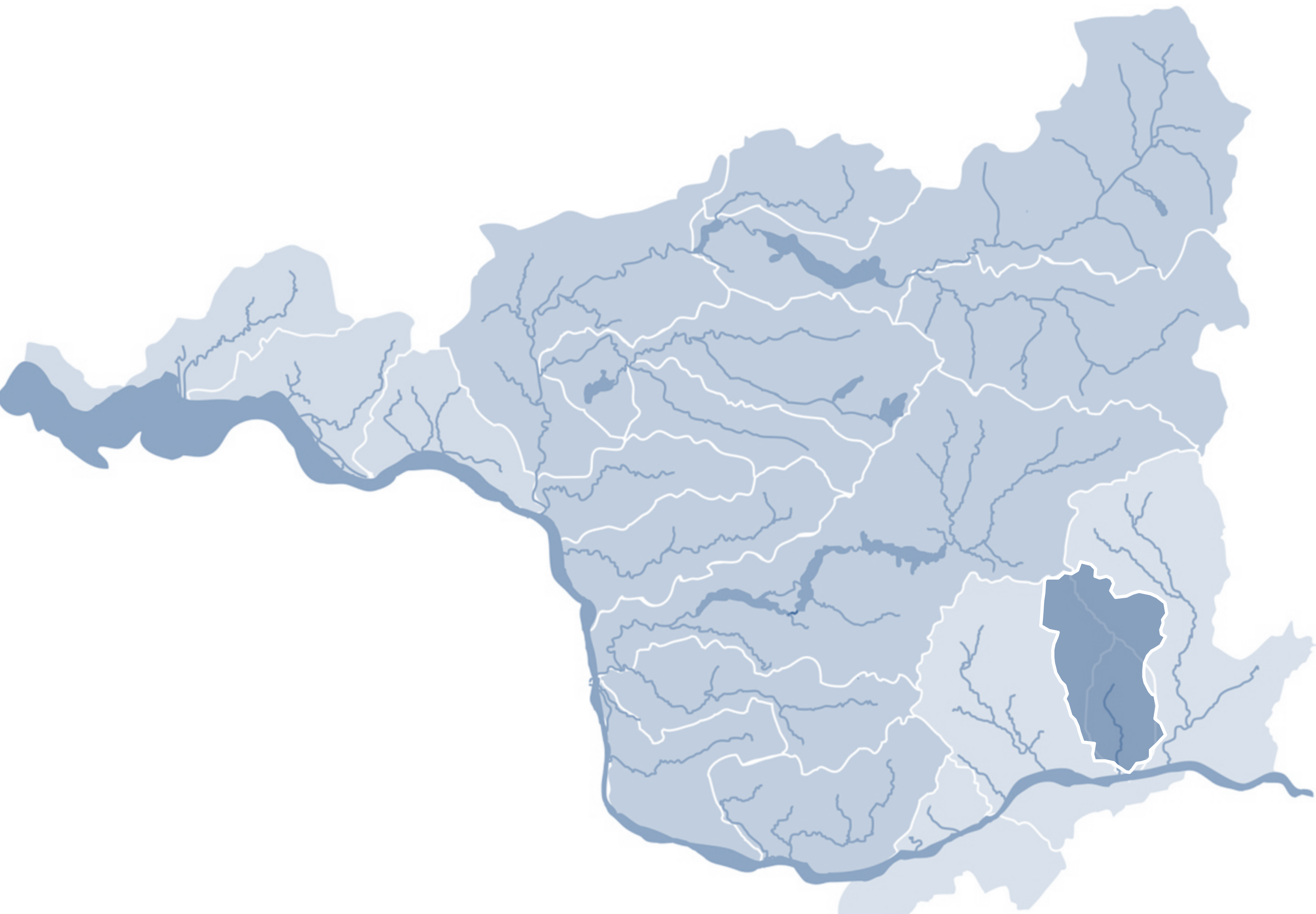
Q. LITTLE WHITE SALMON SUBBASIN



Q. LITTLE WHITE SALMON SUBBASIN

Tables

Figures

Q.1. Executive Summary

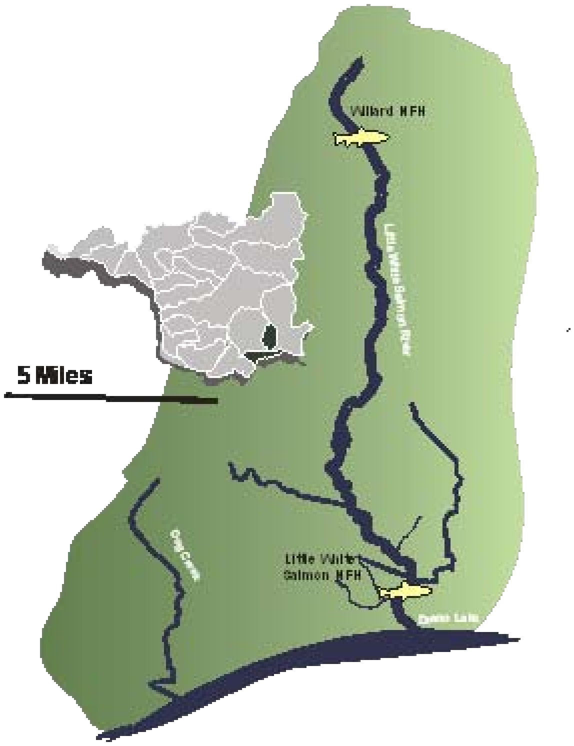


Figure Q-1. Map of Little White Salmon River

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 Little White Salmon 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 (LCFRB), Northwest Power and Conservation Council (NPCC), federal agencies, state agencies, tribal nations, local governments, and others.

The Little White Salmon River is one of twelve major NPCC subbasins in the Washington portion of the Lower Columbia Region. Historically, this subbasin had a limited amount of habitat accessible to anadromous fish yet it supported thousands of fall Chinook and a chum salmon population of unknown abundance. Much of the already limited habitat was lost with the construction of the Bonneville Dam. Today, numbers of naturally spawning salmon have plummeted to record lows in the tens or hundreds. Chinook, coho and chum have been listed as Threatened under the Endangered Species Act. The decline has occurred over decades and the reasons are many. Freshwater and estuary habitat quality has been reduced by agricultural and forestry practices. Key habitats have been isolated or eliminated. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or non-local hatchery fish has reduced productivity. Hydropower construction and operation has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries. The Little White Salmon River will play a relatively minor role in the recovery of salmon and steelhead due to the very small amount of available habitat. Regional recovery objectives call for restoring fall Chinook from a very low to a medium viability level and maintaining spring Chinook at a low viability level.

In recent years, agencies, local governments, and other entities have addressed 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 Little White Salmon 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 LCFRB is confident that by implementation of the recommended actions in this Plan, the population goals in the Little White Salmon 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.

Q.1.1. Key Priorities

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

1. Reduce Passage Mortality at Bonneville Dam and Mitigate for Effects of Reservoir Inundation

Anadromous fish populations in the Little White Salmon River are affected by Bonneville Dam operations including inundation of historically available key habitat in the lower river and dam passage effects. Approximately one mile of spawning habitat was inundated by Bonneville Pool. This loss of key habitat is particularly significant due to the naturally limited amount of suitable habitat in the lower river. Upstream and downstream fish passage facilities are operated at Bonneville Dam in the mainstem Columbia River but significant mortality and migration delay occurs. Adults are typically delayed in the tailrace but most eventually find and use fish ladders. A varying percentage of adults do not pass successfully or pass but fall back over the spillway. Juvenile passage mortality results primarily from passage through dam turbines rather than spillway or fish bypass systems. Anadromous fish populations will benefit from regional recovery measures and actions identified for operations of Bonneville Dam with respect to fish passage. The suite of in-subbasin and out-of-subbasin actions will help to mitigate for habitat loss and dam passage impacts.

2. Protect Intact Forests in Headwater Basins

Portions of the Little White Salmon Subbasin, particularly those protected through Wilderness and Late Successional Reserve designations, are heavily forested with relatively intact landscape conditions that support functioning watershed processes. 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

The majority of the Little White Salmon Subbasin has been 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 small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Habitat Conservation Plan (state 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 terrestrial and aquatic species.

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

The human population in the basin is low but 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. Population growth will primarily occur along the lower and middle mainstem, especially in the vicinity of Mill A, Cook, and Willard, WA. This growth will result in the conversion of forest 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.

5. Evaluate and Restore Passage at Artificial Barriers

A barrier dam near the mouth that is associated with the hatchery limits access to the lower mainstem below the barrier falls at river mile 3. Two miles of potentially productive habitat exists above the dam if fish health concerns can be adequately addressed. Culverts restrict passage to resident fish in the upper basin. Further assessment and prioritization of passage barriers is needed throughout the basin. Passage restoration projects should focus only on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

6. 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 fishing benefits. The Little White Salmon Hatchery Complex produces Carson stock spring Chinook, URB stock fall Chinook, and early stock coho for treaty Indian and non-Indian harvest. The main threats associated with the salmon hatchery programs are domestication of natural salmon populations and potential ecological interactions between hatchery and natural juveniles. Regional hatchery strategies and measures are focused on evaluating and reducing biological risks and reducing the risks to natural populations. The Little White Salmon Hatchery Complex will mass mark hatchery produced coho and spring Chinook which will enable out-of-basin selective fishing and accountability of hatchery fish spawning in the wild. Release strategies will be aimed at minimizing interactions between hatchery released spring Chinook smolts and wild fall Chinook and chum. The Little White Salmon Hatchery Complex will adaptively manage hatchery programs to further protect and enhance natural populations and improve operational efficiencies.

7. 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 Little White Salmon River salmon. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some Little White Salmon River salmon 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 Little White Salmon. Chum will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. 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. Marking of fall Chinook upstream of Bonneville Dam must be addressed in the *U.S. v. Oregon* Forum. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

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

Little White Salmon River salmon and steelhead are exposed to a variety of human and natural threats in migrations outside of the subbasin. Out-of-subbasin 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 out-of-subbasin effects so that the benefits of 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.

Q.2. Background

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

Development of this Plan was led and coordinated by the Washington Lower Columbia Fish Recovery Board (LCFRB). The LCFRB 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.

Q.3. Assessment

Q.3.1. Subbasin Description

Topography & Geology

The headwaters of the Little White Salmon River originate just east of the Cascade crest in south central Washington. The basin encompasses approximately 136 square miles and enters the Columbia River at Drano Lake at RM 162. Anadromous fish use is limited in this basin, with only about 500 meters of available habitat in the lower river.

Basin topography varies from gentle slopes formed by lava flows and volcanic cones to steep, rugged landforms (WDW 1990). The basin drains the Indian Heaven Wilderness and the Monte Cristo Range, which lie in the northwest and northeast portions of the basin, respectively. A major feature is the Big Lava Bed, comprising a large area in the western portion of the subbasin. The geology of this area, and the Indian Heaven Wilderness to the north, consists of relatively young quaternary basalt/andesite flows, of which the Big Lava Bed is a recent (8,000 years ago) example. The area in and around the Monte Cristo Range, on the other hand, is made up of older, tertiary deposits of volcanic tuff and pyroclastic flows. This area makes up much of the mainstem of the Little White Salmon and is susceptible to large, deep seated landslides due to decomposition of the older deposits into silts and clays (USFS 1995). Deep soils of glacial origin are present in alluvial deposits in valley bottoms. These soils also tend to be susceptible to deep-seated landslides. Elevation in the basin ranges from 5,300 feet to 50 feet at the mouth. The major tributaries to the Little White Salmon are Rock Creek, Lava Creek, Moss Creek, Wilson Creek, Cabbage Creek, Berry Creek, Homes Creek, Lusk Creek, and Beetle Creek.

Climate

Situated near the Cascade crest, the subbasin has characteristics of both continental and marine climates. Winters are wet and mild, while summers are warm and dry. Mean annual precipitation is 65 inches – 75% of which falls October through March. Most of the basin above 3,000 feet receives winter snowfall.

Land Use, Ownership, and Cover

Nearly the entire basin is forested, with timber harvest being the primary land use. The northern 3/4 of the basin is within the Gifford Pinchot National Forest (GPNF). The southern portion is privately owned, with scattered rural residential development and small-scale agriculture. The southeastern half of the subbasin is within the grand fir/Douglas fir ecological zone; the northwest portion is within the Pacific silver fir zone except for the Big Lava Bed, composed of scattered lodgepole pine, subalpine fir, western white pine, and Douglas fir. Approximately 20% of the basin is in early-seral vegetation.

A long history of fire suppression has resulted in no large (>100 acre) fires since the 1930s. Timber harvest has replaced fire as the dominant disturbance agent affecting basin hydrology (USFS 1995).

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 in the Little White Salmon basin is presented in Figure Q-2 and Figure Q-3. Figure Q-2 also displays the pattern of landownership for the basin. Figure Q-3 displays the pattern of land cover / land-use.

Human Disturbance Trends

The major population centers are Willard, Cook, and Mill A. The year 2000 population, estimated at 513 persons, is forecasted to increase to 753 by 2020 (Greenberg and Callahan 2003). Continued population growth will increase pressures for conversion of forest land uses to residential uses, with potential impacts to habitat conditions.

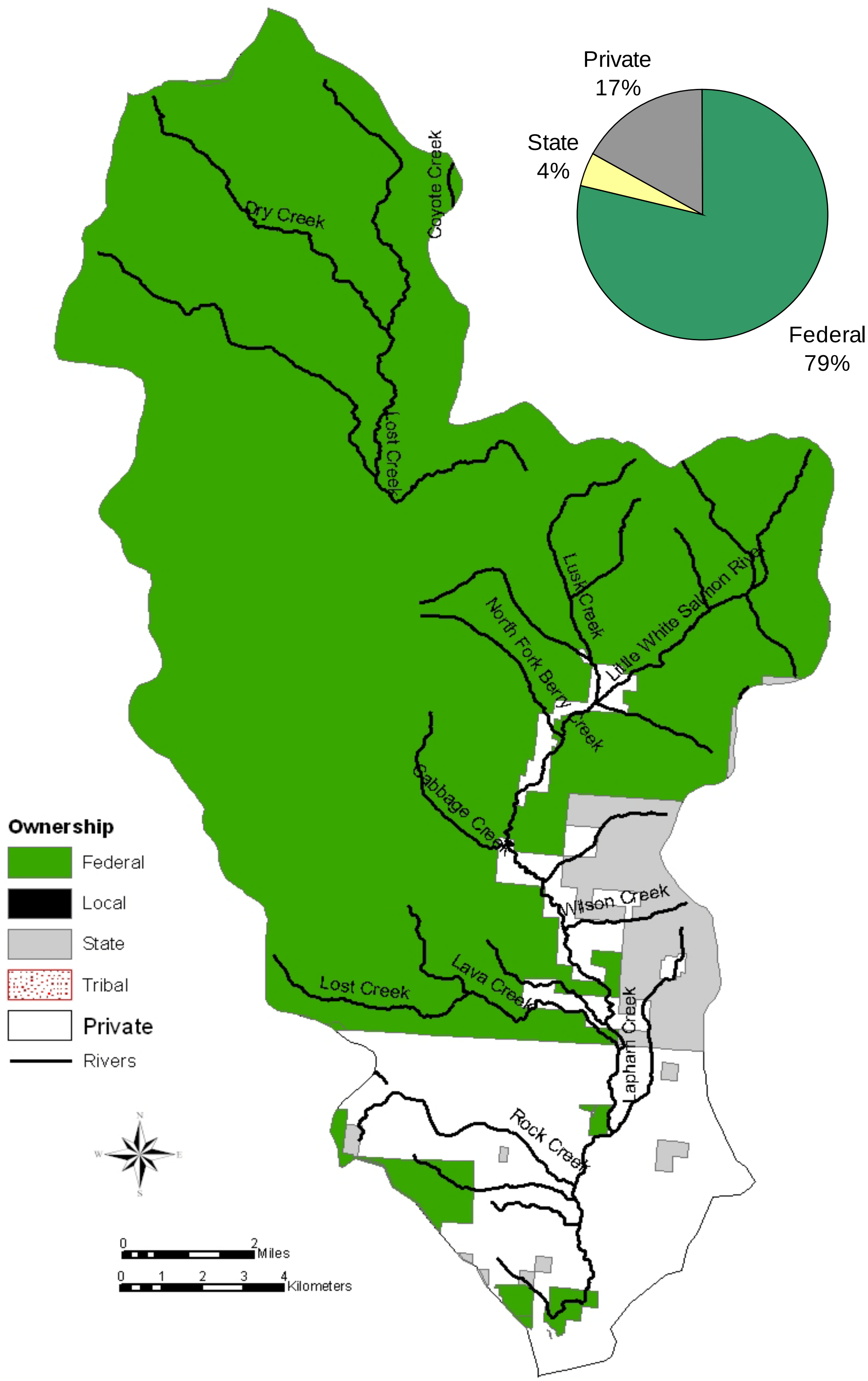


Figure Q-2. Landownership within the Little White Salmon basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

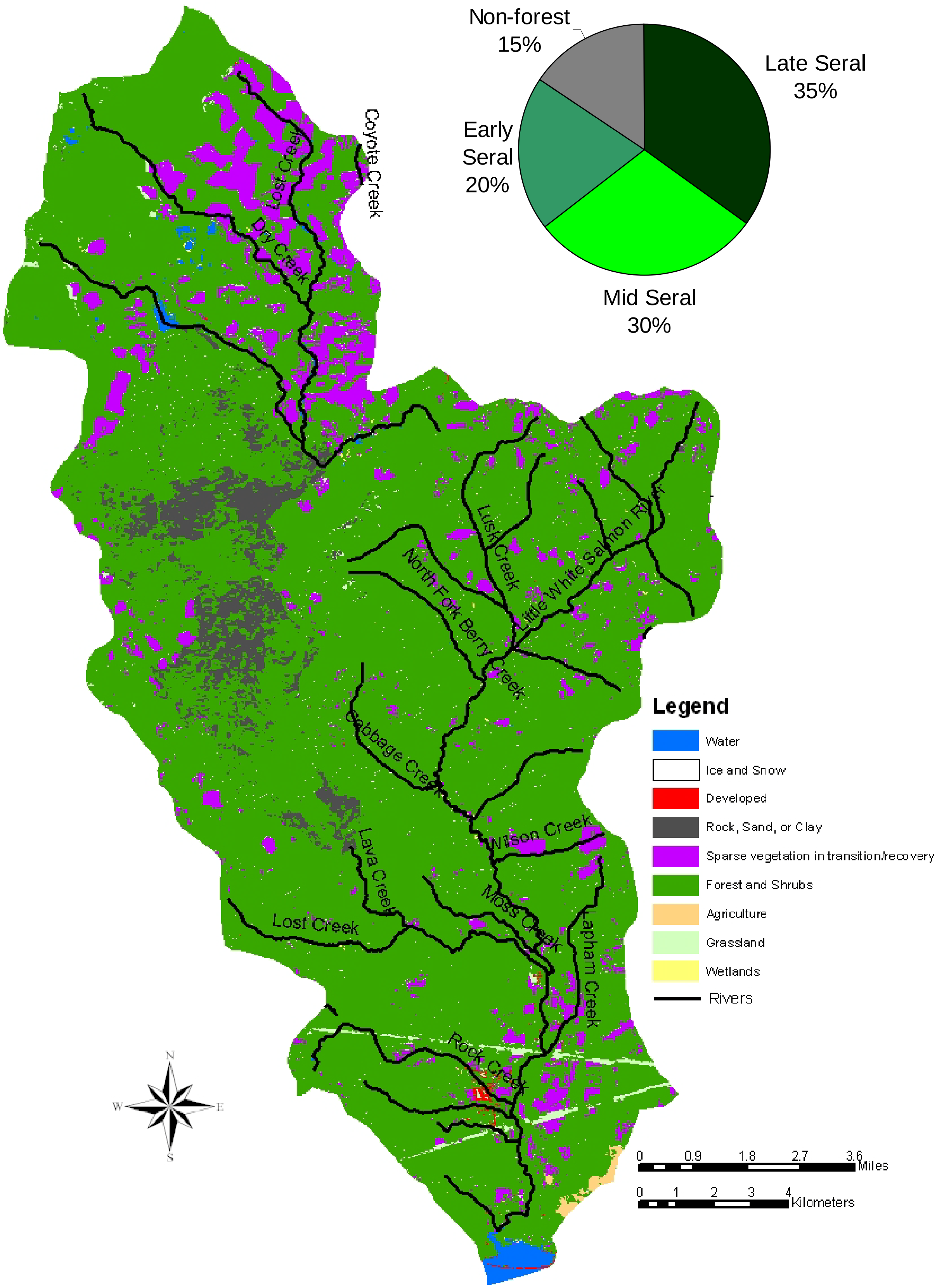


Figure Q-3. Land cover within the Litle White Salmon Subbasin. Vegetation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. (1997). Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

Q.3.2. Focal and Other Species of Interest

Listed salmon are focal species of this planning effort for the Little White Salmon River Subbasin. Other species of interest were also identified as appropriate. Species were selected because they are listed 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 significant within the Little White Salmon River basin. The lower reach of the river has neen inundated by Bonneville Reservoir, eliminating most of the chum and fall Chinook habitat, and salmon are effected by passage obstacles at Bonneville Dam. Little White Salmon River anadromous species are also subject to hydro operation effects in the Columbia River, estuary, and nearshore ocean. The Little White Salmon 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 Little White Salmon River watersheds include fall and spring Chinook and coho. When considering biological objectives for recovery, the fall Chinook are combined with Wind River fall Chinook to form the Upper Gorge fall Chinook population, and the coho are combined with the Wind and Upper Gorge Tributarties population to form the Upper Gorge coho population. Bull trout do not occur in the subbasin however individual Bull Trout (likely from the Hood River Basin) have been observed in Drano Lake on occasion. Salmon numbers have declined to only a fraction of historical levels (Table Q-1). Extinction risks are significant for the focal species – the current health or viability is very low for all species.

Brief summaries of the population characteristics and status follow. There was not enough information on chum in the Little White Salmon to develop a population summary. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

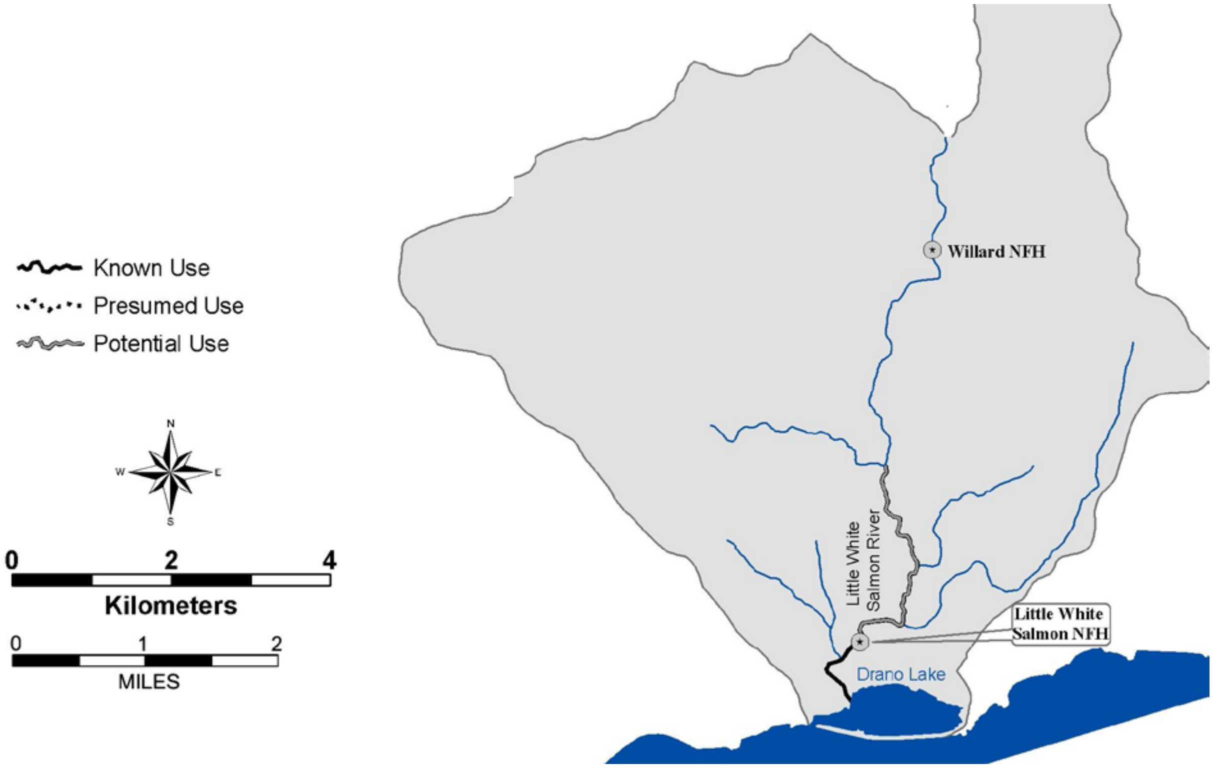
Table Q-1. Status and goals of focal salmon and steelhead populations in the Little White Salmon River (Upper Gorge population).

Species	Population	Recovery priority[1]	Viability Status[2]	Viability Obj.[3]	Improve-ment[4]	Abundance Historic[5]	Abundance Current[6]	Abundance Target[7]
Fall Chinook (Tule)	Upper Gorge	Contributing	VL	M	>500%	n/a[8]	<50	1,200
Chum	Upper Gorge	Contributing	VL	M	>500%	11,000	<50	900
Winter Steelhead	Upper Gorge	Stabilizing	L	L	0%	n/a[8]	200	200
Summer Steelhead	Wind	Primary	H	VH	0%[9]	n/a[8]	1,000	1,000
Coho	Upper Gorge	Primary	VL	H	400%	n/a[8]	<50	1,900

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

Spring Chinook—Little White Salmon Subbasin

ESA: Threatened 1999 **SASSI: NA**



Distribution

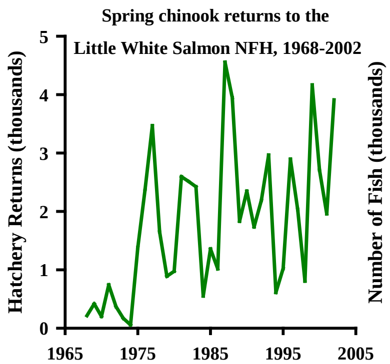
- Historically, few spring Chinook were found in the Little White Salmon River basin; spring Chinook were limited to the lower river below a barrier falls at about RM 2
- Completion of Bonneville Dam (1938) inundated the primary spring Chinook spawning areas in the lower river

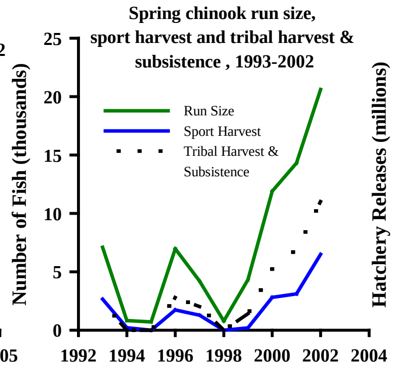
Life History

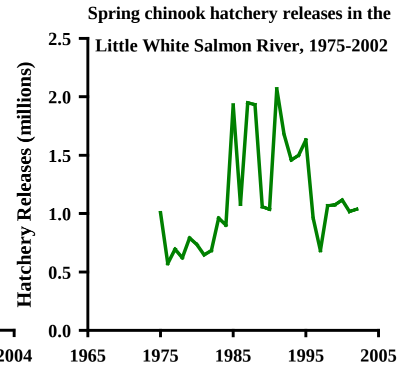
- Spring Chinook return to the Little White Salmon River from April through July; spring Chinook counts peak at Bonneville Dam in late April
- Natural spawning in the Little White Salmon River is Limited to a small area immediately below the salmon hatchery; spawning at the Little White Salmon Hatchery occurs in July and August
- Age ranges from 3 year old jacks to 6 year old adults, with 4 and 5 year olds usually the dominant age class (averages are 72.0% and 21.9%, respectively)
- No natural fry emergence data are available

Diversity

- One of four spring Chinook populations in the Columbia River Evolutionarily Significant Unit (ESU)
- Spring Chinook in the Little White Salmon River basin are hatchery fish of mixed origin







Abundance

- Chinook were reported in the Little White Salmon River during escapement surveys in 1936
- Hatchery production accounts for all spring Chinook returning to the Little White Salmon River; from 1970-2002, spring Chinook total returns ranged from 58 in 1974 to 20,601 in 2002

Productivity & Persistence

- Smolt density model predicted natural production potential for the Little White Salmon River was 32,350 smolts
- Juvenile production from natural spawning is presumed to be low; the run is not considered to be self-sustaining
- Baseline risk assessment determined a high to very high risk of extinction for spring Chinook in the White Salmon subbasin

Hatchery

- The Little White Salmon (RM 1) and the Willard National Fish Hatcheries (RM 5) are located in the basin; spring Chinook releases began in the 1960s
- Current spring Chinook releases into the Little White Salmon River are just over 1 million smolts annually

Harvest

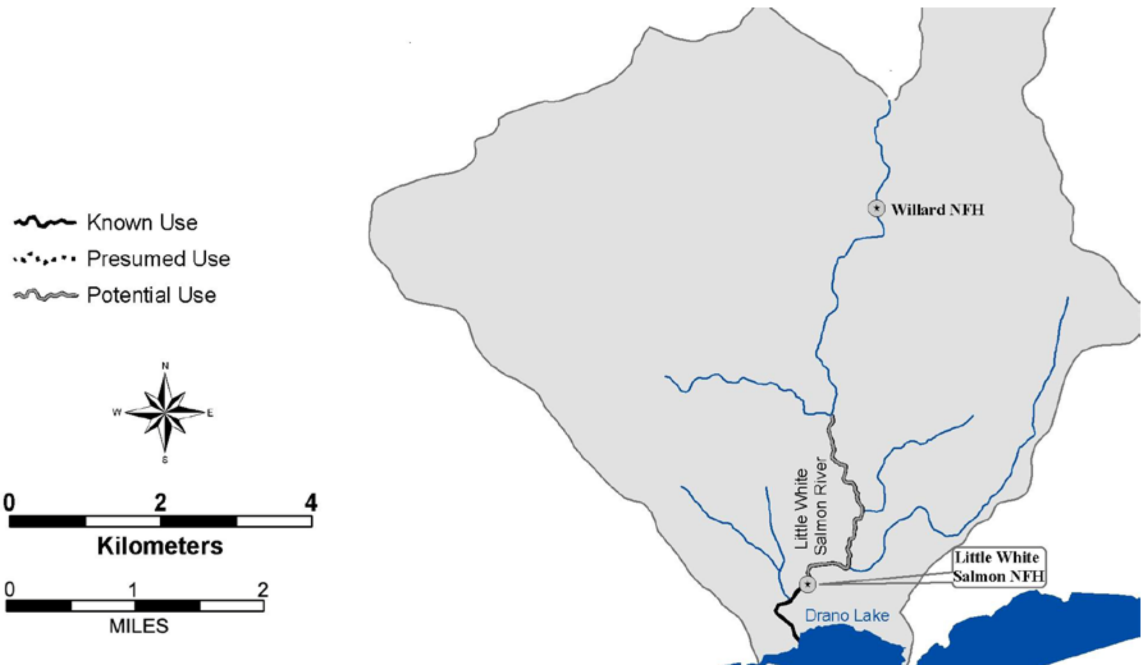
- Spring Chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial and sport fisheries
- CWT analysis indicated that upriver spring Chinook are impacted less by ocean fisheries than lower Columbia River Chinook stocks
- From 1938-1973, about 55% of upriver spring Chinook runs were harvested in directed Columbia River commercial and sport fisheries; from 1975-2000 (excluding 1977), no lower river fisheries have targeted upriver stocks and the combined Indian and non-Indian harvest rate was limited to 11% or less
- Beginning in 2001, selective fisheries and abundance based management agreement through U.S. v. Oregon, has enabled an increase in Columbia harvest of hatchery spring Chinook
- WDF and the Yakama Indian Nation negotiate an annual harvest plan for sharing the Little White Salmon Hatchery surplus between the sport fishery and tribal commercial and subsistence fisheries in Drano Lake

- Sport harvest in Drano Lake from 1993-2002 averaged 1,847, with a record 6,495 harvested in 2002
- Tribal harvest and hatchery subsistence distributions have averaged 3,175 during 1993-2002

Fall Chinook—Little White Salmon Subbasin

ESA: Threatened 1999	SASSI: NA

The historical Little White Salmon adult tule fall Chinook population is estimated from 4,000-5,000 fish. Current natural spawning returns are 100-200 fish. The Little White Salmon Hatchery produces URB fall Chinook which are not part of the lower Columbia ESU. Fall Chinook spawning occurs in a ¼ mile stretch of river downstream from the Little White Salmon Hatchery and upstream of Drano Lake. Tule fall Chinook Spawning occurs from mid-September to mid-October. The URB fall Chinook spawn from late October through November. Juvenile rearing occurs near and downstream of the spawning areas. Juveniles migrate from the Bonneville tributaries in the spring and early summer of their first year.

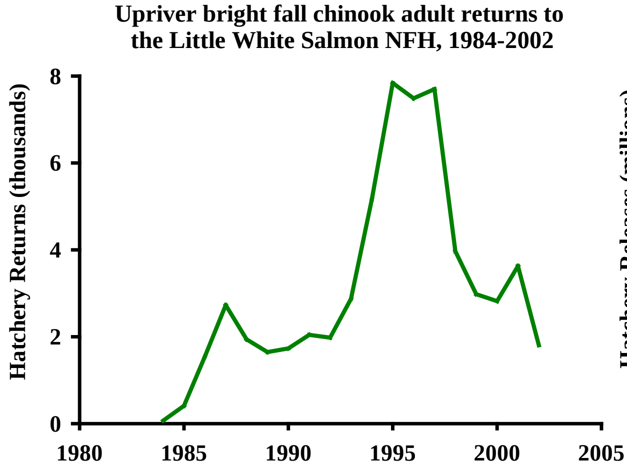


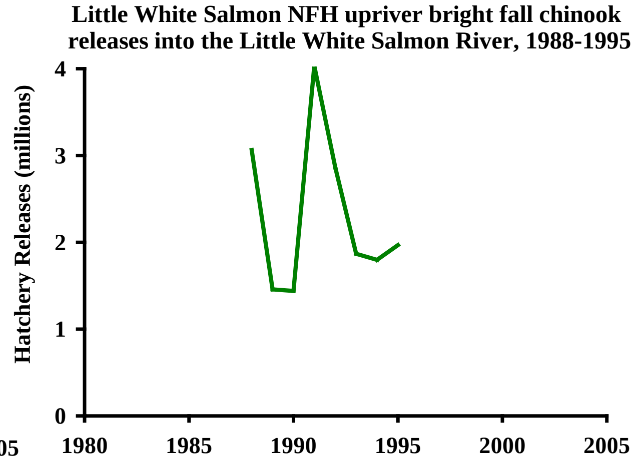
Distribution

- Historically, fall Chinook were limited to the lower river below a barrier falls at about RM 2; currently, very limited natural production occurs in this area
- Completion of Bonneville Dam (1938) inundated the primary fall Chinook spawning areas in the lower river

Life History

- Mid Columbia bright fall Chinook upstream migration in the Columbia River occurs from August to October; peak counts at Bonneville Dam occur around September 4-9
- Spawning of bright fall Chinook at the Little White Salmon National Fish Hatchery occurs in November; natural spawning timing in the Little White Salmon River occurs in late October and November
- Historically, the Little White Salmon fall Chinook population was earlier spawning tule stock and was substantial, but the population has not persisted
- Age ranges from 2-year-old jacks to 5-year-old adults, with dominant adult ages of 3 and 4 (averages are 46.1% and 46.1%, respectively)
- Emergence and emigration timing of naturally produced fry is unknown; hatchery fry emerge in March; emigration timing is based on hatchery release timing





Diversity

- Considered an upriver bright stock in the lower Columbia River ESU
- Current bright fall Chinook production is a result of hatchery strays

Abundance

- Fall Chinook eggs taken from the Little White Salmon River between 1897 and 1920 (as high as 40 million) indicate a very large historical abundance of naturally produced early spawning tule fall Chinook
- In the late 1930s, fall Chinook were reported in the Little White Salmon River during escapement surveys
- Fall Chinook returns to the Little White Salmon NFH ranged from 238-2,653 from 1979-83 (average 981)

Productivity & Persistence

- A smolt capacity model estimated that 73,652 fall Chinook fingerlings could be produced in the Little White Salmon River basin
- The White Salmon River tule fall Chinook stock is currently produced at Spring Creek NFH
- Baseline risk assessment determined a high to very high risk of extinction for fall Chinook in the White Salmon subbasin

Hatchery

- The Little White Salmon (RM 1) and the Willard National Fish Hatcheries (RM 5) are located in the basin; hatchery production began in 1896
- Annual hatchery egg take of fall Chinook during 1897-1920 were typically 10-30 million and as high as 40 million
- Hatchery production shifted from tules to upriver bright (URB) late fall Chinook as part of the John Day Dam mitigation and a U.S. v. Oregon Agreement in 1988
- The current Little White Salmon Hatchery fall Chinook program includes 3.7 million URB fall Chinook, with 2.0 million released into the Little White Salmon River and the remainder transferred to the Yakima River as part of John Day Dam mitigation

Harvest

- Fall Chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial gill net and sport fisheries
- URB fall Chinook migrate farther North in the ocean than lower Columbia Chinook, with most ocean harvest occurring in Alaska and Canada
- URB fall Chinook are also an important sport fish in the mainstem Columbia from the mouth upstream to the Hanford Reach, and an important commercial fish from August-early October
- Fall Chinook originating upstream of Bonneville Dam are subject to Federal Court Agreements regarding Indian and non-Indian harvest sharing
- CWT data analysis of the 1989-1994 brood years suggests that the majority of the URB fall Chinook harvest occurred in Alaska (24%), British Columbia (23%), and mainstem Columbia River (42%) fisheries
- Columbia River harvest of URB fall Chinook is limited to 31.29% (23.04% Indian/ 8.25% non-Indian) based on by ESA limits for Snake River wild Chinook
- Fall Chinook that pass Bonneville Dam are also harvested in Treaty Indian commercial and subsistence fisheries in August and September
- Sport harvest in the Little White Salmon River averaged 45 fall Chinook annually from 1985-1987

Q.3.3. Focal Wildlife Species

A complete list of wildlife species potentially occurring within the Little White Salmon River subbasin has been compiled by the Northwest Habitat Institute (NHI) and is available on their Interactive Biodiversity Information System (IBIS) website (www.nwhi.org/ibis/home/ibis.asp). Of those species potentially occurring within the Little White Salmon River subbasin, many are considered species of concern by the State of Washington (Table Q-2).

A subset of these species of concern are considered focal species because of their special ecological, cultural, or legal status. A total of one mammal, two bird, two amphibian, and one reptile species were chosen as focal or indicator species that represent the various wildlife habitats in the Little White Salmon River subbasin (Table Q-4).

Additionally, some wildife species in the Little White Salmon River subbasin are of interest because of their ecological, cultural, or legal status (Table Q-3). Wildlife species of interest differ from focal species in that management of these species and their habitats may not be a significant part of future subbasin planning efforts. In the case of the fisher and the Oregon spotted frog, there is uncertainty regarding their current statewide distribution; presence in the Little White Salmon River has not been confirmed. Considering the unknown presence and habitat association of fishers and Oregon spotted frogs in the Little White Salmon River, it is difficult to develop management actions to benefit either species. Either of these species may become an important part of future subbasin management if presence and habitat association in the Little White Salmon River subbasin are confirmed. In the case of bald eagle, the statewide population has increased in abundance and productivity; WDFW supports downgrading the eagle’s legal status. Thus, management of eagles and their associated habitat will not likely be part of future subbasin planning.

Table Q-2. Federal and state legal status of Washington species of concern that are potentially found in the Little White Salmon River subbasin.

