult migration, juvenile migration, mainstem spawning success, estuarine rearing, water temperature, water clarity, gas supersaturation, and predation. Dams block or impede passage of anadromous juveniles and adults. Columbia River spring flows are greatly reduced from historical levels as water is stored for power generation and irrigation, while summer and winter flows have increased. These flow changes affect juvenile and adult migration, and have radically altered habitat forming processes. Flow regulation and reservoir construction have increased average water temperature in the Columbia River mainstem and summer temperatures regularly exceed optimums for salmon. Supersaturation of water with atmospheric gases, primarily nitrogen, when water is spilled over high dams causes gas bubble disease. Predation by fish, bird, and marine mammals has been exacerbated by habitat changes. The net effect of these direct and indirect effects is difficult to quantify but is expected to be less significant for populations originating from lower Columbia River subbasins than for upriver salmonid populations. Additional information on hydropower effects can be found in the Regional Recovery and Subbasin Plan Volume I.

3.6.5 *Ecological Interactions*

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

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

3.6.6 *Ocean Conditions*

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

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

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

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

3.7 Summary of Human Impacts on Salmon and Steelhead

Stream habitat, estuary/mainstem habitat, harvest, hatchery and ecological interactions have all contributed to reductions in productivity, numbers, and population viability. Pie charts in Figure 21 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for East Fork Lewis Basin salmon and steelhead. Impact values were developed for a base period corresponding to species listing dates. This depiction is useful for identifying which factors are most significant for each species and where improvements might be expected to provide substantial benefits. Larger pie slices indicate greater significance and scope for improvement in an impact for a given species. These numbers also serve as a working hypothesis for factors limiting salmonid numbers and viability.

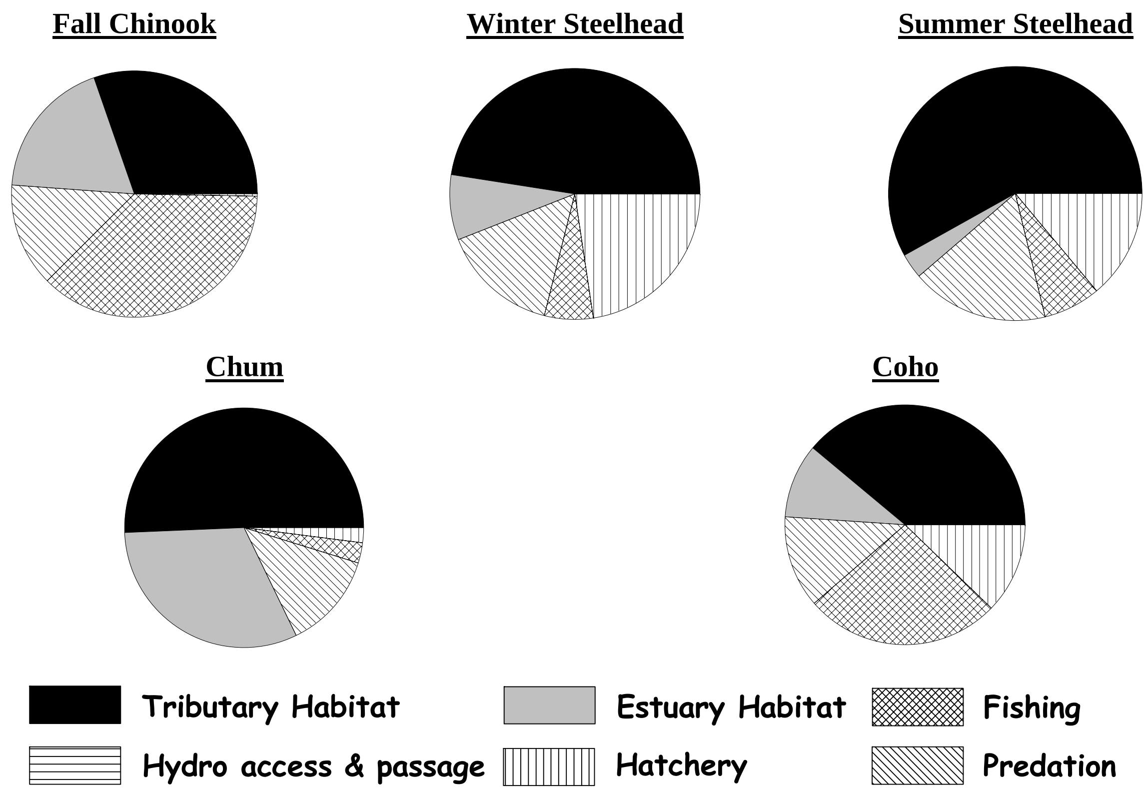

Figure 21. Relative contribution of potentially manageable impacts on East Fork Lewis River salmonid populations.

This assessment indicates that current salmonid status is the result of large impacts distributed among several factors. No single factor accounts for a majority of effects on all species. Thus, substantial improvements in salmonid numbers and viability will require significant improvements in several factors. Loss of habitat quality and quantity accounts for the largest relative impact on all species. Loss of estuary habitat quality and quantity has high relative impacts on chum and moderate impacts on fall Chinook and winter steelhead. Loss of estuary habitat impacts are minor on summer steelhead. Harvest has a sizeable effect on fall Chinook, but impacts to chum, coho, and steelhead are relatively minor. Hatchery impacts are high to moderate for summer steelhead and coho, but are low for chum, fall Chinook and winter steelhead. Predation impacts are moderate for chum, coho, and winter and summer steelhead; but are relatively minor for fall Chinook. Hydrosystem access and passage impacts appear to be relatively minor for all species in the East Fork Lewis.

Impacts were defined as the proportional reduction in average numbers or productivity associated with each effect. Tributary and estuary habitat impacts are the differences between the pre-development historical baseline and current conditions. Hydro impacts identify the percentage of historical habitat blocked by impassable dams and the mortality associated with juvenile and adult passage of other dams. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries. Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in its relative significance. Methods and data for these analyses are detailed in Appendix E.

Potentially-manageable human impacts were estimated for each factor based on the best available scientific information. Proportions are standardized to a total of 1.0 for plotting purposes. The index is intended to illustrate order-of-magnitude rather than fine-scale differences. Only the subset of factors we can potentially manage were included in this index – natural mortality factors beyond our control (e.g. naturally-occuring ocean mortality) are excluded. Not every factor of interest is included in this index – only readily-quantifiable impacts are included.

4.0 Key Programs and Projects

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

4.1 Federal Programs

4.1.1 *NOAA Fisheries*

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

4.1.2 *US Army Corps of Engineers*

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

4.1.3 *Environmental Protection Agency*

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

4.1.4 *United States Forest Service*

The Unites States Forest Service (USFS) manages federal forest lands within the Gifford Pinchot National Forest (GPNF). The GPNF operates under the Gifford Pinchot Forest Plan (GPFP). Management prescriptions within the GPFP have been guided by the 1994 Northwest Forest Plan, which calls for management of forests according to a suite of management designations including Reserves (e.g. late successional forests, riparian forests), Adaptively-Managed Areas, and Matrix Lands. Most timber harvest occurs in Matrix Lands. The GPNF implements a wide range of ecosystem restoration activities.

4.1.5 *Natural Resources Conservation Service*

Formerly the Soil Conservation Service, the USDA Natural Resources Conservation Service (NRCS) works with landowners to conserve natural resources on private lands. The

NRCS accomplishes this through various programs including, but not limited to, the Conservation Technical Assistance Program, Soil Survey Program, Conservation Reserve Enhancement Program, and the Wetlands Reserve Program. The NRCS works closely with local Conservation Districts; providing technical assistance and support.

4.1.6 *Northwest Power and Conservation Council*

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

4.2 State Programs

4.2.1 *Washington Department of Natural Resources*

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

4.2.2 *Washington Department of Fish & Wildlife*

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

4.2.3 *Washington Department of Ecology*

The Department of Ecology (DOE) oversees: the Water Resources program to manage water resources to meet current and future needs of the natural environment and Washington's communities; the Water Quality program to restore and protect Washington's water supplies by preventing and reducing pollution; and Shoreline and the Environmental Assistance program for implementing the Shorelines Management Act, the State Environmental Protection Act, the Watershed Planning Act, and 401 Certification of ACOE Permits.

4.2.4 *Washington Department of Transportation*

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

4.2.5 *Interagency Committee for Outdoor Recreation*

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

4.2.6 *Lower Columbia Fish Recovery Board*

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

4.3 Local Government Programs

4.3.1 *Clark County*

Clark County is conducting Comprehensive Planning under the State's Growth Management Act. Clark County manages natural resources under various programs including Critical Areas Ordinance, ESA Program, Road Operations, Parks Operations, Stormwater Management, and the Conservation Futures Program.