Common Name	Scientific Name	Federal Status	State Status
MAMMALS			
Fisher	*Martes pennanti*	FCo	SE
Townsend's Big-Eared Bat	*Coryhorhinus townsendii*	FCo	SC
Western Gray Squirrel	*Sciurus griseus*	FCo	ST
Wolverine	*Gulo gulo*	FCo	SC
Yuma Myotis	*Myotis yumanensis*	FCo	none
BIRDS			
Bald Eagle	*Haliaeetus leucocephalus*	FT	ST
Black-Backed Woodpecker	*Picoides arcticus*	none	SC
Flammulated Owl	*Otus flammeolus*	none	SC
Golden Eagle	*Aquila chrysaetos*	none	SC
Harlequin Duck	*Histrionicus histrionicus*	FCo	None
Lewis' Woodpecker	*Melanerpes lewis*	none	SC
Northern Goshawk	*Accipiter gentilis*	FCo	SC
Olive-Sided Flycatcher	*Contopus borealis*	FCo	None
Pileated Woodpecker	*Dryocopus pileatus*	none	SC
Purple Martin	*Progne subis*	none	SC
Spotted Owl	*Strix occidentalis*	FT	SE
Vaux's Swift	*Chaetura vauxi*	none	SC
White-headed Woodpecker	*Picoides albolarvatus*	none	SC
Willow Flycatcher	*Empidonax traillii*	FCo	None
AMPHIBIANS			
Cascade Torrent Salamander	*Rhyacotriton cascadae*	none	SC
Larch Mountain Salamander	*Plethodon larselli*	FCo	SS
Oregon Spotted Frog	*Rana pretiosa*	FC	SE
Red-Legged Frog	*Rana aurora*	FCo	None
Van Dyke's Salamander	*Plethodon vandykei*	FCo	SC
Western Toad	*Bufo boreas*	FCo	SC
REPTILES			
California Mountain Kingsnake	*Lampropeltis zonata*	none	SC
Sagebrush Lizard	*Sceloporus graciosus*	FCo	SC
Sharptail Snake	*Contia tenuis*	none	SC
Striped Whipsnake	*Masticophis taeniatus*	none	SC
Western Pond Turtle	*Clemmys marmorata*	FCo	SE

Status codes are defined as follows: FT=Federal threatened, FC=Federal candidate, FCo=Federal Species of Concern, SE=State endangered, ST=State threatened, SC=State candidate, SS=State sensitive.

Table Q-3 Wildlife species of interest in the Little White Salmon River subbasin.

Common Name	Habitat Association	Priority Habitat Species	Status	
			Federal	State
Fisher	Mixed Conifer-Hardwood Forests	Yes	FCo	SE
Bald Eagle	Mature Forests in proximity to Open	Yes	FT	ST

	Water			
Oregon Spotted Frog	Open Water associated with Mixed Conifer-Hardwood Forests	Yes	FC	SE

Status codes are defined as follows: FT=Federal threatened, FC=Federal candidate, FCo=Federal Species of Concern, SE=State endangered, ST=State threatened.

Table Q-4. Focal or indicator wildlife species in the Little White Salmon River subbasin.

Common Name	Habitat Association	Priority Habitat Species	Status	
			Federal	State
Western Gray Squirrel	Mixed Conifer Forests (near Oak Woodlands)	Yes	FCo	ST
Yellow Warbler	Riparian areas with deciduous shrubs	No	-	-
Pileated Woodpecker	Mature stands of hardwood, conifer, or mixed forests	Yes	-	SC
Western Pond Turtle	Open Water associated with Mixed Conifer-Hardwood Forests	Yes	FCo	SE
Larch Mountain Salamander	Mixed Conifer-Hardwood Forests with talus slopes	Yes	FCo	SS

Status codes are defined as follows: FCo=Federal Species of Concern, SE=State endangered, ST=State threatened, SS=State sensitive, SC=State candidate.

Western Gray Squirrel

The western gray squirrel (*Sciurus griseus*) is a Washington state threatened species and a Federal species of concern (Table Q-2). Although the western gray squirrel was once abundant and widespread throughout oak-conifer forests, its range in Washington State has contracted to three disjunct populations (Figure Q-4). In the Little White Salmon River subbasin, little is known about historical populations of western gray squirrels. Population loss and fragmentation most likely occurred in the lower drainage because of habitat loss and degradation. Competition from the introduced eastern grey squirrel may also be an issue in the Little White Salmon River subbasin. The western gray squirrel is heavily associated with both ponderosa pine and Oregon white oak forests in the remainder of its range in the Columbia River Gorge. These forests follow stream drainages northward toward Goldendale and into Yakima County (Franklin and Dyrness 1973). A 1993 unpublished status review by the Washington Department of Wildlife (currently WDFW) found that the species was “in danger of extirpation from most of its range in Washington” (WDW 1993).

Western gray squirrels prefer habitat with the following characteristics (Foster 1992): contiguous canopy cover (mean = 60%); nest tree age (69-275 yr, mean = 108 yr); diameter at breast height (21-58 cm, mean = 40 cm); within 180 m (600 ft) of water; adequate food sources (acorns important in winter and early spring while pine cones and seeds in late summer and fall); and adequate habitat within home range (in Klickitat County 95% home ranges from 10-187 ha (mean 73 ha) for males and 3-44 ha (mean 21 ha) for females (Linders 2000)).

Western gray squirrels need a variety of mast-producing trees for food, cover and nesting sites (WDW 1993). The quality of the habitat is influenced by the number of mast-bearing tree species in and near the nest tree sites, the age and size of the trees, and proximity to permanent water (Cross 1969, Gilman 1986, Foster 1992). The western gray squirrel is usually associated with mature forests (Table Q-5), which provide the above-mentioned characteristics (WDW 1993). Generally, the squirrels require trees of sufficient size to produce an interconnected canopy for arboreal travel (Foster 1992). Barnum (1975) observed no use of a lone pine tree that was full of green cones, conceivably because there was no travel cover available.

Since extinction or extirpation rates are partly area-dependent, the size of reserves, spacing of reserves, and location of dispersal corridors are important. Individual reserves must be large enough to ensure stability of the ecosystem and to provide a buffer from disturbance (Frankel and Soulé 1981). The western gray squirrel was probably more widely distributed in prehistoric times and has diminished recently along with the oak woodlands (Rodrick 1986). Presently, both the oak and the squirrel are at the northern extent of their ranges and are subject to increased pressure from a variety of environmental factors.

Most squirrels build round stick nests, approximately 60 cm (2 ft) in diameter, in pole to sawtimber-sized conifers, about one third of distance from the top of the tree and next to the trunk. The nests are lined with lichen, moss, and bark shavings (WDW 1993).

In a 2003 Status Review and 12-month finding for a petition to list the Washington population of the western gray squirrel (68 FR 34682), the USFWS concluded that listing was not warranted because the Washington population of western gray squirrels is not a distinct population segment and, therefore, not a listable entity. The Washington populations are discrete from the Oregon and California populations and are declining, but they are not "significant to the remainder of the taxon". The U.S. Forest Service considers the squirrel to be a sensitive species, and uses it as an oak-pine community management indicator species in the Columbia River Gorge National Scenic Area.

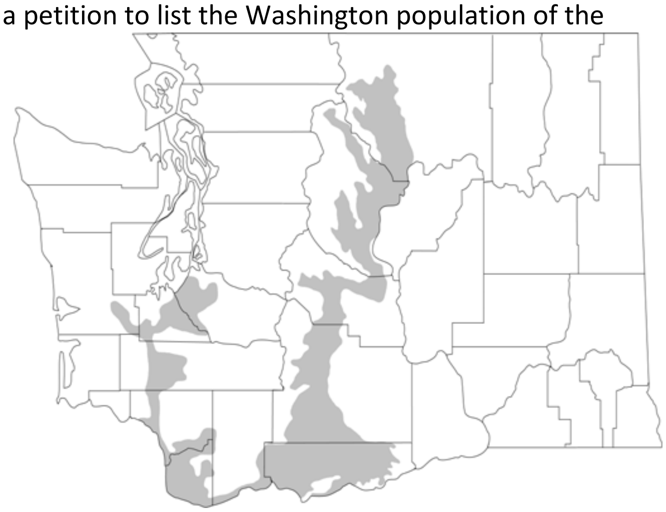


Figure Q-4. Historical distribution of western gray squirrels in Washington (adapted from Booth 1947, Ingles 1947, Source: WDFW 2004).

Persistence of this species in the state of Washington will likely depend on state-level protections of oak-conifer habitats and voluntary efforts by landowners federal entities. The WDFW completed a recovery plan in November 2007. Anecdotal evidence suggests there was essentially no acorn crop in the Columbia Gorge in 1991, and an insignificant crop in 1992 (from WDW 1993), indicating that weather cycles associated with mast failures also may cause cyclical declines in squirrel populations.

Table Q-5. Western gray squirrel association with wildlife habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Present	Feeds and Breeds	High	Uses this habitat where adjacent to Westside Oak and Dry Douglas-fir habitat.
Ponderosa Pine & Interior White Oak Forest and Woodlands	Closely Associated	Feeds and Breeds	Moderate	Requires an oak component.

Yellow Warbler

The yellow warbler (*Dendroica petechi*a) is a long-distance neotropical migrant; spring migrants begin to arrive in the Pacific Northwest region in April but the peak of spring migration in the region is in late May (Gilligan et al. 1994). Southward migration begins in late July, and peaks in late August to early September; very few migrants remain in the region in October (Lowther et al. 1999). Western populations overwinter primarily in Mexico and northern Central America. The yellow warbler is strongly associated with riparian and wet, deciduous habitats throughout its North American range. It is positively associated with sub-canopy/shrub habitats in riparian areas, making it a good species index of this habitat (Altman 2001; Sauer *et al*. 2003).

The habitat requirements of neotropical migrants are extremely diverse. Within a single species, the habitat and food preferences on breeding grounds, is often different than wintering areas (Petit et al. 1990). The yellow warbler is a common breeder in riparian habitats with hardwood trees throughout the state, generally found at lower elevations. Associated with riparian habitats, they prefer the presence of nearby water. Their habitat suitability index strongly associates them with a dense deciduous shrub layer 1.5-4 m. (5-13.3 feet), with edge, and small patch size (heterogeneity). Other suitability index associations include % of deciduous shrub canopy comprised of hydrophytic shrubs (wetlands dominated by shrubs had the highest average of breeding densities of 2males/ha) and deciduous tree basal area (abundance is positively associated). Negative associations are closed canopy and cottonwood proximity. Some nests have been found in cottonwood, but more often in shrubs with an average nest height of 0.9-2.4 m., maximum being 9-12 m. (Schroeder 1982).

Partners in Flight have established biological objectives for this species in the lowlands of western Oregon and western Washington. These include providing habitats that meet the following definition: >70% cover in shrub layer (<3 m) and subcanopy layer (>3 m and below the canopy foliage) with subcanopy layer contributing >40% of the total; shrub layer cover 30-60% (includes shrubs and small saplings); and a shrub layer height >2 m. At the landscape level, the biological objectives for habitat included high degree of deciduous riparian heterogeneity within or among wetland, shrub, and woodland patches; and a low percentage of agricultural land use (Altman 2001).

Little is known about yellow warbler breeding behavior in Washington, although substantial information is available from other parts of its range. Yellow warblers have developed effective responses to nest parasitism

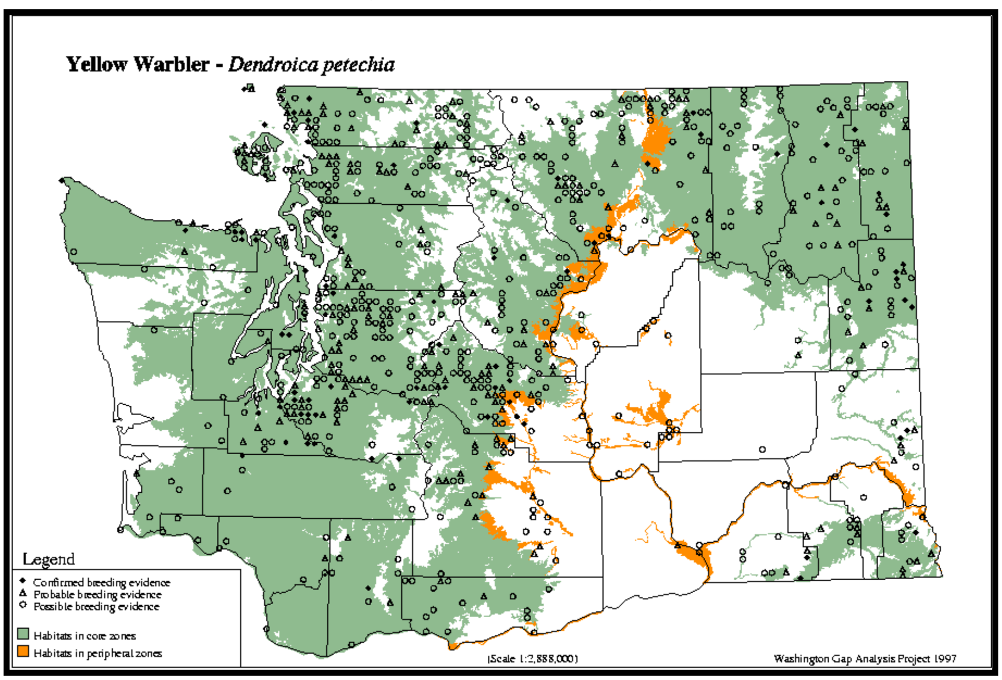


Figure Q-5. Breeding bird atlas data (1987–95) and species distribution for yellow warbler in Washington.

by the brown-headed cowbird (*Molothrus ater*). The brown-headed cowbird is an obligate nest brood parasite that does not build a nest and instead lays eggs in the nests of other species. When cowbird eggs are recognized in the nest the yellow warbler female will often build a new nest directly on top of the original. In some cases, particularly early in the incubation phase, the female yellow warbler will bury the cowbird egg within the nest. Some nests are completely abandoned after a cowbird egg is laid (Lowther *et al.* 1999). Up to 40% of yellow warbler nests in some studies have been parasitized (Lowther *et al.* 1999).

Pair formation and nest construction may begin within a few days of arrival at the breeding site (Loather et al. 1999). Egg dates have been reported from British Columbia, and range between 10 May and 16 August; the peak period of activity there was between 7 and 23 June (Campbell et al. 2001). The incubation period is about 11 days and young fledge 8-10 days after hatching. The young often associate with their parents for up to 3 weeks following fledging (Lowther et al. 1999). Yellow warblers typically lay only one clutch with 4 or 5 eggs. Re-nesting may occur, however, following nest failure or nest parasitism by Brown-headed Cowbirds (Sibley 2001; Lowther et al. 1999).

Yellow warblers capture and consume a variety of insect species and occasionally wild berries, especially when migrating. Food is generally obtained by gleaning from sub-canopy vegetation, although the species also sallies and hovers to a much lesser extent (Lowther *et al*. 1999; Sibley 2001).

They are primarily insectivores on their breeding grounds, and this enables them to take advantage of the high insect productivity that occurs in riparian areas. Generally, there is a positive relationship in, the greater the structural layering and complexity of the habitat, the greater the insect productivity, and the greater the diversity of bird species. Many studies have reported higher species richness, abundance, or diversity in riparian zones than adjacent habitats, particularly at lower elevations (Stauffer and Best 1980; Sibley 2001).

Washington breeders represent the western subspecies *D. p. morcomi* (AOU 1998). Little is known about population size, although it is locally common where habitat exists. It is one of two widespread species in the Wood-warbler family exhibiting vast geographic variation, each species containing 10 or more sub-species occurring north of Mexico. Browning (1994) recognized 43 subspecies of the yellow warbler; two of these are known to occur in Washington. One of them, *Dendroica petechia brewsteri*, is found in western Washington (Sibley 2000).

Little is known about the size of the breeding population in Washington State. Locally common where riparian and wet, deciduous habitat exists, the yellow warbler can be found in the riparian areas along the Columbia River, and most riverine systems. See Figure Q-5 for Washington breeding distribution of yellow warbler from 1987-1995.

Loss of riparian and riparian-marsh habitat for these birds resulted from the inundation and alteration of habitats in the Little White Salmon River Subbasin and in the mainstem of the Columbia River.

Pileated Woodpecker

Pileated woodpeckers are the largest woodpeckers in North America (i.e. crow-sized). Any forest type (broadleaved, coniferous, or mixed) can sustain pileated woodpeckers as long as there are trees large enough for roosting and nesting. Pileated woodpeckers are often associated with mature and old-growth forests but can breed in younger forests if they contain some large trees. In western Washington, they typically roost in western hemlock and western red cedar. Although generally resident, pileated woodpeckers sometimes wander from their breeding areas and many move down-slope or into streamside forests or suburban areas in winter.

These powerful woodpeckers chip out characteristic oval or rectangular excavations in the trees in which they forage. Their drumming can be heard for long distances, as can their loud "laughing" call. They roost in hollow trees with multiple entrance holes.

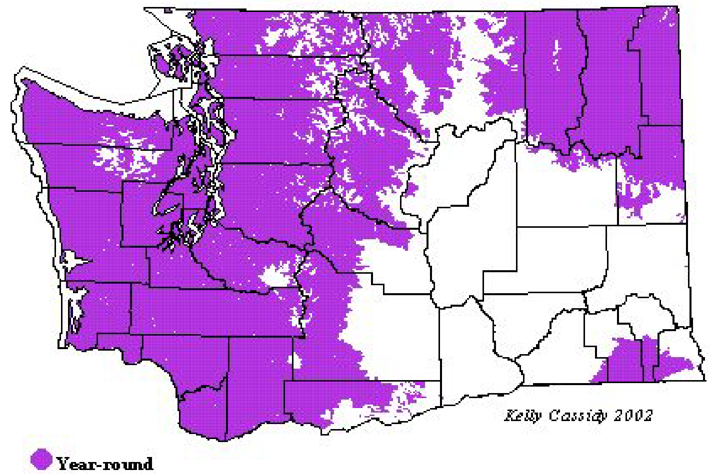


Figure Q-6. Distribution of pileated woodpeckers in Washington.

Long-term monogamous pairs stay together on territories year round. Both members of the pair excavate a new nest cavity in a dead tree or branch every year. The excavation can take the pair up to six weeks to complete. The nest is lined only with woodchips from the excavation. Both sexes typically incubate the 3 to 5 eggs for about 18 days and brood the young for the first 7 to 10 days after they hatch. Both regurgitate food for the young, which leave the nest after 24 to 28 days but may stay with the parents for another 2 to 3 months while they learn to forage. Pileated woodpeckers eat wood-boring insects and insects that nest in trees, including long-horned beetles and especially carpenter ants. They eat some fruits and nuts as well.

Pileated woodpeckers play an important role within their ecosystems by excavating nesting and roosting cavities that are subsequently used by many other birds and by many small mammals, reptiles, amphibians, and invertebrates. Shooting for sport and food was formerly a significant source of mortality. Although shooting pileated woodpeckers is now illegal, the practice may continue in some places but probably not enough to significantly affect the population. Clear-cutting of old-growth and other forests currently has the most significant impact on pileated woodpecker habitat, but pileated woodpeckers are fairly adaptable, which offsets some of the impact from habitat loss. They are, however, currently candidates for endangered species listing by the Washington Department of Fish and Wildlife.

Table Q-6. Pileated woodpecker association with wildlife habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Generally Associated	Feeds and Breeds	High	none
Montane Mixed Conifer Forest	Generally Associated	Feeds and Breeds	Moderate	none
Interior Mixed Conifer Forest	Generally Associated	Feeds and Breeds	High	none
Lodgepole Pine Forest and Woodlands	Present	Feeds	Low	none
Ponderosa Pine & Interior White Oak Forest and Woodlands	Generally Associated	Feeds and Breeds	Moderate	none
Montane Coniferous Wetlands	Generally Associated	Feeds and Breeds	Moderate	none

Band-tailed Pigeon

Band-tailed pigeons (*Columba fasciata*) are primarily restricted to coniferous forest zones in mountainous areas of western North America (Jarvis and Passmore 1992); the Pacific Coast race (*Columba fasciata monilis*) breeds west of the Cascade and Sierra Nevada crests up to 4,200 m (13,800 ft) elevation (Pacific Flyway Council 1983). The band-tailed pigeon breeds throughout much of Western Washington (Figure Q-7).

During the breeding season (April - September), most of the population is found below 305 m (1,000 ft) elevation (Jeffrey 1989). In late summer, band-tailed pigeons may move to higher elevations. By late September, most band-tailed pigeons leave Washington and migrate to their wintering grounds.

In Washington, band-tailed pigeons are associated with Douglas-fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), western hemlock (*Tsuga heterophylla*), red cedar (*Thuja plicata*), bigleaf maple (*Acer macrophyllum*), sitka spruce (*Picea sitchensis*), willow (*Salix* spp.), pine (*Pinus* spp.), cottonwood (*Populus* spp.), and Garry oak (*Quercus garryana*) (Jeffrey 1989, Braun 1994). Berry- and nut-producing trees and shrubs are also common in their range (Keppie and Braun 2000). Nests are placed in conifers or broad-leafed trees, typically 4.5-12.0 m (15-40 ft) above the ground. Nests may be distributed in small groups or well-dispersed (Jeffrey 1977, Curtis and Braun 1983).

Band-tailed pigeons have specific habitat requirements for reproduction. The band-tailed pigeon requires mineral springs as a source of calcium for egg-laying and the production of crop-milk for its young (March and Sadleir 1975, Jarvis and Passmore 1992, Braun 1994). The proximity of these mineral springs to suitable foraging habitats is an important factor for band-tailed pigeons (Jarvis and Passmore 1992). Pigeons have been documented returning to mineral springs in subsequent years (Jarvis and Passmore 1977, 1992).

Band-tailed pigeons are listed as a State and Federal Game species. The hunting season in Washington underwent an emergency closure in 1991 due to a rapid decline in the population as determined from pigeon surveys (Braun 1994). Breeding Bird Survey data indicated the population of band-tailed pigeons in Washington declined significantly from 1968 to 1993 (Braun 1994, Keppie and Braun 2000). However, more recent data showed increases in population that allowed the reinstatement of a limited hunting season in 2002, after a 10-year restriction on hunting (WDFW 2001, 2002).

A scarcity of mineral sites combined with the alteration of available nesting habitat jeopardizes band-tailed pigeon populations (Braun 1994). Intensive hunting pressure in the past has also been held responsible for declines in the population (Jarvis and Passmore 1992). Land development and forest practices that degrade or destroy mineral springs and nesting habitat limit band-tailed pigeon populations (Pacific Flyway Council 1983). Although undocumented mineral sites likely occur, only a limited number of mineral sites actively used by pigeons are known to exist in western Washington (Gillum 1993). Outbreaks of the protozoan disease Trichomoniasis are suspected in periodic large-scale mortalities of band-tailed pigeons (Keppie and Braun 2000). Trichomoniasis is transmitted through contaminated feed at urban bird feeders.

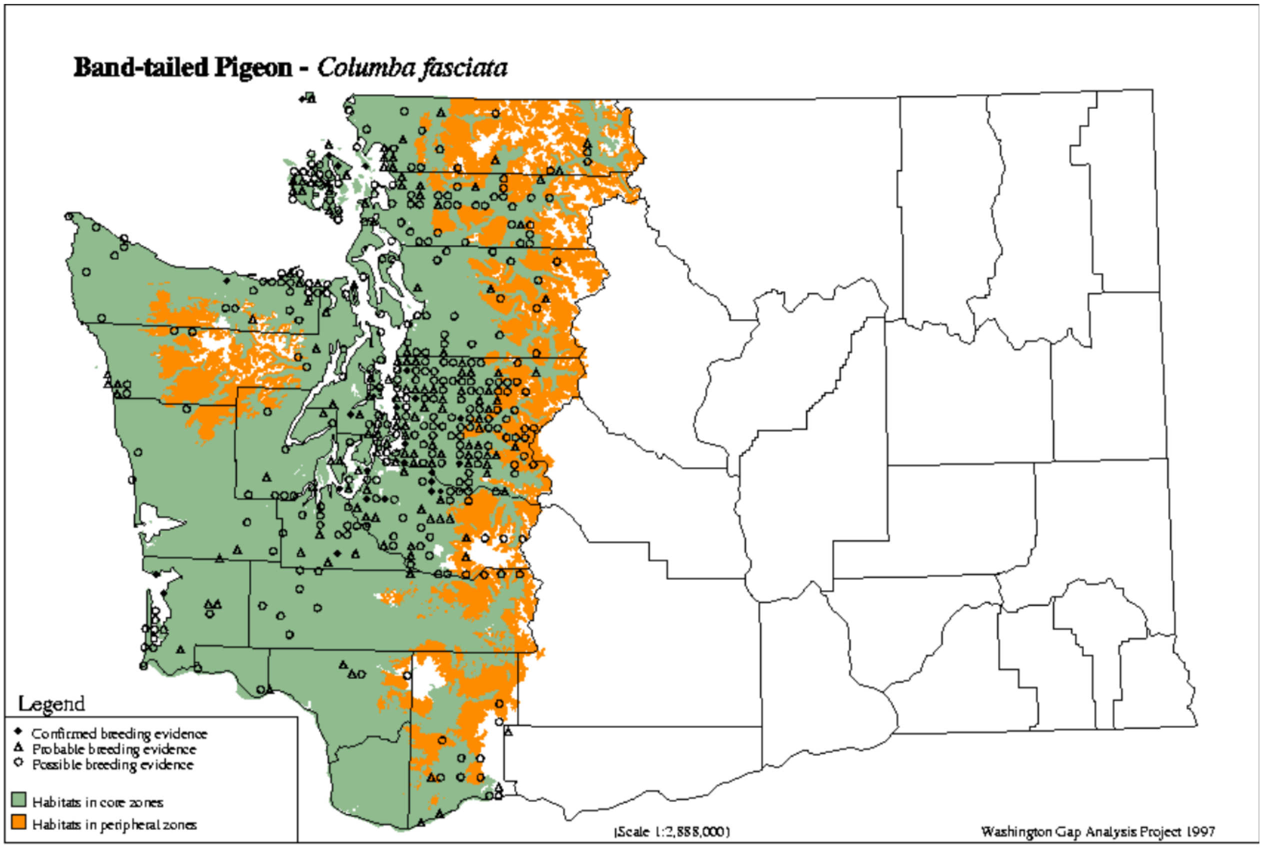


Figure Q-7. Distribution of band-tailed pigeon in Washington.

Table Q-7. Band-tailed pigeon association with wildlife habitats in the Wind River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Closely Associated	Feeds and Breeds	Moderate	none
Montane Mixed Conifer Forest	Generally Associated	Feeds and Breeds	High	none
Interior Mixed Conifer Forest	Present	Feeds	High	none

Western Pond Turtle

The western pond turtle (*Clemmys marmorata*) is listed by Washington State as an endangered species and has been extirpated from most of its range in Washington. Their present range in Washington is thought to be composed of two small populations in Skamania and Klickitat counties, and a small pond complex in Pierce County where they were recently reintroduced from captive bred stock. The species is not listed under the federal Endangered Species Act. It was petitioned in 1992 for federal listing, but the Fish and Wildlife Service found that listing was not warranted in 1993. The species requires a continued recovery program (Hays et al. 1999) to ensure its survival in the state until sources of excessive mortality can be reduced or eliminated.

This highly aquatic turtle occurs in streams, ponds, lakes, and permanent and ephemeral wetlands. Although pond turtles spend much of their lives in water, they require terrestrial habitats for nesting (Table Q-8). They also often overwinter on land, disperse via overland routes, and may spend part of the warmest months in aestivation on land. Pond turtles are generally wary, but they may be seen basking on emergent or floating vegetation, logs, rocks, and occasionally mud or sand banks. In Washington, the species overwinters in mud bottoms of lakes or ponds or in upland habitats adjacent to water bodies. Nesting occurs from May to mid-July in soils with scant vegetative cover. They usually nest within 100 meters of water, but occasionally up to 400 m. Western pond turtles are long-lived, with some reaching an estimated maximum life-span of 50 to 70 years, though most individuals may not live that long. They require more than 10 years to attain sexual maturity.

Table Q-8. Western pond turtle association with wildlifec habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Present	Feeds and Breeds	High	Uses this habitat where it is near marshes, streams, rivers, ponds or lakes. Nests are placed in dry, well-drained soils in open areas with grass and herbaceous vegetation, with trees and shrubs in close proximity. Overwintering sites are characterized as having deep leaf or needle litter and logs and shrubs.
Ponderosa Pine & Interior White Oak Forest and Woodlands	Generally Associated	Feeds and Breeds	High	Uses this habitat where it is near marshes, streams, rivers, ponds or lakes. Nests are placed in dry, well-drained soils in open areas with grass and herbaceous vegetation, with trees and shrubs in close proximity. Overwintering sites are characterized as having deep leaf or needle litter and logs and shrubs.
Open Water - Lakes, Rivers, and Streams	Closely Associated	Feeds	High	none

Table Q-9. Potential relationships between western pond turtle and salmonids (IBIS 2004).

Common Name	Relationship Type	Salmonid Stage	Comments
Western Pond Turtle	Rare	Freshwater rearing - fry, fingerling, and parr	none
Western Pond Turtle	Rare	Carcasses	none

The initial cause of the decline in western pond turtle numbers in Washington may have been commercial exploitation for food. Western pond turtle populations cannot be sustained under exploitation, due to their low rate of recruitment and lower densities at the northern portion of the range. Pond turtles never recovered from this decline, in part, due to concurrent or subsequent alteration and loss of habitat. Wetlands were filled for residential and industrial development, particularly in the Puget Sound region. Dam construction and water diversion projects reduced available habitat and isolated populations. Introduced predators such as bullfrogs and warm-water fish, which were introduced to lakes and ponds, probably took a toll on hatchlings and young turtles. Human disturbance may have kept females from crossing over land to lay eggs, or may have reduced the amount of time spent basking, which in turn, may be important for egg maturation. Loss of lakeside emergent wetland vegetation to grazing and trampling may have made habitat less suitable for hatchlings and juveniles. Successional changes through fire suppression on native grasslands may have resulted in excessive shade on nesting grounds.

Two native populations of the species remain in the Columbia River Gorge (Figure Q-8). The total number of western pond turtles in known Washington populations is estimated at greater than 500 individuals, approximately half of which went through the head-start program at the Woodland Park Zoo. Additional turtles may still occur in wetlands that have not been surveyed in western Washington and the Columbia Gorge. Currently, WDFW is working on Western Pond Turtle recovery in habitat near the mouth of the Klickitat River. The goal of the recovery program is to re-establish self-sustaining populations of western pond turtles in the Columbia Gorge region (Hays et al. 1999). The recovery objectives are to establish at least 5 populations of >200 pond turtles, composed of no more than 70% adults, which occupy habitat that is secure from development or major disturbance. It is also necessary that the populations show evidence of being sustained by natural recruitment of juveniles. The core pond turtle sites should be wetland complexes that may be less susceptible to catastrophes than sites of a single water body. The recovery objectives need to be met before the western pond turtle would be considered for downlisting to threatened. Objectives for downlisting to sensitive are similar, except those 7 populations of >200 pond turtles will be needed.

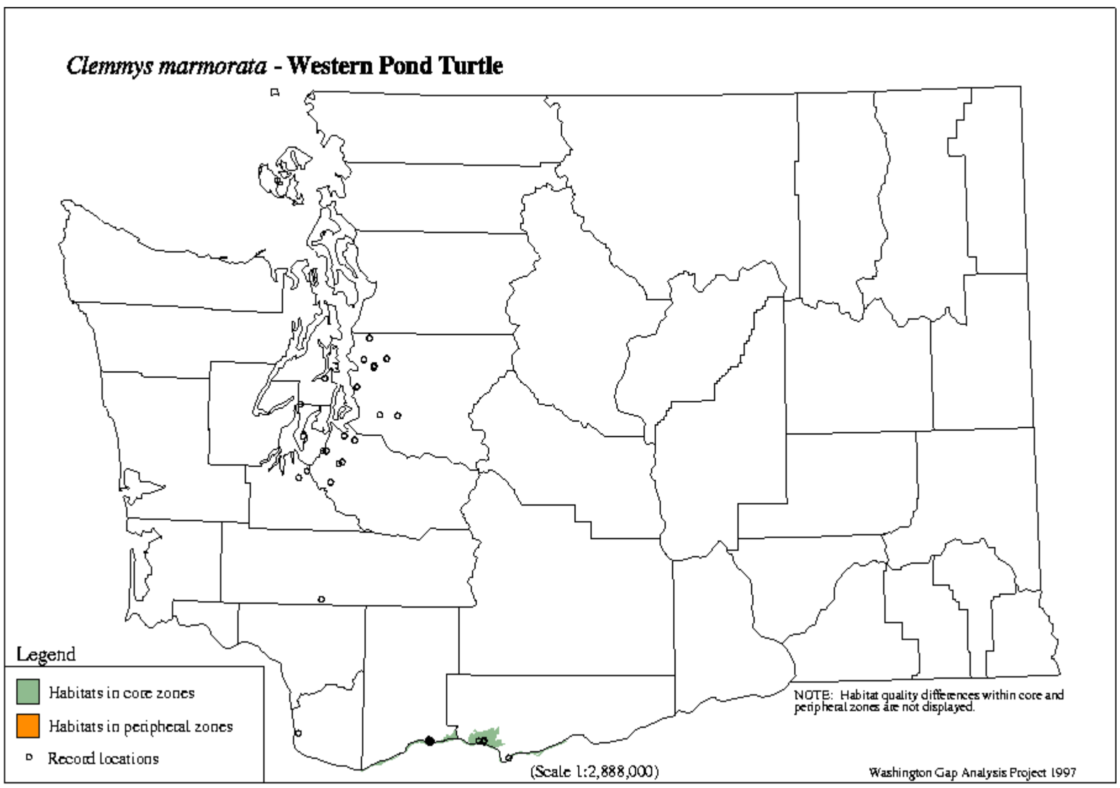


Figure Q-8. Distribution of western pond turtles in Washington.

Larch Mountain Salamander

The Larch Mountain salamander (*Plethodon larselli*) occurs only in Washington and Oregon. Its known distribution includes west-side habitats of the southern Cascades region in Washington and the Columbia Gorge area of Oregon and Washington, including the Little White Salmon River subbasin

(Figure Q-9). The southern edge of its range is roughly defined by the towns of Hood River and Troutdale, Oregon. The northern edge of its range extends into the central Cascade Range of Washington. Isolated populations have been found near Snoqualmie Pass, Washington, and in a lava tube cave in Mount St. Helens National Volcanic Monument ([Nussbaum et al. 1983, Aubry et al. 1987, Leonard et al. 1993, McAllister 1995, Corkran and Thoms 1996] as cited in Larsen 1997).

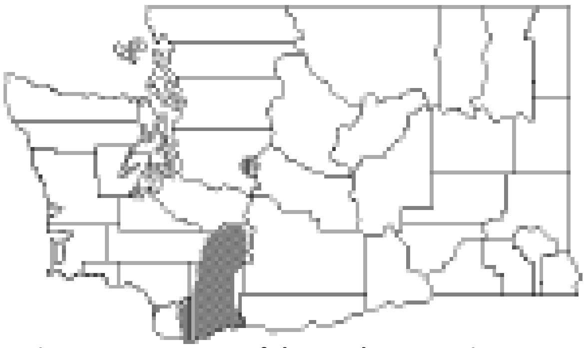


Figure Q-9. Range of the Larch Mountain salamander in Washington.

Larch Mountain salamanders depend on cool, moist environments; they require a suitable combination of slope, rock size, shade, and organic debris. Larch Mountain salamanders are most often associated with steep talus slopes in forested areas but have also been found on steep slopes in old growth forests, under woody debris on the forest floor or in piles of detritus beneath snags (Corkran and Thoms 1996 as cited in Larsen 1997;). They have been described as the most terrestrial of the western *Plethodon* salamanders and are usually found some distance from streams (Brodie 1970 as cited in Larsen 1997). Most talus slopes occupied by Larch Mountain salamanders have an overstory of bigleaf maple (*Acer macrophyllum*), Douglas-fir (*Pseudotsuga menziesii*), and sometimes Oregon ash (*Fraxinus oregona*) ([Larsen and Schaub 1982, Herrington and Larsen 1985] as cited in Larsen 1997). Organic matter has been identified as one of the more important habitat features for sustaining Larch Mountain salamander populations because it supports an invertebrate prey base and maintains moisture within the talus (Larsen 1997). Herrington and Larsen (1985 as cited in Larsen 1997) found that sites with all habitat requirements except organic debris lacked salamanders and over half the Larch Mountain salamander sites they found had substrates that contained less than 10% soil.

Larch Mountain salamanders are generally found within the top 30 cm of moss or detritus covered talus, where rock size is 1-6 cm in diameter, substrate temperatures range between 5°C and 14.5°C (41-58°F), moisture values average between 35 and 64%, and slopes are greater than 30° (Larsen 1997). Increased temperatures and reduced moisture during the summer months may cause the salamanders to nestle deeper into the talus (Herrington and Larsen 1985 as cited in Larsen 1997).

Populations of Larch Mountain salamanders are small, isolated, and occur in a limited geographic area. This salamander is sedentary and its very specific habitat requirements may hinder dispersal (Larsen 1997). Colonization of suitable, unoccupied habitat may be difficult if the habitat is far from existing Larch Mountain salamander populations (Dumas 1956 as cited in Larsen 1997). Because the habitats preferred by these salamanders are naturally discontinuous, they are vulnerable to disturbance from human activity (Larsen 1997). They are vulnerable to disturbances such as logging, rock extraction, and inundation that can alter these habitats and make them unsuitable. As the species is patchily distributed in the landscape, disturbances at the local level may negatively impact the population as a whole. For these reasons, the Larch Mountain salamander is a Federally-listed species of concern as well as a sensitive species in the states of Washington and Oregon.

Table Q-10. Larch Mountain salamander association with wildlife habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Generally Associated	Feeds and Breeds	High	Requires mossy talus, logs, or woody debris.
Montane Mixed Conifer Forest	Generally Associated	Feeds and Breeds	Moderate	Requires mossy talus, logs, or woody debris.
Interior Mixed Conifer Forest	Unsure	Unsure	Low	Requires mossy talus, logs, or woody debris.
Ponderosa Pine & Interior White Oak Forest and Woodlands	Present	Feeds and Breeds	High	Only one population known in this habitat. Requires mossy talus, logs, or woody debris.

Fisher

The fisher (*Martes pennanti*) is a Washington state endangered species and a federal species of concern (Table Q-2). The Little White Salmon River subbasin is part of the historical range of the fisher (Figure Q-10). Overtrapping, and loss and alteration of habitats are considered the most significant reasons for the decline of fishers in Washington. Although extensive surveys for fishers have been conducted throughout their historical range, no known population of fishers exists in Washington. The apparent absence of fishers in Washington represents a significant gap (i.e., lack of population continuity) in the species range from Canada to Oregon and California. Riparian habitats, especially those with large diameter snags, live trees and downed logs, are considered high quality habitats for fishers, especially for resting and reproduction. Loss and fragmentation of these habitats can limit the suitability of a landscape for fishers. Oregon now has a resident population of fishers in the Cascades that could serve as a source population for Washington. However, the Bonneville Dam makes the Columbia River a more formidable barrier for fisher dispersal from Oregon to Washington.

Fishers historically occurred throughout much of the forested areas of Washington, though they were not particularly abundant. The fisher was over-trapped in the 19th and early 20th centuries. Trapping, predator and pest control programs, and loss and alteration of habitat combined to push the fisher to near extirpation. Despite protection from legal harvest for 64 years, the fisher has not recovered. The fisher population may have been kept from recovering by a combination of factors. These factors likely include: a reduction in quality and quantity of habitat due to development and logging; past predator and pest control programs; low inherent reproductive capacity of the species; and demographic and genetic effects of small population size.

Fisher biology is characterized by low population density and a low reproductive rate. They have large home ranges and generally avoid large openings, which suggests that viable populations would require large areas of relatively contiguous habitat. Throughout their range, fishers are generally associated with late-successional coniferous and mixed coniferous-deciduous forest (Table Q-11). In western Washington, fishers may have been restricted by frequent soft snows or deep snow packs to elevations below 1800 m. Forests with high canopy closure, multiple canopies, shrubs, and that support a diverse prey base are most used. Large diameter trees, large snags, tree cavities, and logs are most often used for den and rest sites, and are an important component of suitable habitat.

Currently, the fisher is very rare in Washington. Infrequent sighting reports and incidental captures indicate that a small number may still be present. However, despite extensive surveys, no one has been able to confirm the existence of a population in the state. The lack of detections of fishers given the extensive carnivore surveys conducted since 1990, an average of less than four fisher sightings per year since 1980, and few incidental captures by trappers, all indicate that fishers are very rare in Washington and could become completely extirpated. We believe that any remaining fishers in Washington are unlikely to represent a viable population, and without a recovery program that includes reintroductions, the species is likely to be extirpated from the state.

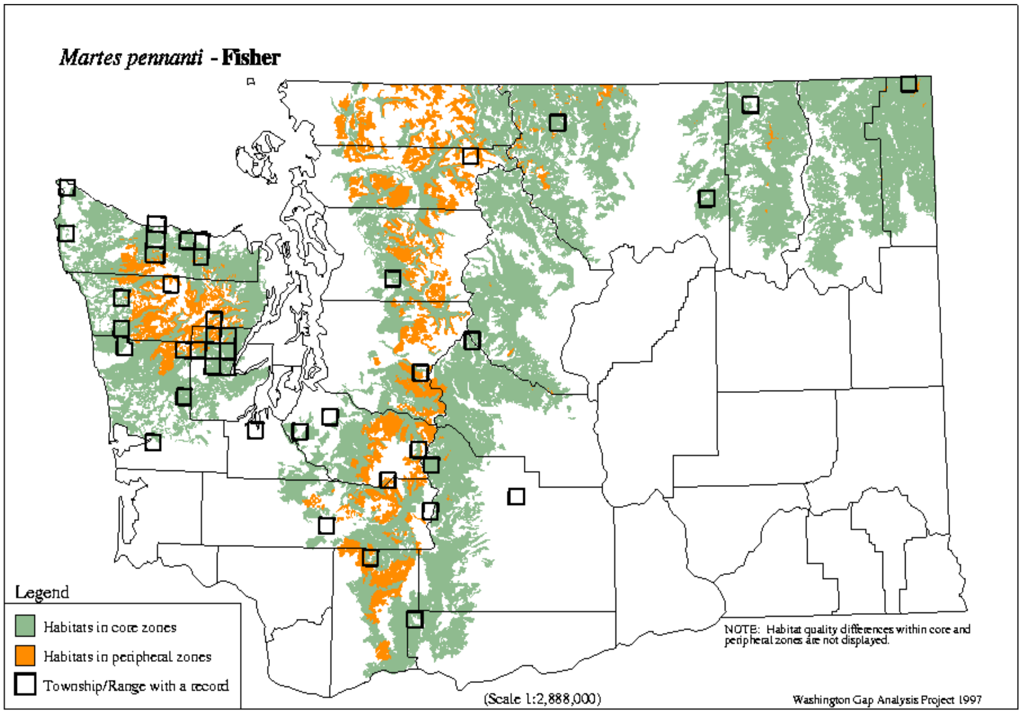


Figure Q-10. Distribution of fisher in Washington.

Table Q-11. Fisher association with wildlife habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Closely Associated	Feeds and Breeds	Moderate	none
Montane Mixed Conifer Forest	Closely Associated	Feeds and Breeds	Moderate	none
Interior Mixed Conifer Forest	Closely Associated	Feeds and Breeds	Moderate	none
Lodgepole Pine Forest and Woodlands	Unsure	Unsure	Low	none
Ponderosa Pine & Interior White Oak Forest and Woodlands	Present	Feeds and Breeds	Low	Not known from ponderosa-dominated forests in Washington.
Montane Coniferous Wetlands	Generally Associated	Feeds and Breeds	Low	none

Table Q-12. Potential relationship between fishers and salmonids (IBIS 2004).

Common Name	Relationship Type	Salmonid Stage	Comments
Fisher	Rare	Carcasses	May feed on salmon carcasses.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is a Federal and Washington state threatened species; the historical eagle population in Washington may have been around 6,500. Persecution, the cutting of forests, commercial exploitation of salmon runs, and finally the use of DDT reduced the state's population to only 105 known breeding pairs by 1980. Loss of wetlands, contamination of estuaries, and declines in water quality also probably have reduced the carrying capacity for eagles. The erection of >1,000 dams and the introduction of warm water fishes, however, has likely added nesting and wintering sites and produced changes in local distribution and abundance of eagles. The population has recovered dramatically with the ban on DDT use after 1972 and increased protection for eagles and eagle habitat. In the past 20 years, the population of nesting bald eagles grew about 10% per year as eagles reoccupied habitat. Based on a model, the population is predicted to reach carrying capacity at about 733 nesting pairs. In 1998, there were 664 occupied nests, and there are some indications that the population has reached carrying capacity in parts of western Washington. The population may still be increasing in northeastern Washington and along some western Washington rivers. Though the nesting habitat may be saturated around Puget Sound and other marine coasts, the total late spring/early summer population may continue to grow with an increase in the pool of non-breeding adults until all available food resources are exploited. If there is no decline in the number of nest sites, productivity, or survival, the population may stabilize around 4,400.

Comprehensive, statewide surveys of wintering eagles in Washington from 1982-89 counted 1,000-3,000 eagles in the state. The increasing trends in those surveys and in resident breeding birds predict a population of 3,200 winter visitors and a total winter population of about 4,500 bald eagles in Washington in the year 2000; this assumes that winter carrying capacity limits have not been reached. Statewide winter counts have not been conducted in recent years, and the carrying capacity is unknown. The number of resident breeders, and trends in localized winter counts suggest that Washington hosts perhaps 3,500 – 4,000 bald eagles each winter. Up to 80% of the eagles seen in mid-winter in Washington consists of migrants, largely from the Canadian provinces and Alaska. Wintering eagles will most benefit from protection of salmon runs and communal roosts, and managing human disturbance at eagle concentration areas.

Almost no late seral forest remains in the lowlands around Puget Sound, and eagles nest in small patches of residual large trees and second growth. The large trees along shorelines used by eagles are a diminishing resource, as more and more shoreline is dedicated to residential development. Only 1% of the Puget Sound Douglas-fir Zone is found on lands dedicated to the conservation of biodiversity. Conservation of bald eagle nesting habitat is difficult because 80% of the land within ½ mile of shores is privately owned, and contains desirable view property. Two thirds of the aggregate land within eagle territories and two thirds of eagle nests are on private lands. The state bald eagle protection rule (WAC 232-12-292) requires a management plan for development, forest practices, or potentially disturbing activities on state and private lands near eagle nests and roosts. Over 1,200 management plans have been signed by Washington landowners since 1986. There are indications that some eagles in Washington, and other states, have become fairly tolerant of human activity near nests. Most eagles, particularly those in rural areas, remain rather sensitive to disturbance during nesting.

The U.S. Fish and Wildlife Service is expected to remove the bald eagle from the federal list of threatened and endangered species in 2001. Bald eagles will still be protected by the Bald and Golden

Eagle Protection Act and the Migratory Bird Treaty Act. The Bald and Golden Eagle Protection Act also prohibits disturbance or molesting of eagles. Despite state and federal protection, a large percentage of fatalities of adult bald eagles have human related causes, including shooting, poisoning, vehicle collisions, and electrocution, and a black market trade in eagle feathers and parts still exists.

Although the breeding population of bald eagles in Washington has increased dramatically in the past 20 years, two thirds of nests are on private lands. Only about 10% of eagle nests are on lands where their habitat values could be considered secure in the absence of habitat protection rules. Land near shores is highly desirable for residential development and the human population of Washington is expected to increase by 2 million to 7.7 million in the next 20 years, and double to 11 million by 2050. Forest near shores is rapidly being cleared, and the needs of eagles and desires of humans are increasingly in conflict. Without protections of nesting and roosting habitat, the bald eagle could again decline dramatically and require re-listing as threatened or endangered in the state. For these reasons we recommend that the bald eagle be down-listed to sensitive, but not de-listed, in the State of Washington, and that the bald eagle protection rule be amended to apply to a Sensitive species.

Table Q-13. Bald eagle association with wildlife habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Generally Associated	Reproduces	High	Could breed in this habitat where near open water habitats.
Montane Mixed Conifer Forest	Generally Associated	Reproduces	High	Could breed in this habitat where near open water habitats.
Interior Mixed Conifer Forest	Generally Associated	Reproduces	High	Could breed in this habitat where near open water habitats.
Lodgepole Pine Forest and Woodlands	Generally Associated	Reproduces	High	Could breed in this habitat where near open water habitats.
Ponderosa Pine & Interior White Oak Forest and Woodlands	Generally Associated	Reproduces	High	Could breed in this habitat where near open water habitats.
Alpine Grasslands and Shrublands	Present	Feeds	Low	Known to occur in sub-alpine and alpine areas on Vancouver Island, B.C.
Open Water - Lakes, Rivers, and Streams	Closely Associated	Feeds	High	none

Table Q-14. Relationship between bald eagle and salmonids (IBIS 2004).

Common Name	Relationship Type	Salmonid Stage	Comments
Bald Eagle	Indirect	Incubation - eggs and alevin	Feed on birds that feed on salmon.
Bald Eagle	Indirect	Freshwater rearing - fry, fingerling, and parr	Feed on birds that feed on salmon.
Bald Eagle	Strong, consistent	Saltwater - smolts, immature adults, and adults	none
Bald Eagle	Indirect	Saltwater - smolts, immature adults, and adults	Feed on birds that feed on salmon.
Bald Eagle	Strong, consistent	Spawning - freshwater	none
Bald Eagle	Strong, consistent	Carcasses	none
Bald Eagle	Indirect	Carcasses	Feed on birds that feed on salmon.

Oregon Spotted Frog

The Oregon spotted frog (*Rana pretiosa*) is a Pacific Northwest endemic recently differentiated from a close relative, the Columbia spotted frog (*Rana luteiventris*). Historically, the Oregon spotted frog occurred from southwestern British Columbia south to the northeast corner of California (Figure Q-12). In Washington, the Oregon spotted frog was historically found in the Puget Trough from the Canadian border to the Columbia River and east into the southern Washington Cascades. McAllister and Leonard (1997) developed a status report for the Oregon spotted frog in Washington state. The Oregon spotted frog is listed as endangered in the State of Washington and is a federal candidate for protection under the Endangered Species Act.

Oregon spotted frogs breed during late winter or early spring. The low-volume calls of the males resemble the sound of the distant tapping of a woodpecker. Females lay their eggs in traditional communal oviposition sites; areas of shallow, still or slow-moving water and sparse, emergent wetland vegetation. Eggs hatch in 18 to 30 days and the tadpoles grow and develop for 13 to 16 weeks prior to metamorphosis in mid-summer. Oregon spotted frogs mature and begin breeding at two or three years of age.

Oregon spotted frogs are preyed upon during all life stages by a wide variety of predators ranging from invertebrates that prey on eggs, to garter snakes (*Thamnophis spp*.) and herons (family Ardeidae) that feed on adults. Among the most significant of predators are various introduced species. Numerous warmwater fish species (primarily of the families Centrarchidae, Percidae, and Ictaluridae) and the bullfrog (*Rana catesbeiana*) have been introduced to waters within the historic range of the Oregon spotted frog. Because of their life histories and habitat affinities, these introduced species pose serious threats to Oregon spotted frog populations.

Oregon spotted frogs are almost entirely aquatic in habit, leaving the wetlands only occasionally and for short duration. Wetlands associated with lakes, ponds, and slow-moving streams can provide suitable habitat (Table Q-15). However, these aquatic environments must include a shallow emergent wetland component to be capable of supporting an Oregon spotted frog population. Historically, this critical element was found in the floodplains of many larger water bodies. Various emergent-wetland and floating aquatic plants are found in abundance in Oregon spotted frog habitat. Adult female and juvenile frogs, in particular, spend summers in relatively warm water of this shallow emergent wetland environment.

Historically, the shallow floodplain pools that Oregon spotted frogs inhabited were drained, diked and filled to accommodate human needs. In the Puget Sound lowlands, existing wetlands represent a small proportion of what was present in pre-settlement times. In addition, exotic plants like reed canarygrass (*Phalaris arundinacea*) have changed the character of many wetlands and reduced their value as habitat for Oregon spotted frogs.

The locations for 11 historical populations in Washington have been verified using museum specimen and published records (Figure Q-11). Only one historically known population and two recently discovered populations are known to remain in Washington. An additional 20 extant populations are known in Oregon and one in British Columbia. Based on an assessment of presence at historical localities, the species is estimated to have been lost from 78% of its former range. However, considering the broad former range suggested by the historical data, it is likely the species has actually been lost from over 90% of its former range.

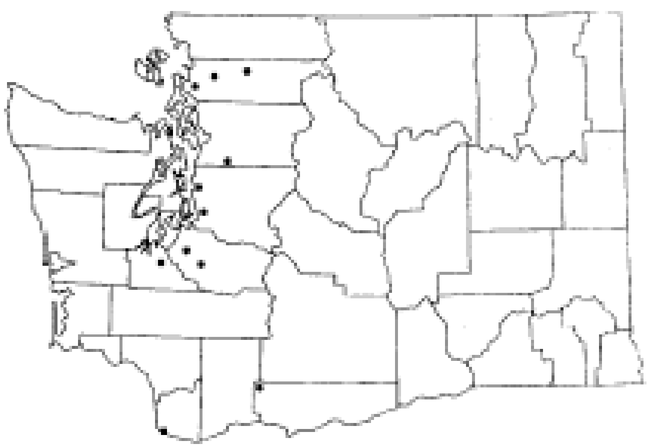


Figure Q-11. Location of Oregon spotted frog populations in Washington known prior to

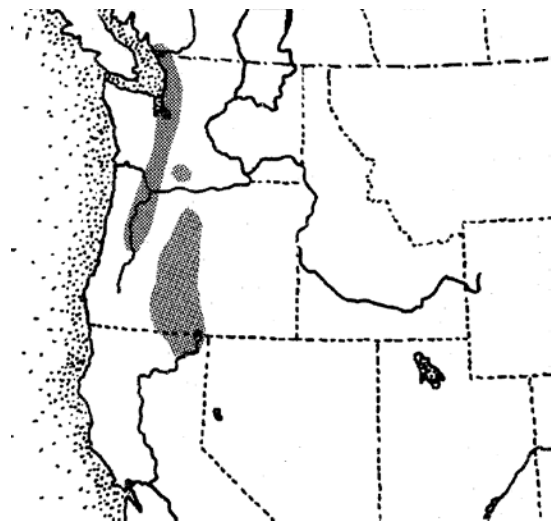


Figure Q-12. Range of the Oregon spotted frog (McAllister and Leonard 1997).

Table Q-15. Oregon spotted frog association with wildlife habitats in the Little White Salmon River subbasin (IBIS 2004).

Wildlife-Habitat Type	Association	Habitat Requisite	Data Confidence	Comments
Mesic Lowlands Conifer-Hardwood Forest	Present	Feeds	Moderate	Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.
Montane Mixed Conifer Forest	Present	Feeds	High	Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.
Interior Mixed Conifer Forest	Generally Associated	Feeds	High	Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.
Lodgepole Pine Forest and Woodlands	Present	Feeds	High	Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.
Ponderosa Pine & Interior White Oak Forest and Woodlands	Generally Associated	Feeds	High	Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.
Open Water - Lakes, Rivers, and Streams	Closely Associated	Feeds and Breeds	High	Rare or absent where predatory fish or bullfrogs occur. Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.
Montane Coniferous Wetlands	Present	Feeds and Breeds	High	Rare or absent where predatory fish or bullfrogs occur. Requires shallow water in wet meadows or stream/pond edges with abundant aquatic vegetation for breeding.

Q.3.4. 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.

Watershed Hydrology

Peak flows in the subbasin are typically related to winter rain and rain-on-snow events. The USGS has periodically monitored streamflows in the basin. The stream gage near Cook, Washington has the longest period of record (1957-1977). High flows in 1972 (9,250 cubic feet per second [cfs]), 1974 (8,120 cfs), and 1978 resulted in some large changes to stream channels in the basin (USFS 1995). The hydrology of the northwest portion of the subbasin is not well understood, including the Big Lava Bed. Small streams in this area disappear into the quaternary basalts and subsurface water routing has not been quantified (Welch et al. 2002). Despite the lack of information, it is assumed that the Big Lava Bed provides some level of buffering of stormflows (USFS 1995). Another unique hydrologic feature is the loss of subsurface water to the White Salmon basin due to seepage through eastward dipping geological features (USFS 1995).

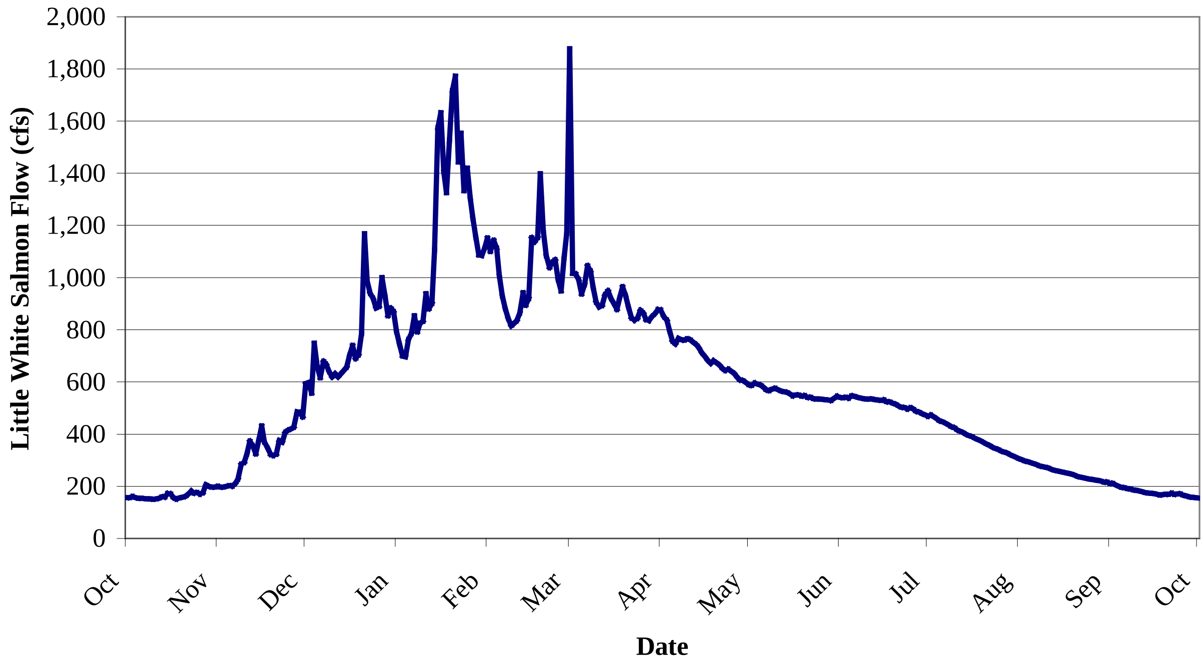


Figure Q-13. Little White Salmon River hydrograph (1968-1977). Peak flows are primarily related to winter rain-on-snow events, with a slight rise in flows due to snowmelt in late May and June. USGS Gage #14125500. Little White Salmon River near Cook, WA.

Investigations conducted as part of the 1995 watershed analysis (USFS 1995) determined that approximately 19% of the subbasin was hydrologically immature, meaning that these areas had the potential to increase peak streamflows. Using Washington's hydrologic change module, which estimates peak flow changes from changes to vegetation cover, over a 10% increase in the 2-year peak flow was estimated for 11 of the 24 USFS subwatersheds (USFS 1995). The extensive road network may also serve to alter the timing and magnitude of peak flows. The overall road density is approximately 3 mi/mi^2, considered moderately high by most standards. Five of the 24 subwatersheds have road densities greater than 4 mi/mi^2 (USFS 1995).

Hydrologic (runoff) impairment was evaluated as part of IWA watershed process modeling, which is presented in greater detail later in this chapter. The Little White Salmon subbasin did not have the same extent and format of data available to run the hydrology assessment as was done for other portions of the lower Columbia region. Due to the absence of data, hydrology impairment was estimated using USFS data (USFS 1995). Based on vegetation conditions and road densities, the following IWA subwatersheds were estimated as "moderately impaired" with respect to conditions that influence sediment supply: Little White Salmon Headwaters, middle Little White Salmon/Cabbage Creek, middle Little White Salmon/Berry Creek, and the 2 lowermost mainstem subwatersheds. All remaining subwatersheds were estimated as "functional".

Low flows may also be of concern in the basin, with annual minimums of less than 25 cfs recorded at the Little White Salmon near Willard gage in the 1940s. The mean monthly flow for October over the period of record at the Cook gage is 160 cfs (Welch et al. 2002). A total of approximately 152 cfs is allocated for water rights in the basin; however, the estimated reduction of the minimum summer low flow due to these rights was less than 1% (Greenberg and Callahan 2003). A flow diversion on Lost Creek (north) directs flow into the Coyote Ditch, which transports as much as 5 cfs over to the Trout

Lake Creek basin (White Salmon watershed) for livestock watering. This diversion can reduce the flow in lower Lost Creek by one-third during low flow periods (USFS 1995).

Passage Obstructions

Anadromous fish passage is naturally blocked on the mainstem by a falls at river mile (RM) 1.5; however, a few fish are believed to ascend to a larger falls at RM 2.5 – 3. Most natural anadromous spawning occurs in only approximately 400-500 meters of river habitat that is available downstream of the falls and above Drano Lake. High temperatures and other conditions in Drano Lake might affect passage. Two dams restrict passage in the basin. One is located near the mouth of the Little White Salmon, at the Little White Salmon Fish Hatchery, and the other is located on Lost Creek (north) adjacent to a diversion intake. A culvert survey in 1995 revealed that 15 of 26 culverts presented barriers to resident fish, though more information is needed (USFS 1995).

Water Quality

Water temperature monitoring from the 1970s into the 1990s on the mainstem near Willard (USFS), and at the Little White Salmon National Fish Hatchery at the mouth (USFWS), indicated no exceedances of the state water temperature standards of 61°F (16°C) for Class AA streams or 64°F (18°C) for Class A streams. However, monitoring in the upper basin in 1994 recorded a temperature of 64°F (18°C) in the mainstem (USFS 1995). More recent water temperature monitoring using continuously recording thermographs has provided greater information on water temperature conditions.

Since 1995, thermographs have been placed in Berry Creek, Cabbage Creek, Dry Creek, East Fork and West Fork Goose Lake Creek, Lost Creek, Lusk Creek, and at several locations on the mainstem. Exceedances of the 61°F (16°C) standard on these streams have occurred on Dry Creek, the mainstem above 201 Road, the mainstem above Lusk Creek, the mainstem at Berry Creek, and the mainstem above Moss Creek. The highest temperatures were measured at the mainstem above Moss Creek site, where 74 days exceeded 61°F (16°C) in 1998 and the maximum recorded temperature was 68°F (20°C) (USFS unpublished data).

USFS monitoring recorded some high lake water temperatures in the 1990s. The highest was 24°C (76°F) (in Forlorn Lake #4), though temperatures are expected to naturally be high due to shallow morphology.

Turbidity monitoring was conducted at 11 locations by the USFS from 1974 to 1975 in response to sediment accumulations at the fish hatcheries during a 1968 flood event. In general, turbidity levels were found to be high throughout the mainstem and in Lusk Creek, and were attributed primarily to bank cutting on the mainstem. Other turbidity monitoring by the USFS is spotty and not very useful for analysis. The USFWS, however, has collected total suspended solid (TSS) data every two weeks since 1975. A general downward trend in TSS is evident over the sampling period. Comparison of this data to estimated streamflow data suggests that the downward trend is more attributable to decreased flow magnitudes than to a true decrease in basin sediment supply (USFS 1995). The 1999 Limiting Factors Analysis identified turbidity problems in the upper basin related to timber harvests (see WCC 1999).

USFS pH monitoring between 1974 and 1987 on the mainstem revealed levels lower than the state standard and the stream was listed on Washington's 303(d) list. However, data collection methods are believed to be suspect (USFS 1995).

Key Habitat Availability

Stream habitat surveys have only been conducted on the Little White Salmon (mainstem), Lost Creek (north), and Goose Lake Creek. Pools per mile were greatest in the mainstem (44.2) and lowest in Goose Lake Creek (10.1). The Range of Natural Conditions (RNC) for this area is 40-60 pools per mile. Width-to-depth ratios in the mainstem were very high (23:1), though conditions were rated good for Goose Lake Creek (5:1) (USFS 1995).

Substrate & Sediment

Information is lacking on substrate conditions in the subbasin. USFS stream surveys revealed that 8.3 of 12.6 surveyed miles of the mainstem (66%) were affected by scour and deposition. In Lost Creek and Goose Lake Creek the rates were 39% and 14%, respectively. Flood related sediment production in the 1970s in Lusk Creek, which followed riparian harvests, increased sediment loading in the mainstem Little White Salmon (USFS 1995).

The same conditions that can alter runoff conditions (i.e. immature vegetation, high road densities) can also alter basin sediment dynamics. The percentage of early-seral vegetation (20%), moderately high road densities (3 mi/mi^2), and the natural instability of the eastern portion of the basin may result in elevated rates of sediment production and delivery to stream channels. Poor road construction has caused numerous shallow landslides and debris flows, especially in steep regions with poor soil conditions. Blocked culverts have also created road erosion, with large volumes of sediment delivered to stream channels in some cases. During a rain-on-snow event in 1968, large volumes of sediment (300 cubic yards) were deposited in the settling basin at the Willard Hatchery. Sediment accumulations created problems in the raceways and similar problems were experienced at the Little White Salmon Hatchery at the mouth. The USFWS suggested that the problems were related to roads, undersized culverts, clear-cut harvesting along streams, and logging debris in stream channels. The USFS subsequently began a turbidity monitoring program to pinpoint the source of sediment. The mainstem Little White and Lusk Creek stood out as the main sources. Despite these concerns, the Little White Salmon basin is considered one of the most stable in the GPNF (USFS 1995).

Sediment supply conditions were evaluated as part of IWA watershed process modeling, which is presented later in this chapter. In summary, the IWA rated 5 of the 13 IWA subwatersheds as "moderately impaired" with respect to landscape conditions that influence sediment supply. The remaining 8 subwatersheds were rated as "functional". The greatest impairments are located in the lower 2 subwatersheds and in the upper western portion of the subbasin (Lava Creek drainage).

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

Woody Debris

Recruitment potential of large wood debris (LWD) has been reduced by past forest practices that allowed harvest up to stream channels. Once thought to be an impediment to fish passage, instream LWD was removed from channels during timber harvest operations (USFS 1995). Current LWD levels are low throughout the basin.

Stream surveys in the mainstem, Lost Creek (north), and Goose Lake Creek indicated very poor instream LWD levels. The lowest level was in Goose Lake Creek (6.1 pieces per mile) and the greatest was in Lost

Creek (14.5 pieces per mile). Less than 40 pieces per mile is considered poor according to the Columbia River Anadromous Fish Policy Implementation Guide (USFS 1995).

Channel Stability

As part of the 1995 Watershed Analysis (USFS 1995), an air photo investigation was used to assess changes to stream channel conditions since the 1960s. Only a limited number of stream reaches were evaluated due to availability of time and air photos. Large changes including bar development and channel widening were observed in the late 1960s and late 1970s, with conditions recovering in the 1980s. Reaches with the largest changes also tended to have the greatest riparian timber harvest impacts.

Lusk Creek experienced dramatic widening and channel straightening during 1970s peak flow events that followed 1960s clear-cutting of riparian areas. By 1989, vegetation and shade conditions had improved, though channel recovery may take considerably longer. Other streams that experienced bar development and channel widening are Berry Creek, Lost Creek (north), and several reaches of the mainstem, particularly below the southernmost Forest Road 18 crossing.

Riparian Function

Riparian areas have been impacted by past forest practices that allowed harvest of trees up to stream channels. Road building and livestock grazing have also impacted riparian forests. Currently, 21% of the riparian areas are in early-seral vegetation, with nine of the 23 subwatersheds falling outside the "range of natural conditions" (USFS 1995).

Air photo and field review of the upper mainstem has revealed that much of the stream channel is exposed to direct solar radiation during the summer, likely impacting stream temperatures. This is attributed to lack of adequate riparian forests, the presence of unvegetated gravel bars, and high width-to-depth ratios (USFS 1995).

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

Floodplain Function

There are very few natural floodplain areas in the subbasin and the bulk of historical floodplain habitats for anadromous species would have been limited to the lower reaches of the mainstem, which are now inundated by the Bonneville Pool (Drano Lake).

Q.3.5. Stream Habitat Limitations

Decades of human activity have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. There is currently very little habitat available to anadromous fish in the Little White Salmon Subbasin. Historically, anadromous fish could ascend only as far as RM 3, where a barrier falls (Spirit Falls) blocked upstream passage. Approximately 1 mile of this historically available habitat was impounded by Bonneville Dam and is now Drano Lake. The remaining two miles are currently blocked by the barrier dam at the Little White Salmon National Fish Hatchery. No fish are passed above the barrier dam due to limited available habitat and a concern of the effects of naturally-spawning fish introducing pathogens to the hatchery.

Population Analysis

Due to the small amount of available habitat and the low potential contribution of Little White Salmon fish populations to regional recovery objectives, the Little White Salmon populations have not been analyzed using the EDT model and reaches have not been prioritized. Nevertheless, the lowest reach of the mainstem between the barrier dam and the barrier falls provides potential habitat for anadromous fish and the remainder of the basin contains abundant habitat for resident fish and wildlife.

Stream Reach Analysis

The area with the greatest potential production of anadromous salmonid populations in the Little White Salmon basin is the lower mainstem, from Drano Lake to the barrier falls (RM 3).

While reach level habitat conditions often result from local factors, they are also affected or shaped by systemic watershed processes. Limiting factors such as temperature, high and low flows, sediment input and large woody debris recruitment are often affected by or result from upstream conditions and degraded watershed processes. Access to key reaches may also be affected by barriers that occur downstream of a reach. Accordingly, restoration of a priority reach may require action outside the targeted reach. The IWA analysis was used to identify potential upstream watershed areas that could influence reach level habitat attributes.

There is very little habitat available to anadromous fish in the Little White Salmon Subbasin. The reach with the greatest potential to support natural spawning is the 400-500 meter reach between the hatchery barrier dam and the hatchery water intake (RM 1.5, measured from the Hwy 14 Bridge). There is additional potential habitat above the intake up to the barrier falls at RM 3 but this stretch of river is confined within a steep canyon and spawning habitat is likely limited. The lower reach (barrier dam to intake) is in relatively good condition though past forest practices (log flumes) and the current hatchery complex have impacted floodplain function and riparian vegetation. Re-introduction of naturally-spawning fish above the barrier dam warrants further investigation and may be reasonable if fish health concerns can be adequately addressed. At a minimum, existing habitat quality should be protected. If fish passage is provided, this reach may present opportunities for riparian and floodplain restoration. Within and downstream of the hatchery complex, there may also be potential sites for creation of new habitats (i.e., spawning channels) to compensate for lost or currently inaccessible habitat.

Q.3.6. Watershed Habitat Conditions

The historical and current wildlife habitat acreage in the Little White Salmon River subbasin are displayed in Figure Q-14 and summarized in Table Q-16. The Northwest Habitat Institute (NHI) has compiled descriptions of each of these habitat types; these detailed descriptions are available on their Interactive Biodiversity Information System (IBIS) website (www.nwhi.org/ibis/home/ibis.asp) and are also included below; additional wildife habitat data are also included in Johnson and O'Neil (2001). IBIS (2004) mapping suggests an almost complete loss of the Interior Mixed Conifer Forest from historical to current conditions; concurrently, acreage of Mesic Lowlands Conifer-Hardwood Forest has increased substantially (Table Q-16). It is unlikely that an actual shift in forest habitat types has occurred in the Little White Salmon River subbasin, rather the habitat changes noted from historical to current conditions appear to be an artifact of habitat mapping. For example, fire suppression and management have reduced the frequency, intensity, and size of fires throughout the region that historically maintained an open canopy, early seral stage Interior Mixed Conifer Forest. As a result, Interior Mixed Conifer Forests have transitioned to a late seral stage with a closed canopy and structure elements that are more characteristic of Mesic Lowlands Conifer-Hardwood Forest on the west side of the Cascades. Thus, it is likely that a substantial amount of Interior Mixed Conifer Forest acreage is still present in the

Little White Salmon River subbasin, but this habitat type was incorrectly mapped because of its current forest structure.

Another factor that may contribute to possible mis-classified habitats during mapping is that the Little White Salmon River subbasin is located within the transition zone between the dry forest types typical of areas east of the Cascades and moist forest types typical of areas west of the Cascades. As a result, the eastside forest types in the Little White Salmon River subbasin are at the extreme end of the moisture gradient for these habitat types, while the westside forest types in the subbasin characterize drier conditions within the range possible for these habitat types. At each end of the moisture regime for the different habitat types (i.e. moist eastside forests and dry westside forests), there is considerable overlap in species composition and forest structure, which leads to possible mis-classification of habitat types.

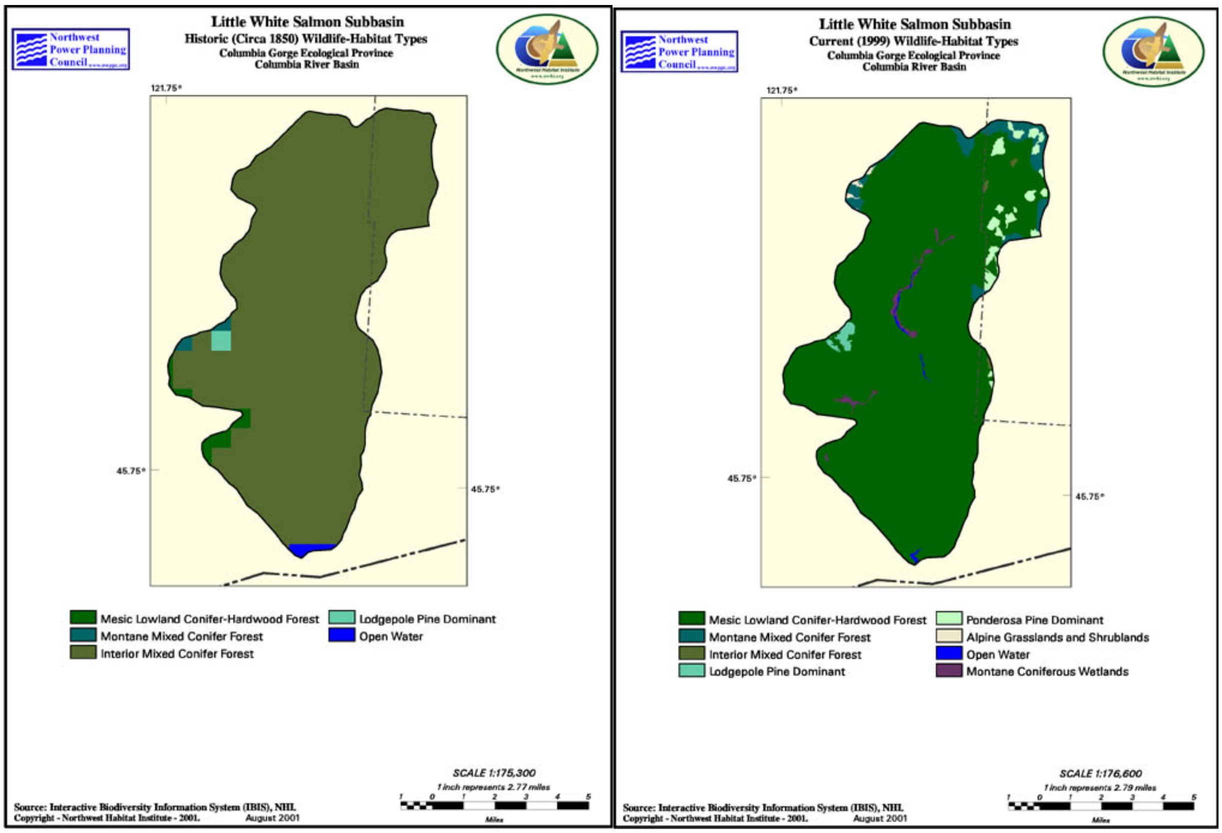


Figure Q-14. Historical (1850) and current (1999) wildlife habitat in the Little White Salmon River subbasin (IBIS 2004).

Table Q-16. Historical (1850) and current (1999) wildlife habitat acreage in the Little White Salmon River subbasin (IBIS 2004).

	Acreage			
Habitat Type [a,b]	**Historical**	**Current**	**Change**	**% Change[c]**
Mesic Lowlands Conifer-Hardwood Forest	659	40,618	+39,959	+6,000
Montane Mixed Conifer Forest	224	1,511	+1,287	+575
Interior Mixed Conifer Forest	42,606	79	-42,527	-100

	Acreage			
Habitat Type [a,b]	**Historical**	**Current**	**Change**	**% Change**[c]
Lodgepole Pine Forest and Woodlands	247	246	-1	-0.04
Ponderosa Pine & Interior White Oak Forest	-	948	+948	-
Alpine Grasslands and Shrublands	-	74	+74	-
Montane Coniferous Wetlands	-	380	+380	-
Open Water-Lakes, Rivers, and Streams	231	112	-119	-52

[a] Old growth forests may be present in late seral stages of any of the forest habitat types.
[b] Riparian habitat may comprise microhabitat components within the forested or grassland habitat types or macro or microhabitat components within the wetland or open water habitat types.
[c] Represents the acreage change in relation to the historical acreage.

Mesic Lowlands Conifer-Hardwood Forest

This forest habitat occurs throughout low-elevation western Washington, except on extremely dry or wet sites. Within the Little White Salmon River subbasin, there has been a massive increase in acreage of this habitat type from historical to current conditions (Table Q-16), however, this appears to be an artifact of mapping instead of an actual habitat change. Climate that produces this habitat type is relatively mild and moist to wet. Mean annual precipitation is mostly 35-100 inches (90-254 cm), but can vary locally. Snowfall ranges from rare to regular, but is transitory. Summers are relatively dry. Elevation ranges from sea level to a maximum of about 2,000 ft (610 m) in much of northern Washington. Soils and geology are very diverse. Topography ranges from relatively flat glacial till plains to steep mountainous terrain.

This is the most extensive habitat in the lowlands on the westside of the Cascades and forms the matrix within which other habitats occur as patches, especially Westside Riparian-Wetlands and less commonly Herbaceous Wetlands or Open Water. Bordering this habitat at upper elevations is generally Montane Mixed Conifer Forest. The primary land use for this habitat is forestry.

Structure of this habitat type is forest, or rarely woodland, dominated by evergreen conifers, deciduous broadleaf trees, or both. Late seral stands typically have an abundance of large (>164 ft [50 m] tall) coniferous trees, a multi-layered canopy structure, large snags, and many large logs on the ground. Early seral stands typically have smaller trees, single-storied canopies, and may be dominated by conifers, broadleaf trees, or both. Coarse woody debris is abundant in early seral stands after natural disturbances but much less so after clearcutting. Forest understories are structurally diverse: evergreen shrubs tend to dominate on nutrient-poor or drier sites; deciduous shrubs, ferns, and/or forbs tend to dominate on relatively nutrient-rich or moist sites. Shrubs may be low (1.6 ft [0.5 m] tall), medium-tall (3.3-6.6 ft [1-2 m]), or tall (6.6-13.1 ft [2-4 m]). Almost all structural stages are represented in the successional sequence within this habitat. Mosses are often a major ground cover. Lichens are abundant in the canopy of old stands.

Western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*) are the most characteristic species and 1 or both are typically present. Most stands are dominated by 1 or more of the following: Douglas-fir, western hemlock, western redcedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*), or bigleaf maple (*Acer macrophyllum*). Western white pine (*Pinus monticola*) is frequent but subordinate in importance through much of this habitat. Common small subcanopy trees are cascara buckthorn (*Rhamnus purshiana*) in more moist climates and Pacific yew (*Taxus brevifolia*) in somewhat drier climates or sites.

Dominant or co-dominant understory shrub species of more than local importance include salal (*Gaultheria shallon*), dwarf Oregongrape (*Mahonia nervosa*), vine maple (*Acer circinatum*), Pacific rhododendron (*Rhododendron macrophyllum*), salmonberry (*Rubus spectabilis*), trailing blackberry (*R. ursinus*), red elderberry (*Sambucus racemosa*), fools huckleberry (*Menziesia ferruginea*), beargrass (*Xerophyllum tenax*), oval-leaf huckleberry (*Vaccinium ovalifolium*), evergreen huckleberry (*V. ovatum*), and red huckleberry (*V. parvifolium*). Salal and rhododendron are particularly associated with low nutrient or relatively dry sites.