4.3.2 *City of Ridgefield*

The city of Ridgefield adopts by reference SEPA provisions. The critical areas are identified on the city's comprehensive plan map, and described in the sensitive lands chapter of the zoning code.

4.3.3 *City of Battle Ground*

The city of Battle Ground's comprehensive planning occurs under the state Growth Management Act. Battle Ground manages natural resource impacts through a Critical Areas Ordinance and a Stormwater Ordinance.

4.3.4 *Clark Conservation District*

Clark Conservation District provides technical assistance, cost-share assistance, and project monitoring in Clark County. Clark CD assists agricultural landowners in the development of farm plans and in the participation in the Conservation Reserve Enhancement Program. Farm plans optimize use, protect sensitive areas, and conserve resources.

4.4 Non-governmental Programs

4.4.1 *Columbia Land Trust*

The Columbia Land Trust is a private, non-profit organization founded in 1990 to work exclusively with willing landowners to find ways to conserve the scenic and natural values of the land and water. Landowners donate the development rights or full ownership of their land to the Land Trust. CLT manages the land under a stewardship plan and, if necessary, will legally defend its conservation values.

4.4.2 *Lower Columbia Fish Enhancement Group*

The Washington State Legislature created the Regional Fisheries Enhancement Group Program in 1990 to involve local communities, citizen volunteers, and landowners in the state's salmon recovery efforts. RFEGs help lead their communities in successful restoration, education and monitoring projects. Every group is a separate, nonprofit organization led by their own board of directors and operational funding from a portion of commercial and recreational fishing license fees administered by the WDFW, and other sources. The mission of the Lower Columbia RFEG (LCFEG) is to restore salmon runs in the lower Columbia River region through habitat restoration, education and outreach, and developing regional and local partnerships.

4.5 NPCC Fish & Wildlife Program Projects

There are no NPCC Fish & Wildlife Program Projects in the East Fork Lewis Basin.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Restoration	EF Lewis River Assessment	EF Lewis
Restoration	East Fork Lewis Riparian Restoration	EF Lewis
Restoration	Lewis River Preserve Restoration	EF Lewis
Study	EF Lewis River Riparian Restoration Monitoring	EF Lewis
Study	EF Lewis River Watershed Assessment	EF Lewis

5.0 Management Plan

5.1 Vision

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

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

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

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

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

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

Columbia basin hydropower effects on East Fork Lewis Subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the East Fork Lewis River will also be called upon to produce fish to help mitigate for hydropower impacts on upriver stocks where compatible with wild fish recovery.

This plan uses a planning period or horizon of 25 years. The goal is to achieve recovery of the listed salmon species and the biological objectives for other fish and wildlife species of interest within this time period. It is recognized, however, that sufficient restoration of habitat conditions and watershed processes for all species of interest will likely take 75 years or more.

5.2 Biological Objectives

Biological objectives for East Fork Lewis Subbasin salmonid populations are based on recovery criteria developed by scientists on the Willamette/Lower Columbia Technical Recovery Team convened by NOAA Fisheries. Criteria involve a hierarchy of ESU, Strata (i.e. ecosystem areas within the ESU – Coast, Cascade, Gorge), and Population standards. A recovery scenario describing population-scale biological objectives for all species in all three strata in the lower Columbia ESUs was developed through a collaborative process with stakeholders based on biological significance, expected progress as a result of existing programs, the absence of apparent impediments, and the existence of other management opportunities. Under the preferred alternative, individual populations will variously contribute to recovery according to habitat quality and the population's perceived capacity to rebuild. Criteria, objectives, and the regional recovery scenario are described in greater detail in the Regional Recovery and Subbasin Plan Volume I.

Focal populations in the East Fork Lewis subbasin are targeted to improve to a level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels.

Recovery goals call for restoring all four anadromous salmonid populations to a high or very high viability level. This level will provide for a 95% or better probability of population survival over 100 years. Cutthroat will benefit from improvements in stream habitat conditions for anadromous species. Lamprey are also expected to benefit from habitat improvements in the estuary, Columbia River mainstem, and East Fork Lewis Subbasin although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the subbasin.

Table 10. Current viability status of East Fork Lewis populations and the biological objective status that is necessary to meet the recovery criteria for the Cascade strata and the lower Columbia ESU.

	ESA	Hatchery	Current		Objective	
Species	**Status**	**Component**	**Viability**	**Numbers**	**Viability**	**Numbers**
Fall Chinook	Threatened	No	Medium	100-700	High+^{P}	1,900-3,900
Winter Steelhead	Threatened	Yes	Low+	100-300	High^{P}	600
Summer Steelhead	Threatened	Yes	Low+	100	High^{P}	200
Chum	Threatened	No	Very low	<150	High^{P}	1,100
Coho	Proposed	No	Low	Unknown	High^{P}	600

P = primary population in recovery scenario
C = contributing population in recovery scenario
S = stabilizing population in recovery scenario

5.3 Integrated Strategy

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

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

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

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

The following table identifies population and factor-specific improvements consistent with the biological objectives for this subbasin. Per factor increments are less than the population net because factor affects are compounded at different life stages and density dependence is largely limited to freshwater tributary habitat. For example, productivity of East Fork Lewis River fall Chinook must increase by 230% to reach population viability goals. This requires impact reductions equivalent to a 39% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts on fall Chinook must decrease from a 53% to a 35% impact in order to achieve the required 39% increase in tributary habitat potential from the current 47% of historical potential to 65% of historical potential.

Table 11. Productivity improvements consistent with biological objectives for the East Fork Lewis River subbasin.

Species	Net increase	Per factor	Baseline impacts					
			Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Fall Chinook	230%	39%	0.53	0.32	0.00	0.24	0.65	0.01
Chum	30%	2%	0.93	0.58	0.00	0.24	0.05	0.04
Coho	na	na	na	na	na	na	na	na
Summer Steelhead	10%	2%	0.79	0.04	0.00	0.24	0.10	0.19
Winter Steelhead	30%	7%	0.75	0.13	0.00	0.24	0.10	0.36

5.4 Tributary Habitat

Habitat assessment results were synthesized in order to develop specific prioritized measures and actions that are believed to offer the greatest opportunity for species recovery in the subbasin. As a first step toward measure and action development, habitat assessment results were integrated to develop a multi-species view of 1) priority areas, 2) factors limiting recovery, and 3) contributing land-use threats. For the purpose of this assessment, limiting factors are defined as the biological and physical conditions serving to suppress salmonid population performance, whereas threats are the land-use activities contributing to those factors. Limiting Factors refer to local (reach-scale) conditions believed to be directly impacting fish. Threats, on the other hand, may be local or non-local. Non-local threats may impact instream limiting factors in a number of ways, including: 1) through their effects on habitat-forming processes – such as the case of forest road impacts on reach-scale fine sediment loads, 2) due to an impact in a contributing stream reach – such as riparian degradation reducing wood recruitment to a downstream reach, or 3) by blocking fish passage to an upstream reach.

Priority areas and limiting factors were determined through the technical assessment, including primarily EDT analysis and the Integrated Watershed Assessment (IWA). As described later in this section, priority areas are also determined by the relative importance of subbasin focal fish populations to regional recovery objectives. This information allows for scaling of subbasin recovery effort in order to best accomplish recovery at the regional scale. Land-use threats were determined from a variety of sources including Washington Conservation Commission Limiting Factors Analyses, the IWA, the State 303(d) list, air photo analysis, the Barrier Assessment, personal knowledge of investigators, or known cause-effect relationships between stream conditions and land-uses.

Priority areas, limiting factors and threats were used to develop a prioritized suite of habitat measures. Measures are based solely on biological and physical conditions. For each measure, the key programs that address the measure are identified and the sufficiency of existing programs to satisfy the measure is discussed. The measures, in conjunction with the program sufficiency considerations, were then used to identify specific actions necessary to fill gaps in measure implementation. Actions differ from measures in that they address program deficiencies as well as biophysical habitat conditions. The process for developing measures and actions is illustrated in Figure 22 and each component is presented in detail in the sections that follow.