Swordfern (*Polystichum munitum*) is the most common herbaceous species and is often dominant on nitrogen-rich or moist sites. Other forbs and ferns that frequently dominate the understory are Oregon oxalis (*Oxalis oregana*), deerfern (*Blechnum spicant*), bracken fern (*Pteridium aquilinum*), vanillaleaf (*Achlys triphylla*), twinflower (*Linnaea borealis*), false lily-of-the-valley (*Maianthemum dilatatum*), western springbeauty (*Claytonia siberica*), foamflower (*Tiarella trifoliata*), inside-out flower (*Vancouveria hexandra*), and common whipplea (*Whipplea modesta*).

Fire is the major natural disturbance in all but the wettest climatic area, where wind becomes the major source of natural disturbance. Natural fire-return intervals generally range from about 100 years or less in the driest areas to several hundred years (Henderson et al. 1989, Morrison and Swanson 1990, Agee 1993). Major natural fires are associated with occasional extreme weather conditions (Agee 1993). Fires are typically high-severity, with few trees surviving. However, low- and moderate-severity fires that leave partial to complete live canopies are not uncommon, especially in drier climatic areas. Bark beetles and fungi are significant causes of mortality that typically operate on a small scale. Landslides are another natural disturbance that occur in some areas.

After a severe fire or blowdown, a typical stand will be briefly occupied by annual and perennial ruderal forbs and grasses as well as predisturbance understory shrubs and herbs that resprout (Halpern 1989). Herbaceous species generally give way to dominance by shrubs or a mixture of shrubs and young trees within a few years. If shrubs are dense and trees did not establish early, the site may remain as a shrubland for an indeterminate period. Early seral tree species can be any of the potential dominants for the habitat, depending on environment, type of disturbance, and seed source. All of these species except the short-lived red alder are capable of persisting for at least a few hundred years. Douglas-fir is the most common dominant after fire, but is uncommon in the wettest zones. It is also the most fire resistant of the trees in this habitat and survives moderate-severity fires well. After the tree canopy closes, the understory may become sparse, corresponding with the stem-exclusion stage (Oliver 1981). Eventually tree density will decrease and the understory will begin to flourish again, typically at stand age 60-100 years. As trees grow larger and a new generation of shade-tolerant understory trees (usually western hemlock, less commonly western redcedar) grows up, a multi-layered canopy will gradually develop and be well expressed by stand age 200-400 years (Franklin et al. 1981). Another fire is likely to return before the loss of shade-intolerant Douglas-fir from the canopy at stand age 800-1,000 years, unless the stand is located in the wet maritime zone. Throughout this habitat, western hemlock tends to increase in importance as stand development proceeds. Coarse woody debris peaks in abundance in the first 50 years after a fire and is least abundant at about stand age 100-200 years (Spies et al. 1988).

Red alder is more successful after typical logging disturbance than after fire alone on moist, nutrient-rich sites, perhaps because of the species' ability to establish abundantly on scarified soils (Haeussler and Coates 1986). Alder is much more common now because of large-scale logging activities (Franklin 1988). Alder grows more quickly in height early in succession than the conifers, thereby prompting many forest managers to apply herbicides for alder control. If alder is allowed to grow and dominate early successional stands, it will decline in importance after about 70 years and die out completely by age 100. Often there are suppressed conifers in the subcanopy that potentially can respond to the death of the alder canopy. However, salmonberry sometimes forms a dense shrub layer under the alder, which can exclude conifer regeneration (Franklin and Dyrness 1973). Salmonberry responds positively to soil disturbance, such as that associated with logging (Barber 1976). Bigleaf maple sprouts readily after logging and is therefore well adapted to increase after disturbance as well. Clearcut logging and plantation forestry have resulted in less diverse tree canopies, and have focused mainly on Douglas-fir, with reductions in coarse woody debris over natural levels, a shortened stand initiation phase, and succession truncated well before late-seral characteristics are expressed. Douglas-fir has been almost universally planted, even in wet coastal areas of Washington, where it is rare in natural stands.

This habitat type remains fairly common throughout the region; some loss has occurred, primarily to development in the Puget Lowland. Condition of what remains has been degraded by industrial forest practices at both the stand and landscape scale. Most of the habitat is probably now in Douglas-fir plantations. Only a fraction of the original old-growth forest remains, mostly in national forests in the Cascade and Olympic mountains. An increase in alternative silviculture practices may be improving structural and species diversity in some areas. However, intensive logging of natural-origin mature and young stands and even small areas of old growth continues.

Montane Mixed Conifer Forest

These forests occur in mountains throughout Washington and Oregon, excepting the Basin and Range of southeastern Oregon. Within the Little White Salmon River subbasin, there has been a sizable increase in acreage of this habitat type from historical to current conditions (Table Q-16), however, this appears to be an artifact of mapping instead of an actual habitat change. The habitat is typified by a moderate to deep winter snow pack that persists for 3 to 9 months. The climate is moderately cool and wet to moderately dry and very cold. Mean annual precipitation ranges from about 40 inches (102 cm) to >200 inches (508 cm). Elevation is mid- to upper montane, as low as 2,000 ft (610 m) in northern Washington, to as high as 7,500 ft (2,287 m) in southern Oregon. On the westside, it occupies an elevational zone of about 2,500 to 3,000 vertical feet (762 to 914 m), and on the eastside it occupies a narrower zone of about 1,500 vertical feet (457 m). Topography is generally mountainous. Soils are typically not well developed, but varied in their parent material: glacial till, volcanic ash, residuum, or colluvium. Spodosols are common.

This habitat is found adjacent to Mesic Lowlands Conifer-Hardwood Forest at its lower elevation limits and to Subalpine Parkland at its upper elevation limits. Inclusions of Montane Forested Wetlands, Westside Riparian Wetlands, and less commonly Open Water or Herbaceous Wetlands occur within the matrix of montane forest habitat. The typical land use is forestry or recreation. Most of this type is found on public lands managed for timber values and much of it has been harvested in a dispersed-patch pattern.

Habitat structure is a forest, or rarely woodland, dominated by evergreen conifers. Canopy structure varies from single- to multi-storied. Tree size also varies from small to very large. Large snags and logs vary from abundant to uncommon. Understories vary in structure: shrubs, forbs, ferns, graminoids or some combination of these usually dominate, but they can be depauperate as well. Deciduous broadleaf shrubs are most typical as understory dominants. Early successional structure after logging or fire varies depending on understory species present. Mosses are a major ground cover and epiphytie lichens are typically abundant in the canopy.

Forest composition is recognized by the dominance or prominence of 1 of the following species: Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), subalpine fir (*A. lasiocarpa*), Shasta red fir (*A. magnific var. shastensi*), Engelmann spruce (*Picea engelmannii*), noble fir (*A. procera*), or Alaska yellow-cedar (*Chamaecyparis nootkatensis*). Several other trees may co-dominate: Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), or white fir (*A. concolor*). Tree regeneration is typically dominated by Pacific silver fir in moist westside middle-elevation zones and by mountain hemlock, sometimes with silver fir, in cool, very snowy zones on the westside and along the Cascade Crest.

Subalpine fir and Engelmann spruce are major species only east of the Cascade Crest in Washington. Douglas-fir is important east of the Cascade Crest and at lower elevations on the westside. Pacific silver fir is a major species on the westside as far south as central Oregon. Noble fir, as a native species, is found primarily in the western Cascades from central Washington to central Oregon. Mountain hemlock is a common dominant at higher elevations along the Cascade Crest and to the west. Western hemlock, and to a lesser degree western redcedar, occur as dominants primarily with silver fir at lower elevations on the westside. Alaska yellow-cedar occurs as a co-dominant west of the Cascade Crest in Washington, rarely in northern Oregon.

Deciduous shrubs that commonly dominate or co-dominate the understory are oval-leaf huckleberry (*Vaccinium ovalifolium*), big huckleberry (*V. membranaceum*), grouseberry (*V. scoparium*), dwarf huckleberry (*V. cespitosum*), fools huckleberry (*Menziesia ferruginea*), Cascade azalea (*Rhododendron albiflorum*), copperbush (*Elliottia pyroliflorus*), and devil's-club (*Oplopanax horridus*). Important evergreen shrubs include salal (*Gaultheria shallon*), dwarf Oregongrape (*Mahonia nervosa*), Pacific rhododendron (*Rhododendron macrophyllum*), deer oak (*Quercus sadleriana*), pinemat manzanita (*Arctostaphylos nevadensis*), beargrass (*Xerophyllum tenax*), and Oregon boxwood (*Paxistima myrsinites*).

Graminoid dominants are found primarily just along the Cascade Crest and to the east and include pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), smooth woodrush (*Luzula glabrata var. hitchcockii*), and long-stolon sedge (*Carex inops*). Deerfern (*Blechnum spicant*) and western oakfern (*Gymnocarpium dryopteris*) are commonly co-dominant. The most abundant forbs include Oregon oxalis (*Oxalis oregana*), single-leaf foamflower (*Tiarella trifoliata var. unifoliata*), rosy twisted-stalk (*Streptopus roseus*), queen's cup (*Clintonia uniflora*), western bunchberry (*Cornus unalaschkensis*), twinflower (*Linnaea borealis*), prince's pine (*Chimaphila umbellata*), five-leaved bramble (*Rubus pedatus*), and dwarf bramble (*R. lasiococcus*), sidebells (*Orthilia secunda*), avalanche lily (*Erythronium montanum*), Sitka valerian (*Valeriana sitchensis*), false lily-of-the-valley (*Maianthemum dilatatum*), and Idaho goldthread (*Coptis occidentalis*).

Fire is the major natural disturbance in this habitat. Fire regimes are primarily of the high-severity type (Agee 1993), but also include the moderate-severity regime (moderately frequent and highly variable) for Shasta red fir forests (Chappell and Agee 1996). Mean fire-return intervals vary greatly, from 800 years for some mountain hemlock-silver fir forests (Agee and Smith 1984) to about 40 years for red fir forests. Windstorms are a common small-scale disturbance and occasionally result in stand replacement. Insects and fungi are often important small-scale disturbances. However, they may affect larger areas also, for example, laminated root rot (*Phellinus weirii*) is a major natural disturbance, affecting large areas of mountain hemlock forests in the Oregon Cascades (Dickman and Cook 1989).

After fire, a typical stand will briefly be occupied by annual and perennial ruderal forbs and grasses, as well as predisturbance understory shrubs and herbs that resprout. Stand initiation can take a long time, especially at higher elevations, resulting in shrub/herb dominance (with or without a scattered tree layer) for extended periods (Hemstrom and Franklin 1982, Agee and Smith 1984). Early seral tree species can be any of the potential dominants for the habitat, or lodgepole pine, depending on the environment, type of disturbance, and seed source. Fires tend to favor early seral dominance of lodgepole pine, Douglas-fir, noble fir, or Shasta red fir, if their seeds are present (Agee 1993). In some areas, large stand-replacement fires will result in conversion of this habitat to the Lodgepole Pine Forest and Woodland habitat, distinguished by dominance of lodgepole. After the tree canopy closes, the understory typically becomes sparse for a time. Eventually tree density will decrease and the understory will begin to flourish again, but this process takes longer than in lower elevation forests, generally at least 100 years after the disturbance, sometimes much longer (Agee 1993). As stand development proceeds, relatively shade-intolerant trees (lodgepole pine, Douglas-fir, western hemlock, noble fir, Engelmann spruce) typically decrease in importance and more shade-tolerant species (Pacific silver fir, subalpine fir, Shasta red fir, mountain hemlock) increase. Complex multi-layered canopies with large trees will typically take at least 300 years to develop, often much longer, and on some sites may never develop. Tree growth rates, and therefore the potential to develop these structural features, tend to decrease with increasing elevation.

Forest management practices, such as clearcutting and plantations, have in many cases resulted in less diverse tree canopies with an emphasis on Douglas-fir. They also reduce coarse woody debris compared to natural levels, and truncate succession well before late-seral characteristics are expressed. Post-harvest regeneration of trees has been a perpetual problem for forest managers in much of this habitat (Gordon 1970, Atzet et al. 1984). Planting of Douglas-fir has often failed at higher elevations, even where old Douglas-fir were present in the unmanaged stand (Henderson et al. 1989). Slash burning often has negative impacts on productivity and regeneration (Ruth 1974). Management has since shifted away from burning and toward planting noble fir or native species, natural regeneration, and advance regeneration (Halverson and Emmingham 1982, Atzet et al. 1984). Noble fir plantations are now fairly common in managed landscapes, even outside the natural range of the species. Advance regeneration management tends to simulate wind disturbance but without the abundant downed wood component. Shelterwood cuts are a common management strategy in Engelmann spruce or subalpine fir stands (Williams et al. 1995).

This habitat type occupies large areas of the region. There has probably been little or no decline in the extent of this type over time. Large areas of this habitat are relatively undisturbed by human impacts and include significant old-growth stands. Other areas have been extensively affected by logging, especially dispersed patch clearcuts. The habitat is stable in area, but is probably still declining in condition because of continued logging. This habitat is one of the best protected, with large areas represented in national parks and wilderness areas. The only threat is continued road building and clearcutting in unprotected areas.

Interior Mixed Conifer Forest

The Interior Mixed Conifer Forest habitat appears primarily in the Blue Mountains, East Cascades, and Okanogan Highland Ecoregions of Oregon, Washington, adjacent Idaho, and western Montana. It also extends north into British Columbia. Within the Little White Salmon River subbasin, there has been almost complete loss of Interior Mixed Conifer Forest habitat from historical to current conditions (Table Q-16), however, this appears to be an artifact of mapping instead of an actual habitat change.

Douglas-fir-ponderosa pine forests occur along the eastern slope of the Oregon and Washington Cascades, the Blue Mountains, and the Okanogan Highlands of Washington. Grand fir-Douglas-fir forests and western larch forests are widely distributed throughout the Blue Mountains and, lesser so, along the east slope of the Cascades south of Lake Chelan and in the eastern Okanogan Highlands. Western hemlock-western redcedar-Douglas-fir forests are found in the Selkirk Mountains of eastern Washington, and on the east slope of the Cascades south of Lake Chelan to the Columbia River Gorge.

The Interior Mixed Conifer Forest habitat is primarily mid-montane with an elevation range of between 1,000 and 7,000 ft (305-2,137 m), mostly between 3,000 and 5,500 ft (914-1,676 m). Parent materials for soil development vary. This habitat receives some of the greatest amounts of precipitation in the inland northwest, 30-80 inches (76-203 cm)/year. Elevation of this habitat varies geographically, with generally higher elevations to the east.

This habitat makes up most of the continuous montane forests of the inland Pacific Northwest. It is located between the subalpine portions of the Montane Mixed Conifer Forest habitat in eastern Oregon and Washington and lower tree line Ponderosa Pine and Forest and Woodlands.

Structure of the Interior Mixed Conifer habitat is montane forests and woodlands. Stand canopy structure is generally diverse, although single-layer forest canopies are currently more common than multilayered forests with snags and large woody debris. The tree layer varies from closed forests to more open-canopy forests or woodlands. This habitat may include very open stands. The undergrowth is complex and diverse. Tall shrubs, low shrubs, forbs or any combination may dominate stands. Deciduous shrubs typify shrub layers. Prolonged canopy closure may lead to development of sparsely vegetated undergrowth.

This habitat contains a wide array of tree species and stand dominance patterns. Douglas-fir (*Pseudotsuga menziesii*) is the most common tree species in this habitat. It is almost always present and dominates or co-dominates most overstories. Lower elevations or drier sites may have ponderosa pine (*Pinus ponderosa*) as a co-dominant with Douglas-fir in the overstory and often have other shade-tolerant tree species growing in the undergrowth. On moist sites, grand fir (*Abies grandis*), western redcedar (*Thuja plicata*) and/or western hemlock (*Tsuga heterophylla*) are dominant or co-dominant with Douglas-fir. Other conifers include western larch (*Larix occidentalis*) and western white pine (*Pinus monticola*) on mesic sites, Engelmann spruce (*Picea engelmannii*), lodgepole pine (*Pinus contorta*), and subalpine fir (*Abies lasiocarpa*) on colder sites. Rarely, Pacific yew (*Taxus brevifolia*) may be an abundant undergrowth tree or tall shrub.

Undergrowth vegetation varies from open to nearly closed shrub thickets with 1 to many layers. Throughout the eastside conifer habitat, tall deciduous shrubs include vine maple (*Acer circinatum*) in the Cascades, Rocky Mountain maple (*A. glabrum*), serviceberry (*Amelanchier alnifolia*), oceanspray (*Holodiscus discolor*), mallowleaf ninebark (*Physocarpus malvaceus*), and Scouler's willow (*Salix scouleriana*) at mid- to lower elevations. Medium-tall deciduous shrubs at higher elevations include fools huckleberry (*Menziesia ferruginea*), Cascade azalea (*Rhododendron albiflorum*), and big huckleberry (*Vaccinium membranaceum*). Widely distributed, generally drier site mid-height to short deciduous shrubs include baldhip rose (*Rosa gymnocarpa*), shiny-leaf spirea (*Spiraea betulifolia*), and snowberry (*Symphoricarpos albus, S. mollis,* and *S. oreophilus*). Low shrubs of higher elevations include low huckleberries (*Vaccinium cespitosum* and *V. scoparium*) and five-leaved bramble (*Rubus pedatus*). Evergreen shrubs represented in this habitat are chinquapin (*Castanopsis chrysophylla*), a tall shrub in southeastern Cascades, low to mid-height dwarf Oregongrape (*Mahonia nervosa* in the east Cascades and *M. repens* elsewhere), tobacco brush (*Ceanothus velutinus*), an increaser with fire, Oregon boxwood (*Paxistima myrsinites*) generally at mid- to lower elevations, beargrass (*Xerophyllum tenax*), pinemat manzanita (*Arctostaphylos nevadensis*) and kinnikinnick (*A. uva-ursi*).

Herbaceous broadleaf plants are important indicators of site productivity and disturbance. Species generally indicating productive sites include western oakfern (*Gymnocarpium dryopteris*), vanillaleaf (*Achlys triphylla*), wild sarsparilla (*Aralia nudicaulis*), wild ginger (*Asarum caudatum*), queen's cup (*Clintonia uniflora*), goldthread (*Coptis occidentalis*), false bugbane (*Trautvetteria caroliniensis*), windflower (*Anemone oregana, A. piperi, A. lyallii*), fairybells (*Disporum hookeri*), Sitka valerian (*Valeriana sitchensis*), and pioneer violet (*Viola glabella*). Other indicator forbs are dogbane (*Apocynum androsaemifolium*), false solomonseal (*Maianthemum stellata*), heartleaf arnica (*Arnica cordifolia*), several lupines (*Lupinus caudatus, L. latifolius, L. argenteus ssp. argenteus var laxiflorus*), western meadowrue (*Thalictrum occidentale*), rattlesnake plantain (*Goodyera oblongifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*), trailplant (*Adenocaulon bicolor*), twinflower (*Linnaea borealis*), western starflower (*Trientalis latifolia*), and several wintergreens (*Pyrola asarifolia, P. picta, Orthilia secunda*).

Graminoids are common in this forest habitat. Columbia brome (*Bromus vulgaris*), oniongrass (*Melica bulbosa*), northwestern sedge (*Carex concinnoides*) and western fescue (*Festuca occidentalis*) are found mostly in mesic forests with shrubs or mixed with forb species. Bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), and junegrass (*Koeleria macrantha*) are found in drier more open forests or woodlands. Pinegrass (*Calamagrostis rubescens*) and Geyer's sedge (*C. geyeri*) can form a dense layer under Douglas-fir or grand fir trees.

Fires were probably of moderate frequency (30-100 years) in presettlement times. Inland Pacific Northwest Douglas-fir and western larch forests have a mean fire interval of 52 years (Barrett et al. 1997). Typically, stand-replacement fire-return intervals are 150-500 years with moderate severity-fire intervals of 50-100 years. Specific fire influences vary with site characteristics. Generally, wetter sites burn less frequently and stands are older with more western hemlock and western redcedar than drier sites. Many sites dominated by Douglas-fir and ponderosa pine, which were formerly maintained by wildfire, may now be dominated by grand fir (a fire sensitive, shade-tolerant species).

Successional relationships of this type reflect complex interrelationships between site potential, plant species characteristics, and disturbance regime (Zack and Morgan 1994). Generally, early seral forests of shade-intolerant trees (western larch, western white pine, ponderosa pine, Douglas-fir) or tolerant trees (grand fir, western redcedar, western hemlock) develop some 50 years following disturbance. This stage is preceded by forb- or shrub- dominated communities. These early stage mosaics are maintained on ridges and drier topographic positions by frequent fires. Early seral forest develops into mid-seral habitat of large trees during the next 50-100 years. Stand replacing fires recycle this stage back to early seral stages over most of the landscape. Without high-severity fires, a late-seral condition develops either single-layer or multilayer structure during the next 100-200 years. These structures are typical of cool bottomlands that usually only experience low-intensity fires.

This habitat has been most affected by timber harvesting and fire suppression. Timber harvesting has focused on large shade-intolerant species in mid- and late-seral forests, leaving shade-tolerant species. Fire suppression reinforces those logging priorities by promoting less fire-resistant, shade-intolerant trees. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. Mid-seral forest structure is currently 70% more abundant than in historical, native systems (Quigley and Arbelbide 1997). Late-seral forests of shade-intolerant species are now essentially absent. Early-seral forest abundance is similar to that found historically but lacks snags and other legacy features.

Quigley and Arbelbide (1997) concluded that the Interior Douglas-fir, Grand fir, and Western redcedar/Western hemlock cover types are more abundant now than before 1900, whereas the Western larch and Western white pine types are significantly less abundant. Twenty percent of Pacific Northwest Douglas-fir, grand fir, western redcedar, western hemlock, and western white pine associations listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson et al. 1998). Roads, timber harvest, periodic grazing, and altered fire regimes have compromised these forests. Even though this habitat is more extensive than pre-1900, natural processes and functions have been modified enough to alter its natural status as functional habitat for many species.

Lodgepole Pine Forest and Woodlands

This habitat is found along the eastside of the Cascade Range, in the Blue Mountains, the Okanogan Highlands and ranges north into British Columbia and south to Colorado and California. Within the Little White Salmon River subbasin, there has been little change in acreage of Lodgepole Pine Forest habitat from historical to current conditions (Table Q-16).

This habitat is located mostly at mid- to higher elevations (3,000-9,000 ft [914-2,743 m]). These environments can be cold and relatively dry, usually with persistent winter snowpack. A few of these forests occur in low-lying frost pockets, wet areas, or under edaphic control (usually pumice) and are relatively long-lasting features of the landscape. Lodgepole pine habitat appears within Montane Mixed Conifer Forest east of the Cascade crest and the cooler Eastside Mixed Conifer Forest habitats.

The lodgepole pine habitat is composed of open to closed evergreen conifer tree canopies. Vertical structure is typically a single tree layer. Reproduction of other more shade-tolerant conifers can be abundant in the undergrowth. Several distinct undergrowth types develop under the tree layer: evergreen or deciduous medium-tall shrubs, evergreen low shrub, or graminoids with few shrubs. On pumice soils, a sparsely developed shrub and graminoid undergrowth appears with open to closed tree canopies.

The tree layer of this habitat is dominated by lodgepole pine (*Pinus contorta var. latifolia* and *P. c. var. murrayana*), but it is usually associated with other montane conifers (*Abies concolor, A. grandis, A. magnifici var. shastensi, Larix occidentalis, Calocedrus decurrens, Pinus lambertiana, P. monticola, P. ponderosa, Pseudotsuga menziesii*). Subalpine fir (*Abies lasiocarpa*), mountain hemlock (*Tsuga mertensiana*), Engelmann spruce (*Picea engelmannii*), and whitebark pine (*Pinus albicaulis*), indicators of subalpine environments, are present in colder or higher sites. Quaking aspen (*Populus tremuloides*) sometimes occur in small numbers.

Shrubs can dominate the undergrowth. Tall deciduous shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), oceanspray (*Holodiscus discolor*), or Scouler's willow (*Salix scouleriana*). These tall shrubs often occur over a layer of mid-height deciduous shrubs such as baldhip rose (*Rosa gymnocarpa*), russet buffaloberry (*Shepherdia canadensis*), shiny-leaf spirea (*Spiraea betulifolia*), and snowberry (*Symphoricarpos albus* and/or *S. mollis*). At higher elevations, big huckleberry (*Vaccinium membranaceum*) can be locally important, particularly following fire. Mid-tall evergreen shrubs can be abundant in some stands, for example, creeping Oregongrape (*Mahonia repens*), tobacco brush (*Ceanothus velutinus*), and Oregon boxwood (*Paxistima myrsinites*). Colder and drier sites support low- growing evergreen shrubs, such as kinnikinnick (*Arctostaphylos uva-ursi*) or pinemat manzanita (*A. nevadensis*). Grouseberry (*V. scoparium*) and beargrass (*Xerophyllum tenax*) are consistent evergreen low shrub dominants in the subalpine part of this habitat. Manzanita (*Arctostaphylos patula*), kinnikinnick, tobacco brush, antelope bitterbrush (*Purshia tridentata*), and wax current (*Ribes cereum*) are part of this habitat on pumice soil.

Some undergrowth is dominated by graminoids with few shrubs. Pinegrass (*Calamagrostis rubescens*) and/or Geyer's sedge (*Carex geyeri*) can appear with grouseberry in the subalpine zone. Pumice soils support grassy undergrowth of long-stolon sedge (*C. inops*), Idaho fescue (*Festuca idahoensis*) or western needlegrass (*Stipa occidentalis*). The latter 2 species may occur with bitterbrush or big sagebrush and other bunchgrass steppe species. Other nondominant indicator graminoids frequently encountered in this habitat are California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), Columbia brome (*Bromus vulgaris*) and oniongrass (*Melica bulbosa*). Kentucky bluegrass (*Poa pratensis*), and bottlebrush squirreltail (*Elymus elymoides*) can be locally abundant where livestock grazing has persisted.

The forb component of this habitat is diverse and varies with environmental conditions. A partial forb list includes goldthread (*Coptis occidentalis*), false solomonseal (*Maianthemum stellata*), heartleaf arnica (*Arnica cordifolia*), several lupines (*Lupinus caudatus, L. latifolius, L. argenteus ssp. argenteus var. laxiflorus*), meadowrue (*Thalictrum occidentale*), queen's cup (*Clintonia uniflora*), rattlesnake plantain (*Goodyera oblongifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*), trailplant (*Adenocaulon bicolor*), twinflower (*Linnaea borealis*), Sitka valerian (*Valeriana sitchensis*), western starflower (*Trientalis latifolia*), and several wintergreens (*Pyrola asarifolia, P. picta, Orthilia secunda*).

This habitat typically reflects early successional forest vegetation that originated with fires. Inland Pacific Northwest lodgepole pine has a mean fire interval of 112 years (Barrett et al. 1997). Summer drought areas generally have low to medium-intensity ground fires occurring at intervals of 25-50 years, whereas areas with more moisture have a sparse undergrowth and slow fuel build-up that results in less frequent, more intense fire. With time, lodgepole pine stands increase in fuel loads. Woody fuels accumulate on the forest floor from insect (mountain pine beetle) and disease outbreaks and residual wood from past fires. Mountain pine beetle outbreaks thin stands that add fuel and create a drier environment for fire or open canopies and create gaps for other conifer regeneration. High-severity crown fires are likely in young stands, when the tree crowns are near deadwood on the ground. After the stand opens up, shade-tolerant trees increase in number.

Most Lodgepole Pine Forest and Woodlands are early- to mid seral stages initiated by fire. Typically, lodgepole pine establishes within 10-20 years after fire. This can be a gap phase process where seed sources are scarce. Lodgepole stands break up after 100-200 years. Without fires and insects, stands become more closed-canopy forest with sparse undergrowth. Because lodgepole pine cannot reproduce under its own canopy, old unburned stands are replaced by shade-tolerant conifers. Lodgepole pine on pumice soils is not seral to other tree species; these extensive stands, if not burned, thin naturally, with lodgepole pine regenerating in patches. On poorly drained pumice soils, quaking aspen sometimes plays a mid-seral role and is displaced by lodgepole when aspen clones die. Serotinous cones (cones releasing seeds after fire) are uncommon in eastern Oregon lodgepole pine (*P. c. var. murrayana*). On the Colville National Forest in Washington, only 10% of lodgepole pine (*P. c. var. latifolia*) trees in low-elevation Douglas-fir habitats had serotinous cones, whereas 82% of cones in high-elevation subalpine fir habitats were serotinous (Ahlenslager 1987).

Fire suppression has left many single- canopy lodgepole pine habitats unburned to develop into more multilayered stands. Thinning of serotinous lodgepole pine forests with fire intervals <20 years can reduce their importance over time. In pumice-soil lodgepole stands, lack of natural regeneration in harvest units has lead to creation of "pumice deserts" within otherwise forested habitats (Cochran 1985).

Quigley and Arbelbide (1997) concluded that the extent of the lodgepole pine cover type in Oregon and Washington is the same as before 1900 and in regions may exceed its historical extent. Five percent of Pacific Northwest lodgepole pine associations listed in the National Vegetation Classification are considered imperiled (Anderson et al. 1998). At a finer scale, these forests have been fragmented by roads, timber harvest, and influenced by periodic livestock grazing and altered fire regimes.

Ponderosa Pine and Interior White Oak Forest and Woodlands

This habitat occurs in much of eastern Washington and eastern Oregon, including the eastern slopes of the Cascades, the Blue Mountains and foothills, and the Okanogan Highlands. Variants of it also occur in the Rocky Mountains, the eastern Sierra Nevada, and mountains within the Great Basin. It extends into south-central British Columbia as well. Within the Little White Salmon River subbasin, this habitat type was not present historically but was present during recent mapping efforts (Table Q-16).

In the Pacific Northwest, ponderosa pine-Douglas-fir woodland habitats occur along the eastern slope of the Cascades, the Okanogan Highlands, and in the Blue Mountains. Ponderosa pine woodland and savanna habitats occur in the foothills of the Blue Mountains, along the eastern base of the Cascade Range, the Okanogan Highlands, and in the Columbia Basin in northeastern Washington. Ponderosa pine-Oregon white oak habitat appears east of the Cascades in the vicinity of Mt. Hood near the Columbia River Gorge north to the Yakama Nation and south to the Warm Springs Nation. Oak dominated woodlands follow a similar distribution as Ponderosa Pine-White Oak habitat but are more restricted and less common.

This habitat generally occurs on the driest sites supporting conifers in the Pacific Northwest. It is widespread and variable, appearing on moderate to steep slopes in canyons, foothills, and on plateaus or plains near mountains. In Oregon, this habitat can be maintained by the dry pumice soils, and in Washington it can be associated with serpentine soils. Average annual precipitation ranges from about 14 to 30 inches (36 to 76 cm) on ponderosa pine sites in Oregon and Washington and often as snow. This habitat can be found at elevations of 100 ft (30 m) in the Columbia River Gorge to dry, warm areas over 6,000 ft (1,829 m). Timber harvest, livestock grazing, and pockets of urban development are major land uses.

This woodland habitat typifies the lower treeline zone forming transitions with Eastside Mixed Conifer Forest and Western Juniper and Mountain Mahogany Woodland, Shrubsteppe, Eastside Grassland, or Agriculture habitats. Douglas-fir-ponderosa pine woodlands are found near or within the Eastside Mixed Conifer Forest habitat. Oregon oak woodlands appear in the driest most restricted landscapes in transition to Eastside Grassland or Shrubsteppe.

This habitat is typically a woodland or savanna with tree canopy coverage of 10- 60%, although closed-canopy stands are possible. The tree layer is usually composed of widely spaced large conifer trees. Many stands tend towards a multilayered condition with encroaching conifer regeneration. Isolated taller conifers above broadleaf deciduous trees characterize part of this habitat. Deciduous woodlands or forests are an important part of the structural variety of this habitat. Clonal deciduous trees can create dense patches across a grassy landscape rather than scattered individual trees. The undergrowth may include dense stands of shrubs or, more often, be dominated by grasses, sedges, or forbs. Shrubsteppe shrubs may be prominent in some stands and create a distinct tree-shrub-sparse-grassland habitat.

Ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) are the most common evergreen trees in this habitat. Grand fir (*Abies grandis*) may be frequent in the undergrowth on more productive sites giving stands a multilayer structure. In rare instances, grand fir can be co-dominant in the upper canopy. Tall ponderosa pine over Oregon white oak (*Quercus garryana*) trees form stands along part of the east Cascades. These stands usually have younger cohorts of pines. Oregon white oak dominates open woodlands or savannas in limited areas.

The undergrowth can include dense stands of shrubs or, more often, be dominated by grasses, sedges, and/or forbs. Some Douglas-fir and ponderosa pine stands have a tall to medium-tall deciduous shrub layer of mallowleaf ninebark (*Physocarpus malvaceus*) or common snowberry (*Symphoricarpos albus*). Grand fir seedlings or saplings may be present in the undergrowth. Pumice soils support a shrub layer represented by green-leaf or white-leaf manzanita *(Arctostaphylos patula* or *A. viscida*). Short shrubs, pinemat manzanita (*Arctostaphylos nevadensis*) and kinnikinnick (*A. uva-ursi*) are found across the range of this habitat. Antelope bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), black sagebrush (*A. nova*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and in southern Oregon, curl-leaf mountain mahogany (*Cercocarpus ledifolius*) often grow with Douglas-fir, ponderosa pine and/or Oregon white oak, which typically have a bunchgrass and shrubsteppe ground cover.

Undergrowth is generally dominated by herbaceous species, especially graminoids. Within a forest matrix, these woodland habitats have an open to closed sodgrass undergrowth dominated by pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*C. rossii*), long-stolon sedge (*C. inops*), or blue wildrye (*Elymus glaucus*). Drier savanna and woodland undergrowth typically contains bunchgrass steppe species, such as Idaho fescue (*Festuca idahoensis*), rough fescue (*F. campestris*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Indian ricegrass (*Oryzopsis hymenoides*), or needlegrasses (*Stipa comata, S. occidentalis*). Common exotic grasses that may appear in abundance are cheatgrass (*Bromus tectorum*), and bulbous bluegrass (*Poa bulbosa*). Forbs are common associates in this habitat and are too numerous to be listed.

Fire plays an important role in creating vegetation structure and composition in this habitat. Most of the habitat has experienced frequent low-severity fires that maintained woodland or savanna conditions. A mean fire interval of 20 years for ponderosa pine is the shortest of the vegetation types listed by Barrett et al. (1997). Soil drought plays a role in maintaining an open tree canopy in part of this dry woodland habitat.

This habitat is climax on sites near the dry limits of each of the dominant conifer species and is more seral as the environment becomes more favorable for tree growth. Open seral stands are gradually replaced by more closed shade-tolerant climax stands. Oregon white oak can reproduce under its own shade but is intolerant of overtopping by conifers. Oregon white oak woodlands are considered fire climax and are seral to conifers. In drier conditions, unfavorable to conifers, oak is climax. Oregon white oak sprouts from the trunk and root crown following cutting or burning and form clonal patches of trees.

Pre-1900, this habitat was mostly open and park like with relatively few undergrowth trees. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that gives the habitat a more closed, multilayered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Fire suppression has lead to a buildup of fuels that in turn increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support cloning of oak and invasion by conifers. Large late-seral ponderosa pine, Douglas-fir, and Oregon white oak are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. Ponderosa pine-Oregon white oak habitat is now denser than in the past and may contain more shrubs than in presettlement habitats. In some areas, new woodlands have been created by patchy tree establishment at the forest-steppe boundary.

Quigley and Arbelbide (1997) concluded that the Interior Ponderosa Pine cover type is significantly less in extent than pre-1900 and that the Oregon White Oak cover type is greater in extent than pre-1900. Quigley and Arbelbide (1997) included much of this habitat in their Dry Forest potential vegetation group, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late-seral, single-layer condition. This habitat is generally degraded because of increased exotic plants and decreased native bunchgrasses. One third of Pacific Northwest Oregon white oak, ponderosa pine, and dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson et al. 1998).

Alpine Grasslands and Shrublands

This habitat occurs in high mountains throughout the region, including the Cascades, Olympic Mountains, Okanogan Highlands, Wallowa Mountains, Blue Mountains, Steens Mountain in southeastern Oregon, and, rarely, the Siskiyous. It is most extensive in the Cascades from Mount Rainier north and in the Wallowa Mountains. Within the Little White Salmon River subbasin, this habitat type was not present historically but was present during recent mapping efforts (Table Q-16).

The climate is the coldest of any habitat in the region. Winters are characterized by moderate to deep snow accumulations, very cold temperatures, and high winds. Summers are relatively cool. Growing seasons are short because of persistent snow pack or frost. Blowing snow and ice crystals on top of the snow pack at and above treeline prevent vegetation such as trees from growing above the depth of the snow pack. Snow pack protects vegetation from the effects of this winter wind-related disturbance and from excessive frost heaving. Community composition is much influenced by relative duration of snow burial and exposure to wind and frost heaving 75. Elevation ranges from a minimum of 5,000 ft (1,524 m) in parts of the Olympics to 10,000 ft (3,048 m). The topography varies from gently sloping broad ridgetops, to glacial cirque basins, to steep slopes of all aspects. Soils are generally poorly developed and shallow, though in subalpine grasslands they may be somewhat deeper or better developed. Geologic parent material varies with local geologic history.

This habitat always occurs above upper treeline in the mountains or a short distance below it (grasslands in the subalpine parkland zone). Typically, it occurs adjacent to, or in a mosaic with, Subalpine Parkland. Occasionally, it may grade quickly from this habitat down into Montane Mixed Conifer Forest without intervening Subalpine Parkland. Small areas of Open Water, Herbaceous Wetlands, and Subalpine Parkland habitats sometimes occur within a matrix of this habitat. Cliffs, talus, and other barren areas are common features within or adjacent to this habitat. Land use is primarily recreation, but in some areas east of the Cascade Crest, it is grazing, especially by sheep.

Structure of this habitat is dominated by grassland, dwarf-shrubland (mostly evergreen microphyllous), or forbs. Cover of the various life forms is extremely variable, and total cover of vascular plants can range from sparse to complete. Patches of krummholz (coniferous tree species maintained in shrub form by extreme environmental conditions) are a common component of this habitat, especially just above upper treeline. In subalpine grasslands, which are considered part of this habitat, widely scattered coniferous trees sometimes occur. Five major structural types can be distinguished: (1) subalpine and alpine bunchgrass grasslands, (2) alpine sedge turf, (3) alpine heath or dwarf-shrubland, (4) fellfield and boulderfield, and (5) snowbed forb community. Fellfields have a large amount of bare ground or rocks with a diverse and variable open layer of forbs, graminoids, and less commonly dwarf-shrubs. Snowbed forb communities have relatively sparse cover of few species of mainly forbs. In the alpine zone, these types often occur in a complex fine-scale mosaic with each other.

Most subalpine or alpine bunchgrass grasslands are dominated by Idaho fescue (*Festuca idahoensis*), alpine fescue (*F. brachyphylla*), green fescue (*F. viridula*), Rocky Mountain fescue (*F. saximontana*), or timber oatgrass (*Danthonia intermedia*), and to a lesser degree, purple reedgrass (*Calamagrostis purpurascens*), downy oat-grass (*Trisetum spicatum*) or muttongrass (*Poa fendleriana*). Forbs are diverse and sometimes abundant in the grasslands. Alpine sedge turfs may be moist or dry and are dominated by showy sedge (*Carex spectabilis*), black alpine sedge (*C. nigricans*), Brewer's sedge (*C. breweri*), capitate sedge (*C. capitata*), nard sedge (*C. nardina*), dunhead sedge (*C. phaeocephala*), or western single-spike sedge (*C. pseudoscirpoidea*).

One or more of the following species dominates alpine heaths: pink mountain-heather (*Phyllodoce empetriformis*), green mountain-heather (*P. glanduliflora*), white mountain-heather (*Cassiope mertensiana*), or black crowberry (*Empetrum nigrum*). Other less extensive dwarf-shrublands may be dominated by the evergreen coniferous common juniper (*Juniperus communis*), the evergreen broadleaf kinnikinnick (*Arctostaphylos uva-ursi*), the deciduous shrubby cinquefoil (*Pentaphylloides floribunda*) or willows (*Salix cascadensis* and *S. reticulata ssp. nivalis*). Tree species occurring as shrubby krummholz in the alpine are subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), mountain hemlock (*Tsuga mertensiana*), Engelmann spruce (*Picea engelmannii*), and subalpine larch (*Larix lyallii*).

Fellfields and similar communities are typified by variable species assemblages and co-dominance of multiple species, including any of the previously mentioned species, especially the sedges, as well as golden fleabane (*Erigeron aureus*), Lobb's lupine (*Lupinus sellulus var. lobbii*), spreading phlox (*Phlox diffusa*), eight-petal mountain-avens (*Dryas octopetala*), louseworts (*Pedicularis contorta, P. ornithorhyncha*) and many others. Snowbed forb communities are dominated by Tolmie's saxifrage (*Saxifraga tolmiei*), Shasta buckwheat (*Eriogonum pyrolifolium*), or Piper's woodrush (*Luzula piperi*).

Most natural disturbances seem to be small scale in their effects or very infrequent. Herbivory and associated trampling disturbance by elk, mountain goats, and occasionally bighorn sheep seems to be an important disturbance in some areas, creating patches of open ground, though the current distribution and abundance of these ungulates is in part a result of introductions. Small mammals can also have significant effects on vegetation: e.g., the heather vole occasionally overgrazes heather communities (Edwards 1980). Frost heaving is a climatically related small-scale disturbance that is extremely important in structuring the vegetation (Edwards 1980). Extreme variation from the norm in snow pack depth and duration can act as a disturbance, exposing plants to winter dessication (Edwards 1980), shortening the growing season, or facilitating summer drought. Subalpine grasslands probably burn on occasion and can be formed or expanded in area by fires in subalpine parkland (Kuramoto and Bliss 1970).

Little is known about vegetation changes in these communities, in part because changes are relatively slow. Tree invasion rates into subalpine grasslands are relatively slow compared to other subalpine communities (Kuramoto and Bliss 1970). Seedling establishment for many plant species in the alpine zone is poor. Heath communities take about 200 years to mature after initial establishment and may occupy the same site for thousands of years (Kuramoto and Bliss 1970).

The major human impacts on this habitat are trampling and associated recreational impacts (e.g., tent sites). Resistance and resilience of vegetation to impacts varies by life form (Cole 1977). Sedge turfs are perhaps most resilient to trampling and heaths are least resilient. Trampling to the point of significantly opening an alpine heath canopy will initiate a degradation and erosion phase that results in continuous bare ground, largely unsuitable for vascular plant growth (Edwards 1980). Bare ground in the alpine zone left alone after recreational disturbance will typically not revegetate in a noticeable time frame. Introduction of exotic ungulates can have noticeable impacts (e.g., mountain goats in the Olympic Mountains). Domestic sheep grazing has also had dramatic impacts (Strickler and Hall 1980), especially in the bunchgrass habitats east of the Cascades.

This habitat is naturally very limited in extent in the region. There has been little to no change in abundance over the last 150 years. Most of this habitat is still in good condition and dominated by native species. Some areas east of the Cascade Crest have been degraded by livestock use. Recreational impacts are noticeable in some national parks and wilderness areas. Current trends seem to be largely stable, though there may be some slow loss of subalpine grassland to recent tree invasion. Threats include increasing recreational pressures, continued grazing at some sites, and, possibly, global climate change resulting in expansion of trees into this habitat.

Montane Coniferous Wetlands

This habitat occurs in mountains throughout much of Washington and Oregon, except the Basin and Range of southeastern Oregon, the Klamath Mountains of southwestern Oregon, and the Coast Range of Oregon. This includes the Cascade Range, Olympic Mountains, Okanogan Highlands, Blue and Wallowa mountains. Within the Little White Salmon River subbasin, this habitat type was not present historically but was present during recent mapping efforts (Table Q-16). It is not clear whether there has been an actual gain of Montane Coniferous Wetlands within the Little White Salmon River subbasin or the estimated habitat gain is an artifact of mapping. The addition of 380 acres of Montane Coniferous Wetlands was accompanied by the loss of 119 acres of Open Water habitats (Table Q-16).

This habitat is typified as forested wetlands or floodplains with a persistent winter snow pack, ranging from moderately to very deep. The climate varies from moderately cool and wet to moderately dry and very cold. Mean annual precipitation ranges from about 35 to >200 inches (89 to >508 cm). Elevation is mid- to upper montane, as low as 2,000 ft (610 m) in northern Washington, to as high as 9,500 ft (2,896 m) in eastern Oregon. Topography is generally mountainous and includes everything from steep mountain slopes to nearly flat valley bottoms. Gleyed or mottled mineral soils, organic soils, or alluvial soils are typical. Subsurface water flow within the rooting zone is common on slopes with impermeable soil layers. Flooding regimes include saturated, seasonally flooded, and temporarily flooded. Seeps and springs are common in this habitat.

This habitat occurs along stream courses or as patches, typically small, within a matrix of Montane Mixed Conifer Forest, or less commonly, Eastside Mixed Conifer Forest or Lodgepole Pine Forest and Woodlands. It also can occur adjacent to other wetland habitats: Eastside Riparian-Wetlands, Westside Riparian-Wetlands, or Herbaceous Wetlands. The primary land uses are forestry and watershed protection.

Structure of this habitat is a forest or woodland (>30% tree canopy cover) dominated by evergreen conifer trees. Deciduous broadleaf trees are occasionally co-dominant. The understory is dominated by shrubs (most often deciduous and relatively tall), forbs, or graminoids. The forb layer is usually well developed even where a shrub layer is dominant. Canopy structure includes single-storied canopies and complex multi-layered ones. Typical tree sizes range from small to very large. Large woody debris is often a prominent feature, although it can be lacking on less productive sites.

Indicator tree species for this habitat, any of which can be dominant or co-dominant, are Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), and Alaska yellow-cedar (*Chamaecyparis nootkatensis*) on the westside, and Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), western hemlock (*T. heterophylla*), or western redcedar (*Thuja plicata*) on the eastside. Lodgepole pine is prevalent only in wetlands of eastern Oregon. Western hemlock and redcedar are common associates with silver fir on the westside. They are diagnostic of this habitat on the east slope of the central Washington Cascades. Douglas-fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*) are sometimes prominent on the eastside. Quaking aspen (*Populus tremuloides*) and black cottonwood (*P. balsamifera* ssp. *trichocarpa*) are in certain instances important to co-dominant, mainly on the eastside.

Dominant or co-dominant shrubs include devil's-club (*Oplopanax horridus*), stink currant (*Ribes bracteosum*), black currant (*R. hudsonianum*), swamp gooseberry (*R. lacustre*), salmonberry (*Rubus spectabilis*), red-osier dogwood (*Cornus sericea*), Douglas' spirea (*Spirea douglasii*), common snowberry (*Symphoricarpos albus*), mountain alder (*Alnus incana*), Sitka alder (*Alnus viridis* ssp. *sinuata*), Cascade azalea (*Rhododendron albiflorum*), and glandular Labrador-tea (*Ledum glandulosum*). The dwarf shrub bog blueberry (*Vaccinium uliginosum*) is an occasional understory dominant. Shrubs more typical of adjacent uplands are sometimes co-dominant, especially big huckleberry (*V. membranaceum*), oval-leaf huckleberry (*V. ovalifolium*), grouseberry (*V. scoparium*), and fools huckleberry (*Menziesia ferruginea*).

Graminoids that may dominate the understory include bluejoint reedgrass (*Calamagrostis canadensis*), Holm's Rocky Mountain sedge (*Carex scopulorum*), widefruit sedge (*C. angustata*), and fewflower spikerush (*Eleocharis quinquiflora*). Some of the most abundant forbs and ferns are ladyfern (*Athyrium filix-femina*), western oakfern (*Gymnocarpium dryopteris*), field horsetail (*Equisetum arvense*), arrowleaf groundsel (*Senecio triangularis*), two-flowered marshmarigold (*Caltha leptosepala* ssp. *howellii*), false bugbane (*Trautvetteria carolinensis*), skunk-cabbage (*Lysichiton americanus*), twinflower (*Linnaea borealis*), western bunchberry (*Cornus unalaschkensis*), clasping-leaved twisted-stalk (*Streptopus amplexifolius*), singleleaf foamflower (*Tiarella trifoliata* var. *unifoliata*), and five-leaved bramble (*Rubus pedatus*).

Flooding, debris flow, fire, and wind are the major natural disturbances. Many of these sites are seasonally or temporarily flooded. Floods vary greatly in frequency depending on fluvial position. Floods can deposit new sediments or create new surfaces for primary succession. Debris flows/torrents are major scouring events that reshape stream channels and riparian surfaces, and create opportunities for primary succession and redistribution of woody debris. Fire is more prevalent east of the Cascade Crest. Fires are typically high in severity and can replace entire stands, as these tree species have low fire resistance. Although fires have not been studied specifically in these wetlands, fire frequency is probably low. These wetland areas are less likely to burn than surrounding uplands, and so may sometimes escape extensive burns as old forest refugia (Agee 1993). Shallow rooting and wet soils are conducive to windthrow, which is a common small-scale disturbance that influences forest patterns. Snow avalanches probably disturb portions of this habitat in the northwestern Cascades and Olympic Mountains. Fungal pathogens and insects also act as important small-scale natural disturbances.

Succession has not been well studied in this habitat. Following disturbance, tall shrubs may dominate for some time, especially mountain alder, stink currant, salmonberry, willows (*Salix* spp.), or Sitka alder. Quaking aspen and black cottonwood in these habitats probably regenerate primarily after floods or fires, and decrease in importance as succession progresses. Pacific silver fir, subalpine fir, or Engelmann spruce would be expected to increase in importance with time since the last major disturbance. Western hemlock, western redcedar, and Alaska yellow-cedar typically maintain co-dominance as stand development progresses because of the frequency of small-scale disturbances and the longevity of these species. Tree size, large woody debris, and canopy layer complexity all increase for at least a few hundred years after fire or other major disturbance.

Roads and clearcut logging practices can increase the frequency of landslides and resultant debris flows/torrents, as well as sediment loads in streams (Swanson and Dyrness 1975, Ziemer 1981, Swanson et al. 1987). This in turn alters hydrologic patterns and the composition and structure of montane riparian habitats. Logging typically reduces large woody debris and canopy structural complexity. Timber harvest on some sites can cause the water table to rise and subsequently prevent trees from establishing (Williams et al. 1995). Wind disturbance can be greatly increased by timber harvest in or adjacent to this habitat.

This habitat is naturally limited in its extent and has probably declined little in area over time. Portions of this habitat have been degraded by the effects of logging, either directly on site or through geohydrologic modifications. This type is probably relatively stable in extent and condition, although it may be locally declining in condition because of logging and road building. Five of 32 plant associations representing this habitat listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson et al. 1998).

Open Water-Lakes, Rivers, and Streams

Within the Little White Salmon River subbasin, there has been a loss of about half of this habitat type from historical to present conditions, although the total acreage of open water habitat represents a small portion of overall habitat in the subbasin (Table Q-16). It is not clear whether there has been an actual loss of Open Water habitats within the Little White Salmon River subbasin or the estimated habitat loss is an artifact of mapping. The loss of 119 acres of Open Water habitat was accompanied by the addition of 380 acres of Montane Coniferous Wetlands (Table Q-16).

Lakes and Reservoirs: Lakes in Oregon and Washington occur statewide and are found from near sea level to about 10,200 ft (3,110 m) above sea level. There are 3,887 lakes and reservoirs in western Washington and they total 176,920 acres (71,628 ha) (Winward 1970). In contrast, there are 4,073 lakes and reservoirs in eastern Washington that total 436,843 acres (176,860 ha) (Wolcott 1973b).

Continental glaciers melted and left depressions, where water accumulated and formed many lakes in the region. The lakes in the Cascades and Olympic ranges were formed through glaciation and range in elevation from 2,500 to 5,000 ft (762 to 1,524 m). Beavers create many ponds and marshes in Oregon and Washington. Craters created by extinct volcanoes, like Battleground Lake, Washington, also formed lakes. Human-made reservoirs created by dams impound water that creates lakes behind them, like Bonneville Dam on the main stem of the Columbia River. In the lower Columbia Basin, many lakes formed in depressions and rocky coulees through the process of seepage from irrigation waters (Wolcott 1973a).

There are 4 distinct structural zones within this aquatic system: (1) the littoral zone at the edge of lakes is the most productive with diverse aquatic beds and emergent wetlands (part of Herbaceous Wetland's habitat); (2) the limnetic zone is deep open water, dominated by phytoplankton and freshwater fish, and extends down to the limits of light penetration; (3) the profundal zone below the limnetic zone, devoid of plant life and dominated with detritivores; (4) and the benthic zone reflecting bottom soil and sediments. Nutrients from the profundal zone are recycled back to upper layers by the spring and fall turnover of the water. Water in temperate climates stratifies because of the changes in water density. The uppermost layer, the epilimnion, is where water is warmer (less dense). Next, the metalimnion or thermocline, is a narrow layer that prevents the mixing of the upper and lowermost layers. The lowest layer is the hypolimnion, with colder and most dense waters. During the fall turnover, the cooled upper layers are mixed with other layers through wind action.

There are seasonal and decadal variations in the patterns of precipitation. The Willamette Valley and the Cascades generally experience 1 month with no rain every year and a 2-month dry period every third year. Dry years, with <33% of normal precipitation occur once every 30 years along the coast, every 20 years in the Willamette Valley, every 30 years in the Cascades, and every 15 years in most of eastern Oregon (Bastasch 1998).

Floods occur in Oregon and Washington every year. Flooding season west of the Cascades occurs from October through April, with more than half of the floods occurring during December and January. Floods are the result of precipitation and snow melts. Floods west of the Cascades are influenced by precipitation mostly and thus are short-lived, while east of the Cascades floods are caused by melting snow, and the amount of flooding depends on how fast the snow melts. High water levels frequently last up to 60 days. The worst floods have resulted from cloudbursts caused by thunderstorms.

Anthropogenic factors affect open water habitat quality: sewage effluents cause eutrophication, where plants increase in biomass and cause decreased light transmission; irrigation projects aimed at watering drier portions of the landscape may pose flooding dangers; and natural salinity of lakes can decrease as a result of irrigation withdrawal and can change the biota associated with them (Frey 1966).

Rivers and Streams: Streams and rivers are distributed statewide in Oregon and Washington, forming a continuous network connecting high mountain areas to lowlands and the Pacific coast. Oregon's longest stretch of river is the Columbia (309 miles [497 km]) that borders Oregon and Washington. Washington has more streams than any other state except Alaska. The rivers and streams range from cold, fast-moving, high-elevation streams to warmer, lowland valley rivers (Williams et al. 1975). In all, there are 13,955 rivers and streams that add up to 24,774 miles (39,861 km); there are many more streams in Washington yet to be catalogued (Phinney and Bucknell 1975).

Climate of the region is generally wet. The southern portion in Washington is characterized by low-lying, rolling hills (Phinney and Bucknell 1975). Water from melting snowpacks and glaciers provide flow during the spring and winter. Annual rainfall in the lowlands ranges from 35 to 50 inches (89-127 cm), from 75 to 100 inches (191 to 254 cm) in the foothills, and from 100 to >200 inches (254 to 508 cm) in the mountains (mostly in the form of snow) (Phinney and Bucknell 1975).

The western Cascades in Washington and Oregon are composed of volcanically derived rocks and are more stable. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events (Everest 1987). Velocities of river flow ranges from as little as 0.2 to 12 mph (0.3 to19.3 km/hr) while large streams have an average annual flow of 10 cubic feet (0.3 m^3) per second or greater (ODF 1994, Bastasch 1998). Rivers and streams in the Cascades and Blue mountains are similar in that they have more runs and glides and fewer pools, similar fish assemblages, and similar water quality (Whittier et al. 1988).

This habitat occurs throughout Washington and Oregon. Ponds, lakes, and reservoirs are typically adjacent to Herbaceous Wetlands, while rivers and streams typically adjoin the Westside Riparian Wetlands, Eastside Riparian Wetlands, Herbaceous Wetlands, or Bays and Estuaries habitats.

Anthropogenic factors affect river and stream habitat quality in many ways. Removal of gravel results in reduction of spawning areas for anadromous fish. Overgrazing and loss of vegetation caused by logging produces increased water temperatures and excessive siltation, harming the invertebrate communities (Mac et al. 1998). Incorrectly installed culverts may act as barriers to migrating fish and may contribute to erosion and siltation downstream (Phinney and Bucknell 1975). Construction of dams is associated with changes in water quality, fish passage, competition between species, loss of spawning areas because of flooding, and declines in native fish populations (Mac et al. 1998). Historically, the region's rivers contained more braided multi-channels. Flood control measures such as channel straightening, diking, or removal of streambed material along with urban and agriculture development have all contributed to a loss of oxbows, river meanders, and flood plains. Unauthorized or over-appropriated withdrawals of water from the natural drainages also have caused a loss of open water habitat that has been detrimental to fish and wildlife production, particularly in the summer (Phinney and Bucknell 1975).

Agricultural, industrial, and sewage runoff such as salts, sediments, fertilizers, pesticides, and bacteria harm aquatic species (Mac et al. 1998). Sludge and heavy waste buildup in estuaries is harmful to fish and shellfish. Unregulated aerial spraying of pesticides over agricultural areas also poses a threat to aquatic and terrestrial life (Phinney and Bucknell 1975). Direct loss of habitat and water quality occurs through irrigation (Knutson and Naef 1997). The Oregon Department of Environmental Quality, after a study of water quality of the Willamette River, determined that up to 80% of water pollution enters the river from nonpoint sources and especially agricultural activity (Bastasch 1998). Very large floods may change the channels permanently through the settling of large amounts of sediments from hillslopes, through debris flow, and through movement of large boulders, particularly in the montane areas. Clearcutting creates excessive intermittent runoff conditions and increases erosion and siltation of streams as well as diminishes shade, and therefore causes higher water temperatures, fewer terrestrial and aquatic food organisms, and increased predation. Landslides, which contributed to the widening of the channel, were a direct result of clearcutting. Clearcut logging can alter snow accumulation and increase the size of peak flows during times of snowmelt (Sullivan et al. 1987). Clearcutting and vegetation removal affects the temperatures of streams, increasing them in the summer and decreasing in winter, especially in eastern parts of the Oregon and Washington (Beschta et al. 1987). Building of roads, especially those of poor quality, can be a major contributor to sedimentation in the streams (Everest et al. 1987).

The principal trend has been in relationship to dam building or channelization for hydroelectric power, flood control, or irrigation purposes. As an example, in 1994, there were >900 dams in Washington alone. The dams vary according to size, primary purpose, and ownership (state, federal, private, local) (WDE 1994). In response to the damaging effects of dams on the indigenous biota and alteration and destruction of freshwater aquatic habitats, Oregon and Washington state governments questioned the benefits of dams, especially in light of the federal listing of several salmon species (Bastasch 1998).

Q.3.7. 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). IWA results were calculated only for sediment conditions for subwatersheds in the Little White Salmon River watershed. See Appendix E for additional information on the IWA.

Collectively, the Little White Salmon watershed covers approximately 95,700 acres (79 mi/mi^2). The watershed also includes two smaller drainages, Dog Creek to the west and an unnamed tributary to the east. IWA results for the Little White Salmon River watershed are shown in Table Q-17. A reference map showing the location of each subwatershed in the basin is presented in Figure Q-15. Maps of the distribution of local and watershed level IWA results are displayed in Figure Q-16.

Hydrology

Current Conditions -- IWA results were not developed for hydrologic conditions in the Little White Salmon watershed because of a lack of GIS based data for forest cover.

However, ratings for local hydrologic conditions can be derived from available sources of information. The 1995 watershed analysis conducted by the USFS indicates that 19% of the subbasin features hydrologically immature forest cover. The USFS watershed analysis divided the watershed into 24 subwatersheds (USFS 1995), which is not compatible with the 15 LCFRB recovery planning subwatersheds. Based on the USFS results, all subwatersheds appear to have hydrologically mature vegetation in excess of 50% of the total area. With the IWA method, percent immature hydrologic vegetation and road density are used to rate likely hydrologic condition where impervious surface information is not available. As a result of generally uniform coverage with hydrologically mature vegetation, road densities would be the determinant of hydrologic conditions in the IWA method. The Little White Salmon headwaters (00302), middle Little White Salmon/Cabbage Creek (00401), middle Little White Salmon/Berry Creek, and the lowermost mainstem subwatersheds (00501 and 00502) have road densities in excess of 3 mi/sq mi). These subwatersheds would all be rated as moderately impaired at the local level. All remaining subwatersheds have road densities below 3 mi/sq mi and would be rated as locally functional.

These ratings must be considered against the complex hydrology of the watershed. Much of the surface flow in the Lost Creek drainage and subwatersheds 00204, 00203 and 00202 flows subsurface into the Big Lava Bed and other porous basaltic geology, buffering the hydrology of Lava Creek and the lower Little White Salmon River and resulting in functional hydrology conditions in these portions of the watershed. In addition, some of the subsurface flows in the watershed appear to route to the east, resurfacing in the White Salmon watershed (USFS 1995).

Predicted future trends -- The predicted trend for Lava Creek, Lost Creek, and the lower Little White Salmon River is for conditions to remain stable or slowly improve based on recovering vegetative cover and the high degree of subsurface flows, which moderate flow variation. Given the large percentage of the watershed that is in public ownership, hydrologic conditions in middle mainstem and headwater areas are predicted to trend towards improvement as vegetation matures

Table Q-17. IWA results for the Little White Salmon River Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
00501	M*	M	ND	ND	M	00101, 00102, 00201, 00202, 00203, 00204, 00205, 00301, 00302, 00401, 00402, 00502
00502	M*	M	ND	ND	M	00101, 00102, 00201, 00202, 00203, 00204, 00205, 00301, 00302, 00401, 00402
00401	M*	F	ND	ND	F	00301, 00302, 00402
00402	M*	F	ND	ND	F	00301, 00302
00301	F*	F	ND	ND	F	00302
00302	M*	F	ND	ND	F	—
00201	F*	F	ND	ND	F	00101, 00102, 00202, 00203, 00204, 00205
00202	ND	M	ND	ND	F	00101, 00102, 00203, 00204, 00205
00203	ND	F	ND	ND	F	00101, 00102, 00204, 00205
00204	ND	M	ND	ND	M	—
00205	ND	F	ND	ND	F	00102
00101	ND	F	ND	ND	F	—
00102	ND	M	ND	ND	M	—

Notes:
[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170701051#####.
[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
ND: Not evaluated due to lack of data
* Rating was qualitatively derived from available sources of data for the watershed (USFS 1995).

[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

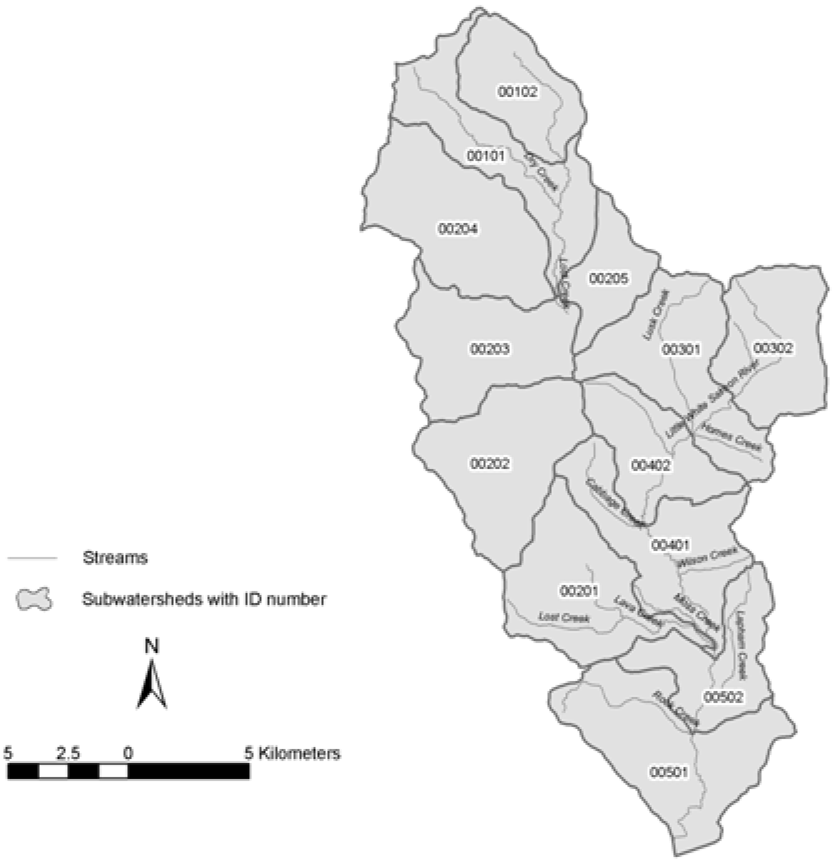


Figure Q-15. Map of the Little White Salmon basin showing the location of the IWA subwatersheds.

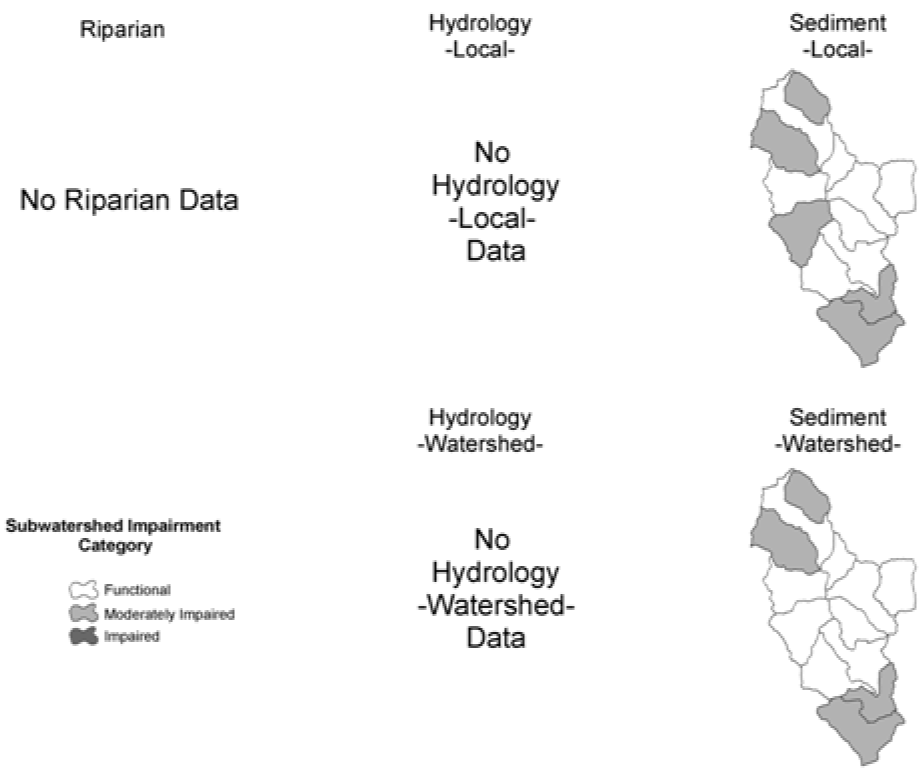


Figure Q-16. IWA subwatershed impairment ratings by category for the Little White Salmon basin

Sediment Supply

Current Conditions -- Local sediment conditions were rated as functional in eight of 15 subwatersheds, with the remaining seven subwatersheds rated as moderately impaired. Watershed level sediment conditions were rated as functional in nine subwatersheds, with six rated as moderately impaired. There are no subwatersheds with impaired sediment conditions at the local or watershed level.

Functional sediment conditions at the local level are distributed throughout the middle subwatersheds while the headwater areas of the Little White Salmon River are rated as functional or moderately impaired. Sediment conditions in these subwatersheds are generally rated functional because of moderate road densities (3 mi/sq mi) and lower concentrations of roads in sensitive areas. These subwatersheds include the Lava Creek drainage (00201) and the subwatersheds along the mainstem, including Cabbage Creek (00401), Berry Creek (00402), Lusk Creek (00301), and streams in the Salmon Creek headwaters (00302). Streamside road densities average less than 1 mile/stream mile in these subwatersheds. Over 90% these subwatersheds are in federal or state lands. Despite the functional ratings, some turbidity problems have been identified as associated with extensive past logging activities in the upper watershed (WCC 1999).

Local sediment conditions in the headwaters of Lost Creek are rated as moderately impaired. Additionally, moderately impaired subwatersheds are concentrated at the downstream end of the watershed and the independent drainages to the east and west.

The distribution of watershed level sediment conditions is similar to the local conditions, with moderately impaired sediment ratings concentrated in the headwaters of the Lost Creek drainage and in subwatersheds at the downstream end of the watershed. It is important to note that moderately impaired sediment ratings in the headwaters of the Lost Creek drainage (00102, 00101) are in subwatersheds that drain to marshlands which feed subsurface flows in the Big Lava Bed. Therefore, sediment conditions in headwaters of the Lost Creek drainage subwatersheds are effectively disconnected from the mainstem Little White Salmon and do not contribute to downstream watershed level sediment conditions.

Predicted Future Trends -- Given the coverage of public lands ownership, moderately low erodability, and moderate road densities, sediment conditions in the headwaters and middle mainstem subwatersheds are predicted to trend stable, with turbidity conditions improving over the next 20 years as vegetation matures.

Riparian Condition

IWA results were not developed for hydrologic conditions in the Little White Salmon watershed because of a lack of GIS based data for forest cover.

Q.3.8. Other Factors and Limitations

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 Little White Salmon subbasin and discusses their potential effects.

Little White National Fish Hatchery: The Little White National Fish Hatchery (since 1937) operates in the Little White Salmon at RM 1, and the Williard National Fish Hatchery is located at RM 5. These hatcheries coordinate production of coho, spring Chinook, and fall Chinook and are referred to as the Little White Salmon Hatchery Complex. The hatchery complex produces Carson stock spring Chinook, URB stock fall Chinook, and early stock coho for treaty Indian and non-Indian harvest. Current production levels for the Little White Salmon Hatchery Complex are shown in Table Q-18.

The spring Chinook program includes releases of just over 1 million smolts annually into the Little White Salmon River. Hatchery production accounts for all spring Chinook returning to the Little White Salmon with broodstock from mixed origin.

Historically, the Little White Salmon fall Chinook population was the earlier spawning tule stock and was substantial, but the population has not persisted. In 1988, hatchery production shifted from tules to upriver bright (URB) late fall Chinook as part of the John Day Dam mitigation and a *U.S. v. Oregon* Agreement. Remaining tule fall Chinook in the Little White Salmon River are likely strays from Spring Creek NFH. The current Little White Salmon Hatchery fall Chinook program includes 3.7 million URB fall Chinook, with 2.0 million released into the Little White Salmon River and the remainder transferred to the, Yakima River as part of John Day Dam mitigation.

Table Q-18. Current Little White Salmon subbasin hatchery production released into the Little White Salmon River

Hatchery	Release Location	Fall Chinook (URB Stock)	Early Coho	Spring Chinook
Little White Salmon Complex	Little White Salmon River	2,000,000	1,000,000	1,000,000

Hatchery Program Assessment: The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC related plans on the Cowlitz River and Lewis River; 4) the federally mandated Artificial Production Review and Evaluation (APRE) process, and 5) the congressionally mandated, Hatchery Scientific Review Group (HSRG) review of all state, tribal and federal hatchery programs in Puget Sound and Coastal Washington, and in the Columbia River Basin. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program.

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

Table Q-19 identifies hazards levels associated with risks involved with hatchery programs in the Upper Gorge Basin (including White Salmon River, the Little White Salmon River, Wind River and Bonneville Tributaries). Table Q-20 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 Q-19. Preliminary BRAP for hatchery programs affecting populations in the Upper Gorge Basin (including White Salmon River, the Little White Salmon River, Wind River and Bonneville Tributaries).

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

Wind 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	Big White Salmon W. Steelhead 1+	0.020				?	?	○				○	○	○
	Drano Lake S. Steelhead 1+	0.020				?	?	○				○	○	○
Spring Chinook	Big White Salmon W. Steelhead 1+	0.020				?	?	○				○	○	○
	Drano Lake S. Steelhead 1+	0.020				○	○	○				○	○	○
Chum	Big White Salmon W. Steelhead 1+	0.020				?	○	○				○	○	○
	Drano Lake S. Steelhead 1+	0.020				?	○	○				○	○	○
Summer Steelhead	No WDFW Programs													
Winter Steelhead	Big White Salmon W. Steelhead 1+	0.020	○	○	?	?	?	○				○	○	○
	Drano Lake S. Steelhead 1+	0.020				?	?	○				○	○	○

Table Q-20. Preliminary strategies proposed to address risks identified in the BRAP for Upper Gorge Basin (including White Salmon River, the Little White Salmon River, Wind River and Bonneville Tributaries) populations.

Upper Gorge Population	Hatchery Program: Name	Release (millions)	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	Big White Salmon W. Steelhead 1+	0.020		—	—	—		●	●		●		—		—	—	
	Drano Lake S. Steelhead 1+	0.020						●	●		●						
Spring Chinook	Big White Salmon W. Steelhead 1+	0.020						●	●		●						
	Drano Lake S. Steelhead 1+	0.020															

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

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

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

For Primary populations:

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

For Contributing populations:

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

For Stabilizing populations:

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

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

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

- In segregated programs, improve the ability to control hatchery fish on the spawning grounds so that harvest benefits can be maintained while improving natural-origin spawning abundance and productivity for instance, by installing weirs in specific drainages where straying limits the ability to meet conservation goals.

- Move production from some tributaries into larger segregated harvest programs in Select Area Fishery Evaluation areas, where excess hatchery fish can be removed by applying higher harvest rates.
- Reduce reliance of some programs on imported out-of-basin broodstock or rearing to improve homing and increase productivity.
- For integrated programs, increase the proportion of natural-origin fish used in hatchery broodstock and control the contribution of hatchery-origin fish to natural spawning areas. In some cases, meeting the criteria for the population designation requires reducing program size.

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

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

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

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

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

Little White Salmon River – Fall Chinook

The HSRG stated that it recognizes the important contribution of this program to harvest and recommends:

- To PIT-tag a representative portion of the release for the purpose of developing in-season management information
- Improve capture efficiency
- Implement a Bacteria Kidney Disease (BKD) control strategy where BKD has proved a recurring problem

Little White Salmon River – Spring Chinook

HSRG suggests maintaining the current program and recommends:

- To PIT-tag a representative portion of the release for the purpose of developing in-season management information
- Implement experiments to evaluate the effectiveness of using reduced rearing densities to reduce BKD in the hatchery
- Implement a BKD control strategy

Little White Salmon River – Coho

The HSRG noted that the hatchery program was eliminated in 2004 and suggested that managers might consider establishing net pens to acclimate hatchery coho in Drano Lake. In addition, a new terminal fishery for tribal and sport fishermen could be created with little potential conflict with natural populations.

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

Harvest

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

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

At the time of interim plan completion, fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table Q-21). 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 Q-21. 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 NMFS for management of Coweeman naturally-spawning fall Chinook. Columbia River Treaty Indian fall fisheries are constrained by ESA limits regarding Snake River wild fall Chinook. Some in-basin sport fisheries are closed to the retention of Chinook to protect naturally spawning populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Rates are very low for chum salmon, which are not encountered by ocean fisheries and return to freshwater in late fall 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 sport fisheries. Chum are impacted incidental to fisheries directed at coho and winter steelhead.

Harvest of Little White Salmon coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River, Columbia River Treaty Indian fisheries above Bonneville Dam, as well as recreational fisheries in the Little White Salmon basin. Wild coho impacts are reduced by fishery maangement to retain marked hatchery fish and release unmarked wild fish.

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 in non-Indian fisheries (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 may be in the future because of recent legislation enacted by Congress. Marking of fall Chinook upstream of Bonneville Dam would be considered in the *U.S. v. Oregon* forum involving Federal, State, and Tribal parties.

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

Hydropower Construction and Operation

There are no hydro-electric dams in the Little White Salmon River Basin. However, Little White Salmon River species are affected by changes in Columbia River mainstem and estuary related to Columbia basin hydropower development and operation. The mainstem Columbia River and estuary provide important habitats for anadromous species during juvenile and adult migrations between spawning and rearing streams and the ocean where they grow and mature. These habitats are particularly important for fall Chinook and chum which rear extensively in the Columbia mainstem and estuary. Aquatic habitats have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control.

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

Ecological Interactions

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

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

Ocean Conditions

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

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

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

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

Q.3.9. 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 Q-17 describe the relative magnitude of potentially-manageable human impacts in each category of limiting factor for Little White Salmon Basin salmon. 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.

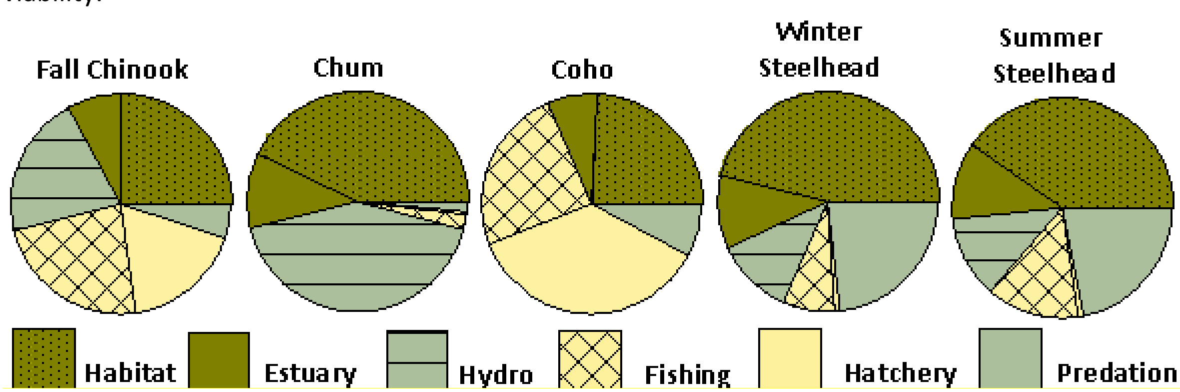


Figure Q-17. Relative contribution of potentially manageable impacts on Little White Salmon River salmonid populations.

Due to the small amount of available habitat, the Little White Salmon populations have not been analyzed using the EDT model and reaches have not been prioritized using the methodology applied to other subbasins. Therefore, these populations are combined with Wind River and Little White Salmon River populations to form the Upper Gorge Tributary populations. Important limiting factors to the Upper Gorge populations include loss of tributary habitat quality and quantity is relatively significant for all species as is loss of estuary habitat quantity and quality. Harvest is assumed to have a sizeable effect on fall Chinook and coho, and moderate for spring Chinook. All species are assumed to be impacted by hatcheries but it is the most significant impact to coho. Predation impacts are assumed moderate for all species. The impact of hydrosystem access and passage is one of the more important impacts for all Chinook and only moderately so for coho.

Impacts were defined as the proportional reduction in average numbers or productivity associated with each effect. Subbasin and estuary habitat impacts are the differences between the pre-development historical baseline and current conditions. Hydro impacts identify the percentage of historical habitat blocked by impassable dams and the mortality associated with juvenile and adult passage of other dams. Fishing impacts are the direct and indirect mortality in ocean and freshwater fisheries.

Hatchery impacts include the equilibrium effects of reduced natural population productivity caused by natural spawning of less-fit hatchery fish and also effects of inter-specific predation by larger hatchery smolts on smaller wild juveniles. Hatchery impacts do not include other potentially negative indirect effects or potentially beneficial effects of augmentation of natural production. Predation includes mortality from northern pikeminnow, Caspian terns, and marine mammals in the Columbia River mainstem and estuary. Predation is not a direct human impact but was included because of widespread interest in its relative significance. Methods and data for these analyses are detailed in Appendix 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-occurring ocean mortality) are excluded. Not every factor of interest is included in this index – only readily-quantifiable impacts are included.

Q.3.10. Wildlife Habitat Limitations

Wildlife managers emphasized an ecosystem approach through use of focal habitat types while including components of single-species, guild, or indicator species assemblages. This approach is based on the following assumption: a conservation strategy that emphasizes focal habitats at the subbasin scale is more desirable than one that emphasizes individual species.