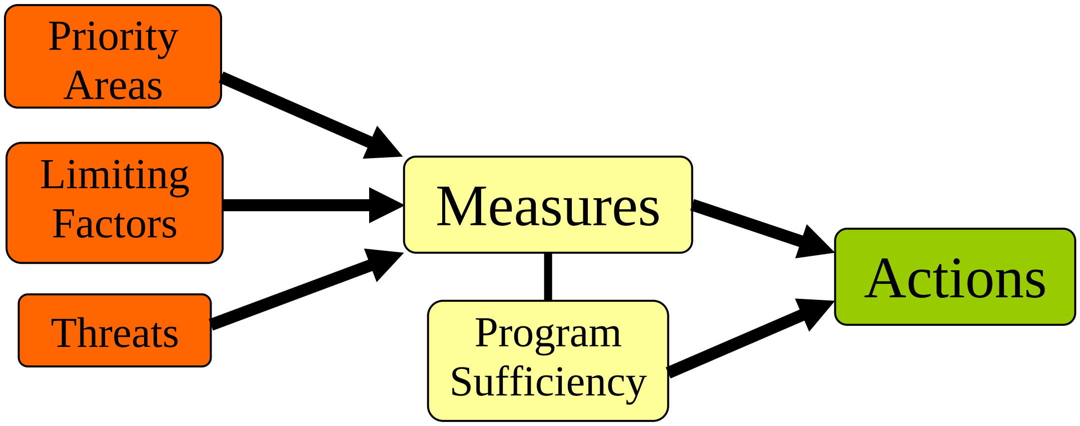

Figure 22. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Areas, Limiting Factors and Threats*

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

Summary

Decades of human activity in the East Fork Lewis River Basin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall Chinook, stream habitat conditions within the East Fork Lewis Basin have a high impact on the health and viability of salmon and steelhead relative to other limiting factors. The following bullets provide a brief overview of each of the priority areas in the basin. These descriptions are a summary of the reach-scale priorities that are presented in the next section. These descriptions summarize the species most affected, the primary limiting factors, the contributing land-use threats, and the general type of measures that will be necessary for recovery. A tabular summary of the key limiting factors and land-use threats can be found in Table 12.

- **Lower mainstem** *(reaches EF Lewis 4-10)* – The lower mainstem EF Lewis contains important spawning and rearing habitats for fall Chinook, chum, and coho. This mixed use area is heavily impacted by agriculture, rural residential development, and gravel mining. The recovery emphasis is for restoration and preservation measures. Effective restoration measures will involve riparian restoration, reductions in streambank erosion, re-connection of floodplains, and restoration of mining related impairments and future avulsion risks. Land-use planning/growth management is critical to make sure that expanding development and land-use conversions do not continue to impair habitat conditions or habitat-forming processes.
- **Middle mainstem & Rock Creek** *(reaches EF Lewis 12-13; Rock Creek 1-4)* – The middle mainstem EF Lewis and Rock Creek are most important for winter steelhead, although summer steelhead also utilize these reaches to some degree. There are agricultural and rural residential uses along these reaches but forestry impacts dominate. The recovery emphasis is for restoration and preservation. Effective restoration measures

will include riparian restoration and restoration of watershed processes related to forest practices (i.e., forest road and timber harvest impacts). Emphasis should be placed on preserving functional sediment supply conditions in the Rock Creek basin.

- **Upper mainstem** *(reaches EF Lewis 15-19C)* **–** Summer steelhead use the greatest proportion of upper EF Lewis reaches. Winter steelhead may utilize some of these reaches but they rarely make significant use of reaches above Sunset Falls (upstream end of reach EF Lewis 17). Nearly the entire upper basin is within the Gifford Pinchot National Forest and forestry impacts dominate. Past wildfires have had a lasting impact on channels. The recovery emphasis is for preservation and restoration. Effective restoration measures will include riparian restoration and watershed process restoration related to forest practices.

Table 12. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the lower mainstem (LM), middle mainstem + Rock Creek (MR), and upper mainstem (UM) portions of the EF Lewis basin. Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

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

Threats	LM	MR	UM
Agriculture/grazing			
Clearing of vegetation	✓		
Riparian grazing	✓		
Floodplain filling	✓		
Rural/suburban development			
Clearing of vegetation	✓		
Floodplain filling	✓		
Increased impervious surfaces	✓		
Increased drainage network	✓		
Roads – riparian / floodplain impacts	✓		
Leaking septic systems	✓		
Forest practices			
Timber harvests –sediment supply impacts		✓	✓
Timber harvests – impacts to runoff		✓	✓
Riparian harvests (historical)		✓	✓
Forest roads – impacts to sediment supply		✓	✓
Forest roads – impacts to runoff		✓	✓
Forest roads – riparian/floodplain impacts			✓
Catastrophic wildfire (historical)			✓
Splash-dam logging (historical)		✓	✓
Channel manipulations			
Bank hardening	✓		
Channel straightening	✓		
Artificial confinement	✓		
Clearing and snagging (historical)			✓
Mining			
Clearing of vegetation	✓		
Channel and/or floodplain substrate removal	✓		
Floodplain filling	✓		
Increased water surface area	✓		
Disrupted hyporheic flow			
Increased sedimentation			

Specific Reach and Subwatershed Priorities

Specific reaches and subwatersheds have been prioritized based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. Reaches have been placed into Tiers (1-4), with Tier 1 reaches representing the areas where recovery measures would yield the greatest benefits towards accomplishing the biological objectives. The reach tiering factors in each fish population's importance relative to regional recovery objectives, as well as the relative importance of reaches within the populations themselves. Reach tiers are most useful for identifying habitat recovery measures in channels, floodplains, and riparian areas. Reach-scale priorities were initially identified within individual populations (species) through the EDT Restoration and Preservation Analysis. This resulted in reaches grouped into categories of high, medium, and low priority for each population (see Stream Habitat Limitations section). Within a subbasin, reach rankings for all of the modeled populations were combined, using population designations as a weighting factor. Population designations for this subbasin are described in the Biological Objectives section. The population designations are 'primary', 'contributing', and 'stabilizing'; reflecting the level of emphasis that needs to be placed on population recovery in order to meet ESA recovery criteria.

Spatial priorities were also identified at the subwatershed scale. Subwatershed-scale priorities were directly determined by reach-scale priorities, such that a Group A subwatershed contains one or more Tier 1 reaches. Scaling up from reaches to the subwatershed level was done in recognition that actions to protect and restore critical reaches might need to occur in adjacent and/or upstream upland areas. For example, high sediment loads in a Tier 1 reach may originate in an upstream contributing subwatershed where sediment supply conditions are impaired because of current land use practices. Subwatershed-scale priorities can be used in conjunction with the IWA to identify watershed process restoration and preservation opportunities. The specific rules for designating reach tiers and subwatershed groups are presented in Table 13. Reach tier designations for this basin are included in Table 14. Reach tiers and subwatershed groups are displayed on a map in Figure 23. A summary of reach- and-subwatershed-scale limiting factors is included in Table 15.

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

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

Table 14. Reach Tiers in the East Fork Lewis River Basin

Tier 1	Tier 2	Tier 4
EF Lewis 10	EF Lewis 1	Big Tree Cr
EF Lewis 12	EF Lewis 11	Brezee Creek
EF Lewis 13	EF Lewis 16	Cedar Cr. (trib Rock Cr)
EF Lewis 15	EF Lewis 19_B	Cold Creek
EF Lewis 17	EF Lewis 19_C	Copper Creek
EF Lewis 18	EF Lewis 20	Dean Creek
EF Lewis 19_A	EF Lewis 3	EF Lewis 14
EF Lewis 4	Lewis 1 tidal	EF Lewis 2
EF Lewis 5	Little Cr	Green Fork
EF Lewis 6	Lockwood Creek	Horseshoe Falls
EF Lewis 7	LW Rock Creek	King Creek
EF Lewis 8	McCormick Creek	Lucia Falls
EF Lewis 9	Mill Creek	Manley Creek
Rock Creek 1	Slide Creek	Mason Creek
Rock Creek 2		McKinley Cr
Rock Creek 3		Moulton Falls
Rock Creek 4		Rock Creek 5
		Sunset Falls

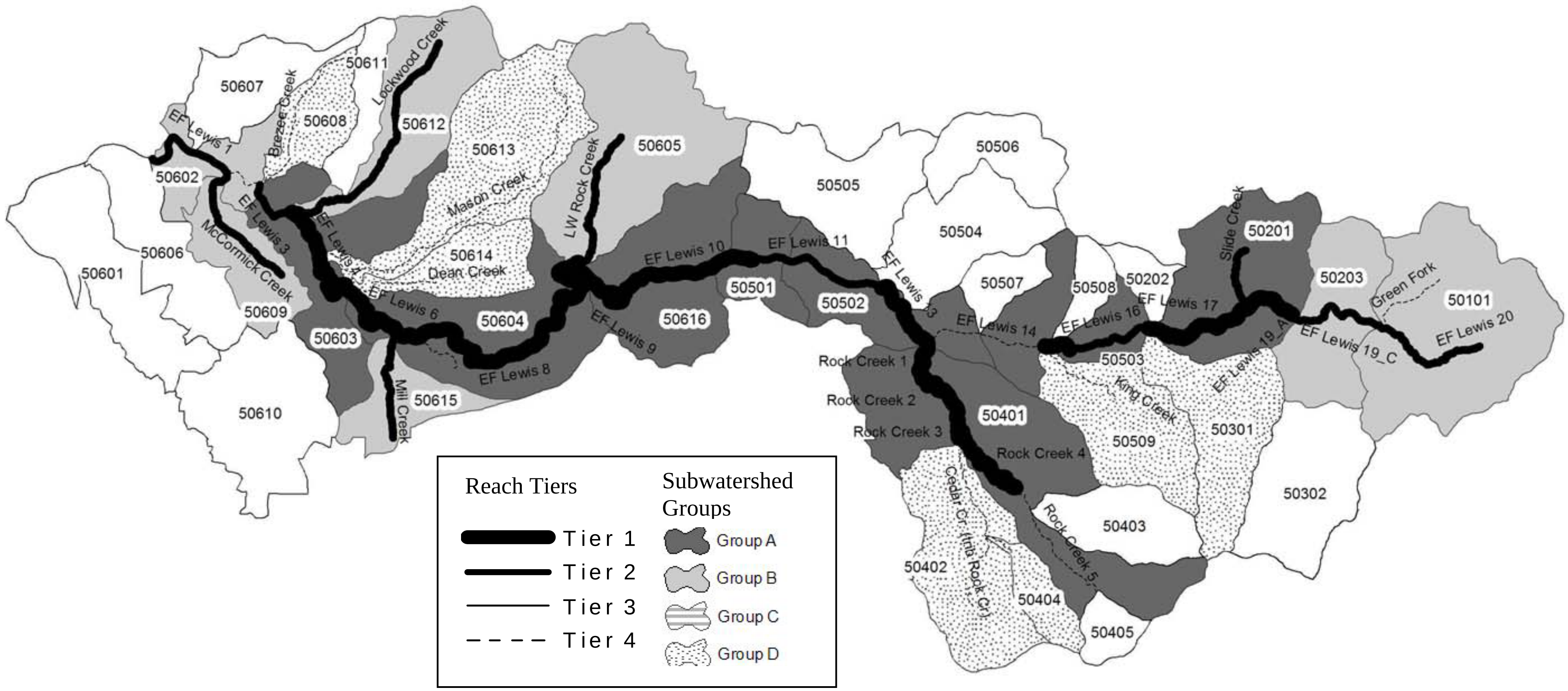

Figure 23. Reach tiers and subwatershed groups in the East Fork Lewis River Basin. Tier 1 reaches and Group A subwatersheds represent the areas where recovery actions would yield the greatest benefits with respect to species recovery objectives. The subwatershed groups are based on Reach Tiers. Priorities at the reach scale are useful for identifying stream corridor recovery measures. Priorities at the subwatershed scale are useful for identifying watershed process recovery measures. Watershed process recovery measures for stream reaches will need to occur within the surrounding (local) subwatershed as well as in upstream contributing subwatersheds.

Table 15. Reach- and subwatershed-scale limiting factors in priority areas. The table is organized by subwatershed groups, beginning with the highest priority group. Species-specific reach priorities, critical life stages, high impact habitat factors, and recovery emphasis (P=preservation, R=restoration, PR=restoration and preservation) are included. Watershed process impairments: F=functional, M=moderately impaired, I=impaired. Species abbreviations: ChS=spring Chinook, ChF=fall Chinook, StS=summer steelhead, StW=winter steelhead

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local): Hydrology	Watershed processes (local): Sediment	Watershed processes (local): Riparian	Watershed processes (watershed): Hydrology	Watershed processes (watershed): Sediment
A	50616	EF Lewis 10 EF Lewis 9 LW Rock Creek	ChF	EF Lewis 9	Spawning Egg incubation Fry colonization Prespawning holding	none	P	I	M	M	M	M
			StW	none								
			StS	none								
			Coho	EF Lewis 10	Spawning Egg incubation Fry colonization 0-age active rearing 0-age migrant 0-age inactive 1-age active rearing	habitat diversity key habitat quantity	R					
	50604	EF Lewis 5 EF Lewis 6 EF Lewis 7 EF Lewis 8 Manley Creek	ChF	EF Lewis 5 EF Lewis 6 EF Lewis 7	Egg incubation Fry colonization 0-age active rearing	temperature sediment key habitat quantity	PR	I	M	M	I	M
			Chum	EF Lewis 5 EF Lewis 6 EF Lewis 7 EF Lewis 8	Spawning Egg incubation Fry colonization Prespawning migrant Prespawning holding	habitat diversity sediment key habitat quantity	PR					
			StW	none								
			StS	none								
			Coho	EF Lewis 5 EF Lewis 6 EF Lewis 7 EF Lewis 8	Spawning Egg incubation Fry colonization 0-age active rearing 0-age inactive 1-age active rearing Prespawning migrant	channel stability habitat diversity sediment key habitat quantity	R					
	50603	EF Lewis 2 EF Lewis 3 EF Lewis 4 EF Lewis 5	ChF	EF Lewis 5	Spawning Egg incubation 0-age active rearing	temperature sediment key habitat quantity	PR	I	M	I	I	M
			Chum	EF Lewis 4 EF Lewis 5	Egg incubation Fry colonization Prespawning migrant Prespawning holding	habitat diversity sediment key habitat quantity	PR					
			StW	none								
			StS	none								
			Coho	EF Lewis 5	Egg incubation 0-age active rearing 0-age inactive	key habitat quantity	R					
	50503	EF Lewis 14 EF Lewis 15 EF Lewis 16 Horseshoe Falls	StW	none				M	M	M	F	M
			StS	EF Lewis 15	0-age active rearing 0,1-age inactive 1-age active rearing	habitat diversity flow	P					
	50502	EF Lewis 11 EF Lewis 12 EF Lewis 13 EF Lewis 14 Moulton Falls Rock Creek 1	StW	EF Lewis 12 EF Lewis 13 Rock Creek 1	Egg incubation 0-age active rearing 0,1-age inactive 1-age active rearing	habitat diversity flow sediment	P	M	F	M	M	M
			StS	none								
	50501	EF Lewis 10 EF Lewis 11 Lucia Falls	ChF	none				I	M	M	M	M
			StW	none								
			StS	none								
			Coho	EF Lewis 10	Spawning Egg incubation Fry colonization 0-age active rearing 0-age migrant 0-age inactive 1-age active rearing	habitat diversity key habitat quantity	R					
	50401	Rock Creek 1 Rock Creek 2 Rock Creek 3 Rock Creek 4 Rock Creek 5	StW	Rock Creek 1 Rock Creek 2 Rock Creek 3 Rock Creek 4	Spawning Egg incubation Fry colonization 0-age active rearing 0,1-age inactive 1-age active rearing Prespawning holding	habitat diversity flow sediment key habitat quantity	PR	M	F	M	F	F
	50201	EF Lewis 17 EF Lewis 18 EF Lewis 19_A Slide Creek Sunset Falls	StS	EF Lewis 17 EF Lewis 18 EF Lewis 19_A	Egg incubation Fry colonization 0-age active rearing 0,1-age inactive 1-age active rearing	habitat diversity flow	PR	M	M	M	F	M

Sub-watershed Group	Sub-watershed	Reaches within subwatershed	Species Present	High priority reaches by species	Critical life stages by species	High impact habitat factors	Preservation or restoration emphasis	Watershed processes (local) Hydrology	Watershed processes (local) Sediment	Watershed processes (local) Riparian	Watershed processes (watershed) Hydrology	Watershed processes (watershed) Sediment
B	50612	Lockwood Creek	Chum	none				I	F	M	I	M
			StW	none								
			Coho	none								
	50615	Mill Creek	Chum	none				I	M	M	I	M
			Coho	none								
	50609	McCormick Creek	Chum	none				I	M	I	I	M
			StW	none								
			Coho	none								
	50605	LW Rock Creek	StW	none				I	M	I	I	M
			Coho	none								
	50602	EF Lewis 1 EF Lewis 2	ChF	none				M	M	M	I	M
			Chum	none								
			StW	none								
			StS	none								
			Coho	none								
	50203	EF Lewis 19_B EF Lewis 19_C	StS	none				M	M	F	F	M
	50101	EF Lewis 20 Green Fork	StS	none				F	M	F	F	M
D	50614	Dean Creek	Chum	none				I	M	I	I	M
			StW	none								
			Coho	none								
	50613	Mason Creek	Chum	none				I	M	M	I	M
			StW	none								
			Coho	none								
	50608	Brezee Creek	Chum	none				I	M	I	I	M
			StW	none								
			Coho	none								
	50509	King Creek	StW	none				M	M	M	M	M
	50404	Cold Creek	StW	none				M	M	F	M	M
	50402	Cedar Cr. (trib Rock Cr)	StW	none				F	F	M	M	F
	50301	Copper Creek	StS	none				F	M	M	M	M

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the East Fork Lewis Basin and are necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin (Section 3.0) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the East Fork Lewis Basin are presented in priority order in Table 16. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the subbasin. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

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

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following prioritized approaches: 1) protect existing functional habitats and the processes that sustain them, 2) allow no further degradation of habitat or supporting processes. 3) re-connect isolated habitat, 4) restore watershed processes (ecosystem function), 5) restore habitat structure, and 6) create new habitat where it is not recoverable. These priorities have been adjusted for the specific circumstances occurring in the East Fork Lewis Basin. These priorities are adjusted depending on the results of the technical assessment and on the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

5.4.3 *Habitat Actions*

The prioritized measures and associated gaps are used to develop specific Actions for the subbasin. These are presented in Table 17. Actions are different than the measures in a number of ways: 1) actions have a greater degree of specificity than measures, 2) actions consider existing programs and are therefore not based strictly on biophysical conditions, 3) actions refer to the agency or entity that would be responsible for carrying out the action, and 4) actions are related to an expected outcome with respect to the biological objectives. Actions are not presented in priority order but instead represent the suite of activities that are all necessary for recovery of listed species. The priority for implementation of these actions will consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table 16. Pioritized measures for the East Fork Lewis River Basin.