By combining the "coarse filter" (focal habitats) with the "fine filter" (focal wildlife species assemblage) approach, subbasin planners believe there is a much greater likelihood of maintaining, protecting and/or enhancing key focal habitat attributes and providing functioning ecosystems for wildlife. This approach not only identifies priority focal habitats, but also describes the most important habitat conditions and attributes needed to sustain obligate wildlife populations within these focal habitats. Although conservation and management is directed towards focal species, establishment of conditions favorable to focal species also will benefit a wider group of species with similar habitat requirements.

To ensure that species dependent on given habitats remain viable, Haufler (2002) advocated comparing the current availability of the habitat against its historic availability. According to Haufler (2002), this "coarse filter" habitat assessment can be used to quickly evaluate the relative status of a given habitat and its suite of obligate species. To ensure that "nothing drops through the cracks," Haufler (2002) also advocated combining the coarse filter habitat analysis with a single species or "fine filter" analysis of one or more obligate species to further ensure that species viability for the suite of species is maintained.

The following rationale was used to guide selection of focal habitats for an illustration of the focal habitat/species selection process:

- Identification of habitats that can be used to evaluate ecosystem health and establish management priorities at the subbasin level (coarse filter)
- Identification of habitats that have experienced a dramatic reduction in acreage or quality within the subbasin
- Identification of habitats that are naturally sensitive and have likely undergone reduction in quantity and quality, although historical records may be lacking (riparian habitats)

Other considerations included cultural, economical, ecological and special factors.

Riparian Wetland Habitats

Protection of riparian wetlands wildlife habitat may yield the greatest gains for fish and wildlife per unit of area (Knutson and Naef 1997). Riparian habitat represents a relatively small portion of the subbasin's total area, but supports a higher diversity and abundance of fish and wildlife than any other habitat type. Riparian habitat provides important fish and wildlife breeding habitat, seasonal ranges, and movement corridors. Many species that primarily dwell in other habitat types depend on riparian areas during key portions of their life history.

Riparian habitat has important social values, including water purification, flood control, recreation, and aesthetics. But riparian wetlands are also highly vulnerable to alteration. The riparian wetlands have suffered degradation and losses to hydrological function as well as fragmentation of habitat. This phenomenon fragments movement corridors for fish and wildlife.

Riparian wetland habitats may be associated with any of the habitat types present within the Little White Salmon River subbasin (Table Q-16). Riparian wetland habitats generally comprise microhabitats within forest habitat types within the Little White Salmon River basin or may be present as either micro or macrohabitat components of Westside Riparian-Wetlands, Montane Coniferous Wetlands, or Open Water habitats. The key findings, limiting factors, and working hypotheses for riparian wetland habitats and associated wildlife species are presented in Table Q-22.

Old Growth Forest

Old growth forests may be associated with any of the forest habitat types in the Little White Salmon River subbasin (Table Q-16). Old growth forested stands represent late seral stage forests with mature trees and defined habitat structure. Fire suppression activities generally promote old growth forest development while logging and development reduces old growth forest acreage. The key findings, limiting factors, and working hypotheses for old growth forest habitats and associated wildlife species are presented in Table Q-23.

Table Q-22. Riparian wetland habitat key findings, limiting factors, and working hypotheses.

RIPARIAN - WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat has suffered degradation and loss of hydrological function.	Overall Loss of Riparian Vegetation	Compliance with state and federal forest practices guidelines will assist in providing adequate riparian buffers. Shoreline development for residential property along key streams and rivers will contribute to overall riparian decline.
	Reduction in Floodplain Acreage	In riparian habitat, avoiding road-building activities, restoring habitat on abandoned roads or railroads and relocating problematic roads would decrease stream bank erosion, decrease sediment, and decrease disturbance to nesting species.
	Displacement of Native Riparian Vegetation with Non-native Vegetation	Reduction of the number of acres dominated by invasive non-native plant species will assist in improving riparian habitat condition for focal species and overall riparian habitat viability. (Weeds replace native trees and shrub)
	Incised Stream Reaches	Increasing floodplain area in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Loss of Hydrological Function	Increasing beaver presence to historic level would help restore hydrological function to floodplains.
	Loss of Stream Complexity and Increased Flows	Appropriate silvicultural practices that maintain and enhance riparian habitat will increase presence of large woody debris in streams. This will increase both fish and wildlife focal species presence and population sizes.
Habitat has suffered habitat loss and fragmentation, removing corridors necessary for wildlife movement.	Hydrological diversions (e.g., irrigation, dams)	Re-establishment of natural floodplain habitat conditions and hydrological pathways would benefit wildlife habitat and result in population increases of focal species.
	Loss of Riparian Habitat and Function	Appropriate silvicultural practices that maintain and enhance terrestrial riparian habitat will decrease sediment discharge, maintain bank stabilization, and increase presence of large woody debris in streams. This will increase both fish and wildlife focal species presence and population sizes.
	Fragmentation of Habitat	Restoring and maintaining adequate riparian amounts of riparian habitat will restore and retain corridors used by wildlife as well as available habitat and forage. This will also retain water storage availability of riparian terrestrial habitat for release in drier seasons.
Yellow Warbler		
Habitat loss and degradation has negatively affected yellow warblers in the	Reduction in Floodplain Acreage	Yellow warblers are an important indicator of riparian habitat. Identifying critical warbler habitat, inventorying habitat remaining, and monitoring habitat changes, both locally and at a landscape level, will increase the effectiveness future management and protection of riparian habitat.
	Overall Habitat Loss	

RIPARIAN - WETLANDS

Key Findings	Limiting Factors	Working Hypotheses
subbasin.	Fragmentation of Habitat	
	Land Conversion	
	Reduced Food Base	Decrease misuse of herbicides and pesticides in riparian areas will decrease mortality of prey based need by yellow warblers.
Western Pond Turtle		
Western Pond Turtles have declined in number largely due to the loss and fragmentation of their historical habitat.	Fragmentation of Habitat	Reducing wetland conversion will decrease the amount of suitable turtle habitat that is lost and populations will increase.
		Reducing the development of wetlands will decrease the amount of suitable turtle habitat that is lost and populations will increase.
	Reduction in Floodplain Acreage	In wetlands, avoiding road-building activities and restoring habitat on abandoned roads / railroads and relocating problematic roads would decrease current and future fragmentation of potential and suitable habitat.
Much of the western pond turtle's suitable habitat has become unsuitable due to habitat degradation.	Land Use Practices associated with Western Pond Turtle Habitat	Removing grazing from known turtle locations and better management of grazing in potential turtle habitat will reduce damage to aquatic and terrestrial wetland vegetation and increase survival of eggs and hatchlings.
	Loss of Meadow and Grassland Habitat	Meadows and grasslands are needed for nesting in close association with wetlands occupied by western pond turtles.
	Displacement of Native Riparian Vegetation with Non-native Vegetation	Scot's broom and blackberry have impacted suitable western pond turtle habitat and will impact recovery efforts.
	Predation by Non-Native Animal Species	Control of non-native animal species, such bullfrogs and non-native fish, in occupied wetlands would increase turtle survival by reducing competition. It would also increase vegetation quality and structural complexity.
	Increase in Human Disturbance	Decreasing human recreational activities around known wetlands used by turtles would increase reproduction success and increase overall population growth.

Table Q-23. Old growth forest key findings, limiting factors, and working hypotheses.

	OLD GROWTH FORESTS	
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat communities have changed considerably in stand structure and composition compared to historical conditions.	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, and decrease understory density will recover late seral composition and structure. These conditions increase habitat and forage available to wildlife.
	Increased Stand Density and Decreased Average Tree Diameter	Reintroduction of an ecologically-based fire regime (or fire mimicking silvicultural practices when fire cannot be reintroduced) will recover late seral stand dynamics, ecological function and habitat quality for wildlife. (Absence of fire leads to increased stand and stem density and susceptibility to disease and stand replacement fire).
	Loss of Native Understory Vegetation and Composition	Anthropogenic factors have resulted in the loss of old growth forest structure and have altered species composition.
Habitat communities have suffered habitat loss and fragmentation.	Loss of Large Tracts of Old Growth, or Late Seral, Forests	Silvicultural practices that retain large tracts of intact late seral forests will decrease temporary fragmentation of focal species habitat.
Western Gray Squirrel		
Western gray squirrels have suffered fragmentation between populations due in large part to fragmentation and degradation of late seral conditions on which they depend.	Reduction of Large Diameter Trees and Snags	Silvicultural practices that retain large tracts of intact late seral forests will decrease temporary fragmentation of western gray squirrel habitat.
	Increased Stand Density and Decreased Average Tree Diameter	Reintroducing fire into used and potentially used squirrel habitat will increase the quality of the habitat and result in greater numbers of western gray squirrels.
	Loss of Native Understory Vegetation and Composition	Proper subbasin management will decrease spread of non-native understory plant species and help reestablish a native plant community, thereby increasing habitat quality for western gray squirrels.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.
Focal species have suffered declines in their population from competition and introduction of disease due to the presence of exotic squirrel species.	Increased Competition to Western Gray Squirrels	Reduction of California ground squirrels and eastern gray squirrels will increase survival of western gray squirrels locally, increasing numbers present in the subbasin.

OLD GROWTH FORESTS

Key Findings	Limiting Factors	Working Hypotheses
Pileated Woodpecker		
Focal species has suffered a decline and degradation of their habitat resulting in loss of nesting and foraging habitat.	Reduction of Large Diameter Trees and Snags	Increasing the number of larger, late seral trees within pileated woodpecker range, with the use of selective silviculture practices and the reintroduction of a more historical fire regime, will increase available nesting trees and forage, resulting in increase in presence and numbers of pileated woodpecker in the subbasin.
	Loss of Large Tracts of Old Growth, or Late Seral Forests	Silvicultural practices and land use that retain large tracts of intact late seral forests will decrease temporary fragmentation of pileated woodpecker habitat.

Ponderosa Pine – Oregon White Oak

Ponderosa pine and Oregon white oak are separate plant habitats that often occur in proximity to one another or overlapping in transitional zones. The difference between conifer encroachment and those oak/conifer associations valuable to wildlife is often unclear. Almost without exception, conifers associated with oaks in eastern Washington and along drier sites in the Columbia Gorge do not encroach negatively on oaks. Conifer/oak associations in these areas are limited and very valuable as actual or potential habitat. Conversely, conifer encroachment on oaks in western Washington and along wetter sites in the Columbia Gorge is prevalent and undesirable.

Noss et al. (1995) considers ponderosa pine ecosystems to be one of the most imperiled ecosystems of the West, with very little late seral or old growth ponderosa pine habitat available today. The loss and alteration of historic vegetation communities has impacted landbird habitats and resulted in species range reductions, population declines and some local and regional extirpations (Altman 2000). Interior Columbia Basin studies (Wisdom et al. 1999) found that wildlife species declines were greatest in low-elevation, old-forest habitats. A more detailed discussion of habitat dynamics for this forest type can be found in Johnson and O'Neil (2001).

There is major dependency on ponderosa pine habitats by white-headed woodpecker *(Picoides albolarvatus),* western gray squirrel *(Sciurus griseus),* Lewis' woodpecker *(Melanerpes lewis)* and flammulated owl *(Otus flammeolus).* Other species that are dependent upon or benefit substantially from this habitat include the pygmy nuthatch *(Sitta pygmaea)* and Williamson's sapsucker *(Sphyrapicus thyroideus).* Other birds that seem to prefer mature ponderosa pine stands are western wood-peewee *(Contopus sordidulus),* mountain chickadee *(Poecile gambeli),* red-breasted nuthatch *(Sitta canadensis),* hermit thrush *(Catherus guttatus),* western tanager (Piranga ludoviciana), chipping sparrow *(Spizella passerine),* Cassin's finch *(Cardopacus cassinii),* red crossbill *(Loxia curvirostra)* and evening grosbeak *(Coccothraustes vespertinus)* (Hutto and Young 1999).

Oregon white oak is Washington's only native oak species (Miller 1985). It provides a unique plant community that provides forage, nesting and cover habitat to oak obligate species as well as many other more generalist species. There is a diversity of wildlife species found in all of Washington's oak forests. In particular, late seral white oak woodlands are valuable to wildlife because these oaks have are larger in diameter, contain more cavities for nesting, produce more acorns, and have a large canopy.

Over the last two centuries, oak habitats have changed because of land conversion, timber practices and fire suppression. Today's oak stands are denser with smaller trees. Younger, denser stands do not provide as good wildlife habitat as the older, more open stands.

Table Q-24. Ponderosa pine – Oregon white oak key findings, limiting factors, and working hypotheses.

		PONDEROSA PINE / OREGON WHITE OAK
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat communities have changed considerably in stand structure and composition compared to historical conditions.	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, and increase snag density and size will recover ponderosa pine late seral composition and structure. These conditions increase habitat and forage available to wildlife.
	Increased Stand Density and Decreased Average Tree Diameter	Reintroduction of an ecologically-based fire regime will recover late seral ponderosa pine and Oregon white oak stand dynamics, ecological function by decreasing stand and stem density, improving wildlife habitat quality and decreasing susceptibility to disease and stand replacement
	Loss of Native Understory Vegetation and Composition	Reintroduction of an ecologically-based fire regime will recover late seral ponderosa pine and Oregon white oak stand dynamics, ecological function by decreasing stand and stem density, improving wildlife habitat quality and decreasing susceptibility to disease and stand replacement
	Loss of Individual, Late SeralTrees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.
Western Gray Squirrel		
Focal Species have suffered fragmentation between populations due in large part to fragmentation and degradation of late seral oak and pine conditions on which they depend.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Silvicultural practices and land use that retain large tracts of intact late seral forests will decrease temporary fragmentation of western gray squirrel habitat.
	Increased Stand Density and Decreased Average Tree Diameter	Utiling fire as a tool to improve used and potentially used western gray squirrel habitat will increase the quality of degraded habitat and result in greater number of squirrels.
	Loss of Native Understory Vegetation and Composition	Utilizing fire as a tool to improve used and potentially used western gray squirrel habitat will increase the quality of degraded habitat and result in greater number of squirrels.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.
Focal species have suffered declines in their population from competition due to the presence of squirrel species not historically	Increased Competition to Western Gray Squirrels	Reduction of California ground squirrels will increase survival of western gray squirrels locally, increasing numbers present in the subbasin.

Montane Coniferous Wetlands

The Montane Coniferous Wetlands wildlife habitat is ecologically and culturally important. This habitat type is naturally limited in its extent. The key findings, limiting factors, and working hypotheses for montane coniferous wetlands and associated wildlife species are presented in Table Q-25.

Categories within this habitat type include wet meadows, streams, ponds, seeps, bogs, swamps, and other forested wetlands. Upland meadows have been declining steadily in numbers, size and quality. Meadows are extremely important to the functioning of the surrounding riparian systems as well as for adding habitat diversity within an otherwise forested matrix. They act as a water storage reserve and provide a continuing source of water for many surrounding streams throughout the summer. In many montane wetland types, forest practices and grazing activities over time have compressed the soil, caused stream channel incisement, increased sediment delivery, and decreased riparian cover. Loss of upland meadow habitat translates to functional losses, such as increased channel sedimentation, channel instability and bank erosion, lowered water table, and increased summer stream temperature. Fire suppression has contributed to forest encroachment on meadow habitats. Loss of wetland function and meadow structure decreases habitat quantity and suitability for native plant and wildlife species, and results in greater runoff peaks and lower baseflows. Meadows are also important culturally, supporting many species of edible and medicinal plants collected by tribal people.

Other montane wetlands (e.g. streams, ponds, seeps, bogs, and swamps) also provide unique habitat that is important to vegetation, fish, wildlife and people. This zone has wide ranging impacts on the terrestrial zones surrounding it and beyond. Likewise, terrestrial zones have an impact on riparian habitat.

Many animal species directly depend on streams for all or part of their life cycle (e.g. amphibians, aquatic insects, and fish). Aquatic secondary production (e.g. insects, tadpoles, and fish) provides food for riparian species such as birds, bats, and adult amphibians. Riparian lands and their vegetation also provide important habitat for land-based plants and animals. Not only is there an increased availability of water, there is often the presence of taller and denser vegetation, a more favorable microclimate, more or higher quality shelter and nesting sites, and greater concentration of food resources. Riparian lands often have the highest level of plant and animal biodiversity in the forest. Riparian land also provides critical corridors for movement of plants and animals across the landscape. Healthy streams are important to fish, but since all wildlife are connected within a food web, water quality is a fisheries, wildlife, and cultural concern.

Healthy riparian zones are also vital to forest health and sustainable land management. Predation upon aquatic organisms (insects, fish, or amphibians) could be a major pathway for movement of aquatic nutrients and energy, through riparian food webs, back into terrestrial ecosystems. This movement of nutrients makes healthy riparian habitats an important forest health issue.

Table Q-25. Montane coniferous wetlands key findings, limiting factors, and working hypotheses.

MONTANE CONIFEROUS WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Montane Coniferous Wetlands have been and reduced in size and quality. Wet meadows have been especially reduced in size and number because of fire suppression, roads and other factors.	Tree and Shrub Encroachment into Wet Meadows	Reintroduction of an ecologically-based fire regime will decrease encroachment of conifers into montane wet meadows, increasing the water table and help reestablish proper hydrological function.
	Incised Streams and Loss of Wetland Function	Restoring stream channels in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Displacement of Native Plant Communities by Non-native Plant Species	Removing reed canary grass (decreasing monotypic stands) will increase presence of native species, and increase habitat quality for wildlife.
	Overall Loss of Native Vegetation and Wetland Function	Appropriate management of livestock grazing in wetland areas minimizes damage to native meadow and streamside vegetation, reduces damage to stream banks, and reduces pollution in streams and ponds.
	Hydrological Alteration	Relocating wetland meadow roads, reducing or improving stream crossings, and locating motorized recreation to more appropriate sites improves hydrologic conditions, reduces fragmentation, and decreases disturbance to sensitive wildlife.
	Upland Hydrological Effects	Limiting silvicultural practices above meadows and enforcing a buffer around meadows will decrease sediment release in meadow hydrology and will increase water quality for fish and wildlife needs.
	Loss of Hydrological Function	Increasing beaver presence to historic level would help restore hydrological function to floodplains.

MONTANE CONIFEROUS WETLANDS

Key Findings	Limiting Factors	Working Hypotheses
Oregon Spotted Frog		
Oregon spotted frogs have declined in number largely because of the loss and fragmentation of their historical habitat.	Loss of Wetlands	Decreasing the loss of wetlands to development and conversion would stabilize the populaton.
Much of the Oregon spotted frog's suitable habitat has become unsuitable because of habitat degradation.	Tree and Shrub Encroachment into Wet Meadows	Reintroduction of an ecologically-based fire regime will decrease encroachment of conifers into montane wet meadows, increasing the water table and help reestablish proper hydrological function.
	Decrease in Water Quality	Increasing water quality in important breeding ponds would increase survivorship of tadpoles.
	Displacement of Native Plant Communities by Non-Native Plant Species	Removing reed canary grass (decreasing monotypic stands) will increase presence of native species, and increase habitat quality for Oregon spotted frog.
	Competition and Predation by Non-Native Species	Control of non-native animal species, such bullfrogs and non-native fish, in wetlands used by Oregon spotted frogs and western pond turtle would increase survival. It would also increase vegetation quality and structural complexity.
	Reduced Viability	Reduction of chemical runoff into key breeding ponds would decrease mortality of frogs.

Q.4. 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 subbasin. 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).

Q.4.1. Federal Programs

NMFS

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

U.S. Army Corps of Engineers

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

Environmental Protection Agency

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

U.S. Forest Service

The Unites States Forest Service (USFS) manages federal forest lands within the Gifford Pinchot National Forest (GPNF), the Columbia River Gorge National Scenic Area (CRGNSA), 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. The CRGNSA was established in 1986 to protect and provide for the enhancement of the scenic, cultural, recreational and natural resources of the Gorge; and to protect and support the economy of the Columbia River Gorge area. CRGNSA lands designated as General Management Area are subject to review of new development and land use. Lands within Wilderness areas are managed for protection and/or passive restoration of ecosystem processes.

Natural Resources Conservation Service

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

Northwest Power and Conservation Council

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

Q.4.2. State Programs

Washington Department of Natural Resources

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

Washington Department of Fish & Wildlife

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

Washington Department of Ecology

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

Washington Department of Transportation

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

Washington Recreation and Conservation Office

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

Lower Columbia Fish Recovery Board

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

Q.4.3. Local Government Programs

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.

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.

Q.4.4. Non-governmental Programs

Columbia Land Trust

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

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.

Q.4.5. Tribal Programs

Cowlitz Indian Tribe

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

Q.4.6. NPCC Fish & Wildlife Program Projects

Western Pond Turtle Recovery

The Bonneville Power Administration is currently funding a reintroduction of western pond turtles at Pierce National Wildlife Refuge (Skamania County) in the Columbia River Gorge. This program is part of the recovery effort for the western pond turtle in Washington. This reintroduction will represent the third population of western pond turtles in the Columbia River Gorge. A total of 250 turtles were released during the first four years of the reintroduction program (40 in 2000; 38 in 2001; 59 in 2002; 51 in 2003; and 62 in 2004). All years, turtles were released at two of the four main bodies of water on the refuge. Currently WDFW is monitoring this population. A representative subset of these turtles was tracked by radio telemetry to determine survival and habitat use.

Q.4.7. Wildlife Programs

Western Gray Squirrel

WDFW has conducted periodic surveys and studies of western gray squirrel populations and habitat. WDFW is currently conducting research on the ecology of the western gray squirrel in Klickitat County.

Yellow Warbler

There are no known on-going or completed yellow warbler-targeted conservation projects. Any project focused on riparian or wetland conservation or restoration is likely to benefit yellow warblers in the vicinity.

Pileated Woodpecker

There are no known on-going or completed pileated woodpecker-targeted conservation projects in the Little White Salmon subbasin.

Band-tailed Pigeon

There are no known on-going or completed band-tailed pigeon-targeted conservation projects in the Little White Salmon subbasin.

Western Pond Turtle

The Washington Department of Fish and Wildlife is actively engaged in management and recovery efforts for the western pond turtle. The Bonneville Power Administration is currently finding the majority of recovery work for the western pond turtle in the Columbia River Gorge Western pond turtle conservation activities are also being conducted in cooperation with the Woodland Park Zoo and the Oregon Zoo. Surveys to determine the status of the pond turtle constituted most of the early work in Washington (Milner 1986, Zimmerman 1986). In 1990, the Department funded an intensive study of the Klickitat County population (Holland 1991); this work is currently ongoing.

Habitat Acquisition: Habitat for the Klickitat County population was purchased by the Department in the early 1990s. The Klickitat pond complex was purchased in 1992 and the lake was purchased in 1994. The USFS has recently purchased western pond turtle habitat in Skamania County. Current plans are to purchase additional small parcels of habitat in the Gorge for western pond turtles.

Habitat Enhancement: Grazing was discontinued at the Klickitat lake site after it was acquired by the Department. Also, at the request of the Department, the landowners of the Skamania County sites have reduced or discontinued grazing of uplands adjacent to some of the wetlands. The Nature Conservancy provided assistance to the Department and private landowners for habitat enhancement in Skamania County. Artificial rafts have been placed at a number of sites to improve opportunities for emergent basking. During 1991 and 1992, 45 rafts were distributed at 31 sites in five counties (Nordby 1992). In 1992, 24 rafts were placed in 22 lakes and marshes at Fort Lewis (Stringer 1992). Use of the woodenplank rafts by western pond turtles in Klickitat County appears to be high.

Surveys: In 1991, 128 wetlands in western Washington and the Columbia River Gorge were surveyed for western pond turtles (WDFW, unpubl. data). The following year, 88 sites in eight counties were surveyed by a group of biologists and 30 trained volunteers using a standardized survey protocol (Nordby 1992). Surveys were completed over an extensive area within the known range of the species based on historical pond turtle records and recent sighting reports (Nordby 1992; Scott 1995a, 1995b). Surveys were conducted during the annual peak of emergent basking activity March 15 through June 15. Each site was visited prior to this time to assess habitat, scout for observation points, and install artificial rafts. Basking rafts were constructed of 2" × 12" wooden planks nailed together to form a triangle or square. Such platforms can increase the probability of observing turtles and increase the number observed. Most sites were surveyed three times during the peak emergent basking period. Observations of suitable emergent basking sites were completed during times when basking was expected (Nordby 1992). Surveys in the Columbia River Gorge were continued in 1993 and 1994 (Scott

1995a, 1995b). The highest count of turtles simultaneously visible, air and water temperatures, weather conditions, a gross habitat assessment, land uses, and other wildlife observed were recorded on a standard form.

The results of these surveys reinforced previous impressions that western pond turtles are no longer present in many lakes and ponds within their historic range. However, knowledge of the distribution of turtles within the Skamania ponds population was greatly enhanced (Nordby 1992, Scott 1995b). These surveys identified potential reintroduction sites, sources of animals for captive propagation, and habitats used.

A draft *Western Pond Turtle Survey and Monitoring Plan* has been developed by the Interagency Western Pond Turtle Working Group (Barkhurst et al. 1997). The plan describes techniques and a standard protocol for inventorying and monitoring western pond turtle populations.

Toxicology: Following the disease outbreak in the Klickitat population in 1990, a toxicology study was conducted to assess water quality in the lake/pond complex. The lake had higher levels of aluminum than the ponds (Landis and Storch 1991) but the level was not high enough to cause acute toxicity, and there was no other evidence of chemical contamination.

Captive Breeding: In 1991, the Department of Wildlife, the Woodland Park Zoo, and the Center for Wildlife Conservation initiated a captive breeding program for western pond turtles. The objective of the program was to produce about 40 hatchlings per year for eventual release into suitable habitat in the state. The sex of hatchling turtles in part is determined by incubation temperature (Ewart et al. 1994), and the pond turtle eggs are incubated at a temperature that will produce mostly females.

The captive breeding program has included 9 adult turtles from Washington and 3 adult turtles from Oregon. Three groups of breeding turtles have been established: one of Columbia River Gorge origin, one likely of Puget Sound lowlands origin, and one of out-of-state origin. These stocks differ morphologically and genetically (Holland 1992, Gray 1995). Adults of Columbia River Gorge origin (3 females and 1 male) have been obtained from extant populations and four captive-bred sub-adults are being kept at the zoo for future captive breeding. Turtles collected from the Puget Sound lowlands were opportunistically obtained when turtles were found by private citizens and reported to the Department. This included: a male found in Tacoma, a female (now deceased) from Port Orchard, a female from Fife, and a male from Ravensdale (released at Lakewood in 1996; found dead in 1997). The third captive breeding group, composed of turtles from outside of Washington, has been assembled from zoos, veterinarians, and wildlife rehabilitators. This group included the 3 turtles from Oregon, and two males of unknown origin that were later released at a pond at Northwest Trek near Eatonville. This third group was used to help refine captive breeding techniques, and has not been used to provide juveniles for release in Washington.

Over the 7-year history of the captive breeding program all 38 juveniles released to the wild were the progeny of 6 adults (4 females and 2 males). Twelve were released into ponds in the Columbia River Gorge and 26 at the Lakewood pond complex in the Puget Sound lowlands.

Head Start Program: The Woodland Park Zoo, the Oregon Zoo, the Center for Wildlife Conservation, and the Department of Wildlife initiated a joint project in 1990 to improve recruitment in the Columbia Gorge populations. The objective of the program is to increase the survival chances of young turtles in the wild by "head starting" them at Woodland Park Zoo to a size where they can escape predation by bullfrogs. Headstarting has been demonstrated to improve survival of hatchling freshwater turtles where predation by bullfrogs is a problem (Haskell et al. 1996). Hatchlings are captive reared in an environment optimally suited for rapid growth. Juvenile turtles kept in these conditions year round can attain the size of a 2-year old wild turtle in a single year.

To obtain hatchlings from wild nests, adult female turtles are trapped in the spring and equipped with transmitters. All captured turtles (except for the smallest juveniles) are marked for individual identification by filing notches in the marginal scutes of the carapace according to the system described by Bury (1972). Transmitter-equipped turtles are monitored at two-hour intervals from 8:00 a.m. until dark starting on May 15 each year, and monitoring is continuous when a female is discovered to have left the pond. Monitoring of transmitter-equipped females continues until the turtle has laid eggs or until July 15, whichever comes first. This program relies heavily on volunteers to monitor the transmitter-equipped females.

Once a female has nested, a frame is placed over the nest to exclude predators and hold in any hatchlings that might emerge. Expected hatching dates are calculated based on the known dates on which the eggs are laid. Arrangements are made to visit nests at the appropriate time to check on the status of the eggs. Once hatching is underway, the hatchling turtles are taken to the zoo to begin a 1 to 2-year stay in captivity. Prior to release back to the wild, juvenile turtles are individually marked with notches in the marginal scutes of the carapace and a Passive Integrated Transponder (PIT tag) is inserted under the skin of a hind leg. The PIT tag is a computer chip encapsulated in medically safe glass that is pre-programmed with an identifying number that can be read with a portable reader.

The Head Start Program has successfully reared and released 805 juvenile western pond turtles since 1991 in the Columbia River Gorge. Of the 805 juvenile turtles, 359 were released in the Klickitat County and 167 in Skamania County. Of 142 juveniles released by fall 1997, 61 had been recaptured at least once by fall 1998 (K. Slavens, unpubl. data). Each was weighed and found to have grown significantly since release. Visual surveys suggest that the survival of these head-started turtles is better than is indicated by the recapture information. Re-sightings of juveniles indicate that the program is likely to be successful at producing recruits that will eventually bolster the breeding population. Size distribution of captured turtles appears to be showing an increase in size classes between 80 and 120mm.

Predator Removal: To further improve the survival of juvenile turtles, considerable effort has been directed toward the removal of non-native predators such as bullfrogs and warmwater fish. Bullfrog control efforts were initiated under permit from the Department in the summer of 1990 (Slavens 1992). Bullfrogs were killed using a variety of techniques including spear and fishing gear. Bullfrogs and bullfrog tadpoles were also removed opportunistically in the course of other work such as when tadpoles were captured in hoop traps set for turtles. During May and June, the shorelines of ponds were searched for bullfrog egg masses and those discovered were removed using a dip net. Introduced warmwater fish (bass, bullheads, pumpkinseed, and bluegills) were gill-netted and removed from the Klickitat lake during a one-time seining operation in 1991. Other fish, primarily bullheads, were removed when caught in hoop traps incidental to turtle trapping. Control efforts at the Klickitat County sites have resulted in the removal of about 500 bullfrogs, 250 bullfrog tadpoles, over 175 bullfrog egg masses, over 400 kg (850 lbs) of warmwater fish, and 2 red-eared sliders. In addition, a local aquaculturist was employed by Woodland Park Zoo in 1998 to find and remove bullfrog egg masses.

Habitat Use: The climate and vegetation at the Skamania County pond complex are similar to areas in the south Puget Sound region, so the area was studied to answer questions about habitat use in a moist, forested environment. This information was also used to help characterize types of sites that should be considered for future reintroductions in the south Puget Sound area.

Since 1995 pond turtles have been monitored with radio-transmitters from May through December and data collected on movements as well as selection of nesting and overwintering sites. Monitoring was limited to twice per week in early summer and once per week after that continuing into December.

Because grazing had recently been discontinued at the Skamania ponds, the grass in the open pasture areas had grown tall and thick. In an attempt to determine how turtles might use these areas, broad paths were mowed through the tall grass. It was expected that turtles might show preference for mowed areas both for travel and, possibly, for nesting. The turtles, however, often moved through the tallest and densest grass rather than the paths that had been mowed.

Reintroduction: An investigation was conducted in 1995-96 to locate a site for the first reintroduction of captive-bred western pond turtles to the Puget Sound lowlands. Survey forms from previous turtle surveys were reviewed and sites were selected for field evaluation. In addition, areas of the south Puget Sound region with naturally open vegetation, such as the oak woodlands of Pierce and Thurston County, were reviewed. National Wetlands Inventory maps were used to find additional potentially suitable wetlands.

Criteria were developed to evaluate potential reintroduction sites. Desired conditions were:

- a complex of small ponds near sea level,
- abundant emergent basking sites,
- isolated by at least one half mile from busy roads and other centers of human activity,
- isolated from large bodies of water and streams
- emergent vegetation and a mud bottom,
- abundant invertebrate and larval amphibian prey,
- few or no non-native predators like largemouth bass and bullfrogs, and
- diversity of upland habitats, including open, grassy areas for nesting and dense clumps of deciduous trees or shrubs for overwintering.

Twenty-one sites were visited and evaluated during 1995-96. Several sites had habitat conditions conducive to successful reintroduction including Camp Pond in Mason County, Nisqually Lake on Fort Lewis in Pierce County, and a pond complex near Lakewood. The Lakewood pond complex was selected for the first reintroduction in part because the property is owned by the Department of Fish and Wildlife. The ponds are permanent, free of introduced aquatic predators, surrounded by open, grass-dominated vegetation, and are beginning to develop a deep silt bottom with abundant emergent and aquatic vegetation. The fence surrounding the site was repaired and a new section of fence was constructed so turtles would be retained within a 5 ha (12+ acre) area. A screen was installed over the stream outflow culvert and emergent basking logs were installed.

Releases were conducted in summer to give the turtles time to acclimate to the ponds prior to overwintering. During July and August 1996, 15 captive bred pond turtles at least one year of age and one adult turtle were released into the pond complex. Seven of the 15 juveniles selected for release were large enough to carry transmitters which were glued to their carapaces prior to release. Additional captive bred turtles were released at the site in 1997 (6), and 1998 (5). Behavior, growth, and survival are being monitored.

Larch Mountain Salamander

There are no known on-going or completed Larch Mountain salamander-targeted conservation projects in the Little White Salmon subbasin.

Fisher

Fisher-targeted surveys have not been conducted, although general forest carnivore surveys have recently been completed. Survey techniques were developed in recent years to improve assessments of the status of rare forest carnivores in the West (Zielinski and and Kucera 1995). These techniques, and variations thereof, have been used to assess the status of fisher. WDFW, in cooperation with the USDA Forest Service, conducted marten surveys in 1992 and carnivore surveys in 1995-97 which would be expected to detect the presence of fisher. Most surveys failed to detect fishers.

In 1994, the Forest Service published a Conservation Assessment for forest carnivores including the lynx, American marten, wolverine, and fisher (Ruggiero et al. 1994). They also produced an extensive literature review and a proposed adaptive management strategy for fishers in the western U. S. (Heinemeyer and Jones 1994). These documents resulted from greater attention to the conservation, research and monitoring of forest carnivores. The Western Forest Carnivore Committee has produced maps of potential fisher habitat, draft Conservation Strategy overlays, and draft management recommendations for the Northern Rockies and for Idaho (Heinemeyer 1995, Ruediger 1994).

WDFW produced a Fact Sheet for the fisher in 1998, and is currently revising Priority Habitats and Species management recommendations for the fisher. Most jurisdictions have developed information brochures, packets, or classes for trappers that include information on techniques to avoid incidentally capturing fishers and other non-target species.

Bald Eagle

Consideration of bald eagles in land use management has increased tremendously since the federal listing of the species in 1978. In Washington, the special needs of bald eagles are incorporated in land management plans developed by all of the major federal landowners, including the U.S. Forest Service, the National Park Service, the Bureau of Land Management, the Department of Energy, and the Department of Defense. Washington tribes, most notably the Quinault and Colville Indian tribes, are also committed to monitoring and managing the bald eagles under their jurisdiction.

The Endangered Species Act also extends additional consideration of bald eagle needs to every project which receives federal funds or requires a federal permit. This requirement produces benefits to bald eagles through project modifications and mitigation associated with a wide variety of activities including transportation projects, developments in or near wetlands, hydroelectric dam licensing, irrigation systems operation, airport operations, and any work done with federal grant monies.

Surveys: The U.S. Fish and Wildlife Service and Washington Department of Game (WDG) conducted statewide annual aerial nesting surveys, from 1976 through 1979. In 1980, the WDG initiated annual inventories of nesting bald eagles. These statewide, comprehensive activity and productivity surveys (usually 2 aerial surveys) were conducted annually from 1980-1992. Statewide single flight nest activity surveys were continued through 1998. Aerial surveys of portions of western Washington where eagles are most abundant and development conflicts are most frequent were done in 1999 and 2000. The USFWS is developing a population monitoring scheme as part of the proposed federal de-listing of the species.

Winter counts of bald eagles began in 1962 when data was collected during the Mid-winter Waterfowl Inventory conducted by personnel from the USFWS and WDG. In 1979, the National Wildlife Federation assumed the task of coordinating a nation-wide combined agency and private volunteer winter count that involved 26,000 participants (Knight et al. 1981). WDG coordinated the Washington portion of the effort that involved 359 individuals in 1979. In subsequent years, the mid-winter survey involved as many as 1,100 volunteer observers (Taylor 1988, 1989). In 1982, the survey was standardized to 1,241 geographic survey units, 8 x 12 mi in area. The standardized Mid-winter Survey was conducted each winter from 1982-89. The state-wide Mid-winter Survey, which required much WDFW staff time to coordinate, compile, and report, was discontinued when it became apparent that the bald eagle was recovering and that much of the year-to-year variation in the number of wintering eagles was at least in part produced by conditions outside of Washington, such as prey abundance in British Columbia. Mid-winter surveys have been continued by volunteers and other agencies for discrete parts of the state (e.g. Skagit River, Whatcom County, Lake Roosevelt, etc.).

Management Plans: In 1984, the Washington legislature enacted state laws to protect the bald eagle and its habitat based on public concern for the species' precarious status, recognition of its role within ecological systems, and its value to human quality of life. Bald eagle protection rules were developed by a group with broad representation from interest groups, including farmers, realtors, tribes, timber companies, environmentalists, counties, and state agencies (Solomon and Newlon 1991). The Washington Wildlife Commission subsequently adopted the rules in November 1986. The rules specifically directed the Washington Department of Wildlife to work with landowners to cooperatively develop site-specific bald eagle management plans when landowner-proposed activities may adversely impact bald eagle habitat. Bald eagle plans consider the unique characteristics of individual eagle pairs, nest and roost sites, and surrounding land uses, as well as the goals of the landowner. Plans apply to individual landowners, and since most territories have multiple landowners, these plans are not a comprehensive territory management plan.

Bald eagle plan development by WDFW biologists began in earnest in 1987. From the inception of Washington's bald eagle protection rules to present, 1,154 bald eagle plans have been developed between WDFW and various landowner entities for activities on private, state, and municipal lands in 26 of 39 (67%) counties in Washington (Waterbury 2000). These bald eagle plans represent agreements for 393 discrete bald eagle occurrences (nest territories or roosts) throughout the state (mean = 2.9 plans/occurrence, range = 1-19). The number of bald eagle plans developed per year showed a steady rise from 9 plans in 1987 to 122 in 1999.

Land use activities prompting the development of bald eagle plans fall under 8 general categories: residential development, forest practice, forest practice with road building, forest conversion (i.e. to nonforestry use, usually residential development), non-residential commercial development, road building, shoreline development, and other development.

A key component of the management plan process is determining habitat protection and/or timing conditions based on landowner objectives and site specific factors. The conditions negotiated in bald eagle plans then become the key components of a legally-binding contract between WDFW and landowners. Nearly all plans (97%) assigned habitat protection or a combination of habitat protection and timing conditions (Waterbury 2000). The remaining 3% involved only timing restrictions and were typically for forest practice/ road building activities. In bald eagle plans prescribing habitat protection measures, four general types of vegetation management strategies were employed: no cut buffer; partial retention of trees; large tree retention; and tree planting, often in combination. 'Partial retention' was most frequently used, appearing in 76% of total bald eagle plans, while the 'no cut buffer' prescription was used in 38% of plans. In several bald eagle plans conditions were negotiated to relocate proposed home sites and roads, reconfigure lots in residential developments, maintain community open space in planned unit developments and curtail pedestrian access in residential commons. A review of plan conditions for minimum distance-to-activity revealed 39% of bald eagle plans permitted conditioned activity within 400 feet of bald eagle nests or roost sites (Waterbury 2000). This occurs primarily in territories where land is platted in many small lots.

Research: The bald eagle is one of the most studied species in the world, and the basics of reproduction, development, behavior, diet, and habitat use are well understood. There are still many unknowns about patterns of habitat use, the effects of various types of disturbance, etc. Filling some important gaps that remain in our knowledge require long term and often expensive studies of parameters such as survival rates, dispersal distance from natal nest to adult nesting location, and mean longevity. Research conducted in Washington is varied and includes most aspects of eagle ecology. Most of the earlier work is summarized in books by Stalmaster (1987) and Gerrard and Bortolotti

(1988). There are numerous recent publications about work in Washington on: population inventory and monitoring (McAllister et al. 1986, Taylor 1989, Watson and Pierce 1998a); diet, foraging, and carrying capacity (Knight et al.1990, Knight and Anderson 1990, Hunt et al. 1992, Watson et al. 1991, Watson and Pierce 1998a); the effects of habitat change and human disturbance (Knight et al. 1991, McGarigal et al. 1991, Stalmaster and Kaiser 1997, 1998, Parson 1994, Watson and Pierce 1998a); contaminants (Anthony et al. 1993, Mahaffy et al. 2001); migration and movements (Watson and Pierce 1998a, 1998b, 2001); and perch and roost trees (Eisner 1991).

Habitat Acquisition: Conservation of bald eagles and their habitats was already underway before the federal listing of the Washington population in 1978. From 1990-98, 22 parcels of land encompassing a total of 2,267 ac of riparian and wetland habitat were acquired through state grants from the Washington Wildlife & Recreation Program that protected habitat for bald eagles.

Other Activities: Many private landowners have willingly retained nest, perch, and screening trees to contribute to bald eagle conservation. Many people appreciate having eagles on their property and have made sacrifices to accommodate them. Farmers and ranchers sometimes purposely leave carrion in their fields to provide food for eagles.

Lead shot was banned from use in hunting waterfowl in 1991, in part because of documented deaths of bald eagles and other protected species from lead poisoning. Eagles and other predators ingest shot incidental to consumption of waterfowl. The switch to non-toxic shot types for waterfowl hunting has probably reduced eagle fatalities resulting from lead poisoning, and poisonings should continue to decline as residual lead shot deposits break down or become unavailable to waterfowl.

Injured eagles have long been treated and cared for by licensed rehabilitators around the state. The Woodland Park Zoo has rehabilitated numerous injured bald eagles and released them at the Skagit River in fall and winter. A telemetry study of the fate of rehabilitated bald eagles in Minnesota found that 13 of 19 survived at least 6 weeks after release, and one female was known to have nested for 3 years after release (Martell et al. 1991).

The EagleCam was the first WDFW WildWatchCam project to appear on the agency website. It was initiated in May 2000, using newly available surveillance technology where a camera was installed at a Puget Sound bald eagle nest. The project was possible through a loan of cameras, volunteer installation by Tim Brown, and the involvement of the owners of the home below the nest. The project brought the home life of a family of eagles into homes all over the world via the internet (www.wa.gov/wdfw/). The website has been visited by over 400,000 people and provided an incredible opportunity to inform and educate the public about eagles and their conservation.

Oregon Spotted Frog

WDFW, WDNR, and the USFWS have surveyed spotted frog egg masses in Klickitat County since 1996. Currently no surveys have been conducted in the Little White Salmon subbasin for Oregon Spotted Frogs.

Other Projects

Since the 1950s, WDFW has surveyed black-tailed deer populations, gathered hunting statistics and has worked with landowners on habitat projects that have benefited many species that use a variety of wildlife habitats. Watershed planning under the Washington Watershed Planning Act for water quanitity purposes has commenced in the Little White Salmon and White Salmon watersheds and is expected to produce a final report before summer 2005.

Q.5. Management Plan

Q.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 Little White Salmon Subbasin will play a relatively minor role in the regional recovery of salmon and steelhead due to the very small amount of available habitat. Recovery will require action to reduce or eliminate all manageable factors or threats. Salmonid recovery efforts will provide broad ecosystem benefits to a variety of subbasin fish and wildlife species. Recovery will be accomplished through a combination of improvements in subbasin, Columbia River mainstem, and estuary habitat conditions as well as careful management of hatcheries, fisheries, and ecological interactions among species.

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

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

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

Columbia basin hydropower effects on Little White Salmon subbasin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Little White Salmon 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.

Q.5.2. Biological Objectives

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

Focal salmonid species in the Little White Salmon Subbasin include fall Chinook, coho, steelhead, and chum. The health or viability of these populations (which are a subset of the large Upper Columbia Gorge populations) is currently very low for chum, coho, and fall Chinook, Low for winter steelhead and high for summer steelhead (subset of Wind River population). 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.

Table Q-26. Current viability status of Little White Salmon (Upper Gorge) populations and the biological objective status necessary to meet the recovery criteria for the Coastal strata and the lower Columbia ESU.

Species	Population	Recovery priority[1]	Viability		Improve-ment[4]	Abundance		
			Status[2]	Obj.[3]		Historic[5]	Current[6]	Target[7]
Fall Chinook (Tule)	Upper Gorge	Contributing	VL	M	>500%	n/a[8]	<50	1,200
Chum	Upper Gorge	Contributing	VL	M	>500%	11,000	<50	900
Winter Steelhead	Upper Gorge	Stabilizing	L	L	0%	n/a[8]	200	200
Summer Steelhead	Wind	Primary	H	VH	0%[9]	n/a[8]	1,000	1,000
Coho	Upper Gorge	Primary	VL	H	400%	n/a[8]	<50	1,900

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

Focal populations need to improve to a targeted level that contributes to recovery of the species (see Volume I, Chapter 6). Recovery goals call for restoring coho to a high viability level, providing for 95% probability of persistence over 100 years. And fall Chinook to a medium viability level, providing for 75-94% probability of persistence over 100 years, and maintaining spring Chinook at low viability levels, providing for a 40-74% probability of persistence over 100 years. Spawning habitat for salmon and other species of interest is limited with only 400 meters of spawning area between a natural anadromous blockage by a falls at RM 1.5 and Drano Lake (where the river mouth is inundated by Bonneville Reservoir).

Q.5.3. Tributary Habitat

Due to the small amount of habitat available to anadromous fish in the Little White Salmon Subbasin, an in-depth stream habitat assessment was not conducted using EDT. Development of prioritized measures and actions in this basin relied upon existing information on salmonid habitat and on the results of the watershed process assessment (IWA). As a first step toward measure and action development, existing habitat information and watershed 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, limiting factors, and 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 Q-18 and each component is presented in detail in the sections that follow.

Q.5.4. Priority Areas, Limiting Factors and Threats

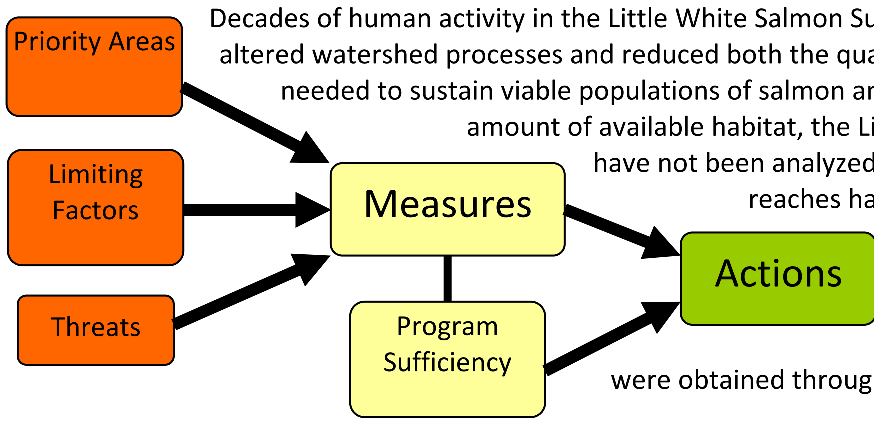


Figure Q-18. Flow chart illustrating the development of subbasin measures

Decades of human activity in the Little White Salmon Subbasin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Due to the small amount of available habitat, the Little White Salmon populations have not been analyzed using the EDT model and reaches have not been prioritized using the methodology applied to other subbasins. The limiting factors and threats that are listed in this chapter were obtained through consideration of various analyses, including the Little White Salmon Watershed Analysis (USFS 1995) and the Washington Conservation Commission Limiting Factors Analysis for WRIA 29 (WCC 1999). The following bullets provide an overview of each of the priority areas in the basin. 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 Q-27.

Lower mainstem *(Drano Lake to the barrier falls at RM 3)* – There is very little habitat available to anadromous fish in the Little White Salmon Subbasin. The reach with the greatest potential to support natural spawning is the 400-500 meter reach between the hatchery barrier dam and the hatchery water intake (RM 1.5, measured from the Hwy 14 Bridge). There is additional potential habitat above the intake up to the barrier falls at RM 3 but this stretch of river is confined within a steep canyon and spawning habitat is limited. The lower reach (barrier dam to intake) is in relatively good condition though past forest practices (log flumes) and the current hatchery complex have impacted floodplain function and riparian vegetation. Re-introduction of naturally-spawning fish above the barrier dam warrants further investigation and may be reasonable if fish health concerns can be adequately addressed. At a minimum, existing habitat quality should be protected. If fish passage is provided, this reach may present opportunities for riparian and floodplain restoration. Within and downstream of the hatchery complex, there may also be potential sites for creation of new habitats (i.e., spawning channels) to compensate for lost or currently inaccessible habitat.

Middle mainstem *(Willard Hatchery to Oklahoma Campground)* – The middle/upper mainstem between the Willard Hatchery and Oklahoma Campground is an alluvial section with intact floodplains and good resident fish habitat. It has been impacted by past timber harvest activities, rural residential development, and roadways. Preventing further degradation of stream channel structure, riparian function, and floodplain function in this reach will be important to support resident fish and wildlife species.

Table Q-27. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the lower mainstem (LM) and the Middle mainstem (MM). Limiting factors are the biophysical conditions directly impacting aquatic species; threats are the land-use conditions contributing to the limiting factors. Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors			Threats		
	LM	MM		LM	MM
Habitat connectivity			***Forest practices***		
Blockages to channel habitats	✓		Timber harvests –sediment supply impacts	✓	✓
Habitat diversity			Forest roads – impacts to sediment supply	✓	✓
Lack of stable instream woody debris	✓	✓	***Channel manipulations***		
Altered habitat unit composition	✓	✓	Blockages to channel habitat	✓	
Loss of off-channel and/or side-channel habitats	✓	✓	***Rural development***		
Riparian function			Roads – riparian/floodplain impacts		✓
Reduced stream canopy cover	✓	✓	Clearing of vegetation		✓
Reduced wood recruitment	✓	✓	***Hatchery complex development***		
Floodplain function			Floodplain filling	✓	
Altered nutrient exchange processes	✓	✓	Clearing of vegetation	✓	
Reduced flood flow dampening	✓	✓	Barrier Dam	✓	
Restricted channel migration	✓	✓			
Disrupted hyporheic processes	✓	✓			
Substrate and sediment					
Excessive fine sediment	✓	✓			

Habitat Measures

Measures are means to achieve the regional strategies that are applicable to the Little White Salmon Subbasin and are necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this basin (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 Little White Salmon Subbasin are presented in priority order in Table Q-28. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the basin. 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 Little White Salmon Subbasin.

Habitat Actions

The prioritized measures and associated gaps are used to develop specific actions for the basin. These are presented in Table Q-29. 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 ini 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 Q-28. Prioritized measures fot the Little White Salmon 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 threats related to limiting factors	All Species	Stream corridors in the Little White Basin have primarily been impacted by forestry activities. The short reach with good potential spawning habitat in the lower mainstem above Drano Lake has been impacted by development of hatchery facilities and past log flume operations. The upper mainstem between the Willard Hatchery and Oklahoma Campground is an alluvial section with intact floodplains and good resident fish habitat, although it has been impacted by past timber harvest activities. Preventing further degradation of stream channel structure, riparian function, and floodplain function in these areas will be an important component of recovery.

Priority Locations

1st- Lower mainstem between Drano Lake and Spirit Falls (RM 3) (potential anadromous use)
2nd- Upper mainstem between Willard National Fish Hatchery and Oklahoma Campground (productive habitat for resident fish)
3rd- Upper mainstem tributaries including Lusk Creek, upper and lower Lost Creek, Lava Creek, Moss Creek, Berry Creek, Cabbage Creek, Pine Creek (resident fish)

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NMFS	ESA Section 7 and Section 10	✓	
USFS	Northwest Forest Plan, Columbia River Gorge National Scenic Area (CRGNSA)	✓	
U.S. Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
WA Department of Natural Resources (WDNR)	State Lands HCP, Forest Practices Rules, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Skamania County	Comprehensive Planning		✓
Underwood Conservation District / Natural Resources Conservation Service (NRCS)	Conservation Programs; Landowner Technical Assistance		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, Control		✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements		✓

Program Sufficiency and Gaps

Alterations to stream corridor structure that may impact aquatic habitats are regulated through the WDFW Hydraulics Project Approval (HPA) permitting program. Other regulatory protections are provided through USACE permitting, ESA consultations, HCPs, and County regulations. 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. 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. Local governments can limit potentially harmful land-use conversions by thoughtfully directing growth through comprehensive planning and tax incentives, by providing consistent protection of critical areas across jurisdictions, and by preventing development in floodplains. In cases where existing programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary. Public land acquisition should be used as a last resort due to strong opposition by Skamania County to reducing their tax base in an area that is already overwhelming publicly owned.

#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 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	All species	Hillslope runoff and sediment delivery processes are functional in much of the subbasin due to mature forest vegetation and low forest road densities. Some areas, however, have received past intensive forest practices and are at greater risk to sediment contribution from forest road sources. Limiting additional degradation will be necessary to prevent further habitat impairment.

Priority Locations

1st- Functional subwatersheds (functional for sediment *or* flow according to the IWA (local rating) and USFS Watershed Analysis)
Subwatersheds: 00102, 00101, 00204, 00203, 00205, 00202, 00301, 00402, 00201

2nd- Moderately Impaired subwatersheds
Subwatersheds: 00502 & 00501

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, State Lands HCP	✓	
USFS	Northwest Forest Plan, CRGNSA	✓	
Skamania County	Comprehensive Planning		✓
Underwood Conservation District / NRCS	Conservation Programs; Landowner Technical Assistance		✓

Program Sufficiency and Gaps

Hillslope processes on federal and state timber lands are protected through the Northwest Forest Plan and State Timber Lands HCP, respectively. 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, County Comprehensive Planning is the primary nexus for protection of hillslope processes. Counties can control impacts through zoning that protects existing uses and through tax incentives to prevent forest lands from becoming developed.

#3 - 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	All species	Degradation of riparian forests in the subbasin has contributed to loss of large woody debris recruitment potential, loss of stream shading, loss of streambank stability, loss of floodplain function, and disruption of nutrient exchange and hyporheic flow processes; all of which have potentially deleterious effects to aquatic and terrestrial species. The increasing abundance of exotic and invasive species is also of concern. Riparian restoration projects are relatively inexpensive and are often supported by landowners.

Priority Locations

1st- Upper mainstem between Willard National Fish Hatchery and Oklahoma Campground
2nd- Lower reaches of upper mainstem tributaries (Lusk Creek, Lava Creek, Lost Creek, Cabbage Creek, Berry Creek, Moss Creek, Pine Creek)
3rd- Lower mainstem between Drano Lake and the hatchery intake

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
USFS	Northwest Forest Plan, CRGNSA, Habitat Projects	✓	
WDFW	Habitat Program	✓	
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Underwood Conservation District / NRCS	Conservation Programs; Landowner Technical Assistance; habitat projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Enforcement, Education, 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 the Northwest Forest Plan, Forest Practices Rules, or the State forest lands HCP. Other lands receive variable levels of protection through the Skamania County Comprehensive Plan. 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.

#4- Restore degraded hillslope processes on forest lands

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	All species	Hillslope runoff and sediment delivery processes are functional in much of the subbasin due to mature forest vegetation and low forest road densities. Some areas, however, have received past intensive forest practices and are at greater risk to sediment contribution from forest road sources. Poor road construction has caused numerous mass wasting events, especially in areas with steep, unstable slopes (USFS 1995). Degraded hillslope processes must be addressed for reach-level habitat recovery to be successful.

Priority Locations

1st- Moderately impaired or impaired subwatersheds (mod. impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: 00102, 00204, 00202, 00502, 00501, 00302, 00401

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	State Lands HCP, Forest Practices Rules	✓	
USFS	Northwest Forest Plan	✓	
WDFW	Habitat Program	✓	
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Underwood Conservation District / NRCS	Conservation Programs; Landowner Technical Assistance; 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), 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. Means of increasing hillslope 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 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	A few barriers to fish passage in the subbasin limit access to spawning and rearing areas. A barrier dam near the mouth that is associated with the hatchery limits access to the lower mainstem below the barrier falls at river mile 3. Culverts restrict passage to resident fish in the upper basin. 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- Lower mainstem (hatchery barrier dam)

2nd- Tributary blockages in the upper basin

Key Programs

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

Program Sufficiency and Gaps

In the lower mainstem, anadromous fish are not passed above the barrier dam due to hatchery fish health concerns. Two miles of potentially productive habitat exists above the dam if fish health concerns can be adequately addressed. Regarding other blockages, 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.

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

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	Resident fish species	There are several areas of elevated stream temperature concern in the subbasin. Riparian canopy cover has been reduced as a result of past timber harvests and channel widening has occurred in some reached due to flooding that followed clear-cutting of riparian areas in the 1960s (USFS 1995). Two segments of the mainstem Little White Salmon are listed on the 2002-2004 draft 303(d) List for temperature impairment. There are two other mainstem segments listed as a concern for temperature.

Priority Locations

1st- Reaches with 303(d) listings (2002-2004 draft list)
Reaches: Mainstem Little White Salmon (between Moss Creek and Wilson Creek; near Lusk Creek confluence)

2nd- All remaining reaches

Key Programs

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

Program Sufficiency and Gaps

Ecology's Water Quality Program manages the State 303(d) list of impaired water bodies. There are two listings in the mainstem Little White Salmon River and two areas of concern (WDOE 2004). A Water Quality Clean-up Plan (TMDL) is required by Ecology and it is anticipated that the TMDL will adequately set forth strategies to address the temperature impairment. It will be important that the strategies specified in the TMDL 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 – 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 Summer low-flows	• Water withdrawals	All species	Current and predicted consumptive water withdrawals are believed to represent a negligible amount of the low flow volume of the Little White Salmon River (Greenberg and Callahan 2003). This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Resources Program		✓
WRIA 29 Watershed Planning Unit	Watershed Planning		✓

Program Sufficiency and Gaps

The Water Resources Program of Ecology, in cooperation with the WDFW and other entities, manages water rights and instream flow protections. A collaborative process for setting and managing instream flows was launched in 1998 with the Watershed Planning Act (HB 2514), which called for the establishment of local watershed planning groups who's objective was to recommend instream flow guidelines to Ecology through a collaborative process. The current status and near-term direction of this planning effort is outlined in the WDOE's Action Plan for Setting, Achieving, and Protecting Instream Flows (WDOE 2004). The action plan is a working document that describes the strategies that will be used to set, achieve, and protect instream flows in each WRIA using the recommendations of local watershed planning units. In the case of the Little White Salmon River, "The [WRIA 29] Planning Unit developed a detailed instream flow proposal, but ultimately voted to not request a supplemental instream flow grant from Ecology. This was largely due to concerns with having responsibility for developing flow recommendations." (from Ecology Watershed Planning website). The role of the Planning Unit in setting instream flows therefore remains uncertain. If the Planning Unit does not make any recommendations to Ecology, Ecology would have until 2007 to establish minimum instream flows.

#8 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Reductions in habitat diversity and channel stability have resulted from loss of instream stable large woody debris, loss of riparian function, and changes to the natural stream flow regime. The primary contributing land use is forest harvest. Goose Lake Creek has low pool availability. The Upper mainstem has high channel instability (high width-to-depth ratios) (USFS 1995). 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- Upper mainstem between Willard National Fish Hatchery and Oklahoma Campground
2nd- Upper mainstem tributaries (Lusk Creek, Lava Creek, Lost Creek, Cabbage Creek, Berry Creek, Moss Creek, Pine Creek, Goose Lake Creek)
3rd- Lower mainstem between Drano Lake and the hatchery intake

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, 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		✓
Underwood Conservation District / NRCS	Conservation Programs; Landowner Technical Assistance; 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. Projects are likely to occur in a piecemeal fashion as opportunities arise and if financing is made available. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

Table Q-29. Habitat actions for the Little White Salmon Subbasin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L White 1. Continue to manage federal forest lands according to the Northwest Forest Plan	Activity is currently in place	USFS	1, 2, 3, 4, 5 & 6	High: National Forest 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	High
L White 2. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Skamania County, Ecology	1	Low: 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 White 3. 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	Skamania County	1 & 2	Low: Applies to 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
L White 4. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of lands to developed uses through zoning regulations and tax incentives	Expansion of existing program or activity	Skamania County	1 & 2	Low: 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
L White 5. Increase funding available to purchase easements in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Low: Residential 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 White 6. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed management	Expansion of existing program or activity	Skamania County				

[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]
L White 7. 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, UCD, WDNR, WDFW, LCFEG, Skamania County	All measures	Low: Private lands. Applies to lands in rural residential and forestland uses	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
L White 8. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 3, 4, 5 & 6	Low: 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 White 9. Address instream flow setting through the WRIA 29 Planning Unit and/or through Ecology	Expansion of existing program or activity	Ecology, WDFW, WRIA 29 Planning Unit, Skamania County	7	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
L White 10. 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, Skamania County, WSDOT, LCFEG	5	Medium: Passage at Hatchery weir at mouth and passage issues for resident fish in upper basin	Medium: Increased habitat availability	Medium
L White 11. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships with landowners and agencies and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, UCD, LCFEG	3, 4, 5, 6 & 8	Low: Priority stream reaches and subwatersheds	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 White 12. 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	Low: Small private timberland owners	Medium: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
L White 13. 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, UCD, LCFEG	1 & 3	Low: Greatest risk is in residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
L White 14. Address stream temperature impairments through the development and implementation of water quality clean up plans (TMDLs)	Expansion of existing program or activity	Ecology	6	Low: Stream segements on the 303(d) list and other areas of concern	Medium: Protection and restoration of natural stream temperature regimes	Low

Q.5.5. Hatcheries

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

Subbasin Hatchery Strategy

The desired future state of fish production within the Little White Salmon Basin includes natural fall Chinook and chum populations that are improving on a trajectory to target viability levels and hatchery programs that either enhance the natural fish improvement trajectory or are operated to not impede progress towards recovery. The Little White Salmon Hatchery production must also meet legal requirements contained in Federal Court ordered Agreements developed through *U.S. v. Oregon*. Hatchery recovery actions in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. This may involve substantial changes in some hatchery programs from their historical focus on production for fishery mitigation. 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. More detailed descriptions and discussion of the regional hatchery strategy can be found in Volume I.

Table Q-22. Summary of potential natural production and fishery enhancement strategies to be implemented in the Little White Salmon Basin.

		Species					
		URB Fall Chinook [2]	Spring Chinook	Coho [3]	Chum	Winter Steelhead	Summer Steelhead
Natural Production Enhancement	Supplemetation	✓		✓			
	Hatch/Nat Conservation [1]						
	Segregation						
	Refuge						
Fishery Enhancement	Hatchery Production	✓	✓	✓			

[1] Hatchery and natural population management strategy coordinated to meet biological recovery objectives. Strategy may include integration and/or segregation strategy over time. Strategy will be unique to biological and ecological circumstances in each watershed.
[2] U.S. v. Oregon agreed production to the Yakama Indian Nation for release in the Yakama River
[3] U.S. v. Oregon agreed production to the Yakama Indian Nation for release in the Wenatchee River

Conservation-based hatchery programs include strategies and actions 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. This option is not identified for the Little White Salmon subbasin.

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 option is not identified for the Little White Salmon basin, although the Little White Salmnon Hatchery could be considered as a future option to rear chum salmon for supplementing selected Upper Gorge Strata areas. The little White Salmon hatcheries are used to supplement production of early coho into the Wenatchee River and URB fall Chinook into the Yakama River as part *of U.S. v. Oregon* mandated production distribution.

Hatchery/Natural Segregation: 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 actions for the Little White Salmon

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 tule fall Chinook hatchery program in the Little White Salmon 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. The Little White Salmon is a site used for meeting specific hydro development mitigation (e.g. John Day Dam) and to provide for Treaty Indian fishing rights. URB fall Chinook, coho, and spring Chinook programs for fishery enhancement and for *U.S. v. Oregon* agreed transfer to mid-Columbia tributaries will continue during the recovery period, but will be managed to minimize risks and ensure they do not compromise recovery objectives for natural populations.

Table Q-30. A summary of potential conservation and harvest strategies to be implemented through Little White Salmon River Hatchery programs.

		Stock
Natural Production Enhancement	Supplementation	Little White Salmon early coho [2] Little White Salmon URB fall Chinook [3]
	Hatch/Nat Conservation [1]	
	Segregation	
	Refuge	
	Broodstock development	
Fishery Enhancement	In-basin releases (final rearing at Little White Salmon)	Carson Spring Chinook URB fall Chinook Little White early coho
	Out of Basin Releases	Early coho to Yakama Indian Nation for Wenatchee River program URB fall Chinook to Yakama Indian Nation for Yakama River program

[1] May include integrated and/or segregated strategy over time.
[2] U.S. v. Oregon agreed production to the Yakama Indianh Nation fro release in the Wenatchee River
[3] U.S. v. Oregon agreed production to the Yakama Indian Nation for release into the Yakima River

Hatchery Measures and Actions

Hatchery strategies and actions are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within Little White Salmon 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 Little White Salmon Basin (Table Q-31). The subbasin 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 NMFS approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the Little White Salmon River Basin hatchery programs. Further explanation of specific strategies and measures for hatcheries can be found in Volume I.

Table Q-31. Potential hatchery implementation actions in the Little White Salmon Basin.

Action	Description	Comments
	Mass mark hatchery produced coho and spring Chinook.	Will enable out-of-basin selective fishing and accountability of hatchery fish spawning in the wild.
	Evaluate Little White Salmon Hatchery Complex facilities and operations	Evaluate through HGMP and APRE processes to assess need for facility and operational changes to reduce impacts to wild salmonids.
	Juvenile release strategies to minimize impacts to naturally-spawning populations.	Release strategies would be aimed at minimizing interactions between hatchery released spring Chinook smolts and wild fall Chinook and chum.
	Adaptively manage hatchery programs to further protect and enhance natural populations and improve operational efficiencies.	Appropriate research, monitoring, and evaluation programs along with guidance from regional hatchery evaluations will be utilized to improve the survival and contribution of hatchery fish, reduce impacts to natural fish, and increase benefits to natural fish.

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

Q.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 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. Sport fishery regulatory and protective actions pertaining to the Little White Salmon basin are displayed in Table Q-32. Additionally, Treaty Indian fisheries occur in the Little White Salmon River mouth (Drano Lake) as per management agreement between WDFW and the Yakama Indian Nation.

Regional actions (Table Q-33) cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and measures for harvest are detailed in Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon.

Table Q-32. Summary of sport fishing regulatory and protective fishery actions in the Little White Salmon River (including Drano Lake) basin

Species	General Fishing Actions	Explanation	Other Protective Fishing Actions	Explanation
Fall Chinook	Open for fall Chinook	Fishery is focused on URB hatchery fall Chinook returning to the Little White Salmon River	Closed area between upper end of Drano Lake and hatchery	Protects fall Chinook in areas of high concentration and while spawning
Spring Chinook	Open for spring Chinook	Fishery targets hatchery spring Chinook produced in the Drano Lake.	Night closure and closed area between upper end of Drano Lake and hatchery	Protects spring Chinook in areas of high concentration and while spawning
chum	Closed to retention	Protects natural chum. Hatchery chum are not produced for harvest		
coho	Open for coho	Fishery targets early coho produced at the hatchery	Closed area between upper end of Drano Lake and hatchery	Protects fall Chinook in areas of high concentration and while spawning
Summer steelhead	Open for adipose fin clipped hatchery steelhead	Fishery targets hatchery summer steelhead from upper Columbia ans Snake River hatchery programs. Wild steelhead must be released.	Closed area between upper end of Drano Lake and hatchery	Protects fall Chinook in areas of high concentration and while spawning

Table Q-33. Regional harvest actions from Volume I with significant application to the Little White Salmon River Subbasin populations.

Action	Description	Responsible Parties	Programs	Comments
	Lower Columbia populations set in the Lower Columbia Recovery Plan will be considered in annual fishery management processes.	WDFW, ODFW, Yakama, Warm Springs, Umatilla, and Nez Perce Treaty Indian Tribes, NMFS, USFWS	Columbia Compact, *U.S. v Oregon, North Of Falcon, PFMC*	Little White salmon basin fishery resource objectives considered in annual fishery management processes
	Develop specific chum management details for pre-season and in-season management of the late fall commercial fisheries	WDFW, ODFW	Columbia Compact,	Compact agencies would develop specific criteria for in-season adjustments based on chum encounter rates.

Q.5.7. Hydropower

No hydropower facilities exist in the Little White Salmon subbasin, however the anadromous fish populations in the Little White Salmon River are affected by Bonneville Dam operations with reservoir conditions now present in the lower Little White Salmon River and by dam passage effects.

The configuration and operation of Bonneville Dam affects juvenile and adult salmon migration and passage. Hydropower operations reduce the resiliency and inhibit the recovery of anadromous salmonid populations in the Little White Salmon River Subbasin. Upstream and downstream fish passage facilities are operated at Bonneville Dam in the mainstem Columbia River but significant mortality and migration delay occurs. No bypass system is 100% effective. Adults are typically delayed in the tailrace but most eventually find and use fish ladders. A varying percentage of adults do not pass successfully or pass but fall back over the spillway. Juvenile passage mortality results primarily from passage through dam turbines rather than spillway or fish bypass systems. Anadromous fish populations will benefit from regional recovery measures and actions identified for operations of Bonneville Dam relative to fish passage and for habitat conditions in the mainstem and estuary (Table Q-34).

Table Q-34. Regional hydropower operation measures from Volume I, Chapter 5 with significant application to the Little White Salmon Subbasin populations

Measure	Description	Responsible Parties	Programs	Comments
D.M2	Maintain and operate effective juvenile and adult passage facilities (including facilities, flow, and spill) at Bonneville Dam.	BPA; NMFS; USACE	ESA Section 7, FPAC, TMT	Effective flow, spill, and facilities are crucial for dam passage.

Q.5.8. Mainstem and Estuary Habitat

Little White Salmon 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.

Q.5.9. Ecological Interactions

For the purposes of this Plan, ecological interactions refer to the relationships of salmon and steelhead with other elements of the ecosystem. Regional strategies and measures pertaining to exotic or non-native species, effects of salmon on system productivity, and native predators of salmon are detailed and discussed at length in Volume I and are not reprised at length in each subbasin plan. Strategies include 1) avoiding and 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.

Q.5.10. Limiting Factors, Biological Objectives, and Strategies

At present, there are numerous recovery plans, status reports, and management recommendations available for habitats and wildlife in the Little White Salmon River subbasin; this subbasin management plan is intended to supplement these existing plans. Little White Salmon River focal wildlife species with existing recovery plans or status reports include the western pond turtle (Hays et al. 1999); Little White Salmon River wildife species of interest with existing recovery plans or status reports include the fisher (Lewis and Stinson 1998), the bald eagle (Stinson et al. 2001), and the Oregon spotted frog (McAllister and Leonard 1997). Only management recommendations for focal species are provided in the subsequent sections; species of interest are not included. Additionally, WDFW has produced management recommendations for priority species groups (amphibians and reptiles – Larsen 1997; birds – Larsen et al. 2004; mammals – Azerrad 2004) and priority habitats (riparian – Knutson and Naef 1997; Oregon white oak woodlands – Larsen and Morgan 1998).

Some general goals, objectives, and strategies were developed by various stakeholders in the Little White Salmon River subbasin (Rawding 2000). However, at the time of publication of the draft subbasin summary, the subbasin summary was not complete and there was a lack of consensus regarding the desired future condition of fish and wildlife habitats and populations. Thus, the subbasin summary presented goals, objectives, and strategies specific to each stakeholder group and not a unified set of goals, objectives, and strategies for the subbasin. Additionally, many of the goals, objectives, and strategies, as well as identified limiting factors and ongoing restoration projects, addressed fish populations and habitats and placed less priority on wildlife populations and their habitat.

Western Gray Squirrel

The western gray squirrel (*Sciurus griseus*) is a Washington state threatened species and a Federal species of concern. Within the Little White Salmon River subbasin, western gray squirrels may be found in mesic lowland conifer-hardwood forest in close proximity to westside white oak – dry Douglas fir forest. Table Q-35 provides a summary of western gray squirrel limiting factors, biological objectives, and restoration strategies.

Table Q-35. Western gray squirrel limiting factors, biological objectives, and restoration strategies.

Limiting Factors	Biological Objectives	Restoration Strategies	Geographical Area
Loss of Large Tracts of Old Growth or Late Seral Forests. Loss of Columbia River lowland riparian vegetation.	Increase quantity of habitat for western gray squirrel.	Increase compliance with forest guidelines for western gray squirrels. Retain remaining large, unfragmented tracts of western gray squirrel habitat.	Entire subbasin and Columbia River shoreline
Increased Stand Density and Decreased Average Tree Diameter Reduction of Large Diameter Trees and Snags Loss of Native Understory Vegetation and Composition	Increase quality of western gray squirrel habitat. Protect all stands of Oregon White Oak.	Use site-specific fire prescriptions to enhance potential and used western gray squirrel habitat. Create / retain optimal habitat (see assessment).	Entire subbasin and Columbia River shoreline
Loss of Individual, Late Seral Trees (i.e. woodcutting)	Retain decadent and other important wildlife trees. Leave all oak and oak snags.	Encourage woodcutting to be used as a tool for thinning overstocked areas. Create public education programs.	Entire subbasin and Columbia River shoreline
Increased Competition to Western Gray Squirrels	Reduce pressure to western gray squirrels from California ground squirrels and eastern gray squirrels.	Create programs to control non-native wildlife and other non-historical species. Create public education programs.	Entire subbasin and Columbia River shoreline

Yellow Warbler

Yellow warblers are an indicator species for riparian habitat; possible habitats in the Little White Salmon River subbasin that may provide suitable riparian areas for yellow warblers include open water and montane coniferous wetlands. Historically, westside riparian-wetland habitat was present in the Little White Salmon River subbasin, but this habitat was not present during recent mapping efforts. Table Q-36 provides a summary of yellow warbler limiting factors, biological objectives, and restoration strategies.

Table Q-36. Yellow warbler limiting factors, biological objectives, and restoration strategies.

Limiting Factors	Biological Objectives	Restoration Strategies	Geographical Area
Reduction in Floodplain Acreage Overall Habitat Loss Habitat Fragmentation	Increase riparian habitat, which will provide quality and quantity habitat for yellow warblers.	Inventory existing and potential yellow warbler habitat. Create / retain optimal habitat (see assessment).	Lower elevations
Reduced Food Base	Reduce mortality of food base (insects) needed by yellow warblers, from chemical applications.	Use alternative control measures for undesirable insect species in riparian buffers, especially in areas used by yellow warbler.	Lower elevations

Pileated Woodpecker

Pileated woodpeckers are currently candidates for endangered species listing by the Washington Department of Fish and Wildlife. Any forest type (broadleaved, coniferous, or mixed) can sustain pileated woodpeckers as long as there are trees large enough for roosting and nesting. Pileated woodpeckers are often associated with mature and old-growth forests but can breed in younger forests if they contain some large trees. In western Washington, they typically roost in western hemlock and western red cedar. Although generally resident, pileated woodpeckers sometimes wander from their breeding areas and many move down-slope or into streamside forests or suburban areas in winter.

Pileated woodpeckers play an important role within their ecosystems by excavating nesting and roosting cavities that are subsequently used by many other birds and by many small mammals, reptiles, amphibians, and invertebrates. Clear-cutting of old-growth and other forests currently has the most significant impact on pileated woodpecker habitat, but pileated woodpeckers are fairly adaptable, which offsets some of the impact from habitat loss. Table Q-37 provides a summary of pileated woodpecker limiting factors, biological objectives, and restoration strategies.

Table Q-37. Pileated woodpecker limiting factors, biological objectives, and restoration strategies.

Limiting Factors	Biological Objectives	Restoration Strategies	Geographical Area
Loss of Large Tracts of Old Growth or Late Seral Forests	Increase quantity of habitat for pileated woodpecker.	Encourage landowner incentives through compensation and land easements. Retain reserves and identify and protect important habitats.	Entire subbasin
Reduction of Large Diameter Trees and Snags	Increase quality of pileated woodpecker habitat.	Increase number of snags and snag recruitment in pileated woodpecker habitat. Retain 2 snags per acre that are >30 in dbh, in stands 60 years and older and >70% canopy closure. In nesting areas retain 7 large snags and 3 decaying large trees per acre. Trees >90 ft in height should be retained. Create site-specific fire prescriptions to enhance potential and used pileated woodpecker habitat.	Entire subbasin

Band-Tailed Pigeon

The band-tailed pigeon breeds throughout much of Western Washington. The band-tailed pigeon requires mineral springs as a source of calcium for egg-laying and the production of crop-milk for its young (March and Sadleir 1975, Jarvis and Passmore 1992, Braun 1994). The proximity of these mineral springs to suitable foraging habitats is an important factor for band-tailed pigeons (Jarvis and Passmore 1992). A mineral spring located in the lower reach of the Wind River has one of the highest concentrations of pigeon use in the state. Management of band-tailed pigeons has been addressed in Larson et al. (2004); Table Q-38 provides a summary of band-tailed pigeon limiting factors, biological objectives, and restoration strategies.

Table Q-38. Band-tailed pigeon limiting factors, biological objectives, and restoration strategies.

Limiting Factors	Biological Objectives	Restoration Strategies	Geographical Area
Reduction in Mineral Springs and Mineral Sources Overall Habitat Loss Habitat Fragmentation	Increase quality and quantity of habitat for band-tailed pigeons.	Inventory existing and potential band-tailed pigeon habitat. Create / retain optimal habitat (see assessment). Avoid removal of perch trees surrounding mineral springs. Enhance access to mineral sources via dense vegetation removal. Maintain and enhance growth of berry/mast-producing shrubs and trees. Avoid large clearcuts in band-tailed pigeon habitat; if cut, replant with a variety of species, especially near mineral sources.	Lower portion of subbasin
Reduced Food Base	Reduce mortality of food-producing shrubs and trees needed by band-tailed pigeons, from chemical applications.	Use alternative control measures for undesirable shrub and tree species in areas used by band-tailed pigeons so that food producing species are maintianed.	Lower portion of subbasin
Mortality from Disease Outbreaks	Minimize disease (protozoan Trichomoniasis) transmission from urban feeders.	Create public education programs to encourage regular cleaning of bird feeders and establish reporting requirements for sick/dead birds.	Lower portion of subbasin

Western Pond Turtle

The western pond turtle is listed as endangered in the State of Washington and is considered a federal species of concern. The western pond turtle is closely associated with open water habitats in close proximity to appropriate soil for nesting and vegetation for nesting and cover. Wildlife habitats in the Little White Salmon River subbasin that may provide these attributes include open water and mesic lowland conifer-hardwood forest. Historically, westside riparian-wetland habitat was present in the Little White Salmon River subbasin, but this habitat was not present during recent mapping efforts. Western pond turtle recovery was discussed in detail in Hays et al. (1999); a synopsis of the recovery strategies is provided in Table Q-39.

Table Q-39. Western pond turtle limiting factors, biological objectives, and restoration strategies.