#1 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	All Species	There currently are productive habitats for steelhead in the upper basin, especially in the portion of the basin upstream of Sunset Falls within National Forest. Significant degradation of stream corridor habitat has occurred over the years in the private, mixed-use lands in the lower and middle basin. This area has historically been utilized for timber harvest, agriculture, mining, and rural residential uses and is experiencing increasing development pressure. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Tier 1 or 2 reaches with functional riparian conditions according to the IWA
Reaches: EF Lewis 19B, 19C & 20
2nd- Tier 1 or 2 reaches in mixed-use lands at risk of further degradation
Reaches: EF Lewis 1, 3-13; McCormick Creek; Lockwood Creek; Mill Creek; LW Rock Creek
3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NOAA Fisheries	ESA Section 7 and Section 10	✓	
US Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
USFS	Northwest Forest Plan	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Clark County	Comprehensive Planning		✓
City of Battle Ground	Comprehensive Planning		✓
City of Ridgefield	Comprehensive Planning		✓
Clark Conservation District (NRCS)	Agricultural land habitat protection programs		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Enforcement, Education, Control		✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements		✓

Program Sufficiency and Gaps
Alterations to stream corridor structure that may impact aquatic habitats are regulated through the WDFW Hydraulics Project Approval (HPA) permitting program. Other regulatory protections are provided through USACE permitting, ESA consultations, HCPs, DNR Aquatic Lands Authorization, and local government regulations. Riparian areas within federal timber lands are protected through the Northwest Forest Plan. Riparian areas within private timberlands are protected through the Forest Practices Rules (FPR) administered by WDNR. The FPRs came out of an extensive review process and are believed to adequately protect riparian areas with respect to stream shading, bank stability, and LWD recruitment. The program is new, however, and careful monitoring of the effect of the regulations is necessary, particularly with respect to effects on watershed hydrology and sediment delivery. Land-use conversion and development are increasing throughout the basin and local comprehensive planning must provide adequate and consistent protections across jurisdictions. Conversion of land-use from forest or agriculture to residential use has the potential to increase impairment of aquatic habitat, particularly when residential development is paired with flood control measures. Local jurisdictions can guide potentially harmful land-use conversions through zoning and tax incentives. It is imperative that ordinances prevent new development in floodplains by utilizing Best Management Practices developed at the state level. In cases where existing programs are unable to provide sufficient resource protections, conservation easements and land acquisition may be necessary.

#2 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage agricultural practices to minimize impacts to sediment supply processes, runoff regime, and water quality C. Manage growth and development to minimize impacts to sediment supply, runoff regime, and water quality	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes • Development – impacts to sediment supply, water quality, and runoff processes	All species	There currently are functioning runoff and sediment supply processes in portions of the headwaters and the Rock Creek basin. Most of the remainder of the basin is moderately impaired with respect to sediment supply. Mixed-use lands are mostly impaired with respect to runoff due to lack of forest cover and impervious surfaces. Preventing additional degradation will be important for habitat recovery.

Priority Locations

1st- Functional subwatersheds contributing to Tier 1 or 2 reaches (functional for sediment *or* flow according to the IWA – local rating)
Subwatersheds: 50612, 50502, 50508, 50202, 50101, 50401, 50301,50402, 50403, 50405

2nd- All other functional subwatersheds plus Moderately Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 50201, 50203, 50302, 50404, 50501, 50503, 50505, 50506, 50507, 50509, 50602, 50603, 50604, 50605, 50607, 50608, 50609, 50611, 50613, 50614, 50615, 50616

3rd- All other Moderately Impaired subwatersheds plus Impaired subwatersheds contributing to Tier 1 or 2 reaches
Subwatersheds: 50601, 50606, 50610

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
USFS	Northwest Forest Plan	✓	
Clark County	Comprehensive Planning		✓
City of Battleground	Comprehensive Planning		✓
City of Ridgefield	Comprehensive Planning		✓
Clark Conservation District / NRCS	Agricultural land habitat protection programs		✓

Program Sufficiency and Gaps

Hillslope processes on federal forest lands in the upper basin are protected through the Northwest Forest Plan. Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands (agriculture and developed), local government comprehensive planning is the primary nexus for protection of hillslope processes. Local govenments can control impacts through zoning that protects existing uses, through stormwater management ordinances, and through tax incentives to keep agricultural and forest lands from becoming developed. These protections are especially important in the EF Lewis basin due to expanding growth. There are few to no regulatory protections of hillslope processes that relate to agricultural practices; such deficiencies need to be addressed through local or state authorities. Protecting hillslope processes on agricultural lands would also benefit from the expansion of technical assistance and landowner incentive programs (NRCS, Conservation Districts).

#3 - Restore floodplain function and channel migration processes in the mainstem and major tributaries

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Set back, breach, or remove artificial confinement structures	• Bed and bank erosion • Altered habitat unit composition • Restricted channel migration • Disrupted hyporheic processes • Reduced flood flow dampening • Altered nutrient exchange processes • Channel incision • Loss of off-channel and/or side-channel habitat • Blockages to off-channel habitats	• Floodplain filling • Channel straightening • Artificial confinement	All species	Much of the lower mainstem has been subject to artificial channel confinement associated with mining, residential development, and agriculture. Restoring floodplain function and channel migration processes will lead to improvements in riparian and channel habitats. Selective breaching, setting back, or removing confining structures would help to restore floodplain and CMZ function as well as facilitate the creation of off-channel and side channel habitats. There are challenges with implementation due to private lands, existing infrastructure already in place, potential flood risk to property, and large expense.

Priority Locations

1st- Tier 1 reaches with hydro-modifications (obtained from EDT ratings)
Reaches: EF Lewis 4, 5, 6, 8 & 19A; Rock Creek 3
2nd- Tier 2 reaches with hydro-modifications
Reaches: EF Lewis 1, 3, 19B & 20; Lewis 1 tidal; Lockwood Creek; LW Rock Creek
3rd- Other reaches with hydro-modifications
Reaches: EF Lewis 2; Brezee Creek; Dean Creek; Green Fork; Manley Creek; Mason Creek

Key Programs

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

Program Sufficiency and Gaps

There currently are no programs that set forth strategies for restoring floodplain function and channel migration processes in the EF Lewis Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. The level of floodplain and CMZ impairment in the Lower EF Lewis and the importance of these processes to listed fish species put an increased emphasis on restoration. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs and government entities to conduct projects. Floodplain restoration projects are often expensive, large-scale efforts that require partnerships among many agencies, NGOs, and landowners. Building partnerships is a necessary first step toward floodplain and CMZ restoration.

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

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

Priority Locations

1st- Moderately impaired or impaired subwatersheds contributing to Tier 1 reaches (mod. impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: 50201, 50203, 50302, 50404, 50501, 50503, 50505, 50506, 50507, 50509, 50603, 50604, 50605, 50613, 50614, 50615, 50616, 50502, 50508, 50202, 50101, 50401, 50301, 50405

2nd- Moderately impaired or impaired subwatersheds contributing to Tier 2 reaches
Subwatersheds: 50612, 50611, 50608, 50607, 50602, 50609

3rd- Moderately impaired or impaired subwatersheds contributing to other reaches
Subwatersheds: 50601, 50606, 50610

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Clark Conservation District / NRCS	Agricultural land habitat restoration programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Clark County	Comprehensive Planning		✓
City of Battle Ground	Comprehensive Planning		✓
City of Ridgefield	Comprehensive Planning		✓

Program Sufficiency and Gaps

Forest management programs including the Northwest Forest Plan (federal timber lands), new Forest Practices Rules (private timber lands), and the WDNR HCP (state timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements for private timber lands are expected to actively address road-related impairments within a 15 year time-frame. While these strategies are believed to be largely adequate to protect watershed processes, the degree of implementation and the effectiveness of the prescriptions will not be fully known for at least another 15 or 20 years. Of particular concern is the capacity of some forest land owners, especially small forest owners, to conduct the necessary road improvements (or removal) in the required timeframe. Additional financial and technical assistance would enable small forest landowners to conduct the necessary improvements in a timeline parallel to large industrial timber land owners. Ecological restoration of existing developed and agricultural lands occurs relatively infrequently and there are no programs that specifically require restoration in these areas. Restoring existing developed and farmed lands can involve retrofitting facilities with new materials, replacing existing systems, adopting new management practices, and creating or re-configuring landscaping. Means of increasing restoration activity include increasing landowner participation through education and incentive programs, building support for projects on public lands/facilities, requiring Best Management Practices through permitting and ordinances, and increasing available funding for entities to conduct restoration projects.