Limiting Factors	Biological Objectives	Restoration Strategies	Geographical Area
Reduction in Floodplain Acreage Habitat Fragmentation Loss of Riparian Habitat and Function Native Riparian Vegetation Displacement with Non-native Vegetation Overall Loss of Riparian Vegetation	Increase quality and quantity of habitat for western pond turtles. Restore western pond turtle population numbers to historical levels.	Utilize purchase easements, leases or agreements, for landowners to restore or protect riparian vegetation (e.g. Farm Program partner, etc.). Create / retain optimal habitat (see assessment). Inventory roads near occupied or potential western pond turtle habitat and assess impacts to determine problem areas in need of resolution. Augment or support shoreline and adjacent uplands weed control programs. Promote silviculture practices that retain buffer of shoreline trees (basking log recruitments) within western pond turtle habitat. Provide incentives through easements, leases or agreements, for landowners to manage livestock in such a way to provide for riparian vegetation restoration (e.g., farm programs).	Columbia River shoreline and adjacent uplands
Predation by Non-native Species	Eliminate predation from non-native species.	Remove bullfrog and non-native fish from occupied sites and control current bullfrog and non-native fish occupation in potential habitat.	Columbia River shoreline and adjacent uplands
Increased Human Disturbance	Decrease disturbance to western pond turtles.	Restrict access to known western pond turtle sites.	Columbia River shoreline and adjacent uplands

Larch Mountain Salamander

Larch Mountain salamander distribution includes west-side habitats of the southern Cascades region in Washington and the Columbia Gorge area of Oregon and Washington, including the Little White Salmon River subbasin. Larch Mountain salamanders depend on cool, moist environments; they require a suitable combination of slope, rock size, shade, and organic debris. Populations of Larch Mountain salamanders are small, isolated, and occur in a limited geographic area. This salamander is sedentary and its very specific habitat requirements may hinder dispersal. Management of Larch Mountain salamanders has been addressed in Larsen (1997); Table Q-40 provides a summary of Larch Mountain salamander limiting factors, biological objectives, and restoration strategies.

Table Q-40. Larch Mountain salamander limiting factors, biological objectives, and restoration strategies.

Limiting Factors	Biological Objectives	Restoration Strategies	Geographical Area
Loss of Habitat	Increase quantity of habitat for Larch Mountain salamander.	Retain current suitable habitat. Avoid logging on talus slopes occupied by Larch Mountain salamander. If logging occurs, maintain a minimum 50m buffer around talus slopes, retain shade, and retain downed slash. Avoid disturbing talus slopes during building/ development; maintain minimum 50m buffer. Restrict gravel removal for road construction from known talus slopes supporting salamanders.	Entire subbasin
Decreased Shade, Moisture, and Detritus on Talus Slopes	Increase quality of Larch Mountain salamander habitat.	Encourage woody debris recruitment of all size and decay classes to talus slopes.	Entire subbasin
Increased Human Disturbance	Minimize human use of known Larch Mountain salamander habitat.	Restrict human access to caves known to support Larch Mountain salamanders.	Entire subbasin

Q.6. References

Agee, J. K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C. 493 pp.

Agee, J. K. and L. Smith. 1984. Subalpine tree establishment after fire in the Olympic Mountains, Washington. Ecology 65:810-819.

Ahlenslager, K. E. 1987. *Pinus albicaulis*. *In* W.C. Fischer, compiler. The Fire Effects Information System (Data base). Missoula, Montana. U.S. Forest service, Intermountain Research Station, Intermountain Fire Sciences Laboratory. http://www.fs.fed.us/database/feis/plants/tree/pinalb.

Altman, B. 2000. Conservation strategy for landbirds of the east-slope of the Cascade Mountains in Oregon and Washington. Oregon-Washington Partners in Flight.

Altman, B., and J. Bart. 2001. Special species monitoring and assessment in Oregon and Washington: landbird species not adequately monitored by the Breeding Bird Survey. Oregon-Washington Partners in Flight.

Anderson, M., P. Bourgeron, M. T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D. H. Grossman, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A. S. Weakley. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume II. The National Vegetation Classification System: list of types. The Nature Conservancy, Arlington, Virginia.

Anthony, R. G., M. G. Garrett, and C. A. Schuler. 1993. Environmental contaminants in bald eagles in the Columbia River estuary. J. Wildlife Management. 57:10-19.

Arp, A.H., J.H. Rose, S.K. Olhausen. 1971. Contribution of Columbia River hatcheries to harvest of 1963 brood fall Chinook salmon. Nation Marine Fisheries Service (NMFS), Portland, OR.

Atzet, T., D.L. Wheeler, G. Riegel, and others. 1984. The mountain hemlock and Shasta red fir series of the Siskiyou Region of southwest Oregon. FIR Report 6(1): 4-7.

Aubry, K.B., Senger, C.M., and R.L Crawford. 1987. Discovery of Larch Mountain salamanders *Plethodon larselli* in the central Cascade Range of Washington. Biol. Conserv. 42:147-152.

Azerrad, J.M., editor. 2004. Management recommendations for Washington's priority species, Volume V: Mammals. Washington Department of Fish and Wildlife, Olympia, WA.

Barber, W. H., Jr. 1976. An autecological study of salmonberry (*Rubus spectabilis*, Pursh) in western Washington. M.S. Thesis. University of Washington, Seattle, WA. 154 pp.

Barkhurst, C. B. Bury, S. Kohlmann, L. Todd, S. Wray, G. Sieglitz, and N. Sisk. 1997. Western Pond Turtle Survey and Monitoring Plan (DRAFT). Western Pond Turtle Working Group. 41 pp.

Barnum, D.A. 1975. Aspects of western gray squirrel ecology. M.S. Thesis, Washington State University, Pullman. WA.

Barrett, S. W., S. F. Arno, and J. P. Menakis. 1997. Fire episodes in the inland Northwest (1540-1940) based on fire history data. U.S. Forest Service, Intermountain Research Station. General Technical Report INT-GTR-370. 17 pp.

Bastasch, R. 1998. Waters of Oregon. A source book on Oregon's water and water management. Oregon State University Press, Corvallis, OR.

Beschta, R. L., R. E. Bilby, G. W. Brown, L. B. Holtby, and T. J. D. Hofstra. 1987. Pages 191-232 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fishery interactions. College of Forest Resources, University of Washington, Seattle, WA.

Bilby, R. E., and J. W. Ward. 1991. Large woody debris characteristics and function in streams draining old growth, clear-cut, and second-growth forests in southwestern Washington. Canadian Journal of Fisheries and Aquatic Sciences 48:2499-2508.

Booth, E.S. 1947. Systematic Review of the Land Mammals of Washington. Ph.D. Diss., State Coll. Wash. (WSU), Pullman, WA.

Braun, C. E. 1994. Band-tailed pigeon. Pages 60-74 *in* T.C. Tacha and C. E. Braun, editors. Migratory shore and upland game bird management in North America. International Association of Fish and Wildlife Agencies, Washington, D.C., USA.

Brodie, E.D., Jr. 1970. Western salamanders of the genus *Plethodon*, systematics and geographic variation. Herpetologica 26:468-516.

Browning, M. R. 1994. A taxonomic review of *Dendroica petechia* (Yellow Warbler; Aves; Parulinae). Proc. Biol. Soc. Wash. 107:27-51

Bryant, F.G. 1949. A survey of the Columbia River and its tributaries with special reference to its fishery resources--Part II Washington streams from the mouth of the Columbia to and including the Klickitat River (Area I). U.S. Fish and Wildlife Service (USFWS). Special Science Report 62:110.

Bureau of Commercial Fisheries. 1970. Contribution of Columbia River hatcheries to harvest of 1962 brood fall Chinook salmon (*Oncorhynchus tshawytscha*). Bureau of Commercial Fisheries, Portland, OR.

Bury, R. B. 1972. Habits and home range of the Pacific pond turtle, *Clemmys marmorata*, in a stream community. Ph.D Diss., Univ. Calif., Berkeley.

Campbell, R. W., Dawe, N. K., McTaggart-Cowan, I., Cooper, J. M., Kaiser, G. W., Stewart, A. C., and McNall, M.C. E. 2001. The Birds of British Columbia, vol. 4. Univ. Br. Columbia Press, Vancouver, B.C.

Chappell, C. B. and J. K. Agee. 1996. Fire severity and tree seedling establishment in *Abies magnifica* forests, southern Cascades, Oregon. Ecological Applications 6:628-640.

Cochran, P. H. 1985. Soils and productivity of lodgepole pine. *in* D. M. Baumgartner, R. G. Krebill, J. T. Arnott, and G. F. Gordon, editors. Lodgepole pine: the species and its management: symposium proceedings, Washington State University, Cooperative Extension, Pullman, WA.

Cole, D. N. 1977. Man's impact on wilderness vegetation: an example from Eagle Cap Wilderness, NE Oregon. Ph.D. Dissertation. University of Oregon, Eugene, OR.

Corkran, C.C. and C. Thoms. 1996. Amphibians of Oregon, Washington, and British Columbia. Lone Pine Publishing, Edmonton, Alta, Canada. 175p.

Cross, S.P. 1969. Behavioural aspects of western gray squirrel ecology. Ph.D. Dissertation. University of Arizona, Tucson, AZ.

Curtis, P. D., and C. E. Braun. 1983. Radio telemetry location of nesting band-tailed pigeons (*Columba fasciata*) in Colorado, USA. Wilson Bulletin 95:464-466.

Dickman, A., and S. Cook. 1989. Fire and fungus in a mountain hemlock forest. Canadian Journal of Botany 67(7):2005-2016.

Dumas, P.C. 1956. The ecological relations of sympatry in *Plethodon dunni* and *Plethodon vehiculum*. Ecology 37:484-495.

Edwards, O. M. 1980. The alpine vegetation of Mount Rainier National Park: structure, development, and constraints. Ph.D. Dissertation. University of Washington, Seattle, WA. 280 pp.

Eisner, S.A. 1991. Bald eagles wintering along the Columbia River in southcentral Washington: factors influencing distribution and characteristics of perch and roost trees. M.S. Thesis, Univ. Montana, Missoula. 58 pp.

Everest, F. H. 1987. Salmonids of western forested watersheds. Pages 3-38 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fishery interactions. College of Forest Resources, University of Washington, Seattle, WA.

Everest, F. H., R. L. Beschta, J. C. Scrivener, K. V. Koski, J. R. Sedell, and C. J. Cederholm. 1987. Fine sediments and salmonid production: a paradox. Pages 98-142 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fishery interactions. College of Forest Resources, University of Washington, Seattle.

Ewart, M. A. D. R. Jackson, and C. E. Nelson. 1994. Patterns of temperature-dependent sex determination in turtles. Journal of Experimental Zool. 270:3-15.

Fiscus, H. 1991. 1990 chum escapement to Columbia River tributaries. Washington Department of Fisheries (WDF).

Fonda, R. W. 1974. Forest succession in relation to river terrace development in Olympic National Park, Washington. Ecology 55:927-942.

Foster, S.A. 1992. Studies of ecological factors that affect the population and distribution of the western gray squirrel in northcentral Oregon.

Frankel, O.H., and M.E. Soulé. 1981. Conservation and Evolution. Cambridge Univ. Press, London.

Franklin, J. F. 1988. Pacific Northwest forests. Pages 104-130 *in* M. G. Barbour and W. D. Billings, editors. North American terrestrial vegetation. Cambridge University Press, New York, NY. 434 pp.

Franklin, J. F., and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S. Pacific Northwest Forest and Range Experiment Station, General Technical Report. PNW-8, Portland, OR. 417 pp.

Franklin, J. F., K. Cromack, Jr., W. Denison, A. McKee, C. Maser, J. Sedell, F. Swanson, and G. Juday. 1981. Ecological characteristics of old-growth Douglas-fir forests. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station. General Technical Report PNW-118. Portland, OR. 48 pp.

Frey, D. G., editor. 1966. Limnology in North America. The University of Wisconsin Press, Madison, Wisconsin.

Furniss, M. J., T. D. Roeloggs, and C. S. Yee. 1991. Road construction and maintenance. Pages 297-323 *in* W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication No. 19, Bethesda, Maryland.

Gerrard, J. M., and G. R. Bortolotti. 1988. The bald eagle: haunts and habits of a wilderness monarch. Smithsonian Institution Press, Washington and London. 177 pp.

Gilligan, J., M. Smith, D. Rogers and A. Contreras. 1994. Birds or Oregon: status and distribution. Cinclus Pubs.

Gilman, K.N. 1986. The Western Gray Squirrel (*Sciurus griseus*): Its Summer Home Range, Activity Times, and Habitat Usage in Northern California. M.S. Thesis, California State Univ., Sacramento, CA.

Gordon, D. T. 1970. Natural regeneration of white and red fir: influence of several factors. U.S. Forest Service, Research Paper PSW-90.

Grant, S., J. Hard, R. Iwamoto, R., O. Johnson, R. Kope, C. Mahnken, M. Schiewe, W. Waknitz, R. Waples, J. Williams. 1999. Status review update for chum salmon from Hood Canal summer-run and Columbia River ESU's. National Marine Fisheries Service (NMFS).

Gray, E. 1995. DNA fingerprinting reveals lack of genetic variation in northern populations of the western pond turtle (*Clemmys marmorata*). Conserv. Biol. 9:1244-1255.

Greenberg, J., and K. Callahan. 2003. WRIA 29 Water Rights and Water Use Assessment. Prepared by Watershed Professionals Network for Envirovision Corp. & WRIA 29 Planning Unit. Bellingham, WA.

Haeussler, S., and D. Coates. 1986. Autecological characteristics of selected species that compete with conifers in British Columbia: a literature review. Land Management Report No. 33. Ministry of Forests, Information Services Branch, Victoria, British Columbia, Canada. 180 pp.

Halpern, C. B. 1989. Early successional patterns of forest species: interactions of life history traits and disturbance. Ecology 70:704-720.

Halverson, N. M., and W. H. Emmingham. 1982. Reforestation in the Cascades Pacific silver fir zone: a survey of sites and management experiences on the Gifford Pinchot, Mt. Hood and Willamette National Forests. U.S. Forest Service. R6-ECOL-091-1982. 37 pp.

Hare, S.R., N.J. Mantua and R.C. Francis. 1999. Inverse production regimes: Alaska and West Coast Pacific salmon. Fisheries 24(1):6-14.

Harlan, K. 1999. Washington Columbia River and tributary stream survey sampling results, 1998. Washington Department of fish and Wildlife (WDFW). Columbia River Progress Report 99-15, Vancouver, WA.

Harr, R. D., and B. A. Coffin. 1992. Influence of timber harvest on rain-on-snow runoff: a mechanism for cumulative watershed effects. Pages 455-469 *in* M. E. Jones and A. Laemon, editors. Interdisciplinary approaches in hydrology and hydrogeology. American Institute of Hydrology. Minneapolis. 618 pp.

Haskell, A., T. E. Graham, C. R. Griffin, and J. B. Hestbeck. 1996. Size related survival of headstarted redbelly turtles (*Pseudemys rubriventris*) in Massachusetts. Journal of Herpetology 30:524-527.

Haufler, J. 2002. Planning for species viability: Time to shift from a species focus. Presented at the Northwestern Section Meeting: The Wildlife Society. Spokane, WA.

Hays, D.W., K.R. McAllister, S.A. Richardson, D.W. Stinson. 1999. Washington State recovery plan for the western pond turtle. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia.

Heinemeyer, K. S. 1995. Conservation assessment for fisher (*Martes pennanti*) in Idaho (DRAFT). Forest Carnivore HCA/S. p 28-70.

Heinemeyer, K. S. and J. L. Jones. 1994. Fisher biology and management in the western United States: a review and adaptive management strategy. USDA Forest Service Northern Region, Missoula, MT. 108 pp.

Hemstrom, M.A. and J. F. Franklin. 1982. Fire and other disturbances of the forests in Mount Rainier National Park. Quaternary Research 18:32-51.

Henderson, J. A., D. A. Peter, R. Lesher, and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest. U.S. Forest Service Publication R6-ECOL-TP 001-88. 502 pp.

Herrington, R.E. and J.H. Larsen. 1985. Current status, habitat requirements and management of the Larch Mountain salamander, *Plethodon larselli* Burns. Biol. Conserv. 34:169-179.

Holland. D.C. 1991. Status and reproductive dynamics of a population of western pond turtles (*Clemmys marmorata*) in Klickitat County, Washington in 1990. Unpubl. Rep. Wash. Dept. Wildl., Olympia.

Holland. D.C. 1992. Level and pattern in morphological variation: a phylogeographic study of the western pond turtle (*Clemmys marmorata*). Ph.D. Diss., Univ. Southwest. La., Lafayette.

Hopley, C. Jr. 1980. Cowlitz spring Chinook rearing density study. Washington Department of Fisheries (WDF), Salmon Culture Division.

Hunt, W. G., B. S. Johnson, and R. E. Jackman. 1992. Carrying capacity for bald eagles wintering along a northwestern river. J. Raptor Research 26:49-60.

Hutto, R.L. and J.S. Young. 1999. Habitat relationships of landbirds in the Northern Region, USDA Forest Service. USDA Forest Service General Technical Report RMRS-GTR-32.

Hymer, J. 1993. Estimating the natural spawning chum population in the Grays River Basin, 1944-1991. Washington Department of Fisheries (WDF), Columbia River Laboratory Progress Report 93-17, Battle Ground, WA.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids, Volume III: Washington subbasins below McNary Dam. Bonneville Power Administration (BPA), Portland, OR.

Ingles, L.G. 1947. Ecology and life history of the Califormia gray squirrel. California Fish and Game Bulletin. 33:139-157.

Interactive Biodiversity Information System (IBIS). 2004. Website Address: www.nwhi.org/ibis/home/ibis.asp.

Jarvis, R. L., and M. F. Passmore. 1977. Band-tailed pigeon investigations in Oregon, an overview. Upland Game Bird Commission, Oregon State University, Corvallis, Oregon, USA.

Jarvis, R. L., and M. F. Passmore. 1992. Ecology of band-tailed pigeons in Oregon. Biological Report, 6, U.S. Fish and Wildlife Service, Washington, D.C.

Jeffrey, R. G. 1977. Band-tailed pigeon (*Columba fasciata*). Pages 210-245 *in* G. C. Sanderson, editor. Management of migratory shore and upland game birds in North America. International Association of Fish and Wildlife Agencies, Washington, D.C.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State Univ. Press, Corvallis, OR.

Keller, K. 1999. 1998 Columbia River chum return. Washington Department of Fish and Wildlife (WDFW), Columbia River Progress Report 99-8, Vancouver, WA.

Keppie, D. M., and C.E. Braun. 2000. Band-tailed pigeon (*Columba fasciata*). Number 530 *in* A Poole and F. Gill, editors. Birds of North America, Incorporated, Philadelphia, Pennsylvania, USA.

Knight, R. L., R. C. Friesz, G. T. Allen, and P. J. Randolph. 1981. A summary of the mid-winter bald eagle survey in Washington. Washington Dept. of Game, Olympia. 74 pp.

Knight, R. L., and D. P. Anderson. 1990. Effects of supplemental feeding on an avian scavenging guild. Wildlife Society Bull. 18:388-394.

Knight, R. L., D. P. Anderson, and N. V. Marr. 1991. Reponses of an avian scavenging guild to anglers. Biological Conservation 56(1991):195-205.

Knight, R. L., P. J. Randolph, G. T. Allen, L. S. Young, and R. J. Wigen. 1990. Diets of nesting bald eagles, *Haliaeetus leucocephalus*, in western Washington. Canadian Field-Naturalist 104:545-551.

Knutson, K. L., and V. L. Naef. 1997. Priority habitat management recommendations: riparian. Washington Department of Fish and Wildlife, Olympia, WA.

Kunze, L. M. 1994. Preliminary classification of native, low elevation, freshwater wetland vegetation in western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 120 pp.

Kuramoto, R. T., and L. C. Bliss. 1970. Ecology of subalpine meadows in the Olympic Mountains, Washington. Ecological Monograph 40:317-347.

Landis, W. G. and T. A. Storch. 1991. Limnological and toxicological evaluation of the habitat of the western pond turtle. Inst. Env. Toxic. and Chemistry, Unpubl. Rep. 59 pp.

Larsen, E.M., editor. 1997. Management recommendations for Washington's priority species, Volume III: Amphibians and Reptiles. Washington Department of Fish and Wildlife, Olympia, WA. 122p.

Larsen, E.M., J.M. Azerrad, and N. Nordstrom, editors. 2004. Management recommendations for Washington's priority species, Volume IV: Birds. Washington Department of Fish and Wildlife, Olympia, WA.

Larsen, E.M., and J.T. Morgan. 1998. Management recommendations for Washington's priority habitats: Oregon white oak woodlands. Wash. Dept. Fish and Wildl., Olympia, WA.

Larsen, J.H. and D.L. Schaub. 1982. Distribution and abundance of the Larch Mountain salamander (*Plethodon larselli* Burns). Unpublished Report, Washington Department of Wildlife, Olympia. 35p.

Lawson, P.W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8):6-10.

LeFleur, C. 1987. Columbia River and tributary stream sruvey sampling results, 1986. Washington Department of Fisheries (WDF), Progress Report 87-8, Battle Ground, WA.

LeFleur, C. 1988. Columbia River and tributary stream survey sampling results, 1987. Washington Department of Fisheries (WDF), Progress Report, 88-17, Battle Ground, WA.

Leider, S. 1997. Status of sea-run cutthroat trout in Washington. Oregon Chapter, American Fisheries Society. In: J.D. Hall, P.A. Bisson, and R.E. Gresswell (eds) Sea-run cutthroat trout: biology, management, and future conservation. pp. 68-76. Corvallis, OR.

Leonard, W.P., Brown, H.A., Jones, L.C., McAllister, K.R., and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, WA. 168p.

Lewis, J.C. and D.W. Stinson. 1998. Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia.

Linders, M.J. 2000. Spatial ecology of the western gray squirrel in Washington: The interaction of season, habitat and home range. M.S. Thesis. Univ. of Washington, Seattle, WA.

Lisle, T., A. Lehre, H. Martinson, D. Meyer, K. Nolan, R. Smith. 1982. Stream channel adjustments after the 1980 Mount St. Helens eruptions Proceedings of a symposium on erosion control in volcanic areas. Proceedings of a symposium on erosion control in volcanic areas. Seattle, WA.

Lower Columbia Fish Recovery Board (LCFRB) 2001. Level 1 Watershed Technical Assessment for WRIAs 25 and 26. Prepared by Economic and Engineering Services for the LCFRB. Longview, Washington.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Salmon-Washougal and Lewis Rivers Watershed Planning - WRIAs 27 and 28. Watershed Management Plan September 2004 DRAFT.

Lowther, P. E., Celada, C., Klein, N. K., Rimmer, C. C., and Spector, D. A. 1999. Yellow Warbler, in The Birds of North America (A. Poole and F. Gill, eds.), no. 454. Birds N. Am., Philadelphia.

Lunetta, R.S., B.L. Consentino, D.R. Montgomery, E.M. Beamer and T.J. Beechie. 1997. GIS-Based Evaluation of Salmon Habitat in the Pacific Northwest. Photogram. Eng. & Rem. Sens. 63(10):1219-1229.

Mac, M. J., P. A. Opler, C. E. Puckett Haecker, and P. D. Doran. 1998. Status and trends of the nation's biological resources. Volume 1. U.S. Department of the Interior, U. S. Geological Survey, Reston, Virginia. 436 pp.

Mahaffy, M.S., K. M. Ament, A.K. McMillan, and D. E. Tillit. 2001. Environmental contaminants in bald eagles nesting in Hood Canal, Washington, 1992-1997. Final Report, Study: 13410-1130-1F05, U. S. Fish and Wildlife Service, Olympia, Washington.

March, G. L., and R. M. F. S. Sadleir. 1975. Studies on the band-tailed pigeon (*Columba fasciata*) in British Columbia: seasonal changes in body weight and calcium distribution. Physiological Zoology 48:49-56.

Marcot, B.G., W.E. McConnaha, P.H. Whitney, T.A. O'Neil, P.J. Paquet, L. Mobrand, G.R. Blair, L.C. Lestelle, K.M. Malone and K.E. Jenkins. 2002. A multi-species framework approach for the Columbia River Basin

Marriott, D. et. al. 2002. Lower Columbia River and Columbia River Estuary Subbasin Summary. Northwest Power Planning Council.

Martell, M., P. Redig, J. Nibe, G. Buhl. 1991. Survival of released rehabilitated bald eagles: final report. The Raptor Center, University of Minnesota. 21 pp.

McAllister, K. R., T. E. Owens, L. Leschner, and E. Cummins. 1986. Distribution and productivity of nesting bald eagles in Washington, 1981-1985. Murrelet 67:45-50.

McAllister, K.R. 1995. Distribution of amphibians and reptiles in Washington State. Northwest Fauna 3:81-112.

McAllister, K.R. and W.P. Leonard. 1997. Washington State status report for the Oregon spotted frog. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia.

McGarigal, K., R. G. Anthony, F. B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildlife Monograph 115:1-47.

McKinnell, S.M., C.C. Wood, D.T. Rutherford, K.D. Hyatt and D.W. Welch. 2001. The demise of Owikeno Lake sockeye salmon. North American Journal of Fisheries Management 21:774-791.

Mikkelsen, N. 1991. Escapement reports for Columbia Rive hatcheries, all species, from 1960-1990. Washington Department of Fisheries (WDF).

Miller, H.A. 1985. Oregon white oak. Pages 275-278 in H. A. Miller and S. H. Lamb., eds. Oaks of North America. Naturegraph Publ., Happy Camp, CA.

Milner, R. 1986. Status of the western pond turtle (*Clemmys marmorata*) in northwestern Washington, 1986. Unpubl. Rep. Wash. Dept. Game, Olympia.

Morrison, P., and F. J. Swanson. 1990. Fire history and pattern in a Cascade Range landscape. U.S. Forest Service General Technical Report PNW-GTR-254.

Naiman, R. J., H. Decamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. Ecological Applications 3:209-212.

National Research Council (NRC). 1992. Restoration of aquatic systems. National Academy Press, Washington, D.C., USA.

National Research Council (NRC). 1996. Upstream: Salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.

Nordby, J. C. 1992. Inventory survey of the western pond turtle (*Clemmys marmorata*) in Washington, 1992. Center for Wildl. Conserv., Seattle, Wash. 36pp.

Noss, R.F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. Biological Report 28. U.S. Department of the Interior, National Biological Service, Washington D.C.

Nussbaum, R.A., Brodie, E.D., Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow. 332 p.

Oliver, C. D. 1981. Forest development in North America following major disturbances. Forest Ecology and Management 3:153-168.

Oregon Department of Forestry (ODF). 1994. Water protection rules: purpose, goals, classification, and riparian management. OAR No.629-635-200-Water classification. Oregon Department of Forestry, Salem, OR.

Pacific Flyway Council. 1983. Pacific Coast band-tailed pigeon management plan. U.S. Fish and Wildlife Service, Portland, Oregon, USA.

Parson, W. 1994. Relationships between human activities and nesting bald eagles in western Washington. Northwestern Naturalist 75:44-53.

Petit, D.R., K.E. Petit, and L.J. Petit. 1990. Geographic variation in foraging ecology of North American insectivorous birds. Studies in Avian Biology 13:254-263.

Phinney, L. A., and P. Bucknell. 1975. A catalog of Washington streams and salmon utilization. Washington Department of Fisheries. Volume 2: coastal region.

Pyper, B.J., F.J. Mueter, R.M. Peterman, D.J. Blackbourn and C.C. Wood. 2001. Spatial convariation in survival rates of Northeast Pacific pink salmon (*Oncorhynchus gorbuscha*). Canadian Journal of Fisheries and Aquatic Sciences 58:1501-1515.

Quigley, T. M., and S. J. Arbelbide, technical editors. 1997. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Volume 2. U.S. Forest Service General Technical Report PNW-GTR-405.

Rawding, D. 2000. Draft Little White Salmon River subbasin summary. Prepared for the Northwest Power Planning Council.

Rodrick, E.A. 1986. Survey of historic habitats of the western gray squirrel (*Sciurus griseus*) in the southern Puget Trough and Klickitat County, WA. Unpubl. report to Washington Dept. of Wildlife, Olympia, WA.

Roni, P., T.J. Beechie, R.E. Bilby, F.E. Leonetti, M.M. Pollock and G.R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest Watersheds. North American Journal of Fisheries Management 22:1-20. American Fisheries Society.

Rothfus, L.O., W.D. Ward, E. Jewell. 1957. Grays River steelhead trout population study, December 1955 through April 1956. Washington Department of Fisheries (WDF).

Ruediger, B. 1994. Wolverine, Lynx and Fisher Habitat and Distribution Maps, Draft Hierarchical Approach and Draft Conservation Strategies (unpublished memo with attachments, 14 Sep 1994). Western Forest Carnivore Committee, USDA Forest Service.

Ruggiero, L. F., K. B. Aubry, S. W. Buskirk, L. Jack Lyon, and W. J. Zielinski, eds. 1994. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Gen. Tech. Rep. RM-254. Fort Collins, CO: U. S. Dept. Agric., Rocky Mountain For. and Range Exp. Sta. 183 pp.

Ruth, R. H. 1974. Regeneration and growth of west-side mixed conifers. *In* O. P. Camer, editor. Environmental effects of forest residues in the Pacific Northwest: a state-of- knowledge compendium. U.S. Forest Service General Technical Report PNW-24.

Sauer, J. R., Hines, J. E., and Fallon, J. 2003. The North American Breeding Bird Survey, results and analysis 1966–2002, version 2003.1. USGS Patuxent Wildl. Res. Ctr., Laurel, MD. Available at www.mbr-pwrc.usgs.gov/bbs/bbs.html.

Schroeder, R. L. 1982. Habitat suitability index models: Yellow Warbler. Office Biol. Serv., U.S.F.&W.S., Washington, D.C.

Scott, J. M. 1995a. Western pond turtle surveys in Klickitat County, 1984-1994. Unpubl. Rep. Washington Department of Fish and Wildlife, Olympia. 11 pp.

Scott, J. M. 1995b. Western pond turtle surveys in Skamania County, 1984-1994. Unpubl. Rep. Washington Department of Fish and Wildlife, Olympia. 13 pp.

Sibley, D. A., C. Elphick and J. B. Dunning. 2001. The Sibley guide to bird life and behavior. Knopf, New York, New York, USA.

Slavens, K. 1992. Report on the western pond turtle 1991. Unpubl. Rep. Wash. Dept. Wildl., Olympia. 5 pp.

Slavens, K. 1995. The status of the western pond turtle in Klickitat County, including notes on the 1995 survey of Lake Washington, King County. Unpubl. Rep. on file at WDFW. 25 pp.

Solomon, S., and T. Newlon. 1991. Living with Eagles: status report and recommendations. Northwest Renewable Resource Center. 48 pp.

Spies, T. A., J. F. Franklin, and T. B. Thomas. 1988. Coarse woody debris in Douglas-fir forests of western Oregon and Washington. Ecology 69:1689-1702.

Stalmaster, M. V. 1987. The Bald Eagle. Universe Books. New York. 227 pp.

Stalmaster, M. V. and J. L. Kaiser. 1997. Flushing responses of wintering bald eagles to military activity. J. of Wildlife Management 61:1307-1313.

Stalmaster, M. V. and J. L. Kaiser. 1998. Effects of recreational activity on wintering bald eagles. Wildlife Monograph 137.

Stauffer, D. F., and L. B. Best. 1980. Habitat selection of birds of riparian communities: Evaluating effects of habitat alternations. J. Wildl. Manage. 44(1):1-15.

Stinson, D.W., J.W. Watson, and K.R. McAllister. 2001. Washington State status report for the bald eagle. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia.

Strickler, G. S. and W. B. Hall. 1980. The Standley allotment: a history of range recovery. U.S. Forest Service, Forest and Range Experiment Station Research Paper, PNW-278. 35 pp.

Stringer, A. B. 1992. Western pond turtle (*Clemmys marmorata*) project 1992, Fort Lewis, Washington. Unpubl. Rep. Coll. For. Resour., Univ. Wash., Seattle. 26 pp.

Sullivan, K., T. E. Lidle, C. A. Dolloff, G. E. Grant, and L. M. Reid. 1987. Stream Channels: the link between forest and fishes. Pages 39-97 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fishery interactions. College of Forest Resources. University of Washington, Seattle, WA.

Swanson, F. J. and C. T. Dyrness. 1975. Impact of clearcutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology 3:393-396.

Swanson, F. J., L. E. Benda, S. H. Duncan, G. E. Grant, W. F. Megaham, L. M. Reid, and R. R. Zeimer. 1987. Mass failures and other processes of sediment production in Pacific Northwest forest landscapes. Pages 9-38 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fisheries interactions. College of Forest Resources Contribution No. 57, University of Washington, Seattle, WA.

Swanson, F. J., R. L. Fredriksen, and F. M. McCorison. 1982. Material transfer in a western Oregon forested watershed. Pages 223-266 *in* R. L. Edmonds, editor. Analysis of coniferous forest ecosystems in the western United States. Hutchinson Ross, Stroudsburg, Pennsylvania.

Taylor, R. H. 1989. Washington State Midwinter Bald Eagle Survey Results for 1989. Washington Dept. of Fish and Wildlife, Olympia, WA. 31 pp.

Tracy, H.B., C.E. Stockley. 1967. 1966 Report of Lower Columbia River tributary fall Chinook salmon stream population study. Washington Department of Fisheries (WDF).

USFS. 1995. Little White Salmon Watershed Analysis. Gifford Pinchot National Forest – Mount Adams Ranger District. Trout Lake, WA.

Wade, G. 2001. Salmon and Steelhead habitat Limiting Factors, Water Resource Inventory Area 25. Washington State Conservation Commission. Water Resource Inventory Area 25.

Wahle, R.J., A.H. Arp, A.H., S.K. Olhausen. 1972. Contribution of Columbia River hatcheries to harvest of 1964 brood fall Chinook salmon (*Oncorhynchus tshawytscha*). National Marine Fisheries Service (NMFS), Economic Feasibility Report Vol:2, Portland, OR.

Wahle, R.J., R.R. Vreeland, R.H. Lander. 1973. Bioeconomic contribution of Columbia River hatchery coho salmon, 1965 and 1966 broods, to the Pacific salmon fisheries. National Marine Fisheries Service (NMFS), Portland, OR.

Wahle, R.J., R.R. Vreeland, R.H. Lander. 1974. Bioeconomic contribution of Columbia River hatchery coho salmon, 1965 and 1966 broods, to the Pacific Salmon Fisheries. Fishery Bulletin 72(1).

Wahle, R.J., R.R. Vreeland. 1978. Bioeconomic contribution of Columbia River hatchery fall Chinook salmon, 1961 through 1964. National Marine Fisheries Service (NMFS). Fishery Bulletin 1978(1).

Washington Conservation Commission (WCC). 1999. Salmon and steelhead habitat limiting factors in WRIA 29.

Washington Department of Ecology (WDOE). 1994. Inventory of dams. Washington Department of Ecology, Water Resources Program, Dam Safety Section. Publication No.9

Washington Department of Ecology (WDOE). 1998. Final 1998 List of Threatened and Impaired Water Bodies - Section 303(d) list. Ecology Water Quality Program. Olympia, WA.

Washington Department of Ecology (WDOE) 2004. 2002/2004. Draft 303(d) List of threatened and impaired water bodies .

Washington Department of Fish and Wildlife (WDFW). 1996. Lower Columbia River WDFW hatchery records. Washington Department of Fish and Wildlife (WDFW).

Washington Department of Fish and Wildlife (WDFW). 1997. Preliminary stock status update for steelhead in the Lower Columbia River. Washington Department of Fish and Wildlife (WDFW), Vancouver, WA.

Washington Department of Fish and Wildlife (WDFW). 2001. 2001 Game status and trend report. Wildlife Program, Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Washington Department of Fish and Wildlife (WDFW). 2002. News release, June 10, 2002. Olympia, Washington, USA.

Washington Department of Fish and Wildlife (WDFW). 2004. Surveys for Western Gray Squirrel nests on sites harvested under approved forest practice guidelines. Wildlife Research Report, Olympia, WA.

Washington Department of Wildlife (WDW). 1993. Status of the western gray squirrel (Sciuris griseus) in Washington. Unpublished report. Olympia, WA.

Washington Department of Wildlife (WDW). 1990. Salmon and steelhead production plan. Little White Salmon River Subbasin.

Waterbury, B. 2000. An analysis of Washington State management plans for the bald eagle. Washington Dept. of Fish and Wildlife, Olympia, WA. unpublished report. 16 pp.

Watson, J. W., and D. J. Pierce. 1998a. Ecology of bald eagles in western Washington with an emphasis on the effects of human activity. Final Report. Washington Dept. of Fish and Wildlife, Olympia, WA.

Watson, J. W., and D. J. Pierce. 1998b. Migration, diets, and home ranges of bald eagles breeding along Hood Canal and at Indian Island, Washington. Final Report. Washington Dept. of Fish and Wildlife, Olympia, WA.

Watson, J. W., and D. J. Pierce. 2001. Skagit River Bald Eagles: movements, origins, and breeding population status. Final Report. Washington Dept. of Fish and Wildlife, Olympia, Washington. 80 pp.

Watson, J. W., M. G. Garrett, and R. G. Anthony. 1991. Foraging ecology of bald eagles in the Columbia River estuary. J. Wildlife Management 55(3):492-499.

Welch, K.F., M.Yinger and K. Callahan. 2002. WRIA 29 – Hydrology and Geology Assessment – Review Draft. Prepared for Envirovision Corp. and WRIA 29 Planning Unit.

Wendler, H.O., E.H. LeMier, L.O. Rothfus, E.L. Preston, W.D. Ward, R.E. Birtchet. 1956. Columbia River Progress Report, January through April, 1956. Washington Department of Fisheries (WDF).

Western Regional Climate Center (WRCC). 2003. National Oceanic and Atmospheric Organization - National Climatic Data Center. URL: http://www.wrcc.dri.edu/index.html.

Whittier, T. R., R. M. Hughes, and D. P. Larsen. 1988. Correspondence between ecoregions and spatial patterns in stream ecosystems in Oregon. Canadian Journal of Fisheries and Aquatic Sciences 45:1264-1278.

Williams, C. K., B. F. Kelley, B. G. Smith, and T. R. Lillybridge. 1995. Forested plant associations of the Colville National Forest. U.S. Forest Service General Technical Report PNW-GTR-360. Portland, OR. 140 pp.

Williams, R. W., R. M. Laramie, and J. J. Ames. 1975. A catalog of Washington streams and salmon utilization. Washington Department of Fisheries. Volume 1: Puget Sound Region.

Winward, A. H. 1970. Taxonomic and ecological relationships of the big sagebrush complex in Idaho. Ph.D. Dissertation. University of Idaho, Moscow. 90 pp.

Wisdom, M.J., B.C. Wales, R.S. Holthausen, C. D. Hargis, V. A. Saab, W. J. Hann, T. D. Rich, D. C. Lee and M. M. Rowland 1999. Wildlife habitats in forests of the Interior Northwest: history, status, trends and critical issues confronting land managers. Trans, 64th No. Am. Wildl. and Natur. Resour. Conf.

Wolcott, E. E. 1973a. Lakes of Washington. Water Supply. State of Washington, Department of Conservation, Bulletin No. 14. Volume 1: Western Washington. Olympia, WA.

Wolcott, E. E. 1973b. Lakes of Washington. Water Supply. State of Washington, Department of Conservation, Bulletin No. 14. Volume 2: Eastern Washington. Olympia, WA.

Woodard, B. 1997. Columbia River Tributary sport Harvest for 1994 and 1995. Washington Department of Fish and Wildlife (WDFW), Battle Ground, WA.

Worlund, D.D., R.J. Wahle, P.D. Zimmer. 1969. Contribution of Columbia River hatcheries to harvest of fall Chinook salmon (*Oncorhynchus tshawytscha*). Fishery Bulletin 67(2).

Zack, A. C., and P. Morgan. 1994. Early succession on hemlock habitat types in northern Idaho. Pages 71-84 *in* D. M. Baumgartner, J. E. Lotan, and J. R. Tonn, editors. Interior cedar-hemlock-white pine forests: ecology and management. Cooperative Extension Program, Washington State University, Seattle, WA.

Zielinski, W. J. and T. E. Kucera. 1995. American marten, fisher, lynx, and wolverine: survey methods for their detection. USDA Forest Service, Gen. Tech. Rep. PSW-GTR-157. 164 pp.

Ziemer, R. R. 1981. Roots and the stability of forested slopes. Pages 343-361 *in* Proceedings of a symposium on erosion and sediment transport in Pacific Rim steeplands. Publication 132. International Association of Hydrological Scientists. Washington, D.C.

Zimmerman, T. 1986. A study of two western pond turtle populations *Clemmys marmorata* in Washington, 1986. Unpubl. Rep. Wash. Dept. Game, Olympia.