#5 - Restore riparian conditions throughout the basin

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore the natural riparian plant community B. Exclude livestock from riparian areas C. Eradicate invasive plant species from riparian areas	• Reduced stream canopy cover • Altered stream temperature regime • Reduced bank/soil stability • Reduced wood recruitment • Lack of stable instream woody debris • Exotic and/or invasive species • Bacteria	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to agriculture and residential development	All species	Riparian areas have been degraded by a host of land-uses including timber harvest, road building, mining, agriculture, and development. Although most riparian areas are now protected, natural recovery is limited in many areas by existing land use. The increasing abundance of exotic and invasive species is also a concern. Riparian restoration projects are relatively inexpensive and are often supported by landowners. There is a high potential benefit due to the many limiting factors that are addressed.

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
USFS	Northwest Forest Plan, Habitat Projects	✓	
WDFW	Habitat Program		✓
Clark Conservation District / NRCS	Agricultural land habitat restoration programs		✓
Clark County	Comprehensive Plan		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Control, and Enforcement		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring riparian conditions; however, existing programs will afford protections that will allow for the *passive* restoration of riparian forests. These protections are believed to be adequate for riparian areas on forest lands that are subject to Forest Practices Rules or the State forest lands HCP. Other lands receive variable levels of protection and passive restoration through the Clark County Comprehensive Plan. Many degraded riparian zones in urban, agricultural, rural residential, or transportation corridor uses will not passively restore with existing regulatory protections and will require active measures. Riparian restoration in these areas may entail livestock exclusion, tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

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

Priority Locations

1st- Tier 1 or 2 reaches with 303(d) listings (2002-2004 draft list)
Reaches: EF Lewis 8 (temperature and bacteria); EF Lewis 15, 16, 19A, 19B & 20 (temperature); EF Lewis 3, 11-13 (bacteria); Lockwood Creek (bacteria); LW Rock Creek (bacteria); McCormick Creek (bacteria); Rock Creek 4 (bacteria)

2nd- Other reaches with 303(d) listings
Reaches: EF Lewis 2 (bacteria); Brezee Creek (bacteria)

3rd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	State Lands HCP, Forest Practices Rules	✓	
USFS	Northwest Forest Plan, Habitat Projects	✓	
WDFW	Habitat Program		✓
Clark Conservation District / NRCS	Agricultural land habitat restoration programs, Centennial Clean Water Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Clark County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

The WDOE Water Quality Program manages the State 303(d) list of impaired water bodies. There are several listings for temperature and fecal coliform bacteria in the EF Lewis Basin and several additional areas listed as a concern (WDOE 2004). Water Quality Clean-up Plans (TMDLs) are required by the WDOE and it is anticipated that the TMDLs will adequately set forth strategies to address the temperature and bacteria impairments. It will be important that the strategies specified in the TMDLs are implementable and adequately funded. The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin, especially regarding agricultural pollutants.

#7 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – Maintain or improve flows during low-flow Summer months	• Water withdrawals	All species	Expanding growth has increased pressures for ground and surface water withdrawals. It is crucial that withdrawals are managed carefully to minimize impacts on aquatic resources. Instream flow management strategies for the EF Lewis Basin have been identified as part of Watershed Planning for WRIA 27 (LCFRB 2004). Strategies include water rights closures, setting of minimum flows, and drought management policies. This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Resources Program		✓
City of Battleground	Water Supply Program		✓
City of Ridgefield	Water Supply Program		✓
Clark Public Utilities	Water Supply Program		✓

Program Sufficiency and Gaps

The Water Resources Program of the WDOE, in cooperation with the WDFW and other entities, manages water rights and instream flow protections. A collaborative process for setting and managing instream flows was launched in 1998 with the Watershed Planning Act (HB 2514), which called for the establishment of local watershed planning groups who's objective was to recommend instream flow guidelines to WDOE through a collaborative process. It is anticipated that the WRIA 27/28 watershed management plan will be adopted by the Planning Unit in December, 2004. Instream flow management in the EF Lewis Basin will be conducted using the recommendations of the WRIA 27/28 Planning Unit, which is coordinated by the LCFRB. Draft products of the WRIA 27/28 watershed planning effort can be found on the LCFRB website: www.lcfrb.gen.wa.us. The recommendations of the planning unit have been developed in close coordination with recovery planning and the instream flow prescriptions developed by this group are anticipated to adequately protect instream flows necessary to support healthy fish populations. The measures specified above are consistent with the planning group's recommended strategies. Development of a regional water source in the Vancouver Lake Lowlands to provide water to the City of Battleground and other communities is a central element of the management plan. Ecology should implement the recommendations of the WRIA 27/28 Planning Unit with respect to instream flow rule development.

#8 – Restore access to habitat blocked by artificial barriers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access to isolated habitats blocked by culverts, dams, or other barriers	• Blockages to channel habitats • Blockages to off-channel habitats	• Dams, culverts, in-stream structures	coho, winter steelhead, summer steelhead	As many as 30 miles of potentially accessible habitat are blocked by culverts or other barriers. The blocked habitat is believed to be marginal in the majority of cases and no individual barriers in themselves account for a significant portion of blocked miles (there are 23 barriers total). Passage restoration projects should focus only on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Culverts on McCormick, Brezee Creek & tribs, Mason Creek, Gee Creek (not in EF basin proper)
2nd- Other small tributaries with blockages

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, Family Forest Fish Passage, State Forest Lands HCP	✓	
WDFW	Habitat Program		✓
USFS	Northwest Forest Plan, Habitat Projects	✓	
Washington Department of Transportation / WDFW	Fish Passage Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Clark County	Roads Program		✓

Program Sufficiency and Gaps

The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Past efforts have corrected major blockages and have identified others in need of repair. Additional funding is needed to correct remaining blockages. Further monitoring and assessment is needed to ensure that all potential blockages have been identified and prioritized.

#9 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Channel structure and stability have been compromised by altered sediment and flow regimes, degraded riparian conditions, stream-adjacent gravel mining/processing, and confinement. Large wood installation projects could benefit habitat conditions in many areas although watershed processes contributing to wood deficiencies should be considered and addressed prior to placing wood in streams. Other structural enhancements to stream channels may be warranted in some places, particularly in reaches that have been simplified through channel straightening and confinement or that has experienced avulsions into streamside gravel processing ponds.

Priority Locations

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

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
WDFW	Habitat Program		✓
USFS	Habitat Projects		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Clark Conservation District / NRCS	Agricultural land habitat restoration programs		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring channel stability and structure. Passive restoration is expected to slowly occur as a result of protections afforded to riparian areas and hillslope processes. Past projects have largely been opportunistic and have been completed due to the efforts of local NGOs, landowners, and government agencies; such projects are likely to continue in a piecemeal fashion as opportunities arise and if financing is made available. The lack of LWD in stream channels, and the importance of wood for habitat of listed species, places an emphasis on LWD supplementation projects. Addressing channel stability and structure associated with the stream-adjacent gravel ponds along the lower river is also a high priority. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

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

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

Priority Locations

1st- Lower Mainstem EF Lewis
2nd- Other reaches that may have potential for off-channel and side-channel habitat restoration or creation

Key Programs

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

Program Sufficiency and Gaps

There are no regulatory mechanisms for creating or restoring off-channel and side-channel habitat. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

Table 17. Habitat actions for the East Fork Lewis Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
EF Lew 1. Expand standards in local government comprehensive plans to provide high levels of protection of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Clark County Battleground	1 & 2	High: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
EF Lew 2. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of agriculture and timber lands to developed uses through zoning regulations and tax incentives (in consideration of urban growth boundaries)	Expansion of existing program or activity	Clark County Battleground	1 & 2	High: Applies to all private lands under county jurisdiction	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
EF Lew 3. Conduct floodplain restoration where feasible along the mainstem and in major tributaries that have experienced channel confinement. Address past and potential avulsions into gravel processing ponds. Build partnerships with landowners and agencies and provide financial incentives	New program or activity	NRCS, CCD, NGOs, WDFW, LCFRB, USACE, LCFEG, Tribes	3, 5, 6, 8 & 9	High: Lower mainstem EF Lewis and lower portion of major tributaries	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
EF Lew 4. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	1, 2, 4, 5, 6 & 8	Medium: National Forest lands in the upper basin	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	High
EF Lew 5. Prevent floodplain impacts through land use controls and Best Management Practices	Expansion of existing program or activity	Clark County, Battleground WDOE	1	Medium: Applies to privately owned flood prone lands under local jurisdiction	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
EF Lew 6. Monitor, evaluate, and enforce the Stordahl Habitat Conservation Plan	Activity is currently in place	NOAA, USFWS	9	Medium: Applies to privately owned lands downstream of Daybreak Park	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), erosion, mass wasting, bank stability and sediment supply processes	High
EF Lew 7. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Medium: Residential, agricultural, or forest lands at risk of further degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
EF Lew 8. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed	Expansion of existing program or	Clark County, Battleground	1, 4, 5, & 6	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery,	High

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

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
management	activity				restoration and preservation of fish access to habitats	
EF Lew 9. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, CCD, WDNR, WDFW, LCFEG, Clark County, Battleground	All measures	High: Private lands. Applies to lands in agriculture, rural residential, and forestland uses throughout the basin	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
EF Lew 10. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 5, 6 & 8	Medium: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
EF Lew 11. Implement the prescriptions of the WRIA 27/28 Watershed Planning Unit regarding instream flows. Develop a regional water source in the Vancouver Lake Lowlands within 10 years and assess the feasibility of a regional source in the North Fork Lewis tidal reach	Activity is currently in place	WDOE, WDFW, WRIA 27/28 Planning Unit, CPU, Battleground, Ridgefield	7	High: Entire basin	High: Adequate instream flows to support life stages of salmonids and other aquatic biota.	High
EF Lew 12. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, CCD, LCFEG	3, 4, 5, 6, 7, 8, & 10	High: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality, LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
EF Lew 13. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 4, 5, 6 & 8	Medium: Small private timberland owners	High: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
EF Lew 14. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, CCD	1 & 5	High: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
EF Lew 15. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Clark County WSDOT, LCFEG, Clark CD	8	Medium: As many as 30 miles of stream are potentially blocked by artificial barriers	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	Medium
EF Lew 16. Conduct forest practices on state lands in accordance with the Habitat Conservation Plan in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 4, 5, 6 & 8	Medium: State timber lands in the EF Lewis Basin (approximately 16% of the basin area)	Medium: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats. Response is medium because of location and quantity of state lands	Medium

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
EF Lew 17. Address water quality issues through the development and implementation of water quality clean up plans (TMDLs)	**Expansion of existing program or activity**	**WDOE**	**6**	**Medium: Temperature impaired and 303(d) listed streams**	**Medium: Protection and restoration of water quality**	**Low**
EF Lew 18. Create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	**New program or activity**	**LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Clark CD**	**10**	**Low: Lower mainstem EF Lewis**	**High: Increased habitat availability for spawning and rearing**	**Low**

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the East Fork Lewis River Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery measures in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. This may involve substantial changes in hatchery programs from their historical focus on production for fishery for lost fishery benefits. The recovery strategy includes a mixture of conservation programs and mitigation programs. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the East Fork Lewis River Basin are displayed by species in Table 18. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 18. Summary of natural production and fishery enhancement strategies to be implemented in the East Fork Lewis River Basin.

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

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

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

Natural Refuge Watersheds: In this strategy, certain sub-basins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These refugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural population on fitness and our ability to measure natural population productivity and will be key indicators of natural population status within the ESU. The East Fork Lewis River Basin would be a refuge area for natural fall Chinook

Hatchery Supplementation: This strategy utilizes hatchery production as a tool to assist in rebuilding depressed natural populations. Supplementation would occur in selected areas that are producing natural fish at levels significantly below current capacity or capacity is expected to increase as a result of immediate benefits of habitat or passage improvements. This is intended to be a temporary measure to jump start critically low populations and to bolster natural fish numbers above critical levels in selected areas until habitat is restored to levels where a population can be self sustaining. This strategy would include chum and coho salmon in the East Fork Lewis Basin.

Hatchery/Natural Isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of fall Chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This strategy would not be included in near-term measures for the East Fork Lewis Basin but could be considered in the future for coho. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations.

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

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

5.5.2 *Hatchery Measures and Actions*

Hatchery strategies and measures are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within the East Fork Lewis Basin have been evaluated in detail through the WDFW Benefit-Risk Assessment Procedure (BRAP) relative to risks to natural populations. The BRAP results were utilized to inform the development of these program actions specific to the East Fork Lewis River Basin (Table 19). The Sub-Basin plan hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NOAA fisheries approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the East Fork Lewis Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 19. Hatchery program actions to be implemented in the East Fork Lewis River Basin.

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Continue to mass mark Skamania Hatchery steelhead releases to provide the means to identify hatchery fish for selective fisheries and to distinguish between hatchery and wild fish returning to the EF Lewis River.	*Adipose fin-clip mark hatchery released steelhead.	Skamania Hatchery winter and summer steelhead released into the EF Lewis River	EF Lewis winter and summer steelhead.	Domestication, Diversity, Abundance	• In-breeding • Harvest	• Continue selective fishery opportunity for hatchery produced summer steelhead in the East Fork Lewis. • Enable visual identification of hatchery and wild returns to provide the means to account for and manage the natural and wild escapement consistent with biological objectives
• Maintain EF Lewis as a refugia for natural fall chinook without genetic influence from hatchery produced fall chinook,	*Preclude release of hatchery produced chinook into the East For Lewis.	All fall chinook programs	EF Lewis fall chinook	Domestication, Diversity	• In-breeding	• EF Lewis fall chinook population rebuilds while maintaining genetic legacy attributes. • EF Lewis fall chinook possesses genetic attributes which enable the population to reach productivity potential.
• Hatchery produced steelhead will be scheduled for release during the time when the maximum numbers of fish are smolted and prepared to emigrate rapidly. • Juvenile rearing strategies will be implemented to provide a fish growth schedule which coincides with an optimum release time for hatchery production survival and to minimize time spent in the EF Lewis Basin.	*Juvenile release strategies to minimize impacts to natural populations	Skamania Hatchery winter and summer steelhead released into the EF Lewis.	EF Lewis steelhead, coho, fall chinook, and chum	Predation, Competition	• Hatchery smolt residence time in the EF Lewis.	• Minimal residence time of hatchery released juvenile resulting in reduced ecological interactions between hatchery and wild juveniles. • Minimized predation by summer steelhead smolts upon natural produced winter and summer steelhead, coho, fall chinook, and chum. • Improved survival of wild juveniles, resulting in increased productivity and abundance of winter and summer steelhead, coho, fall chinook, and chum
• Develop a chum brood stock utilizing natural returns to the North Lewis and East Fork Lewis. Establish a brood stock program at	** Hatchery programs utilized for chum and coho supplementation	Lewis River chum (not yet a program), lower Columbia coho	EF Lewis chum and coho.	Abundance, spatial distribution	• Risk of low number of natural	• Establish an appropriate brood stock to supplement and decrease risks to the East Fork Lewis chum population. Chum abundance will increase with East Fork

Activity	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
Lewis River hatchery complex to supplement East Fork Lewsis chum populations. • Utilize coho production from a lower Columbia facility, as determined by WDFW, to supplement the natural coho population in the East Fork Lewis. Program would be aimed towards early and late stock coho supplementation					spawners • Ecologically appropriate brood stock.	Lewis habitat improvements resulting in expanded distribution in the Cascade strata. • Supplementation, strategies in key East Fork Lewis tributaries will assist in “kick-starting” natural coho recovery, coinciding with habitat improvements and harvest management actions.
• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes • Performance standards developed for each actions with measurable criteria to determine success or failure • Adaptive Management applied to adjust or change actions as necessary	** Monitoring and evaluation, adaptive management	All species	All species	Hatchery production performance, Natural production performance	• All of above	• Clear standards for performance and adequate monitoring programs to evaluate actions. • Adaptive management strategy reacts to information and provides clear path for adjustment or change to meet performance standard

** Extension or improvement of existing actions-may require additional funding*
*** New action-will likely require additional funding*

5.6 Harvest

Fisheries are both an impact that reduces fish numbers and an objective of recovery. The long-term vision is to restore healthy, harvestable natural salmonid populations in many areas of the lower Columbia basin. The near-term strategy involves reducing fishery impacts on natural populations to ameliorate extinction risks until a combination of actions can restore natural population productivity to levels where increased fishing may resume. The regional strategy for interim reductions in fishery impacts involves: 1) elimination of directed fisheries on natural populations, 2) regulation of mixed stock fisheries for healthy hatchery and natural populations to limit and minimize indirect impacts on natural populations, 3) scaling of allowable indirect impacts for consistency with recovery, 4) annual abundance-based management to provide added protection in years of low abundance, while allowing greater fishing opportunity consistent with recovery in years with much higher abundance, and 5) mass marking of hatchery fish for identification and selective fisheries.

Actions to address harvest impacts are generally focused at a regional level to cover fishery impacts accrued to lower Columbia salmon as they migrate along the Pacific Coast and through the mainstem Columbia River. Fisheries are no longer directed at weak natural populations but incidentally catch these fish while targeting healthy wild and hatchery stocks. Subbasin fisheries affecting natural populations have been largely eliminated. Fishery management has shifted from a focus on maximum sustainable harvest of the strong stocks to ensuring protection of the weak stocks. Weak stock protections often preclude access to large numbers of otherwise harvestable fish in strong stocks.

Fishery impact limits to protect ESA-listed weak populations are generally based on risk assessments that identify points where fisheries do not pose jeopardy to the continued persistence of a listed group of fish. In many cases, these assessments identify the point where additional fishery reductions provide little reduction in extinction risks. A population may continue to be at significant risk of extinction but those risks are no longer substantially affected by the specified fishing levels. Often, no level of fishery reduction will be adequate to meet naturally-spawning population escapement goals related to population viability. The elimination of harvest will not in itself lead to the recovery of a population. However, prudent and careful management of harvest can help close the gap in a coordinated effort to achieve recovery.

Fishery actions specific to the subbasins are addressed through the Washington State Fish and Wildlife sport fishing regulatory process. This public process includes an annual review focused on emergency type regulatory changes and a comprehensive review of sport fishing regulations which occurs every two years. This regulatory process includes development of fishing rules through the Washington Administrative Code (WAC) which are focused on protecting weak stock populations while providing appropriate access to harvestable populations. The actions consider the specific circumstances in each area of each subbasin and respond with rules that fit the relative risk to the weak populations in a given time and area of the subbasin. A summary of fishery regulatory and protective actions in the East Fork Lewis River are displayed in Table 20.

Table 20.Summary of regulatory and protective fishery actions in the East Fork Lewis basin

Species	General Fishing Actions	Explanation	Other Protective Fishery Actions	Explanation
Fall Chinook	Closed to retention	Protects wild fall Chinook. No hatchery produced fall Chinook in the East Fork Lewis	No fisheries for other salmon	Further protection of wild fall Chinook spawners
Chum	Closed to retention	Protects wild chum. Hatchery chum are not released in the East Fork Lewis for harvest	No fisheries for other salmon	Further protection of wild chum spawners
Coho	Closed to retention	Protects wild coho. Hatchery coho are not released in the East Fork Lewis for harvest.	No fisheries for other salmon	Further protection of wild coho spawners
Winter steelhead	Retain only adipose fin-clip marked steelhead	Selective fishery for hatchery steelhead, unmarked wild steelhead must be released	Steelhead fishing closed in the spring and minimum size restrictions in affect	Spring closure Protects adult wild steelhead during spawning and minimum size protects juveniles
Summer steelhead	Retain only adipose fin-clipped steelhead	Selective fisheries for hatchery steelhead, unmarked wild steelhead must be released	Steelhead fishing closed in the spring and minimum size restrictions in affect	Spring closures protect adult wild steelhead during spawning and minimum size protects juveniles

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in the Regional Recovery and Subbasin Plan Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. Harvest actions with significant application to the East Fork Lewis Subbasin populations are summarized in Table 21:

Table 21. Regional harvest actions from Volume I, Chapter 7 with significant application to the East Fork Lewis River Subbasin populations.

Action	Description	Responsible Parties	Programs	Comments
**F.A12	Monitor chum handle rate in tributary winter steelhead.	WDFW	Columbia Compact	State agencies would include chum incidental handle assessments as part of their annual tributary sport fishery sampling plan.
**F.A8	Develop a mass marking plan for hatchery tule Chinook for harvest management and for naturally-spawning escapement monitoring.	WDFW, NOAA, USFWS, Col. Tribes	U.S. Congress, Washington Fish and Wildlife Commission	A regional marking program for tule fall Chinook would provide regional selective fishing options. This program would not affect sport harvest in the East Fork Lewis as there is no hatchery production in the basin.
*F.A13	Monitor and evaluate commercial and sport impacts to naturally-spawning steelhead in salmon and hatchery steelhead target fisheries.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Includes monitoring of naturally-spawning steelhead encounter rates in fisheries and refinement of long-term catch and release handling mortality estimates. Would include assessment of the current monitoring programs and determine their adequacy in formulating naturally-spawning steelhead incidental mortality estimates.
*F.A14	Continue to improve gear and regulations to minimize incidental impacts to naturally-spawning steelhead.	WDFW, ODFW	Columbia Compact, BPA Fish and Wildlife Program	Regulatory agencies should continue to refine gear, handle and release methods, and seasonal options to minimize mortality of naturally-spawning steelhead in commercial and sport fisheries.
*F.A20	Maintain selective sport fisheries in ocean, Columbia River, and tributaries and monitor naturally-spawning stock impacts.	WDFW, NOAA, ODFW, USFWS	PFMC, Columbia Compact, BPA Fish and Wildlife Program, WDFW Creel	Mass marking of lower Columbia River coho and steelhead has enabled successful ocean and freshwater selective fisheries to be implemented since 1998. Marking programs should be continued and fisheries monitored to provide improved estimates of naturally-spawning salmon and steelhead release mortality.

* Extension or improvement of existing action
** New action

5.7 Hydropower

No dams hydropower facilities exist in the East Fork Lewis Subbasin, hence, no in-basin hydropower actions are identified. East Fork Lewis River anadromous fish populations will benefit from regional hydropower measures recovery measures and actions identified in regional plans to address habitat effects in the mainstem and estuary.

5.8 Mainstem and Estuary Habitat

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

5.9 Ecological Interactions

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

5.10 Monitoring, Research, & Evaluation

Biological status monitoring quantifies progress toward ESU recovery objectives and also establishes a baseline for evaluating causal relationships between limiting factors and a population response. Status monitoring involves routine and intensive efforts. Routine monitoring of biological data consists of adult spawning escapement estimates, whereas routine monitoring for habitat data consists of a suite of water quality and quantity measurements.

Intensive monitoring supplements routine monitoring for populations and basins requiring additional information. Intensive monitoring for biological data consists of life-cycle population assessments, juvenile and adult abundance estimates and adult run-reconstruction. Intensive monitoring for habitat data includes stream/riparian surveys, and continuous stream flow assessment. The need for additional water quality sampling may be identified. Rather than prescribing one monitoring strategy, three scenarios are proposed ranging in level of effort and cost from high to low (Level 1-3 respectively). Given the fact that routine monitoring is ongoing, only intensive monitoring varies between each level.

An in-depth discussion of the monitoring, research and evaluation (M, R & E) approach for the Lower Columbia Region is presented in the Regional Recovery and Management Plan. It includes site selection rationale, cost considerations and potential funding sources. The following tables summarize the biological and habitat monitoring efforts specific to the East Fork Lewis River. This subbasin was selected as a long-term monitoring area for the Cascade Strata.

Table 22. Summary of the biological monitoring plan for East Fork Lewis River populations.

EF Lewis: Lower Columbia Biological Monitoring Plan					
Monitoring Type	**Fall Chinook**	**Chum**	**Coho**	**Winter Steelhead**	**Summer Steelhead**
Routine	AA	AA	AA	AA	AA
Intensive					
Level 1	✓	✓	✓	✓	✓
Level 2	✓	✓	✓	✓	✓
Level 3	✓	✓	✓	✓	✓

AA Annual adult abundance estimates
✓ Adult and juvenile intensive biological monitoring occurs periodically on a rotation schedule (every 9 years for 3-year duration)
× Adult and juvenile intensive biological monitoring occurs annually

Table 23. Summary of the habitat monitoring plan for East Fork Lewis River populations.

East Fork Lewis: Lower Columbia Habitat Monitoring Plan				
Monitoring Type	**Watershed**	**Existing stream / riparian habitat**	**Water quantity[3] (level of coverage)**	**Water quality [2] (level of coverage)**
Routine [1] (level of coverage)	Baseline complete	Moderate	Stream Gage-Good IFA-Good	WDOE-Good USGS-Moderate Temperature-Moderate
Intensive				
Level 1		✓	✓	
Level 2		✓	✓	
Level 3		✓	✓	

IFAComprehensive Instream Flow Assessment (i.e. Instream Flow Incremental Methodology)
[1] Routine surveys for habitat data do not imply ongoing monitoring
[2] Intensive monitoring for water quality to be determined
[3] Water quantity monitoring may include stream gauge installation, IFA or low flow surveys

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